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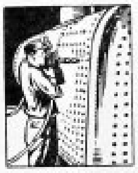
The Boiler Maker

Reg. U. S. Pat. Off.



Annual Locomotive Inspection Report

The decrease of 46.1 percent in the number of crown sheet failures during the fiscal year 1932 as compared with the previous year, as noted in the annual report of the Bureau of Locomotive Inspection, is highly commendable. This showing was undoubtedly partially due to the decrease in locomotive miles but, nevertheless, it was made in the face of stringent economies in the maintenance department.

The low record in boiler failures was accompanied by a decrease of 46.6 percent in the number of persons killed and of 75 percent in the number of persons injured from explosions.

In looking ahead to the future, A. G. Pack, chief inspector of the bureau, sounds a warning to the railroads that in order to keep the gains made and still further to improve the record, inspectors and shop staffs must more than ever be painstaking in carrying out their duties.

The problems that confront the maintenance department are difficult no matter how the tide turns in general conditions. If, as seems unlikely, the period of depression continues at the present low point, then more drastic operating economies must be enforced which will react against the condition of motive power. On the other hand, if the improvement in railroad earnings continues to gain, as it has in the past four months, and general business is actually on the up-turn, shops will increasingly be called on to meet rush schedules for repairs to put the motive power of the country in serviceable condition to meet an increasing demand in traffic. In any case, the shops and their staffs will have to carry the responsibility for the safe condition of every locomotive that is put on the road.

Railroad Prospects

The last months of the past year gave substantial proof that a real improvement in the financial condition of the railroads was under way.

During the first eight months of the year the net operating income was only $152,300,000 or about $19,000,000 a month. In September it was $49,647,000 and in October $63,840,000. In November the net earnings were about $34,000,000 which is a marked drop over the previous months' earnings, but practically the same as for the month of October, 1931.

Car loadings for July, 1932, averaged 447,862 per week. In August a gain over this figure occurred of 7.8 percent; in September the gain was 17.4 percent; in October 32.2 percent and in November 14.8 percent. For the first three weeks of December the average gain per week over the July average was 10.6 percent. The gains for this period of the year have been far greater than in corresponding periods from 1925 to 1931, which indicates there has been a real element of basic recovery in addition to ordinary seasonal gains.

These facts, combined with the decline in the number of serviceable locomotives given in the December issue should indicate that vital changes in maintenance policy must soon occur. If the railroad plant of the country is to continue as the major transportation arm of industry, then inevitably adequate shop operations are necessary to maintain the motive power of the railroads. With increasing revenue available the point is bound to come at which an increased proportion of this revenue must be expended on essential maintenance work.

With prospects that the trend actually is upward, however slow it may be, expenditures can be made with assurance that additional revenue will follow. The one significant indication that this trend is actually under way is the fact that for 35 months from October 1, 1929, to September 1, 1932, traffic steadily declined as well as net return to the railroads. Since September the upward movement in both traffic and revenue has been steadily improving.

Equipment and Personnel

Any appreciable demand for locomotive maintenance will tax shop facilities and personnel that have for so long been organized on a hand to mouth basis. It is time to plan and organize for the upswing. Tools and equipment must be in serviceable condition. Many of the wastes in shop management that grew into being during the rush of production in past years should forever be rectified by the development of simple and usable systems. Waste in material handling can be overcome by consideration of the problems peculiar to any plant layout.

Above all, thought should be given to personnel, and when work again gets under way in measurable quantities employment should be stabilized on a basis that will give assurance of security.

This period can be used to reorganize not only the physical establishment of the railroads, but the conditions under which the personnel can live and work as well.

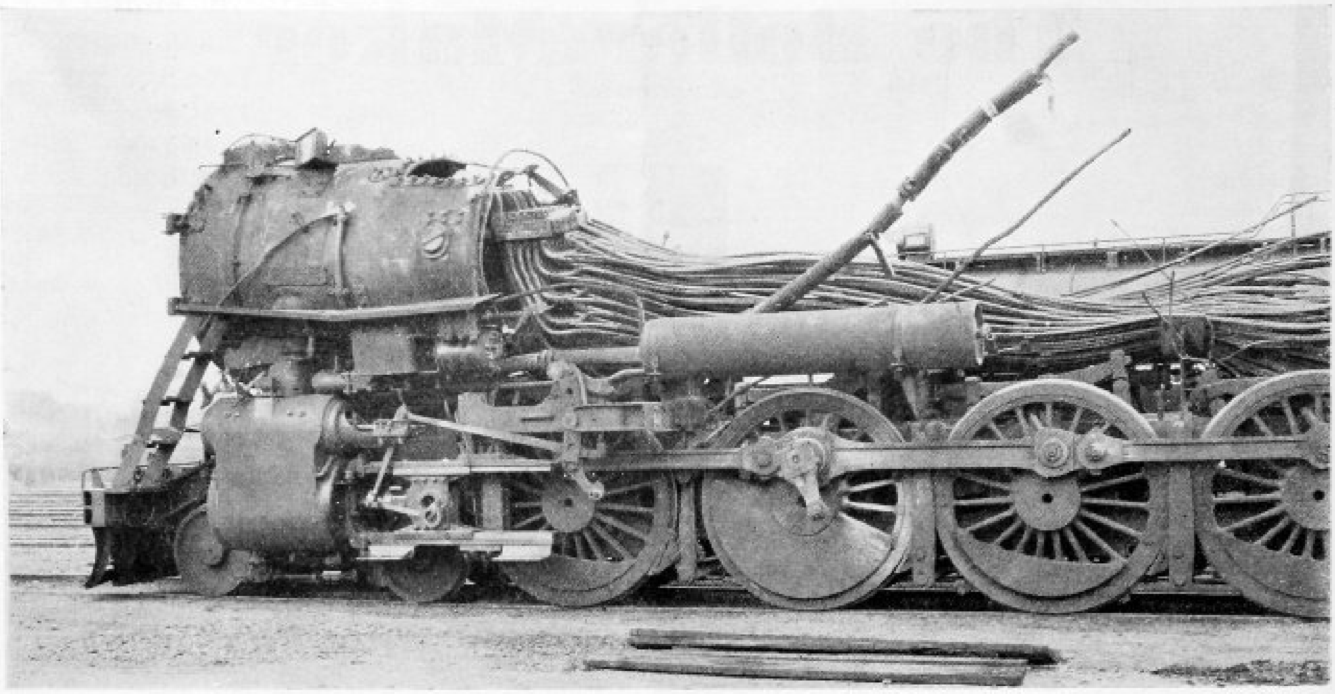


Fig. 1.—Result of a crown-sheet failure caused by overheating due to low water

Annual Report of Bureau of Locomotive Inspection

The twenty-first annual report of A. G. Pack, chief inspector, Bureau of Locomotive Inspection, to the Interstate Commerce Commission shows a further reduction in the number of locomotives found defective to eight percent and a reduction in the number of accidents and casualties resulting from the same. In this report, however, Mr. Pack has issued a warning that the drastic economies now being practiced by the railroads will require energetic action on the part of the Bureau's inspectors if the excellent record of improvement since 1923 is to be maintained.

The fiscal year ending June 30, 1923, as shown in the chart, was the peak year for the number of locomotives found defective and likewise for accidents and casualties resulting from them. From that time up to and including the fiscal year ending June 30, 1932, the number of defective locomotives, accidents and casualties have continued to decrease. Although traffic compared to previous years has fallen off considerably, the total number of locomotives inspected in 1932 compares favorably with the number inspected in past years. During the fiscal year ending June 30, 1932, the Bureau's inspectors examined a total of 96,924 locomotives. In 1931 the number inspected amounted to 101,224; in 1930, 100,794; in 1929, 96,465; in 1928, 100,415, and 97,227 locomotives for the fiscal year ending June 30, 1927. Following is an abstract of Mr. Pack's report:

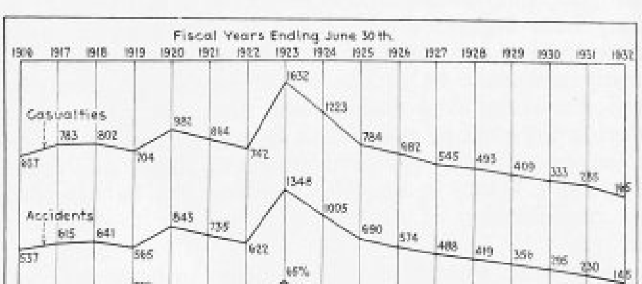


Fig. 2.—Relation of defective steam locomotives to accidents and casualties resulting from locomotive failures

During the year eight percent of the steam locomotives inspected by our inspectors were found with defects or errors in inspection that should have been corrected before being put into use. However, the drastic economies now being practiced by the carriers, together with increasing traffic, will require energetic action on our part if the current conditions are to be maintained.

The decrease in accidents and casualties brought about by decrease in defective locomotives, and the converse, are illustrated in the chart.

Detailed reports of our inspections of the steam locomotives of each carrier and a comparison of the condition of locomotives over a period of years show that some of the carriers are maintaining their locomotives in such condition as to meet the requirements of the law and the rules, while others were found to be seriously delinquent.

There was a decrease of 46.1 percent in the number of crown-sheet failures, a decrease of 46.6 percent in the number of persons killed, and a decrease of 75 percent in the number of persons injured from boiler explosions as compared with the previous year.

Table 1.—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

Table 2.—Reports and Inspections—Steam Locomotives

	1932	1931	1930	1929	1928	1927
Number of locomotives for which reports were filed	59,110	60,841	61,947	63,562	65,940	67,835
Number inspected	96,924	101,224	100,794	96,465	100,415	97,227
Number found defective .	7,724	10,277	16,300	20,185	24,051	29,995
Percentage inspected found defective	8	10	16	21	24	31
Number ordered out of service	527	688	1,200	1,490	1,725	2,539
Total number of defects found	27,832	36,968	60,292	77,268	85,530	112,008

Table 3.—Accidents and Casualties Caused by Failure of Some Part of the Steam Locomotive, Including Boiler, or Tender

	1932	1931	1930	1929	1928	1927
Number of accidents............	145	230	295	356	419	488
Percent increase or decrease from previous year	36.9	22	17.1	15	14.1	14.9
Number of persons killed.........	9	16	13	19	30	28
Percent increase or decrease from previous year................	43.7	*23	31.6	36.6	*7.1	*27.3
Number of persons injured.......	156	269	320	390	463	517
Percent increase or decrease from previous year	42	15.9	17.9	15.8	10.4	21.6

* Increase.

Table 4.—Accidents and Casualties Caused by Failure of Some Part or Appurtenance of the Steam Locomotive Boiler*

	1932	1931	1930	1929	1928	1927	1915	1912
Number of accidents...	43	91	105	119	150	185	424	856
Number of persons killed	8	15	12	14	26	20	13	91
Number of persons injured	46	122	113	133	174	205	467	1,005

* The original act applied only to the locomotive boiler.

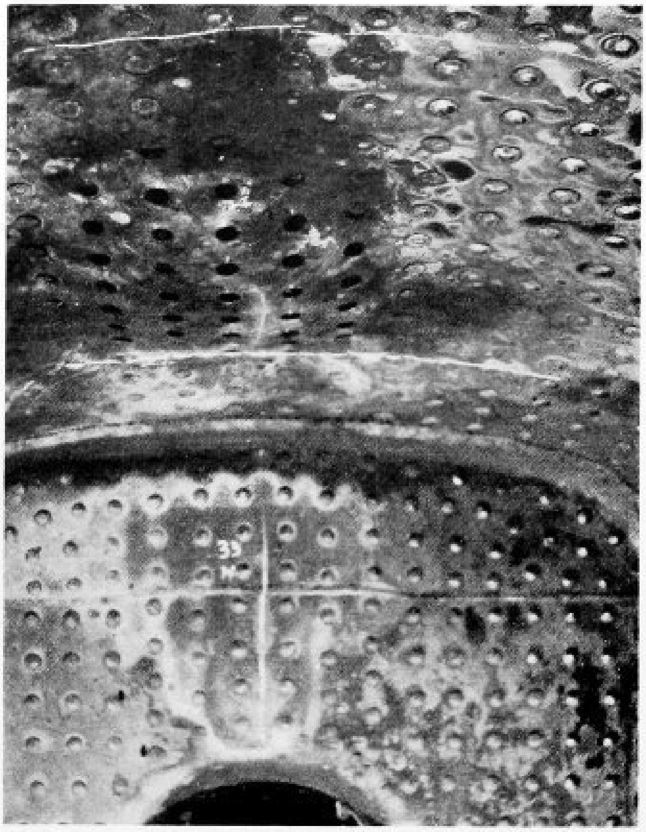


Fig. 4.—Crown-sheet failure due to water foaming and defective stays

A total of 644 applications were filed for extensions of time for removal of flues. Our investigations disclosed that in 31 of these cases the condition of the locomotives was such that extensions could not properly be granted. Fifty-seven were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. Fifty-three extensions were granted after defects disclosed by our investigations had been repaired. Forty-nine applications were canceled for various reasons. Four hundred and fifty-four applications were granted for the full periods requested.

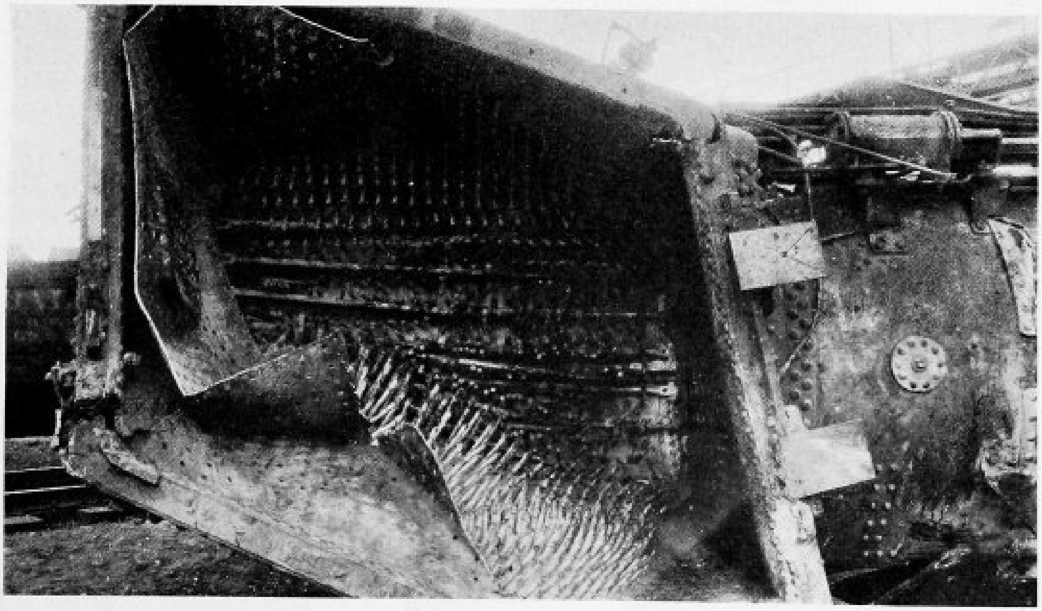


Fig. 3.—A crown-sheet failure caused by overheating due to low water

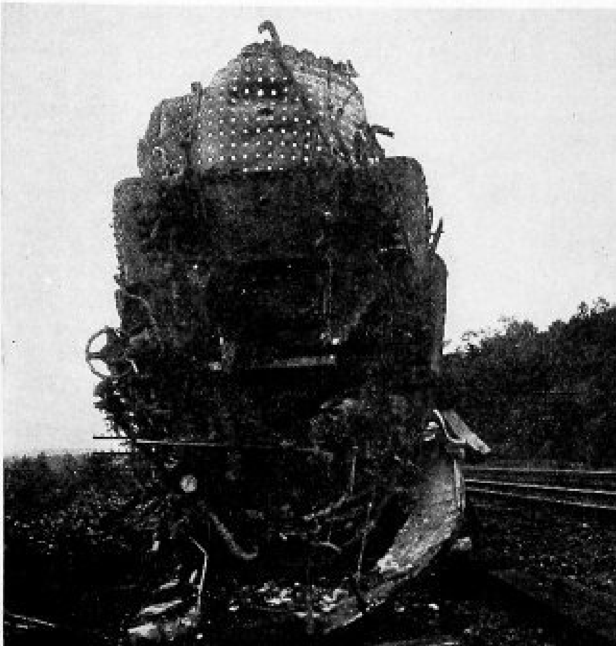


Fig. 5.—Crown-sheet failure, resulting in the deaths of three employees, caused by a clogged water glass

Under Rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives, 343 specification cards and 4753 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, 50 specifications and 6 alteration reports were filed for locomotive units and 25 specifications and 13 alteration reports were filed for boilers mounted on

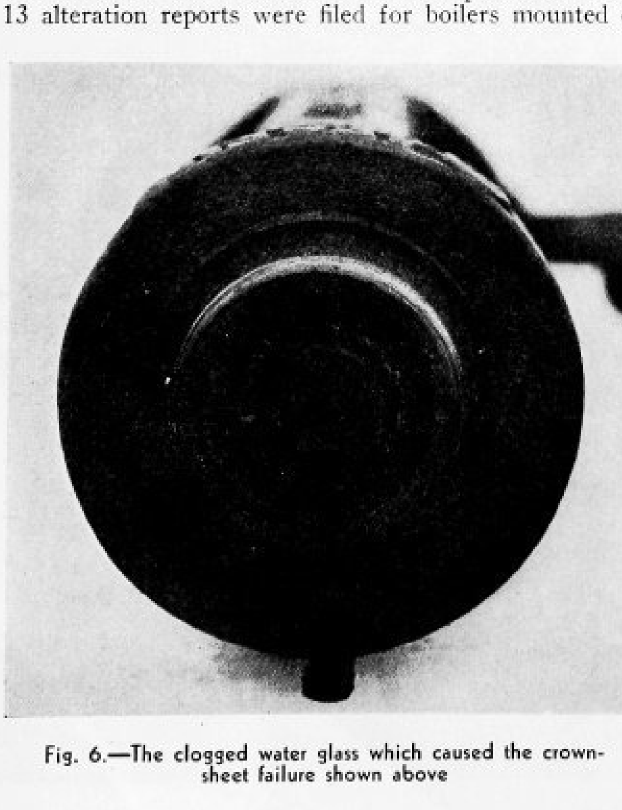


Fig. 6.—The clogged water glass which caused the crown-sheet failure shown above

Table 5.—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,—					
	1932	1931	1930	1929	1928	1927
1. Air compressors	417	481	873	1,202	1,282	1,679
2. Arch tubes	54	60	87	104	103	127
3. Ash pans and mechanism	69	81	76	132	133	192
4. Axles	13	10	12	20	7	13
5. Blow-off cocks	144	191	325	442	469	650
6. Boiler checks	214	263	521	761	914	1,043
7. Boiler shell	220	430	579	841	954	1,422
8. Brake equipment ...	1,645	1,923	2,706	3,894	5,214	6,572
9. Cabs, cab windows, and curtains	851	1,484	3,066	2,140	1,670	2,055
10. Cab aprons and decks	262	415	710	1,005	852	1,086
11. Cab cards	162	211	226	305	378	575
12. Coupling and uncoupling devices	85	98	122	154	179	289
13. Crossheads, guides, pistons, and piston rods	763	856	1,421	1,887	2,088	2,602
14. Crown bolts	50	96	95	129	164	233
15. Cylinders, saddles, and steam chests....	841	1,265	2,311	3,210	3,264	4,526
16. Cylinder cocks and rigging	376	411	848	967	1,007	1,634
17. Domes and dome caps	45	83	154	227	281	388
18. Draft gear	325	568	950	1,310	1,453	2,037
19. Draw gear	371	640	1,003	1,367	1.650	2,210
20. Driving boxes, shoes, wedges, pedestals, and braces	821	925	1,359	1,993	1,990	2,710
21. Fire-box sheets	235	341	471	657	730	796
22. Flues	120	187	254	334	464	465
23. Frames, tailpieces, and braces, locomotive	611	740	1,271	1,377	1,354	1,682
24. Frames, tender	86	105	177	297	256	264
25. Gages and gage fittings, air	156	192	290	309	461	721
26. Gages and gage fittings, steam	214	324	553	678	969	1,425
27. Gage cocks	330	415	783	1,114	1,413	2,024
28. Grate shakers and fire doors	288	410	767	295	377	613
29. Handholds	382	562	865	1,125	1,373	2,285
30. Injectors, inoperative.	31	55	103	86	93	84
31. Injectors and connections	1,168	1,815	3,275	4,484	5,563	7,188
32. Inspections and tests not made as required	3,801	4,862	7,456	9,246	6,623	8,889
33. Lateral motion	237	289	372	618	699	673
34. Lights, cab and classification	55	77	119	121	118	107
35. Lights, headlights ...	119	180	373	488	571	835
36. Lubricators and shields	119	176	312	423	500	746
37. Mud rings	166	318	445	636	822	1,073
38. Packing nuts	402	523	828	991	1,265	1,851
39. Packing, piston rod and valve stem......	444	706	1,429	1,708	1,904	2,214
40. Pilots and pilot beams	145	160	272	371	386	507
41. Plugs and studs......	176	182	348	482	619	740
42. Reversing gear	202	299	579	788	967	1,247
43. Rods, main and side, crank pins, and collars	1,256	1,520	2,488	3,465	4,152	5,137
44. Safety valves	63	61	116	170	172	212
45. Sanders	289	314	804	1,008	1,031	1,268
46. Springs and spring rigging	1,851	2,161	3,311	4,557	4,939	5,956
47. Squirt hose	96	184	313	387	478	644
48. Stay bolts	181	293	395	542	590	631
49. Stay bolts, broken....	552	938	1,098	1,197	1,867	2,373
50. Steam pipes	285	512	730	925	1,020	1,308
51. Steam valves	143	226	399	471	708	774
52. Steps	622	676	1,021	1,394	1,817	2,440
53. Tanks and tank valves	587	732	1,426	1,717	1,941	2,747
54. Telltale holes	108	151	183	174	241	377
55. Throttles and throttle rigging	434	574	1,175	1,554	1,889	2,233
56. Trucks, engine and trailing	648	714	1,141	1,605	1,914	2,363
57. Trucks, tender	766	1,059	1,531	2,144	2,610	4,114
58. Valve motion	520	497	827	1,067	1,262	1,568
59. Washout plugs	599	815	1,283	1,871	2,211	2,786
60. Train-control equipment	13	9	48	60	112	....
61. Water glasses, fittings, and shields	676	955	1,501	1,816	2,115	2,973
62. Wheels	603	750	1,025	1,325	1,609	2,119
63. Miscellaneous—Signal appliances, badge plates, brakes (hand).	325	418	691	1,101	1,273	1,511
Total number of defects	27,832	36,968	60,292	77,268	85,530	112,008
Locomotives reported ...	59,110	60,841	61,947	63,562	65,940	67,835
Locomotives inspected ..	96,924	101,224	100,794	96,465	100,415	97,227
Locomotives defective ...	7,724	10,277	16,300	20,185	24,051	29,995
Percentage of inspected found defective	8	10	16	21	24	31
Locomotives ordered out of service	527	688	1,200	1,490	1,725	2,539

locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found.

One suit for penalties, involving 30 counts for placing locomotives in service while defective and in violation of the rules, was disposed of during the year. Judgment in favor of the government on six counts for $600 was obtained, while 24 counts were dismissed. No formal appeal by any carrier was taken from the decisions of any inspector during the year.

Illustrative of typical locomotive failures, particularly boiler disasters, Mr. Pack has permitted the publication and description of the following accidents, which are not contained in this year's report to the Interstate Commerce Commission:

The result of a crown sheet failure caused by overheating due to low water in which two employees lost their lives, is shown in Fig. 1. This illustration shows the running gear with the smokebox attached and superheater units lodged in the locomotive frame.

The force of the explosion tore the boiler from the frame and hurled it upward and forward. The boiler first alighted on the back head, then bounded and landed on its front end; rebounded and finally came to rest in a position approximately 600 feet from the point of explosion. The head end of the passenger train that the locomotive was hauling stopped about opposite the boiler; the running gear and tender which became uncoupled from the train ran about two miles before coming to a stop.

In Fig. 3 the result of a crown sheet failure, also caused by overheating due to low water, is illustrated. This explosion caused the death of two employees. The force of the explosion tore the boiler from the frame, turned it over and hurled it 195 feet from the point of the explosion where it struck a hillside then bounded and finally came to rest 78 feet further on between the hillside and the eastbound track but turned in the opposite direction from that in which the train was running. The head end of the passenger train that the locomotive was hauling together with the tender and the trailing truck come to a stop about 40 feet from the point where the explosion occurred. The locomotive frame broke to the rear of the driving wheels, and the running gear ran an additional 467 feet before coming to a stop.

A crown sheet failure due to overheating caused by water foaming and defective stays in the crown sheet, is shown in Fig. 4. In this case the door sheet also was overheated. The condition of the water had been reported on the day of the failure and on the day prior thereto but the water was not changed nor was the boiler washed. This accident caused the serious injury of one employee.

Fig. 5 shows the result of a crown sheet failure in which the casualties included the instant death of two employees, the fatal injury of one employee who died two hours after the accident; the fatal injury of one employee who died 27 hours after the accident and the serious injury of two others.

The force of the explosion tore the boiler from the frame and hurled it upward and forward. The boiler alighted on the westbound track a distance of approximately 270 feet from the point of explosion, rebounded 85 feet forward and came to rest adjacent to and obstructing the westbound track.

The stopped up water glass, which was the primary cause of this crown sheet failure, is shown in Fig. 6. The illustration gives an end view of the water glass gage with the opening into the water glass completely stopped up by the extrusion of a rubber gasket.

Other accidents cited include one in which a watertube failed in the crown of a watertube-type firebox. In this accident one employee was seriously injured.

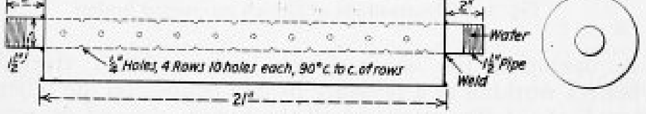
Instances of defective water glass cocks still come to the attention of the inspectors, the defects in most cases being caused by the almost complete stoppage of the opening in the cock with hard scale. Another cause of defects in water glass cocks is excessive reaming in restoring the valve seat which eventually causes its destruction. When this occurs the valve stem wedges into the opening far beyond its proper position and requires many turns of the valve stem to make sufficient opening to permit proper functioning of the water glass.

Silent Water Heater

By E. T. Kausch

The illustration shows a shop kink which is in general use in The Minneapolis & St. Louis Railroad round house at Watertown, S. D., and should be very useful in shops where no hot water is available. When applying hydrostatic tests on boilers, it was the practice to heat the water in the boiler by connecting a steam line to the blow-off cock, and, as this made so much noise, the "silent water heater," shown in the illustration, was constructed.

To make such a device, take a piece of second-hand superheated tube, weld disks on both ends and insert a



Home-made silent water heater

1½-inch perforated pipe with threads on each end. Connect this contrivance to a water hydrant and connect the house blower line to the steam inlet nipple, then connect the washout hose to the other end. Open the water and steam valves to suit and you will hear no noise whatever, even if you open the steam valve wide.

I designed this apparatus for my personal use, but it is in general use at the Watertown round house today. We fill our largest locomotives with scalding hot water in 25 minutes, so that it takes only 35 minutes from the time they light the fire until they raise 50 pounds of steam. Where cheap stationary coal is available it ought to save quite a lot of high-priced locomotive coal for firing up purposes.

We also use this heater when engines come in all frozen up, to thaw out ash pans and to remove snow. This is much easier than using a steam hose and is much safer.

Frank D. Almy Dies

Frank D. Almy, former president of the Almy Water Tube Boiler Company, Providence, R. I., died on December 14, at his home in Providence, R. I. Mr. Almy retired from active business several years ago. He was 68 years of age. Born at Tiverton, R. I., Mr. Almy was associated with the boiler manufacturing concern from the time of its organization in 1890 until he retired.

German Method of Producing Welded High-Pressure Boiler Drums

Through the courtesy of *The Engineer* of London, the process for manufacturing water gas welded high-pressure boiler drums, as practiced at the Thyssen Works of United Steel Works, Mülheim-Ruhr, Germany, is described.

Boiler drums were originally made, almost without exception, by riveting plates together. Up to 215 pounds per square inch such boilers had in general a satisfactory life. It was soon found, however, that with further increases in pressure, boiler defects began to assume hitherto unknown proportions. Fig. 1 shows graphically the interesting observations of Ullrich on riveted boilers with working pressures of 185 pounds, 285 pounds, and 485 pounds per square inch respectively. From the diagram it will be seen that up to 185 pounds appreciable defects only occurred in the boilers after they had been in operation for about fifteen years. With riveted boilers working at a pressure of 285 pounds on the other hand, about 40 percent of all the boilers showed defects after only seven years, while with 485 pounds 60 percent of the boilers under observation showed defects after only two to three years.

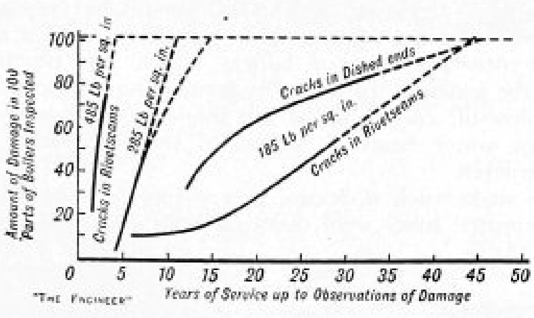


Fig. 1.—Observations of Ullrich on riveted boilers

Careful investigations as to the cause of such defects showed that they were mainly traceable to the effects of deformations of the material in the cold state, more particularly during riveting. It is now a matter of common knowledge that soft mild steel exhibits considerable stress within the deformed areas, to which must be added progressive embrittlement or aging. It would appear that the pressure stresses in the boiler, acting on the strained parts which have become brittle, lead to the formation of cracks, which occur all the sooner if the boiler is highly stressed. These deformation effects occuring in the cold state can be removed by annealing, a measure which can, however, only be adopted with non-riveted drums, as any riveted joints would undoubtedly become loose during such heat treatment.

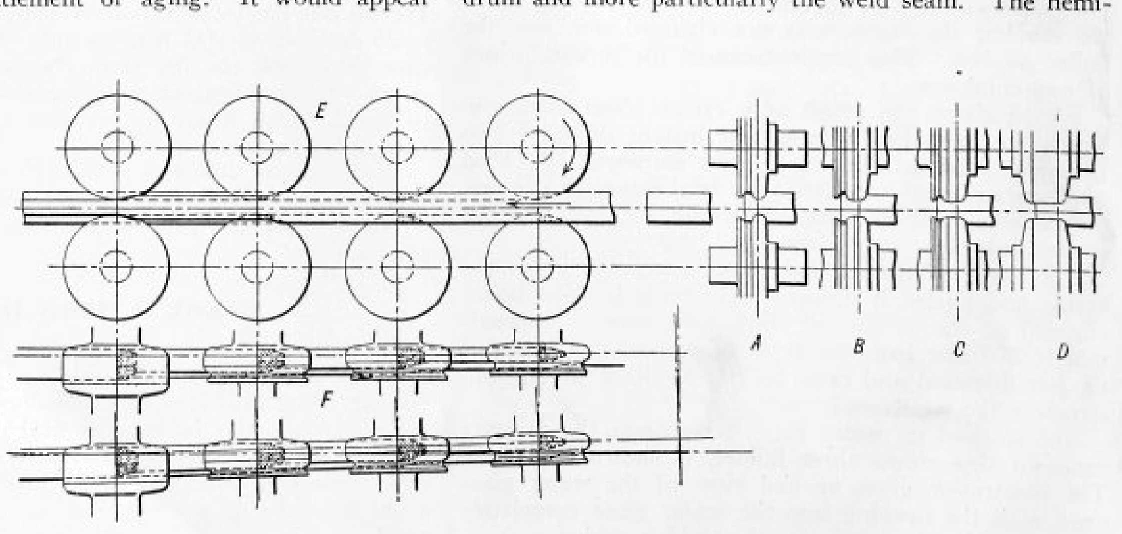
Water gas welding was the only method employed until quite recently, but within the last few years successful attempts have been made to introduce electric welding in the manufacture of boilers. To what extent, however, fusion welding may replace water gas welding only practical experience over a number of years can show. For the present the water gas method, which has proved so satisfactory for boiler manufacture, must take first place. For relatively low pressures it is usual to weld the longitudinal seam and rivet in dished ends. While experience has shown that this type of drum is quite satisfactory for medium pressures, say, of about 215 pounds to 355 pounds per square inch, and few boiler defects have so far appeared, yet for higher pressures the riveted end seams form a source of danger, as rivet hole cracks may occur. By closing in the ends of the shells hemispherically by means of a special hydraulic press all riveting was entirely dispensed with.

In this process the wall of the boiler end becomes thicker towards the edge of the manhole, a fact which is important from the constructional point of view, as by this means the strength at the highly stressed manhole edge is thereby considerably increased.

With modern rolling mills having rolls of 14 feet 9 inches length, which will take plates of the largest size made, water gas welded drums up to 4 feet 5 inches, external diameter can be made with a single longitudinal seam. Only for larger diameters does it become necessary to make the boiler drums out of two plates having two longitudinal seams.

The introduction of the closed drum has made it possible to eliminate all cold deformations and strains caused during manufacture by a subsequent heat treatment, and in addition it enables the finished drum to be subjected to a test which guarantees the reliability of the whole drum and more particularly the weld seam. The hemi-

Fig. 2.—Continuous rolling process substituted for the costly forging process of manufacturing boiler drums



spherical shape of the closed-in end and the thickening of the wall at the manhole edge allow all finished drums to be subjected to a static or oscillating test pressure, during which the cylindrical part is stressed beyond the yield point without, however, any bulging of the ends occurring.

By applying such severe stresses as could never occur in service without serious permanent deformation resulting, any faulty place either in the plates or the weld seam must show up. As, however, the material may become strained and local cold deformation may even occur during this test, the drum is annealed as a whole in order to get rid of these and also any strains and deformations caused during the earlier operations. More than 1000 drums made in this manner have so far been supplied, in the manufacture of which about 10,000 tons of plates have been used, yet none has failed or shown the slightest defect, although over 70 percent of them operate at a pressure of 500 pounds per square inch, and higher.

While relatively soft steels have hitherto had to be used for the manufacture of water gas welded boiler drums, it becomes necessary with high pressures to adopt greater wall thicknesses, which are undesirable in all cases where a saving in weight is a consideration. Hence attention has been given to the manufacture of seamless drums which can be made of harder steels and those of relatively higher alloy content. With a view to reducing the manufacturing costs of such seamless drums the United Steel Works has now substituted a continuous rolling process for the laborious and costly forging process. This process is based on the work of Herr. M. Roeckner, who has invented a radial rolling mill in which hollow ingots can be rolled out to long drums of large diameter. The process is based on an operation long recognized in the forging art. This process is illustrated in Fig. 2. It will be seen that the material is extended by the use of profiled rolls, see A B C D, Fig. 2. If a plate, brought to red heat, is passed through such a system of rolls placed one behind the other in the direction of the arrow at a certain distance from the edge of the plate the plate would be drawn out by a certain amount towards the edge. The same effect can be obtained with a hollow ingot if the rolls be arranged in such a manner that the upper rolls, as indicated at F in Fig. 2, engage at the outer periphery and the lower rolls at the inner side of the hollow ingot. If the rolls be, moreover, slightly inclined, the hollow ingot will be drawn through the rolling mill with a screw-like action and be continuously extended.

By means of this rolling process a hollow ingot can be quickly rolled out into a seamless drum. This radial rolling process ensures a thorough homogeneity of structure resulting from a very complete working of the material, as every part of the hollow ingot is forced to pass the narrowest caliber of the rolls. These drums after being closed are subjected to the excess pressure test and annealed in the same way as welded drums.

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 society for approval, after which it is issued to the inquirer and published.

Below are given records of the interpretations of the Committee in Cases Nos. 732, 733, 734, 735 and 736, as formulated at the meeting on October 28, 1932, all having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 732.—*Inquiry:* May open hearth process steel having a tensile strength of from 55,000 to 65,000 pounds per square inch, which meets A.S.T.M. Specifications A7-29 for Structural Steel for Bridges, be used for Class 3 fusion-welded unfired pressure vessels having a shell thickness of less than ¼ inch, provided it is of good weldable quality, the working stress does not exceed 5600 pounds per square inch, and all other Code requirements are met?

Reply: In view of the data submitted regarding the successful use of this material over a long period of time under the conditions specified in the inquiry, it is the opinion of the Boiler Code Committee that with the restrictions as stated, safe construction will result from the use of this material.

CASE No. 733.—(In the hands of the Committee).

CASE No. 734.—(In the hands of the Committee).

CASE No. 735.—*Inquiry:* Is it permissible to form a manhole opening by insertion of a structural steel ring in the opening in a shell or head and welding it thereto, provided the ring is so proportioned as to adequately reinforce the opening under revised Par. U-59 of the Code?

Reply: Rules are given in Par. U-59 for the proper reinforcement of openings cut in shells or heads and it is the opinion of the Boiler Code Committee that if manhole openings are fitted with welded reinforcing rings of the type referred to, which are proportioned according to the requirements of Par. U-59, the construction will not conflict with the requirements of the Code.

CASE No. 736.—*Inquiry:* Was it the intention of the Boiler Code Committee to eliminate the former provision in Par. P-186 of the Code for the use of fusion welding on pressure parts of boilers where the stress is carried by other construction and the safety of the structure is not dependent upon the weld? This clause was replaced in the latest edition of the Code by a stipulation that "fusion welding may be used in boilers as specified in this section of the Code." Examples of the construction details in question are the welding together of abutting plate edges under the butt straps of riveted joints and the cutting away of one edge of a lapped joint where the end of the shell meets a circumferential joint or a head.

Reply: It was not the intent of the Committee to eliminate the provision in the Code for the use of fusion welding on pressure parts of boilers where the stress is carried by other construction and the safety of the structure is not dependent upon the weld. The provisions of the third section of Par. P-186 are based upon the above-mentioned former rule. Construction details of the type described in the inquiry are therefore permissible.

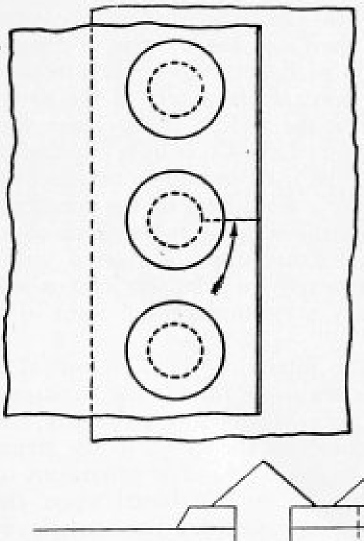
How Defects Can and Do Develop in Riveted Boiler Seams*

By J. P. Morrison†

The riveted boiler seam became a problem early in the development of industries involving power produced by steam, and difficulties of one kind or another have followed in wake of each new seam design. Improvements in men, methods, materials and machinery have resulted in a decrease in those minor difficulties attributable to materials and workmanship, but, in keeping pace with the demands for higher pressures and higher rates of evaporation brought about by the demand for decreased capital investment and increased fuel economy, boiler design and operation have become complicated. Likewise, the problem of preventing and of discovering defects which do develop has become quite intricate.

The defect illustrated in Fig. 1, which develops between the rivet hole and the calked edge of the plate, has become universally known as a "fire crack." It first became a source of trouble in railway locomotive operation, a class of service that involves high firebox temperatures and high rates of heat absorption by those surfaces exposed directly to the radiant heat. This condition resulted in temperature differentials, and expansion and contraction stresses that were beyond the endurance limit afforded by the material and workmanship obtainable at the time steel was coming into a common use in boiler construction.

Old time stationary and portable boilers of the locomotive type and the various forms of firetube boilers having external furnaces using wood or coal fuel were hand fired and operated at 100 pounds pressure or less. The rate of evaporation was low as compared with that in the railway locomotive boiler of that time, and with the load carried by similar equipment today. In fact it was not unusual for the purchaser of a 100 horsepower engine to install a boiler of 150 horsepower, commercial rating, so that there would be a surplus of boiler capacity. As a result, the boiler furnace temperatures were low and where the feed water was of average quality there was little or no detrimental effect upon the firebox and shell plate seams exposed to the heat of combustion.



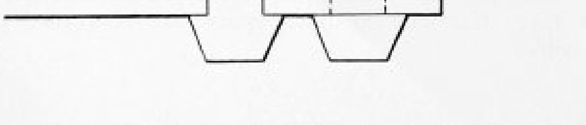


Fig. 1.—(Left) Typical example of fire crack. Fig. 2.—(Below) Lap-seam crack on inner surface of outer plate

However, as industries improved their methods of production and the smaller central electrical generating stations increased their output, boiler loads, rates of evaporation, pressures and plate thicknesses increased until the furnace and shell seams, where two thicknesses and a row of rivets were exposed to the new operating conditions, could no longer transmit the heat from the furnace to the water with sufficient rapidity to maintain a comparatively uniform temperature throughout the plate thickness. Under these conditions there were frequent cases in which the outer sheet of the lap seam exposed to the heat attained a considerably higher temperature than that reached by the inner sheet in contact with the water, and trouble started.

In this connection, it may be noted that a temperature differential of 100 degrees, encountered under normal conditions, may be doubled if a small amount of scale or oil has coated the interior surface of a ½-inch shell plate forming a lap seam. The tendency of the outer and hotter plate to expand is opposed by the inner plate and by the rivets holding the two plates together. When the outer plate contracts as the temperature decreases, the rivets and inner plate cause longitudinal tension stresses which in time produce fire cracks. The use of metal lacking proper ductility, or poor workmanship in construction, such as punched or drifted rivet holes, hastens this development.

Fire cracks in girth seams became so common 25 or 30 years ago that in an effort to overcome them there was developed a horizontal tubular boiler constructed of only two plates, each plate forming a semicircle without circumferential seams between the head seams, but with longitudinal seams of the lap joint type extending the full length of the boiler. Later, another boiler of somewhat similar construction was tried, this one having one fire or bottom sheet but with two or three sheets forming the upper half of the shell. However, the lack of the stiffening influence of the girth seam as well as the stresses that developed in the longitudinal seams, whether of the lap joint or of the butt joint types, resulted in several failures.

The fire crack, which had been a most common trouble maker in those districts where the available feed waters were of poor quality, was frequently accompanied by overheating and bulging of the plates exposed to furnace temperatures, and the construction intended to avoid the girth seam fire cracks complicated, in many cases, the work of making repairs when repeated overheating led to the necessity of applying patches. The logical solution of the trouble, which at first appeared to depend upon the elimination of the mid-shell girth seam in the construction of boilers having shell plates exposed to furnace heat, later was found to rest upon limiting the thickness of the shell plate so that the combined thickness of the two plates at the girth seam would not be sufficient to cause an undesirably high temperature in the outer sheet.

* Published through the courtesy of *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company.

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As a consequence, for a number of years the specifications prepared by The Hartford Steam Boiler Inspection and Insurance Company for boilers of the horizontal tubular type have called for shell plate thicknesses not exceeding 9/16 inch; and the A.S.M.E. Boiler Code carries a limit of ⅝ inch for the thickness of the plate at the seam. If the shell plate thickness of an A.S.M.E. Code horizontal tubular boiler exceeds ⅝ inch, it must be reduced at the girth seam to 9/16 inch, thus reducing the total thickness of both sheets at that point to 1⅛ inches.

The fire crack necessitates repair of some description, and is annoying if it results in leakage. However, as it is not due to or affected by steam pressure, it is not ordinarily a source of danger, unless continued leakage results in corrosion to an extent sufficient to weaken the structure. The problem of repair is a small one or a large one, depending upon the extent of the defect and the conditions which have contributed to its formation.

Steam boiler engineers recognized some of the inherent weaknesses of the lap-seam longitudinal joints a great many years ago. In fact, as early as 1875 *The Locomotive* printed accounts of boiler explosions due to lap seam failures, and in 1890 published a special article on the stresses developing in single riveted lap joints. Following several disastrous explosions of boilers having double or triple riveted longitudinal seams of the lap-joint type, it published in 1907 an article that explained in detail the stresses which must exist as a result of the eccentric loading of the seam, and urged the use of boilers of butt-strap construction.

However, a mistaken idea of production economy led to the manufacture of thousands of boilers of the firetube and watertube type with lap-joint longitudinal seams before public sentiment and legal restriction prevented. Many of those boilers have since been retired from service and the working pressure of others has been reduced to 15 pounds, but in spite of the fact that the A.S.M.E. Boiler Code provides for a reduction of pressure to 50 pounds on each boiler of that type and does not sanction a pressure greater than 15 pounds on a new lap seam boiler over 36 inches in diameter, many lap seam boilers still remain in high-pressure service.

The lap-seam crack is found in the overstressed material of one of the sheets where it is hidden by the lap of the other sheet forming the seam. Even at the start the shallow fissure in the surface of the plate may extend the length of the entire course or the length of the entire seam, its depth nearly uniform from end to end. However, the crack grows progressively deeper into the plate along its entire length, so that when the fracture finally pierces the plate at one point, making its presence known by leakage there, the sheet may be on the verge of being torn asunder by steam pressure from girth seam to girth seam. In fact, such failure has occurred in many cases simultaneously with the first appearance of leakage, so that no advance warning of the disastrous accident was given.

A lap-seam crack, as it develops in the inner surface of the outer plate of the seam is illustrated by Fig. 2. A similar crack is shown in Figs. 3 and 4 which show plates removed from a boiler in which one of our inspectors found a lap-seam crack extending from the middle girth seam to the head seam. The discovery of this crack was accompanied by a similar finding in a duplicate boiler built of the same material by the same manufacturer and installed at the same time. The two boilers were operated in connection with the same header and at the same pressure, so that in every respect the material, design, construction and operation of the boilers were as nearly alike as could be. The lack of proper curvature at the seam, which can be noted in Fig. 3, was

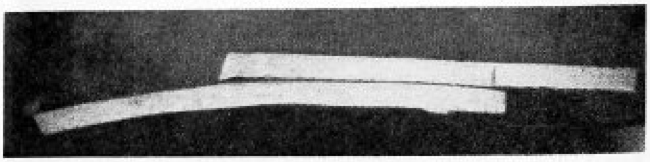


Fig. 3.—Example of lap-seam crack

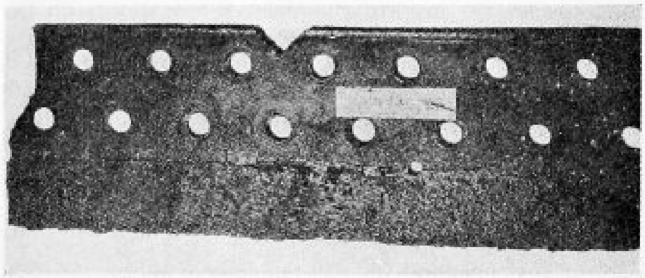


Fig. 4.—Plate showing lap-seam crack

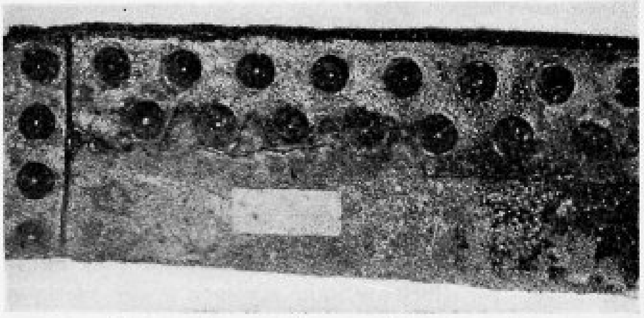


Fig. 5.—Section of lap-seam showing crack

increased by rough handling, but it was partly due to improper construction methods and partly to operating stresses which exceeded the yield point of the weakened seam and permitted permanent deflection to take place. The path of the lap-seam crack did not lead through the rivet holes but was comparatively close to the rivet heads and along the line of greatest bending stress due to eccentric loading of the lap seam.

The V notch in the calking edge of the plate, shown in Fig. 4, was made before the plate was removed, to afford our inspector an opportunity to examine the outer surface of the inner sheet of the seam. Similar notches were made in the edge of the inner plate, but the upper row of tubes was located so close to the seam that a thorough examination was impossible. However, there was sufficient indication of cracking to justify further investigation. The ½-inch diameter hole, visible below the marker pasted on the plate, was drilled into the outer surface of the plate opposite the location where it was thought a crack was developing. The drill did not reach a depth equal to one-quarter the thickness of the plate before the crack was visible across the bottom of the drill hole, as may be judged from the depth of the crack as shown by Fig. 3. Owing to the limited range of the telltale holes the exploration slot is preferred and has been used to great advantage.

Fig. 5 is of a section of a lap seam removed from a boiler which was retired from service recently as the result of a discovery of a lap-seam crack by one of our inspectors. The boiler was used to furnish steam for prime movers and for process work in a steam laundry where 20 girls were employed in the flat work ironing department adjoining the boiler room. The V notches cut to permit examination of the hidden surface in which the crack was discovered were enlarged after the section of plate was removed from the boiler. The seam shown in the illustration has its normal appearance near the right hand end where the inside lap covers the crack, which, however, can be traced along a line near the edge of the rivet heads where the notches have been cut. The crack did not extend into any of the rivet holes.

We have chosen these two of several illustrations of seam cracks in boilers of lap-joint construction, not only to emphasize the need of complete co-operation with the inspector, when an investigation of this kind is necessary, but also to repeat the old warning that a boiler of lap seam construction is a source of *hidden* danger which increases year by year with each change in pressure and temperature. The opinion expressed freely some years ago that the usefulness of a lap-seam boiler should be limited to 10 years as a reasonable safety requirement was probably too conservative for the average case, but we do subscribe to the belief that after 20 years of service at a pressure of 100 pounds, or more, the lap-seam boiler constructed according to practices which were standard at that time is likely to have developed defects affecting its safety to such an extent that a reduction in stresses by reducing the working pressure is justified, and this should be done promptly.

The effects of a long time load and of age hardening or dispersion hardening of stressed steel due to the decomposition of supersaturated solid solutions at relatively low temperatures are receiving increased attention, particularly in the consideration of the need for stress relieving, at elevated temperatures, of welded seams. There is no doubt that age hardening takes place at room temperature and is accelerated at temperatures of 400 to 470 degrees F., which are quite common in the sheets of steam boilers. As the plate weakens, the rate of "decay" increases so much after a certain condition is reached that a lap-seam crack may develop so rapidly that detection is impossible and advance warning of failure is lacking. The longitudinal seam of a boiler of lap-joint construction should be slotted as a matter of precaution, and to afford the inspector a better opportunity of making a thorough examination.

The hydrostatic test is looked upon by some as a means for determining definitely the safety of steam boilers. It is, however, a short-time load not accompanied by temperature stresses, and unless the pressure applied is greatly in excess of normal working pressure, the test is of no real value other than to assist in the location of leakage of known or at least suspected existence. A lap-seam crack may have weakened the seam throughout its entire length to such an extent that a hydrostatic test at 1½ times the maximum working pressure may cause overstresses in the remaining material without giving evidence of the existing weakness. This overstress may not be of sufficient magnitude to produce immediate failure but it may lead to failure shortly after the boiler is placed in service under pressure and temperature stresses.

There is no doubt that some of the boiler explosions attributed to lap-seam cracks have been due to other causes which were not understood a few years ago. The same may be said of some girth seam failures. This conclusion is based on events subsequent to those earlier explosions rather than on the results of investigations of those accidents, for in a multitude of cases the explosion of a boiler, which was uninsured and was operated without legal restriction, left the owner in financial distress. Confronted with the problem of rebuilding his factory and re-establishing his trade, to say nothing of the claims for personal injury and death, he was usually not in a position to conduct or finance an investigation into the causes which contributed to the failure.

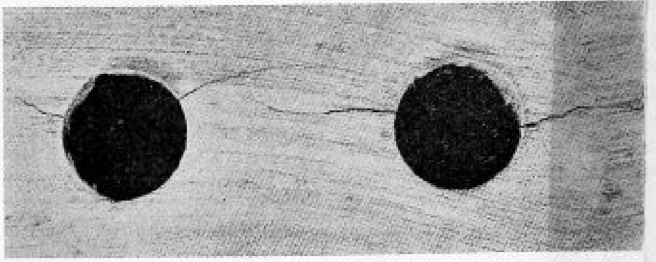


Fig. 6

However, as exploded boilers of lap-seam construction were replaced with butt-strapped boilers of an entirely different type, material and make, and those in turn gave trouble and were replaced by other boilers which in turn followed in the same footsteps, so to speak, it became obvious that some factor other than design and material was having an influence. Operating conditions became a source of inquiry, for within reasonable limits those conditions had remained constant while the design, construction and manufacturers of the boilers and materials had changed. Eventually, after distressing failures of a similar nature had developed in boilers of large industries and institutions where those interested had the means and desire to make investigation, extensive research pointed to the feed water as the probable source of trouble. This resulted in the development of the caustic embrittlement theory now quite generally accepted.

The feed waters used in the boilers examined during these early investigations were all from deep wells and were referred to locally as free-stone waters, because the absence of lime caused them to lather freely with a small amount of soap of standard quality. In their lack of hardness they resembled rain water, although they did contain a considerable amount of sodium carbonate.

As a result of those investigations, many of the locations (principally in the middle west and far west) where this soft well water occurs, were plotted. Concerns using such water for boiler purposes should understand the difficulty which may be encountered. New areas are being discovered from time to time, principally as a result of boiler failures, and to those locations plotted in Bulletin 216 of the Experimental Station of the University of Illinois, we would now add an area in the vicinity of the junction of the Mississippi River with the Arkansas-Louisiana boundary line and extending for 50 miles or more from each bank of the river. Another recently developed area of sodium carbonate water is in the Medical Lake district in the eastern part of the State of Washington. Water from spring fed lakes has been used there for boilers, and explosions and minor seam difficulties have been occurring since 1896. Quite recently a distressed condition of a butt strap seam due to caustic embrittlement was discovered in that region in time to avoid what might have been a violent explosion.

A comparison of the details of Fig. 4 with those of Fig. 6 will enable the layman without the aid of special optical instruments to distinguish one of the principal differences in the general characteristics of the lap seam crack and the defect resulting from the use of feed water of high alkalinity. The lap-seam crack, as has been explained, starts in the surface of the plate, and its depth increases more or less uniformly throughout the length of the course until the plate is pierced, possibly the entire distance from girth seam to girth seam. The fracture may pass through a rivet hole but more frequently is near the line of the edge of the rivet heads. On the other hand, caustic embrittlement defects, whether found in the lap seam or butt-strap seam of a steam boiler, reach out in several directions from each of several rivet holes. As in the case of the lap-seam crack, there is no serious weakening of the vessel at the start, but the long-continued and progressive deterioration of the cement binding together the microscopic steel crystals may, over a period of time, extend the weakened condition so far into the plate that steam pressure can then cause a sudden and violent explosion.

The first appearance of caustic embrittlement distress is usually along the line of rivet holes next to the calking edge, while the lap-seam crack in general develops near the line of rivet holes farthest from the calking edge.

The University of Illinois Experimental Engineering Station in Bulletins Nos. 98, 155, 177 and 216, deals with caustic embrittlement and outlines in technical terms the cause and effect. Those publications should be available for study in any city library; but a thorough understanding of the theory requires some knowledge of chemistry and metallurgy.

Stripped of technicalities, the difficulty may be stated briefly as being due to a concentration of sodium hydroxide in capillary spaces between the sheets forming the boiler seams. The effect of the sodium hydroxide concentration upon the stressed steel has been described as a chemical and as an electrochemical action. With this the layman is not interested primarily. It is sufficient to understand that the material which cements the grains of steel together is gradually weakened or destroyed. Difficulty of this kind is not confined to steam boilers but is encountered in the operation of caustic evaporators, caustic kiers and devulcanizers. Nickel tubes are now frequently used in the construction of vessels of that kind in an effort to overcome the trouble.

Inside calking is sometimes used as a means of preventing the concentration of sodium hydroxide within the boiler joints, but inside calking is of value only when the seams and rivets are not calked at the outside surface of the plate. If outside calking is necessary to secure tightness of the seam, the inside calking is not tight and a concentration may build up between the sheets.

Laboratory as well as plant experiments indicate that a concentration of sodium hydroxide within the boiler joints is prevented by the use of feed water containing

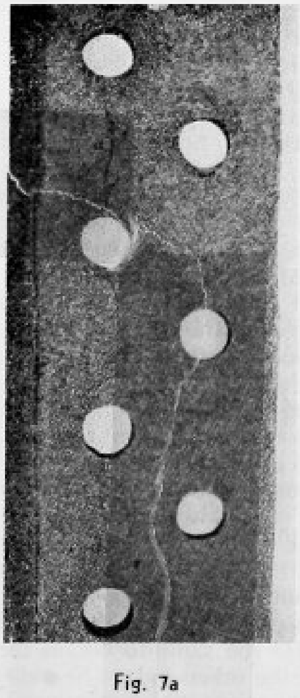


Fig. 7a

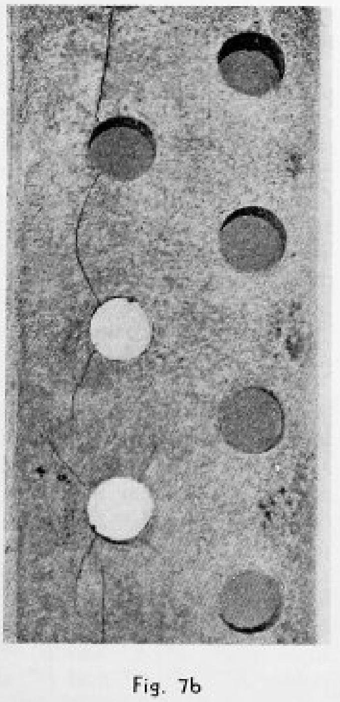


Fig. 7b

a substance which will seal the capillary openings so that the solution cannot enter. Sodium sulphate in the form of Glauber salts and various other chemicals have been used as inhibitants but the determination of which chemical to use and how much of it to use for a particular feed water should be left to the judgment of the chemical engineer experienced with boiler feed-water analysis and fully acquainted with recent developments in that work. A definite ratio of sodium sulphate-sodium carbonate alkalinity has been worked out as necessary for each range of pressure, and the chemist should prescribe with these ratios in mind.

The chemical engineer should be in close contact with the boiler plant and supervise the treatment by frequent analysis of the boiler water. A daily test of the boiler water is preferable. A hardness test with standard soap solution is not sufficient. The condition of the water supply and, therefore, the alkalinity of the boiler water may change seasonally, so that water which may be harmless at one season of the year may be dangerous to use at another. Likewise a treatment suitable at one season may be injurious at other seasons.

The concentration acting upon the grain binder of the steel starts minute fissures in the highly stressed material around the rivet holes. The defect develops and extends in the general direction of an adjacent rivet hole. It may meet and merge with a similar defect or it may run practically parallel with a similar defect extending in the opposite direction. If two of the lines extend in a more or less parallel path between two rivet holes a piece of the plate is sometimes entirely surrounded and forms what has been termed an "island."

In its early stages a caustic embrittlement defect is not visible to the naked eye. Its outline cannot be detected until magnified sometimes as much as 100 diameters. As the condition progresses, the development of the fissure lines from each rivet hole may lead to formation of a visible defect extending practically the length of the seam.

A boiler which has been operated under conditions suitable to the production of caustic embrittlement may become infected and continue the development of the "disease" even after the objectionable feed-water conditions have been corrected. Hence, the fact that the feed water is satisfactory at the time persistent leakage or a dislodged rivet is detected is not conclusive proof that caustic embrittlement has not developed.

The boiler using untreated well water or spring lake water which forms comparatively little scale, or the boiler using treated water which prevents the formation of scale, may be looked upon with suspicion, and a dependable method should be used for determining whether or not the boiler water has the proper sulphate-carbonate alkalinity ratio. Manufacturers of feed-water treating equipment and preparations should be in a position to advise the owner of the boiler regarding the chemicals used, and to guarantee by analysis of the boiler water weekly, or more frequently, that the sulphate-carbonate alkalinity ratio recommended in the A.S.M.E. Boiler Code is being maintained. A copy of the latest analysis should be available for examination by the boiler inspector at the time of each inspection visit.

This procedure is intended to prevent damage to the boilers by the use of injurious chemicals and it also has the advantage of protecting the manufacturer of the feed-water treating process from blame in case his treatment is used in a boiler plant where previous feed water conditions have initiated the development of caustic embrittlement.

Caustic embrittlement defects are not confined to any particular seam of a boiler. Girth seams, longitudinal seams, lap seams and butt-strap seams all have been found affected in very much the same way, so in case of persistent leaking, or in case a rivet head has become dislodged, or if one may be broken by a sharp twisting blow of a light hammer, sufficient rivets should be removed to afford an opportunity to examine the plate at the wall of the rivet holes with the aid of a Hartford Magniscope, a magnifying instrument developed by this company especially for the purpose.

In the light of what has been learned in recent years, it now seems probable that some of the boiler accidents which were in the past attributed to defective material and workmanship, temperature stresses, or mysterious causes, were actually the result of caustic decay, particularly those cases known to have been operated under feed water conditions that now are recognized as dangerous. In the issue of July 27, 1907, of the Journal of the German Engineers' Association there appeared an article by Mr. C. Sulzer, a mechanical engineer of high standing in his profession. The article dealt with crack formations resulting from heat stresses which occurred in a boiler of unquestionable material and workmanship, although the design and operation were not fully in accordance with American practice current at that time. No mention was made in the article of the characteristics of boiler water. An illustration of the defective seam is reproduced in Fig. 7a, while Fig. 7b illustrates a defective double riveted head flange seam removed quite recently from a watertube boiler in which heat stresses were negligible. We diagnosed this one as a case of caustic embrittlement because of the unmistakably intercrystalline nature of the minute fissures and the high alkalinity of the untreated feed water drawn from a deep well. The seams are quite similar and the failures are strikingly so, although one occurred in Germany and the other in Texas. Undoubtedly the German failure also was due to caustic embrittlement.

The importance of complete co-operation between the owner and the inspector is best emphasized by reference to one or two of the large number of caustic embrittlement cases that we have encountered. Following an inspection of a boiler in which the inspector suspected that caustic embrittlement was developing, our chemist analyzed the feed water and reported: "The continued use of this water may also, under certain conditions, cause embrittlement of the shell plate along the seams." Within six years of that analysis four boilers were removed from the plant because of caustic distress at the butt strap longitudinal seam.

In 1924 two inspectors visited a plant where treated feed water was used. The examination of a piece of broken feed pipe led to an inquiry concerning the base exchange treatment of water drawn from the Mississippi river, and the probability of caustic embrittlement was discussed. Within two years of that inspection unmistakable signs of the development of caustic embrittlement were discovered and in 1928 a boiler had to be removed because of weakness which developed in the longitudinal seam. Approximately two years later a second boiler was removed from this plant, due to the same condition.

These experiences may be duplicated in any plant using deep-well water of high alkalinity or where feed water treatment, boiler compounds, scale solvents or boiler preparations are used without proper supervision.

Layout of a Transition Piece

By I. J. Haddon

Fig. 1 shows a large pipe and smaller pipe connected by a transition piece, the whole length of one side, when completed, to lie in one plane.

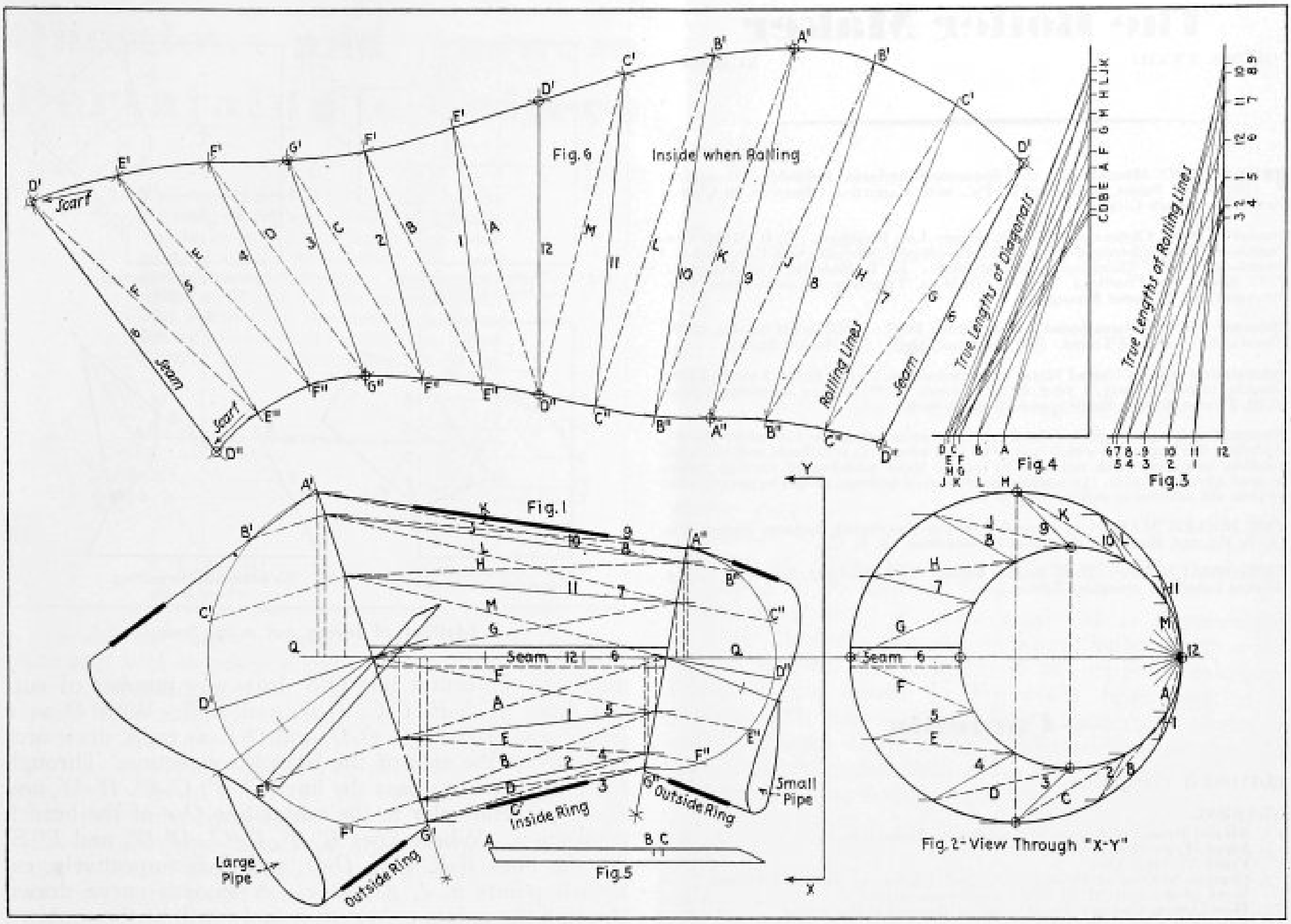
First draw the center lines through the three pipes, as shown, at the desired angle to each other and at the distance apart as required. Bisect the angles formed by the center lines so as to obtain the correct miter lines as *G'-A'* and *G"-A"*. Draw lines representing the center of thickness of the large and small pipes, terminating at the miter lines as shown. Now draw lines representing the center of the thickness of the transition piece, either *outside* of the center of thickness of the large and small pipes or *inside,* according to whether the transition piece is to form an outside ring or an inside ring. As drawn, the transition piece is an inside ring.

Draw the circles, Fig. 2, representing the center of thickness of the sides of the transition piece where they meet the miter lines. Now divide the larger circle into any number of equal parts, say 12, as shown. From the points obtained, draw lines to the point *12*, cutting the smaller circle into the same number of equal parts, and number the lines *12, 1, 2, 3, 4*, etc., as shown. These lines will be the plan of the rolling lines on the transition piece. We will assume the seam has to be on line *6*. Of course it could be anywhere else if desired.

Now in Fig. 2, draw dotted lines from the smaller circle to the larger circle as *A, B, C, D*, etc. These lines will form triangles with the numbered lines and the circles, but none of the lines yet drawn are shown in their true lengths.

From the points on the circles, Fig. 2, draw lines parallel to the center line *Q-Q* until they cut their respective miter lines of the transition piece, Fig. 1, as shown. Connect by heavy and dotted lines, and number and letter them as shown in Fig. 1. Now, the true faces of the miter lines of the pipes and transition piece are ellipses. Therefore, from the centers of the miter lines draw lines perpendicular to each miter line and cut them off equal to the radius of their respective circles, taken from Fig. 2, and shown as *D'* and *D"* in Fig. 1. These will be half the minor axes of the ellipses, and the miter lines will be the major axes of the ellipses.

Now, from the points on the miter lines, draw perpendiculars as shown by dotted lines. Now take a thin lath, as shown in Fig. 5, and on it mark from one end, *A*, the points *B* and *C*, *A-B* to equal half the minor axis and *A-C* to equal half the major axis. Then if this lath is applied as shown in Fig. 1, always keeping the point *B* on the miter line, and the point *C* on the line from *D'* and *D"*, the whole of the ellipses may be drawn by moving the lath around; but, as the whole need not be drawn, just draw the parts that will cut the dotted lines in *F', E', C'* and *B'*. Do the same to obtain the points *F", E", C"* and *B"* at the other end. (See also



Method of laying out a transition piece

layout of an ellipse in the March, 1932 issue of THE BOILER MAKER).

To obtain the true lengths of the lines: Draw base lines of any convenient length and erect perpendiculars at the ends, as shown in Figs. 3 and 4. Now along the base of Fig. 3, set off the lengths *1, 2, 3, 4,* etc., as shown in Fig. 2, and along the perpendicular, set off from 12 the *vertical heights* of the lines *1, 2, 3, 4,* etc., Fig. 1. This may be done by dropping perpendiculars from the respective points on to the line *Q-Q,* as shown, and taking their measurements on *Q-Q,* then transferring them to the perpendicular, Fig. 3 in *3, 2, 1, 12, 11,* etc., as shown. Join *11* to *11, 10* to *10* and so on, then these new lines will be the true lengths of the rolling lines. Do the same to obtain the true lengths of the diagonal lines and letter them as shown in Fig. 4

We are now ready to develop the plate forming the transition piece. Draw the line *12,* Fig. 6, and cut it off from *D″* to *D′* equal to the line *12-12,* Fig. 3. From *D″*, with a radius equal to the true length of *A,* Fig. 4, draw an arc. Then from *D′,* Fig. 6, and with a radius equal to *D′-E′* on the ellipse, Fig. 1, cut the arc in *E′* as shown. Now from *E′,* Fig. 6, and with a radius equal to *1-1,* Fig. 3, draw an arc; then from *D″*, Fig. 6, and with a radius equal to *D″-E″* on the ellipse, Fig. 1, cut the arc in *E″*, Fig. 6. Join *E′-E″* and number it *1,* as shown; then *12* and *1* will be rolling lines. Proceed in a similar manner to obtain all the other points as *F′, G′, F″, G″*, etc. Join them, and mark them rolling lines; curves drawn through these points will be the lines for holes on the miter lines. Holes may be put in at *D′, G′, D′, A′* and *D′*; also at *D″, G″, D″, A″* and *D″*, as shown. The remainder of the holes on the curves are to be divided between these because of the fact that the divisions around the ellipses are *not* equidistant. Line *6,* Fig. 6, represents the center of the holes for a single lap seam. After marking in the necessary number of holes required, allow material for the lap to complete the development.

By leaving the rolling lines on the plate and laying the plate out, so that these lines are on the inside of the pipe when finished, it becomes a great help to the roller man.

A transition piece similar to this was lately laid out by the writer, and was for a pipe line now being laid at Philadelphia. Its large end was 84 inches in diameter; small end, 72 inches in diameter by ⅜ inch thick; ⅞-inch riveting and double riveting at the longitudinal seam. There were two other scalene conical lengths in the one long section of piping reducing the piping from 84 inches to 47 inches. All of one side to lie in one plane.

Trade Publications

STAINLESS CLAD STEEL.—The Ingersoll Steel and Disc Company, (a division of Borg-Warner Corporation), 310 South Michigan Avenue, Chicago, has issued a folder describing the composition, method of manufacture and fabrication of Ingersoll stainless clad steel as well as illustrating and listing many applications for this new low cost corrosion resisting material.

WELDING.—A 20-page illustrated leaflet describing the features, characteristics and applications of the Westinghouse FlexArc welders has recently been published by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

The Boiler Maker

VOLUME XXXIII NUMBER 1

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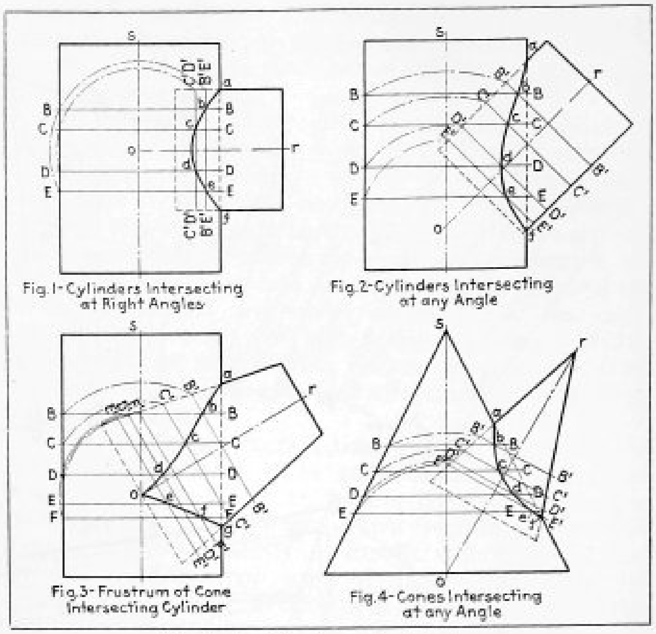
Communications

Short-Cut Method for Obtaining Miter Lines

To the Editor:

When developing intersecting cylinders or cones, it is customary to construct at least two views in order to obtain the miter line. If only the shape of the branch connections is required, as shown in Figs. 1 to 4, two views are unnecessary. The mitre line is found as follows:

Draw the elevation of the intersecting cylinders or cones, Figs. 1 to 4, with their center lines intersecting at point *O*, and project the branch connections into the large sections as shown by the dotted outlines. At right angles to the center line *O-S* draw any number of cutting lines as *B-B*, *C-C*, *D-D*, and *E-E*. With *O* as a center and *O-B*, *O-C*, *O-D*, and *O-E* as radii, draw arcs to intersect the side of the branch connection. Through these intersections pass the lines *B'-B'*, *C'-C'*, *D'-D'*, and *E'-E'* perpendicular to the center line *O-r* of the branch connection. Where lines *B'-B'*, *C'-C'*, *D'-D'*, and *E'-E'* cut the lines *B-B*, *C-C*, *D-D*, and *E-E* respectively, establish points *b*, *c*, *d* and *e*. A smooth curve drawn through the points *a*, *b*, *c*, *d*, *e*, and *f* will be the required miter line.



Method of laying out miter lines

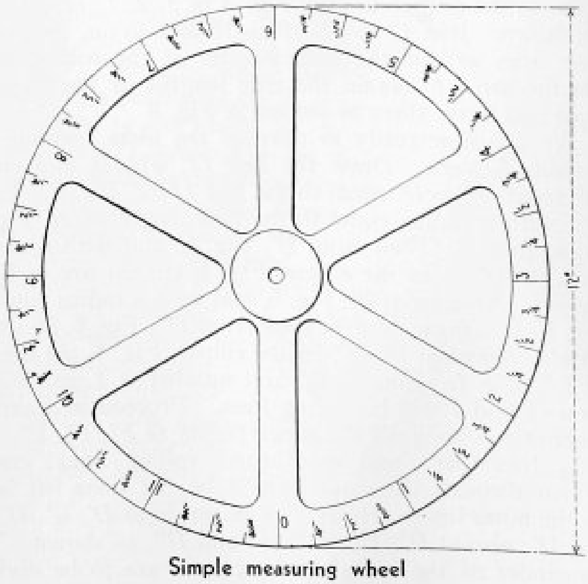
Muskegon, Mich. Sidney Cheasley

Measuring Wheel

To the Editor:

In the illustration is shown a type of measuring wheel which I use for determining the length of angle rings,

(*Continued on page 16*)



Simple measuring wheel

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

Installing Boiler Stays

Q.—What care would you take when placing stays in a boiler? K. C.

A.—All flat surfaces shall be straight and held in place and kept in position until the stays are fitted. In case of threaded staybolts, the threads of the bolts and tapped holes shall be cut clean and fit snug as far as practical. The ends of the staybolts shall extend through the plates a sufficient distance on each side to be properly and neatly riveted over. If staybolts are laminated or brittle they must be rejected.

Riveted diagonal braces or stays in boilers shall be properly heated and fitted. Braces or stays of any type must have correct and even tension.

Crown bars shall be fitted and stayed and shall bear evenly and rest firmly upon their supporting members.

Fire Line in Horizontal Boiler

Q.—What is the fire line in a horizontal return tubular boiler? C. C.

A.—The fire line in a horizontal tubular boiler is that line which divides the portion of the shell exposed to the products of combustion from the portion which is not exposed to the products of combustion. It is illustrated in Fig. 1, the edge of the firebrick forming the fireline.

Combustion Under Forced Draft

Q.—What is the rate of combustion with forced draft and why use forced draft? H. B.

A.—In the case of power plant work the rate of combustion commonly runs from 20 to 40 pounds of coal per square foot of grate area per hour with an ash pit pressure of from ½ to 2 inches of water column, depending on the kind of fuel.

Mechanical draft is often employed as a substitute for a tall chimney, and also in case a boiler plant is increased beyond the capacity of the original chimney. Again, certain kinds of low-grade fuels require a stronger draft than is provided by a chimney of ordinary height. Forced draft is also necessary for mechanical stokers of the under-feed type. In a general way, the advantages of mechanical draft are as follows:

The capacity of a boiler may be increased, as well as the efficiency, which is due to the more intimate mixture of the air with the fuel, when under pressure, thus making it possible to carry deeper fires, ease of regulation, and the ability to provide just the right amount of air for complete combustion. The use of poorer grades of fuel that can be burned with a natural draft, and the possibility of forcing the boilers, if necessary without regard to outside weather conditions. Forced draft also permits the use of feed-water heaters in the smoke flues, which cool the chimney gases to a comparatively low temperature, and which would interfere with the natural draft of a chimney.

The cost of the equipment for mechanical draft is also considerably less than for a chimney. For comparison, for forced draft, with single fan and short stack, the cost is about 20 percent of that for a brick chimney.

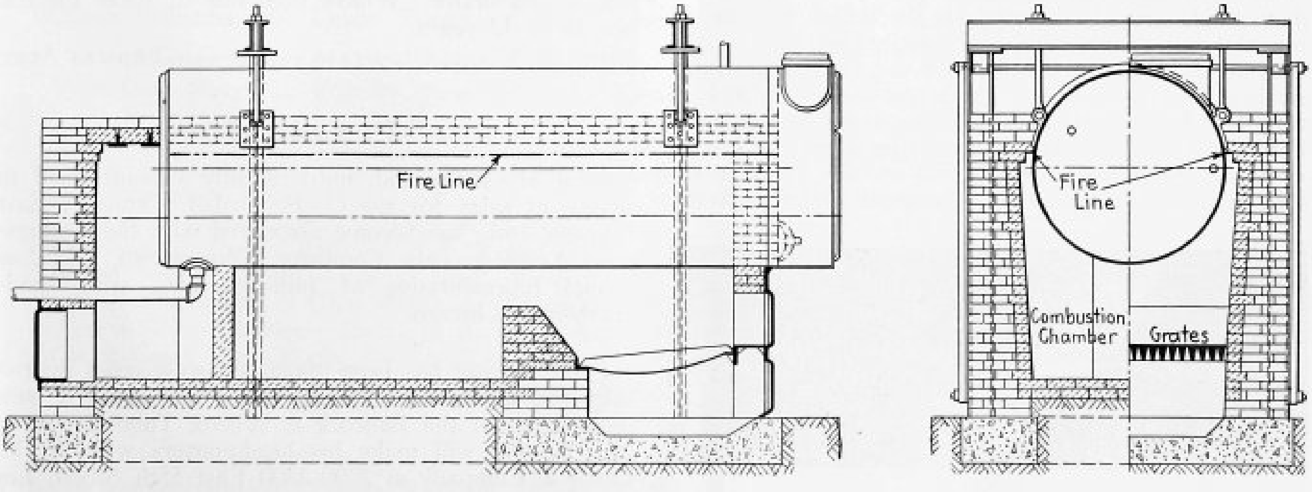


Fig. 1.—Horizontal boiler showing location of fire line

Pitch of Grate Bars

Q.—How are grate bars pitched and why? L. S.

A.—Grate bars for short grates are set horizontal but for long grates are best placed sloping towards the rear to facilitate firing. A slope of one inch per foot is a good allowance.

Patch Efficiency

Q.—Will you please answer the following through your Questions and Answers Department:

THE BOILER MAKER of November, 1932, page 244, "Circular Patch Efficiency." Please refer to Fig. 1. Diameter of rivet circle, 11⅝ inches. Refer to Fig. 2. $A = 5\ 5/16$; $S = 5\frac{1}{2}$. Is this not in error? $S =$ net plate measured on an arc subtended by chord A, Fig. 2. $A =$ a chord equal in length to the radius of the rivet circle, Fig. 2, for circles of 12 inches or under. In this case, should not $A = 5\ 13/16$ inches; $S = 6\ 1/16$ inches? R. H. L.

A.—Fig. 2 is in error, the dimension A should have been taken as one-half of the rivet circle or $5\frac{13}{16}$ inches as indicated in the question; the dimension S would then be $6\frac{1}{16}$ inches as also stated in the question. The efficiency would then become

$$(1)\text{—Efficiency} = \frac{S}{A}$$

$$\text{Efficiency} = \frac{6.0625 - (2 \times 0.9375)}{5.8125}$$

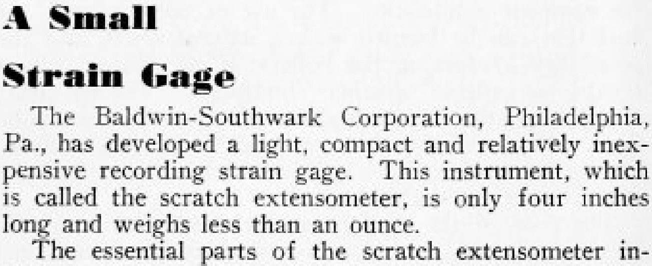
$$\text{Efficiency} = \frac{4.1875}{5.8125} = 0.72 = 72 \text{ percent}$$

The efficiency of the patch would be 72 percent instead of 68.2 percent as computed in the November issue.

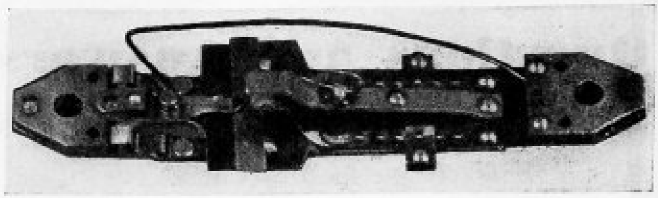
A Small Strain Gage

The Baldwin-Southwark Corporation, Philadelphia, Pa., has developed a light, compact and relatively inexpensive recording strain gage. This instrument, which is called the scratch extensometer, is only four inches long and weighs less than an ounce.

The essential parts of the scratch extensometer include a light, two-part frame, a small, genuine white diamond, and a small target of specially heat-treated steel. The diamond and the target of the instrument are suitably mounted on the frame in such manner that any variable strain in the member under test causes the diamond to scratch a record on the target, the line of record lying parallel with the longitudinal axis of the instrument. Simultaneously with the formation of the strain record on the target, the target is acted upon by a resultant force, manually variable, which moves it at right angles to both the longitudinal axis of the instrument and the axis of the diamond travel. Thus, in the scratch record formed, one co-ordinate indicates strain,



Section of an extensometer target bearing a record of variable stresses



The scratch extensometer is only four inches long

while the other is availed of in order that the strain record may be had over a period of more or less extent as fixed by the variability of the resultant transverse force applied to the target and the amount and rate of strain variation. There is no motion of the target when there is no change of strain in the member under test, and small changes in strain cause only correspondingly small transverse movements of the target.

With the target removed from the instrument, the strains indicated in the record thereon may be evaluated by means of filar microscopes of either the moving eyepiece or moving-table types, or the record may be photographed microscopically and the prints measured directly.

In addition to the advantages of convenience and economy inherent in the scratch extensometer because of its small size and its simplicity, it is said that the instrument is highly accurate. The targets used in the instrument are only 1 inch long by 3/16 inch wide by 1/100 inch thick, and, therefore, can be readily filed for future reference, if desired, without inconvenience.

Measuring Wheel

(*Continued from page 14*)

etc. Now, if you get a piece of No. 10 plate and mark it off as is shown in the illustration, you will find that it is an easy means of finding the diameter of a drum or similar piece and it will be unnecessary to figure the circumference. This wheel is 12 inches in diameter, and it must be turned exact.

Now, once around the measuring wheel will be the circumference of a 1-foot diameter circle, or twice around will be the circumference of a 2-foot diameter circle. You will note that I have marked off the wheel in quarter inches. Of course you can mark it off in eighths. These marks on the wheel are the circumferences of ¼-inch, ½-inch, ¾-inch and 1-inch diameter circles, and so on. You may put on any kind of handle you desire. I have used one of these for the last 10 or 15 years.

Utica, N. Y. THOMAS ADEY

Personal

John M. Mulholand, until recently vice-president in charge of sales for the O. F. Jordan Company, East Chicago, Ind., has become associated with the Youngstown Sheet & Tube Company, Youngstown, Ohio, as special representative of railroad sales, with headquarters at Chicago.

Fritz Hoving has been appointed west coast district sales manager of the A. M. Castle & Company, west coast agent of the Babcock & Wilcox Tube Company. Mr. Hoving will make his headquarters with A. M. Castle & Company at 2200-2300 East 55th Street, Los Angeles, Cal.

Associations

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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
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

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.		Tampa, Fla.

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

States

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

Cities

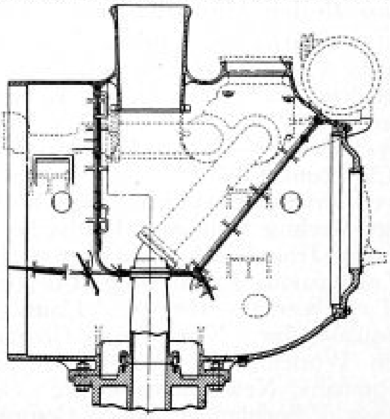
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

Selected Boiler 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.

1,788,559. LOCOMOTIVE SMOKEBOX STRUCTURE. WILLIAM L. BEAN, OF WEST HAVEN, CONN.

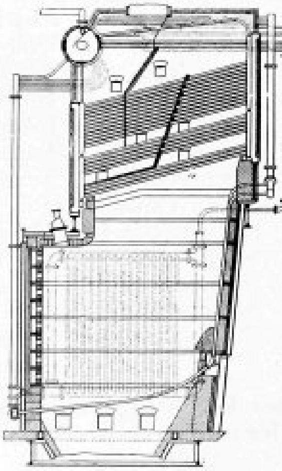
Claim.—In a locomotive smokebox structure, a smokebox wall and a deflector extending transversely thereof, said wall and deflector having tongue and groove connection with each other, said deflector comprising



a plurality of plates lying in the same general plane and having tongue and groove connection with each other, at least one of said plates having its edges engaging the edges of adjacent plates and serving to hold the latter in assembled relation with said wall. Six claims.

1,790,707. STEAM BOILER FURNACE. JAMES C. HOBBS, OF PAINESVILLE, O.

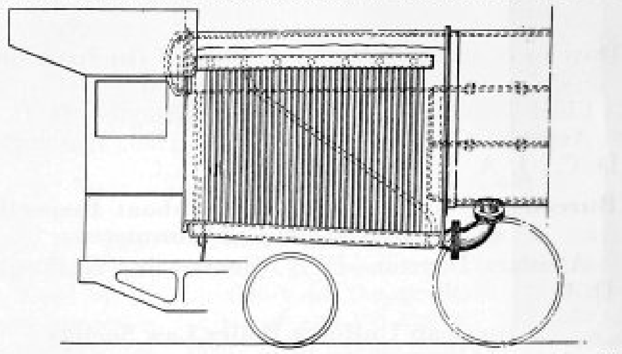
Claim.—A furnace chamber having a powdered fuel burner, slag screen tubes extending across the lower part of the chamber, water inlet connections to said tubes at one end and water and steam outlet connections



to the other end whereby water is circulated therethrough, the end of each tube adjacent said outlet end having a long bend therein with its center of curvature above the tube and the remainder of the tube being substantially straight. Eleven claims.

1,789,037. LOCOMOTIVE BOILER. GEORGE H. EMERSON AND WILLIAM B. WHITSITT, OF BALTIMORE, MD.

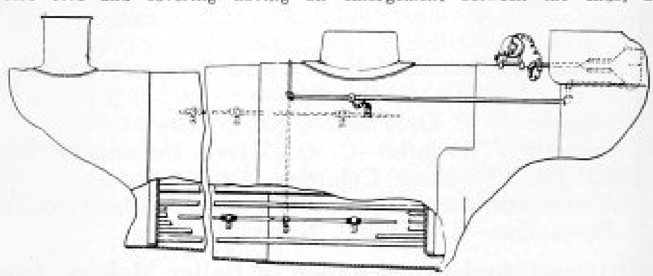
Claim.—In a locomotive firebox steam generator, a pair of drums arranged at the top and on opposite sides of the longitudinal center of the firebox, communicating front, rear and side headers at the bottom of the firebox, upper headers arranged on the outer sides of the drums and in communication therewith, a barrel into which the aforesaid drums extend, other drums, arranged within the barrel and having their rear ends overhanging the front header at the bottom of the firebox, watertubes at opposite sides of the firebox and connecting the upper and lower headers, watertubes connecting the rear lower header with the rear ends of the first-named drums, watertubes connecting the front lower header with the first-named drums adjacent to the rear ends of the latter and in advance of the second-named watertubes, fire tubes in the second-named drums, and brickwork resting on the front header at the bottom of the firebox



and enclosing the overlying portions of the drums and forming therewith the front wall of the firebox. Eleven claims.

1,788,485. MEANS FOR PREVENTING PITTING, CORROSION AND SCALE FORMATION. LEWIS O. GUNDERSON, OF BLOOMINGTON, ILL.

Claim.—In combination with a liquid container, an electrode for employment therein including a metallic core having an insulating covering, said core and covering having an enlargement between the ends, a



metallic projection at one end of said core, a metallic casing threaded into said container and encompassing said enlargement, and means in said casing for retaining said electrode in position in said container. Nine claims.

The Boiler Maker

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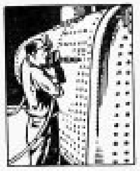

Roosevelt and the Railroads

It is well understood that in addition to self-correction of evils inherent in the railroad transportation system as it has developed, activity on the part of the Government is also necessary to make rehabilitation of plant and equipment possible. With this appreciation of the situation it is encouraging to find the President-elect proposing Government support and easing the scaling down of the railroads' debt structure where necessary.

The fact that Mr. Roosevelt's understanding of the railroad problem is a broad one, and that he has given evidence of appreciating the urgency of the situation, makes it almost inevitable that action will be taken early in the special session of the Seventy-third Congress to convene in March.

If the railroad program, as outlined in his campaign speech, at Salt Lake City is executed by the new Administration, the railroads of the nation will be given a tremendous impetus towards recovery. Briefly, this program included placing the Federal Government's support behind the entire railroad system for a specified period. During this period he proposed that the railroads be rehabilitated by the scaling down of their debt, where necessary, the modification of the competitive principle to eliminate unprofitable mileage, and the co-ordination of motor and air transportation with the railways to produce a national transportation system.

American Uniform Boiler Law Society

The 1932 annual report of the American Uniform Boiler Law Society by its chairman, C. E. Gorton, focuses the attention of the boiler industry on a work that is continually improving the status of the field and expanding the application of the best standards of boiler construction. The American Society of Mechanical Engineers' Boiler Code and Pressure Vessel Code, with their revisions, have been adopted in twenty-one states and territories and seventeen cities through the unceasing efforts of this society.

As stated in its constitution, the society is organized "to obtain the legal adoption of the various codes issued by the Boiler Code Committee in order to secure uniformity in the rules and regulations of the various states, cities and other governmental divisions; to obtain the adoption of revisions and interpretations of such codes; to assist the states and political subdivisions, in the formulation of uniform laws and the organization of departments for enforcement of the codes; and to keep the members of the society informed of the actions of the various states in adopting and revising codes for the construction and operation of boilers and other pressure vessels."

During the past year, in spite of adverse conditions, and the fact that only nine state legislatures were convened—three of them code states—much preliminary work towards the later adoption of the codes and their revisions was accomplished. In Georgia efforts are being made to organize an engineering council with all engineers of Atlanta as members to co-operate with the Chamber of Commerce and other bodies in the consideration of the introduction of a code bill in the next session of the legislature. A bill creating a department of public safety was introduced in Kentucky but owing to present conditions in the state it was not passed at this session. The city of Houston, Texas, has adopted a code and standard of boiler construction while Memphis recognizes and accepts equipment manufactured under code rule and consideration is being given the adoption of the code in full.

Since its reorganization during the year and the broadening of its council membership considerable improvement has been observed in the scope of the society's activities. The fullest co-operation has been given by all organizations associated in the work of the Uniform Boiler Law Society.

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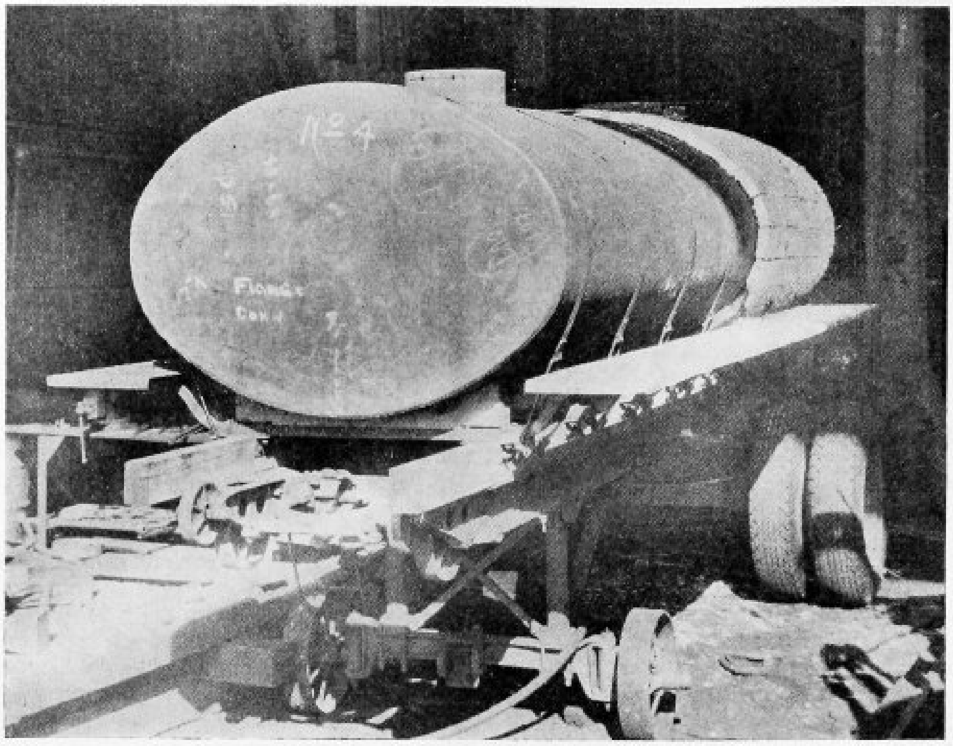


Fig. 1.—Truck tank, 2000 gallons capacity made of nickel-clad steel

Methods for the Fabrication of Nickel-Clad Steel Plate*

By F. P. Huston

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 under normal conditions 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, especially in equipment operating under vacuum.

The intimate metallic contact between the two metals gives the clad plate the heat conductivity equal to 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. In choosing between nickel-clad steel and loose sheet linings for the smaller steel and wood tanks, the light sheet lining will generally prove more economical.

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, through the co-operation of the General American Tank Car

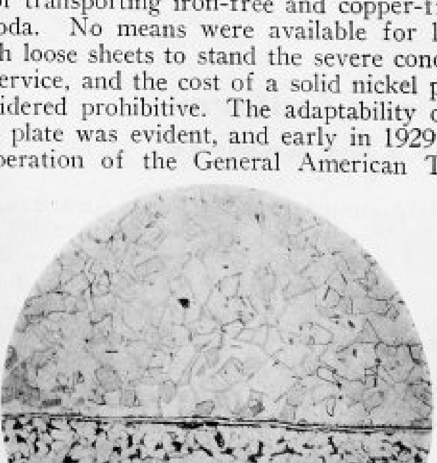


Fig. 2.—Photomicrograph of typical bond between nickel cladding and steel plate × 100

* From an article issued by the Development and Research Department of The International Nickel Company, Inc., New York.

Corporation, Lukens Steel Company, and The International Nickel Company, 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.

The bond between the nickel cladding and the steel base plate is a solid solution nickel-iron alloy which is formed when the two metals are brought in contact at high temperatures. The nickel is actually welded to the steel. The mechanism of welding differs from autogenous welding operations in that the union is effected at temperatures below the melting point of either the nickel or the steel. The action of bonding is by diffusion of the iron into the nickel. The alloy bond is shown clearly in the photomicrograph, Fig. 2.

The composite plate, clad one side only, is obtainable with various thicknesses of nickel. Standards of 10 percent, 12½ percent, 15 percent, 17½ percent 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 0.050 inch.

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 as follows:

NICKEL CLAD STEEL - 10% AND 20% CLADDING, ONE SURFACE

WIDTHS AND LENGTHS

THICKNESS	24"	36"	48"	60"	66"	72"	78"	84"	90"	96"	102"	108"	114"	120"	126"	132"	138"	144"	DIA. of CIRCLES
3/16"	240	240	240	220	200	180	170												78"
1/4"	280	280	280	260	260	260	230	210	200										90"
5/16"	380	380	380	380	380	380	380	380	350	350	310								102"
3/8"	400	400	400	400	400	400	370	340	320	300	280	270	260	240	230				126"
7/16"	410	410	410	410	410	410	380	350	330	310	290	270	260	250	230	220			132"
1/2"	440	440	440	440	440	440	410	380	350	330	310	290	280	280	250	240	230		138"
9/16"	460	460	460	460	430	400	370	340	320	300	280	270	260	240	230	220	210	200	144"
5/8"	480	480	460	460	410	370	360	320	300	280	260	250	230	220	210	200	190	180	144"
11/16"	480	480	480	410	370	340	310	290	270	250	240	230	210	200	190	180	180		138"
3/4"	470	470	470	380	340	310	290	270	250	230	220	210	200	190	180	170			132"
7/8"	410	410	410	330	300	270	250	230	220	200	190	180	170	160	150	150			132"
1"	410	410	390	280	260	230	210	200	180	170	160	150	140	140					120"

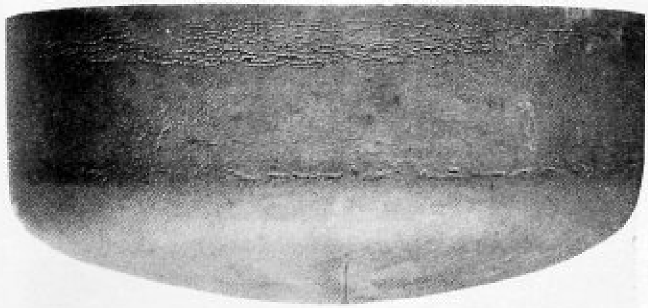


Fig. 4.—Cold pressed, flanged and dished head showing effect of annealing nickel clad flat circle in combustion zone of fuel oil of about 2 percent sulphur content

Two finishes are available from the mill—"regular hot rolled" and "hot rolled and cleaned." The nickel surface of the regular hot-rolled plate carries the glossy, tightly adherent, nickel oxide film, dark olive brown in color. The glossy appearance and color serve to distinguish the nickel side from the steel side. The oxide film is removed from the nickel surface on plates specified as hot rolled and cleaned. The cleaning gives the nickel surface a matt appearance nearly white in color. This finish must not be confused with the bright lustrous surface of cold-rolled and full-finished solid nickel sheet, where refinement is obtained by cold rolling.

The steel of the composite plate is low carbon steel and is regularly furnished, unless otherwise specified, of flange quality, with a nominal tensile strength of 55,000 pounds per square inch. The nickel contributes an additional strength to the steel plate and, in general, increases the ultimate tensile strength 500 to 5000 pounds per square inch. Design data, therefore, follows closely the practice used in designing similar vessels in steel.

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

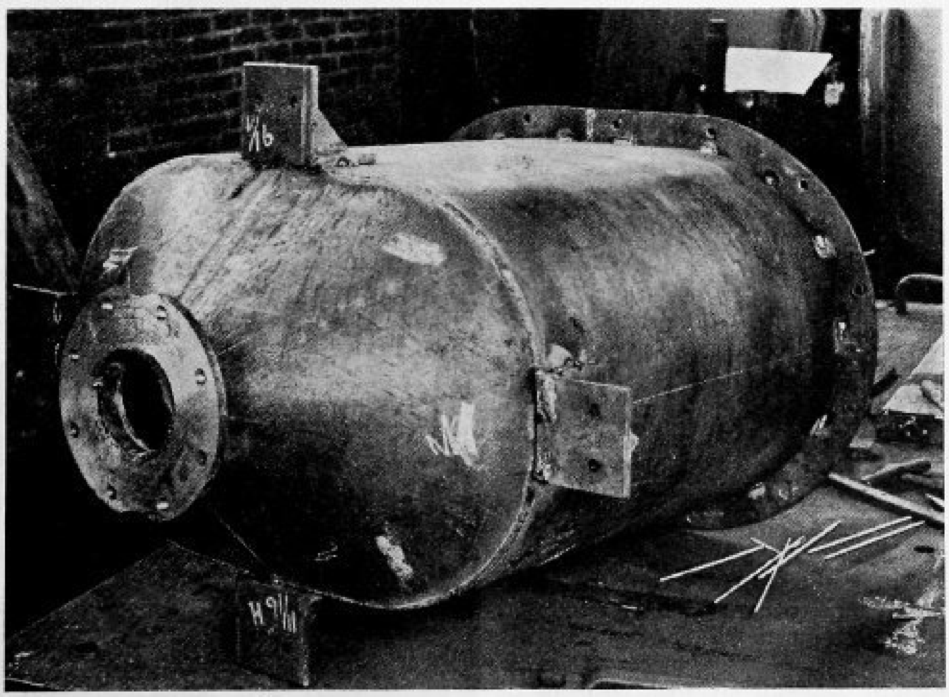


Fig. 3.—Elliptical nickel-clad steel pressure vessel

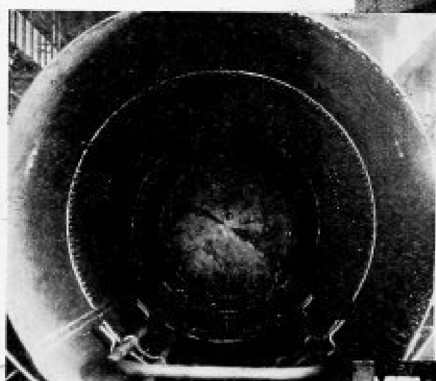
Fig. 5.—Tank car of 8000 gallons capacity

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.

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. Pack annealing in boxes or car-type furnaces at 1250-1350 degrees F., about 5 hours at heat, will yield comparable results. Temperatures higher than 1350 degrees F. may cause excessive grain growth from long-time heating, incidental to pack annealing, with resultant loss in ductility.

A marked and important difference in hot working nickel-clad steel over low carbon steel is found, when heating the plate for hot work, in the sensitiveness of nickel to sulphur, oxidizing atmospheres, cinder, and other active substances that attack the grain boundaries of the nickel at elevated temperatures. Heating conditions entirely satisfactory for steel may have disastrous results on nickel.



Sulphur attack is progressive, beginning at the surface and penetrating inward at a rate dependent on the amount of sulphur present, the temperature, and the time. The metal suffers a complete loss of ductility and cracks may easily extend completely through the thin cladding as shown in Fig. 4.

Another harmful condition results from heating the metal within the combustion zone even with sulphur-free fuels.

Satisfactory fuels for plate work are those having a sulphur content not over ½ percent. Among these are acetylene, natural gas, butane, city gas, washed producer gas, light distillate oils, kerosene, gasoline, charcoal, blacksmith coal, and coke from coal treated to reduce the sulphur content to a safe limit. The fuels most apt to embrittle the nickel and cause cracking and failure on bending are high-sulphur coal, coke, or oil used extensively in plate shops.

The thickness of the nickel coating is not great, and no considerable damage from sulphur can be tolerated. The use of the proper fuel and the complete combustion of the fuel before the gases contact with the metal are points of utmost importance.

The natural tendency in torch heating with oil fuel is toward the intense oxidizing flame due to the low efficiency in open oil burners. The major portion of the oil is burned after it is vaporized by impingement against the hot metal. This may have harmful results if the impingement is against the nickel side, as the nickel is placed directly within the zone of combustion. An improvised furnace of loose firebrick can often be assembled to confine the heat and allow for proper combustion conditions. The rapid loss of heat to the surrounding air makes it difficult to heat heavy plate to the required temperature even with large preheating torches.

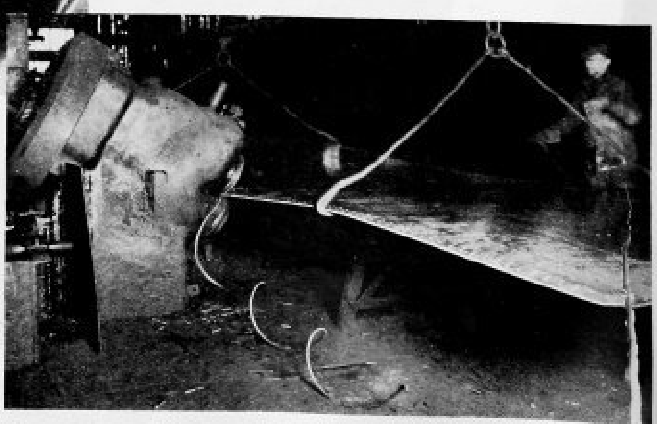
Heavy acetylene welding torches will give better results in most instances. The flame should, if possible, be applied against the steel side, but if necessary to heat from the nickel side, the mixture must be adjusted to give a reducing flame.

Given the proper means of heating, no change need be made over usual steel practice as to temperatures, amount of work done on the heat, or the methods used in performing the work.

Overcoming Adverse Heating Conditions

Shops not equipped with furnaces fired with low-sulphur fuel, or designed to give proper combustion, can do some types of work if special and careful means are used to protect the nickel against attack; for

Fig. 6.—(Above) Hydraulic riveting with pure nickel rivets. Fig. 7.—(Left) Interior of tank car. Fig. 8.—(Below) Bevel shearing nickel-clad steel plate for tank car



example, it may be possible to heat a circle for hot pressing, in a coal or coke fired furnace by providing a shallow, flanged or welded head slightly larger in diameter to contain a layer about ½ inch thick of a mixture of lime and powdered charcoal—one part charcoal to about ten parts of lime. The nickel-clad plate is placed nickel down against the lime-charcoal mixture, charged in the furnace, and drawn in the shortest possible time consistent with uniform heating. The ample use of the lime-charcoal mixture can be expected to give some measure of insurance against sulphur attack, and its use, whenever possible, is advisable.

Coke-pit forges were used to heat the edges of the dome wrapper sheet for sledge flanging in constructing the tank car shown in Fig. 5. The plate was placed on a well burned bed of coke with the steel side down, and the nickel surface was kept completely out of contact with the fuel. Entirely satisfactory results were obtained except in a small portion of one dome, when care was relaxed and the coke was allowed to remain in contact with the nickel.

Open-torch heating is generally safe except when sharp, highly oxidizing flames are allowed to strike the nickel surface.

Suitable fuels, i. e., fuels low in sulphur or free from sulphur, are available to any locality. Furnaces to provide the complete combustion of the fuel before the gases strike the metal, and to eliminate stratification from poorly constructed doors and stack vents, present problems solely of design. Properly designed furnaces are generally no more costly to build than the grossly inefficient furnaces often found in shops doing heavy plate work. The fuel cost per pound of metal heated is probably the lowest item of expense, and the additional cost of proper fuels is more than offset by the saving in the cost of material and labor that is lost through spoilage.

The continuity of the nickel surface is gained, in all but a few instances, by welding with nickel to close the break in the clad surface at the joint. The steel base plate is protected in this manner from galvanic corrosion due to the iron-nickel couple and contamination of the product is prevented. Without this protection the attack on the steel, under certain conditions of temperature, aeration, and concentration, may bring about premature failure of the vessel through galvanic or concentration cell corrosion. It is important that this factor be stressed in order that the designer may give thought to adequate safeguards. The shop must heed the instructions covering the preparation of the plate edges and the welding practice efficiently to effect the full protection of the steel.

Riveting as a means of joining will be necessary only when codes or regulations prohibit the welded

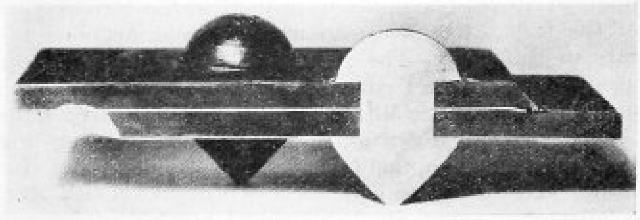
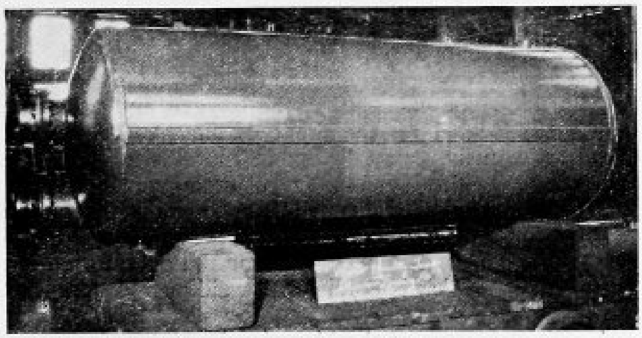


Fig. 10.—Lap riveted joint, with pure nickel rivets and calk weld



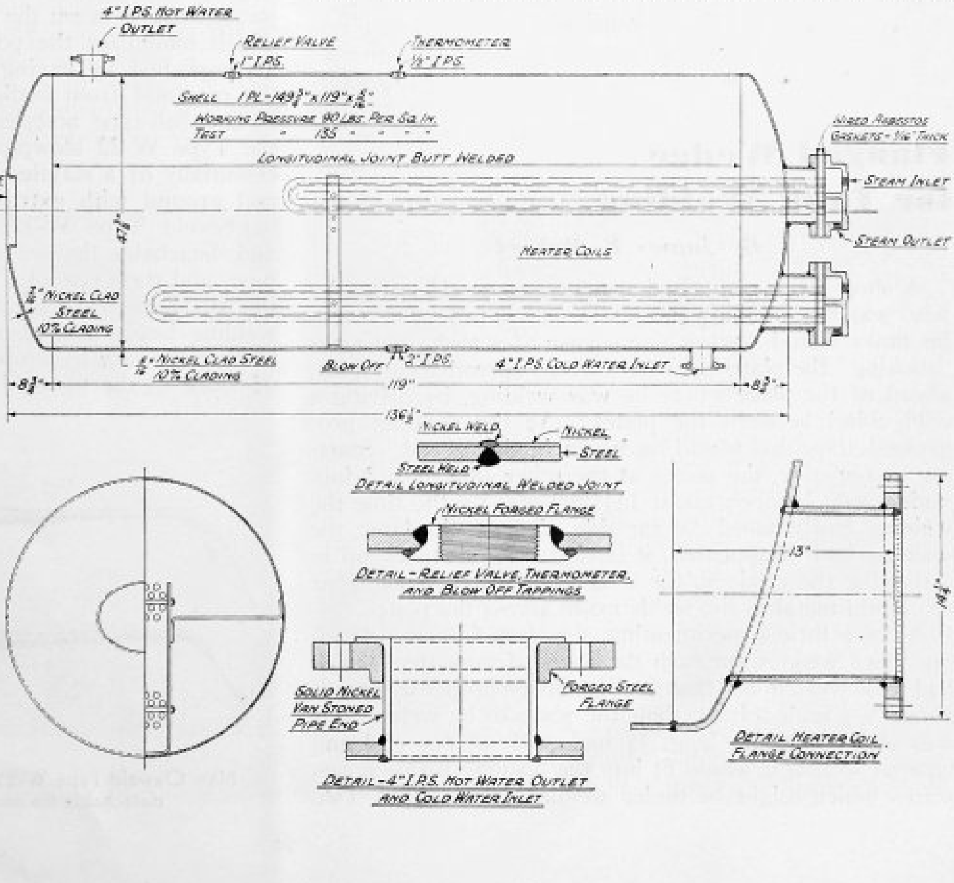


Fig.9.—(Above) Hot water heater tank, 1000 gallons capacity, 48 inches inside diameter, 11 feet 4 inches length overall. Details of construction shown at right

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. Fig. 10 represents the type of joining used in these cars. Riveting and calk welding are 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 relatively high iron content in the calk weld in lap riveted joints may, however, be objectionable for certain special applications, and the strapped butt joint with nickel straps against the clad surface will provide a means of joining that is entirely free from iron.

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. Electric rivet heaters are ideal. Rivet heating in a forge burning gas, kerosene, light distillate oils, or similar low-sulphur fuels will yield satisfactory results when operated with 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, as 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 at temperature about five minutes.

(*To be continued*)

Flanged Wedge for Tank Welding

By James F. Hobart

A shop foreman noticed that an oxy-acetylene welder who was butt-welding the plates of square or rectangular tanks would start at one corner of a tank, and after "sticking" the plates together, would spread them apart, ahead of the place where he was welding, by driving a cold chisel between the plates. As the welding progressed, the chisel would be driven further ahead. Starting at one side, the plates at the other side of a 3-foot tank would be open about 1¼ inches. By the time the welding had reached the far side of the tank plates, the opening had disappeared, it having been all taken up in satisfying the strain in the steel plates by the cooling of the liquid metal in the welds made across the plates.

After a little experimenting, the shop foreman developed two wedges for each thickness of tank steel which had to be welded into tanks. The wedge proper was made about 1/32 inch thicker than the plate to be welded. It was about 6 inches long, ¾ inch wide at one end and tapered so that it would fit into the opening between two plates which might be under welding operations. Two other wedge-shaped pieces of plate, of equal or perhaps less thickness, were riveted, one on either side of the wedge above described. The edges of these flange wedges projected ⅜ or ½ inch past the longer sides of the wedge. The three pieces were securely riveted together and then welded, so they would never come loose from each other, no matter how much the wedge might be driven back and forth with a heavy hammer.

The other wedge was made with no projecting flange on one side of one long edge. This wedge was for use when a weld was being made close to or in a corner. The wedge with four flanges was used upon seams a little away from a corner, also in the middle of any side of a tank. The flanges held the plates in line with each other, making it necessary for the welder merely to drive the wedge back as he approached it, thus losing no time in keeping the plates fair with each other.

Blowpipe Has Convenient Valve Arrangement

The Linde Air Products Company, 30 East Forty-Second street, New York, has just announced a new welding blowpipe, designated as the Oxweld Type W-22. Although it has been developed primarily for use on pipe-line work, its application is not thus restricted.

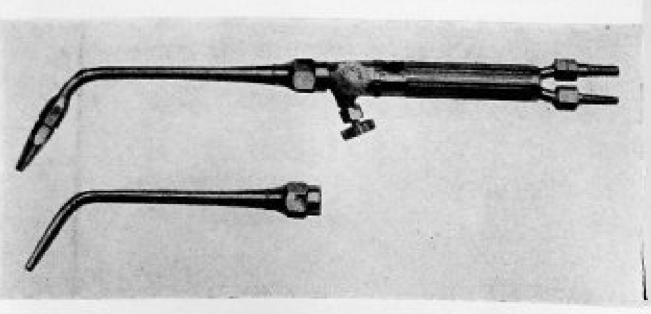
The new blowpipe is similar to the Oxweld Type W-17 welding blowpipe except that the oxygen and acetylene valves are located on the front of the handle, so that flame adjustments may be made more readily by the operator while the blowpipe is in operation.

The oxygen valve is located on the underside of the handle where it may also be easily reached. This arrangement makes it unnecessary for the operator to use his left hand, which is holding the welding rod, to adjust the blowpipe valves.

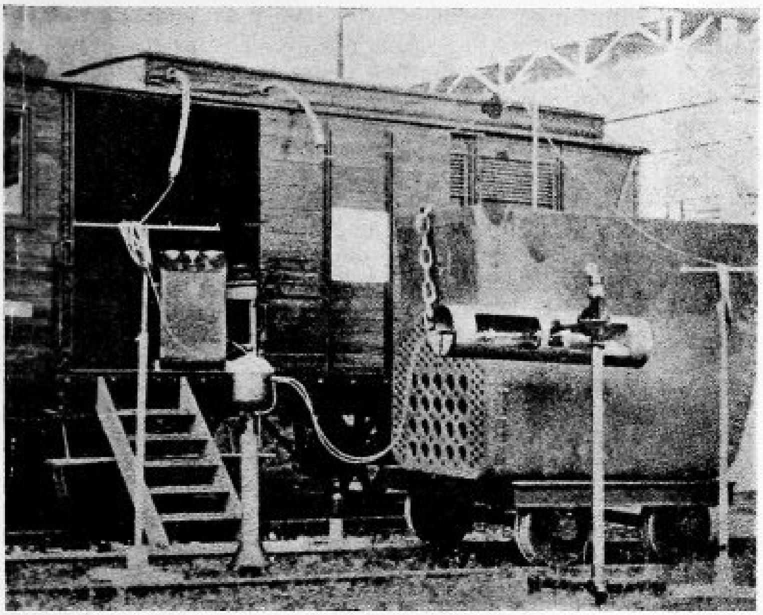
A special feature of the blowpipe is the long acetylene passageway between the acetylene valve and the injector which minimizes the possibility of flashback. This is accomplished by having three acetylene tubes between the rear and front bodies.

The ball-type acetylene valve is another feature of the Type W-22 blowpipe. This type of valve consists essentially of a stainless steel sphere which is hardened and ground with extreme accuracy by a new process.

Oxweld Type W-17 welding heads, both one-piece and detachable tip, are used with the Type W-22 blowpipe, and the Oxweld Type CW-17 cutting attachment, the W-17 to W-15 adaptor and extra long Type W-17 welding heads may also be used on the W-22 handle, so that the new blowpipe covers exactly the same range of work as the Oxweld Type W-17 welding blowpipe.



New Oxweld Type W-22 welding blowpipe, showing both detachable tip and one-piece welding heads



Testing Locomotive Details with X-Rays

The first adaptation of the Röntgen rays for the inspection and test of material and equipment on a large scale was carried out by the German State Railways in 1926, and was chiefly applied to welding. The experiments showed that both X-ray radiation (diascopy) and interference (Sach Weirt precision process) may be used to advantage if skilfully applied.

At first the tests were all carried out in the laboratory, but later means have been perfected by which the inspection of rolling stock, permanent way material, and constructional work, bridges, etc., can be undertaken. During the time practical use has been made of X-ray tests, improvement in the quality of manufacture, workmanship in material, and repairs, has been noted, as all interested in the operations are conscious that the work may be subjected to X-ray examination. Any attempt to conceal small defects by patching them up after manufacture is rendered useless by the X-ray tests.

In the workshop, finished parts of boilers, rolling stock, and driving gear, are the principal items subjected to X-ray examination. The inspection of the inner firebox after it has been fixed in position is of special importance. For these tests the X-rays are directed from the outside through the outer shell of steel, 16 millimeters thick, on to the copper plate of the inner firebox and thence through its thickness of 20 millimeters. The X-ray photographic film is applied to the inner side of the firebox plate, at the spot where it is desired to make an examination, and the rays passing through the metal record a photographic shadow image of the material on the film, clearly revealing any faults in the riveting, welded seams, burns, or similar defects. If necessary, the parts can be subjected to further examination after repair and before they are put into service; this applies to many locomotive details.

In the wagon shops large capacity goods wagons of "all welded" construction are now examined by X-rays, and the bodies subjected to inspection at those points particularly liable to stress. Welded details of bogie frames, rail motor cars, and electric locomotives, are likewise treated in this manner.

The arrangement used for securing "skiagraphs" is

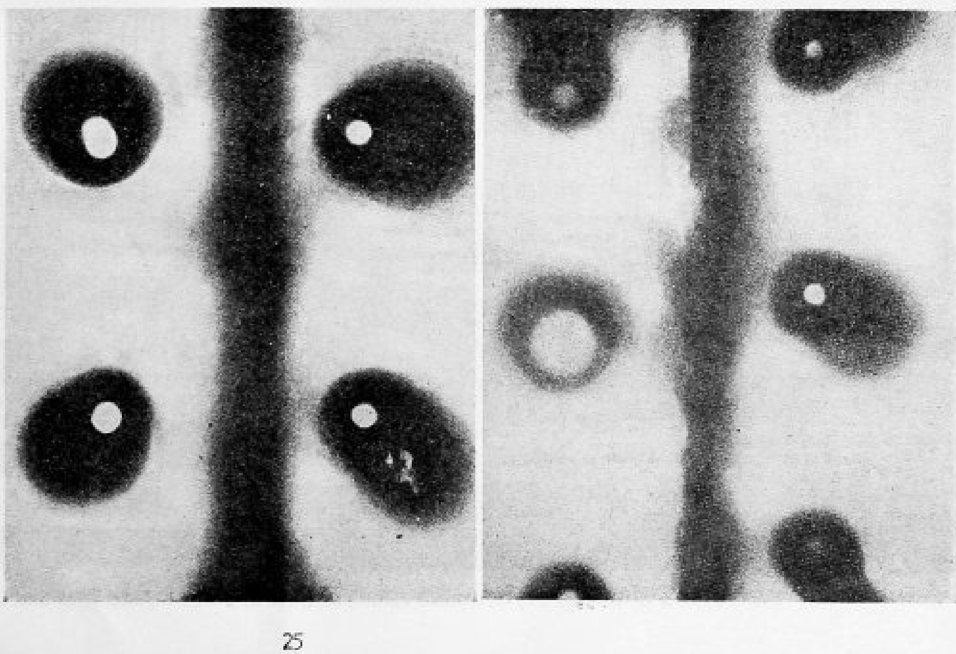


Fig. 1 (Above).—X-ray plant and car showing locomotive firebox being X-rayed. Figs. 2 and 3 (Right).—Skiagraphs of normal and imperfect weld sections of gas-welded copper, 20 millimeters thick

shown to good advantage in the illustration, Fig. 1.

A high-tension safety cable carries the requisite current to the tube from a portable X-ray plant installed in a special car standing on an adjacent track. Skiagraphs can be made at points where it is not possible to use the fluorescent screen. Fig. 1 also shows the X-ray car with a locomotive internal firebox in the process of being inspected. In the foreground is the X-ray tube in its protective shield; on the left is the water-cooling pump, and on the roof of the car, the high-tension leads may be seen.

Figs. 2 and 3 show the resulting skiagraphs of the examination of welded seams in this manner. There can be no doubt as to the deficiency of Fig. 3 as an inferior weld when compared with Fig. 2.—*The Locomotive.*

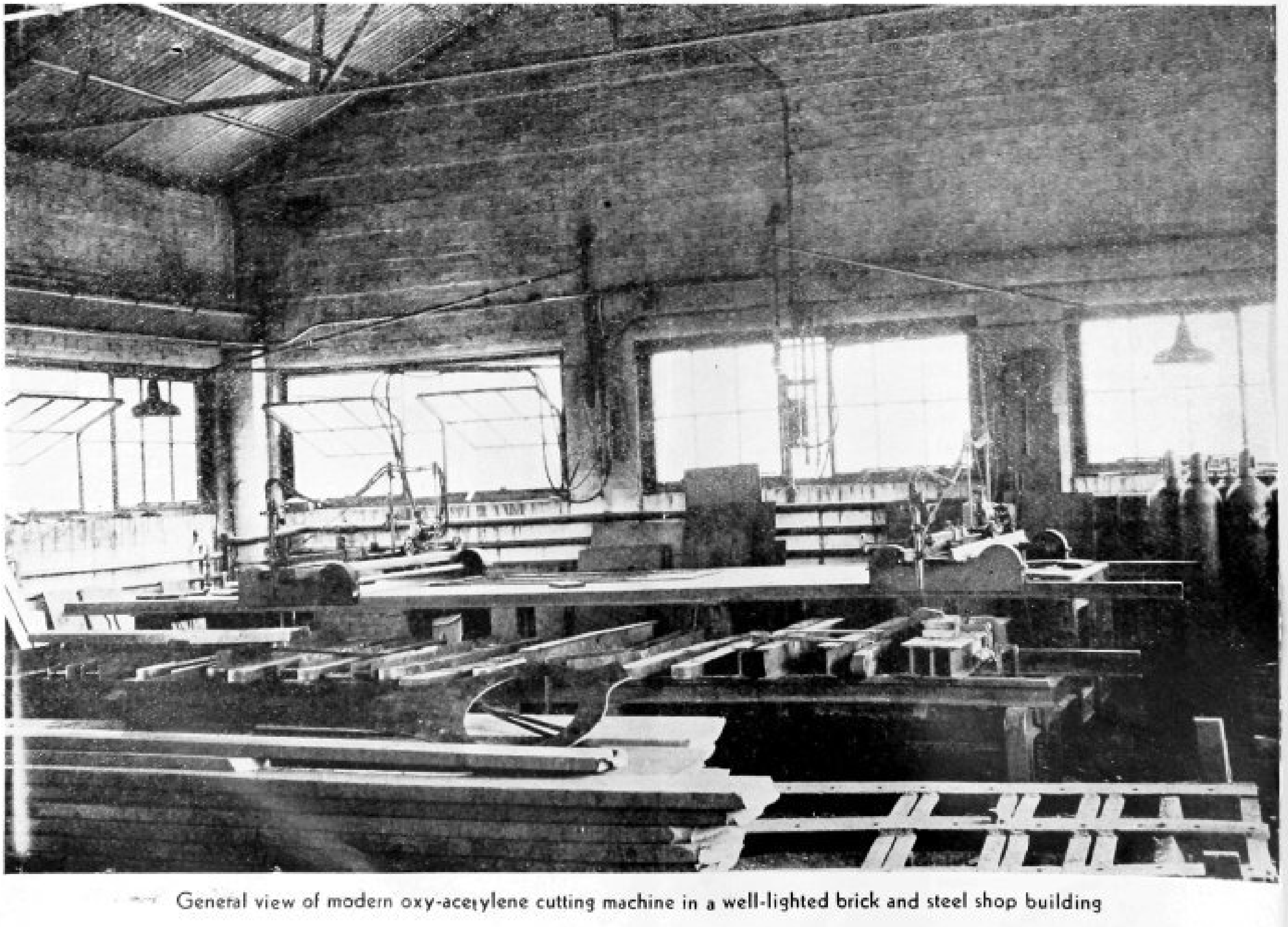
Efficient Oxy-Acetylene Cutting Machine

The illustration shows a modern oxy-acetylene cutting machine, as installed in a new building which provides unusually good lighting conditions. The installation includes the necessary furnace and crane facilities for the efficient handling of this important phase of railway repair work. Numerous cutting operations on boiler sheets, tube sheets, door sheets, and the like, can be handled by this machine.

While the illustration does not show any particular operation, several important ones are suggested. In the foreground is a blacksmith's template for a solid-end main rod. Most of the railroad shops which are equipped with cutting machines make their main and side rods by the oxy-acetylene cutting process. The general procedure is to block out the rod under the big steam hammer, leaving the ends rough and oversize and blocking out the shank square and straight, but only approximately ¼-in. over size to provide stock for machining. After the rod forging has cooled, the ends are laid out and punchmarked, leaving all dimensions ¼ in. over the finish size. These forgings are then placed in a preheating furnace and brought up to a temperature of about 1,200 deg. F. and allowed to soak. The red-hot forging is then placed in position on the cutting-machine work table where the ends are profiled, the torch being guided by a template placed on the cutting machine table.

After making both inside and outside cuts on the ends, the rod is ready for the finish machine cuts. This method of making rods shows a substantial economy over the old practice of completely machining the rought forgings. The time and cost of forging is substantially reduced, due to the fact that the blacksmith does not have to work to close limits on the rod ends while the final machining operations are reduced to a simple finishing cut which is considered desirable to remove any possible heat effect resulting from the cutting operation. The actual heat effect produced by the cutting torch does not penetrate the steel to a distance of more than .02 in. or .03 in., so that a light finishing cut removes any metal in which there might be any small heat cracks.

The pile of bar iron under the rod template in the illustration suggests a number of operations for which the cutting machine is effectively used. From stock similar to this, brake levers and equalizers of all kinds are cut at a cost substantially lower than is entailed in the manufacture of similar parts by methods previously employed.



General view of modern oxy-acetylene cutting machine in a well-lighted brick and steel shop building

Reinforcing Boiler Openings

By George M. Davies

In reply to an inquiry on the reinforcing of boiler shell openings the following explanation is given:

There are numerous openings into the water and steam space of the boiler which are necessary for proper operation and care. These may be divided into two classes:

(1)—The major openings
(a)—Handhole
(b)—Manhole

The largest diameter of unreinforced circular opening in the shell of a drum shall not exceed 8 inches, in any case, nor shall it exceed the values given by the following equations when such values are less than 8 inches:

$$d = 1.154\, t \sqrt{\frac{S}{P}\left(\frac{1.0 - K}{K}\right)} \quad (1)$$

or

$$d = \frac{1.154}{K} \sqrt{Rt\,(1.0 - K)} \quad (2)$$

$$d_1 = \frac{d + L\left(\dfrac{1.0 - K}{K}\right)}{2} \quad (3)$$

where d = maximum diameter of unreinforced circular opening, inches, which may either be single or in multiple on a line parallel to the axis of the drum and so spaced that the minimum ligament efficiency, considering any two holes, is not less than the maximum longitudinal joint or ligament efficiency used in determining the maximum allowable working pressure of the drum.

d_1 = same as (d) with the exception that the pitch of the holes on any one row is unequal.

t = minimum thickness of shell plate.

S = one-fifth of the minimum tensile strength stamped on shell plates, pounds per square inch.

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

K = ratio of computed stress in the solid plate to one-fifth of the ultimate tensile strength stamped on the plate $= \dfrac{PR}{ST}$

R = the inside radius of the weakest course of the shell or drum, inches, provided the thickness of the shell does not exceed 10 percent of the radius. If the thickness is over 10 percent of the radius, the outer radius shall be used for R.

L = the distance on the center line between the edges of the two holes with the smallest pitch where the pitch of holes on any one row is unequal, inches.

Manholes are reinforced with manhole frames or reinforcing rings.

A manhole reinforcing ring, when used, shall be of wrought or cast steel, and shall be at least as thick as the shell plate thickness.

Manhole frames on shells or drums shall have the proper curvature, and on boilers over 48 inches in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in Fig. 1.

The strength of manhole frames and reinforcing rings on any line parallel to the longitudinal axis of the shell shall be at least equal to the tensile strength of a cross-sectional area computed by multiplying the required shell plate thickness by the maximum length of shell plate removed by the opening plus the rivet holes for the reinforcement, on any line parallel to the longitudinal axis of the shell through the manhole opening.

When a flanged manhole frame is used the flanged portion of the frame may be considered as reinforcement to the depth (h) of three times the flange thickness, Fig. 2.

(a) The strength of the rivets in shear on each side of a frame or ring reinforcing manholes shall be at least

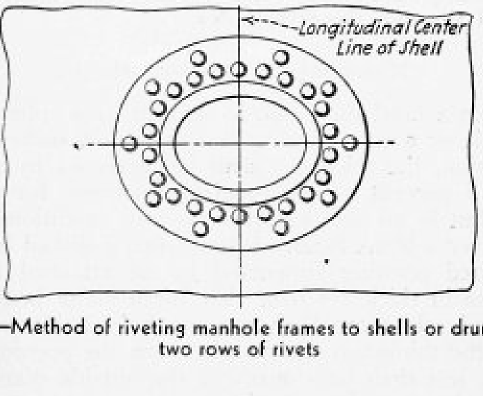


Fig. 1.—Method of riveting manhole frames to shells or drums with two rows of rivets

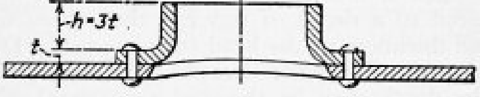


Fig. 2.—Cross section of flanged manhole frame

equal to the tensile strength of the maximum amount of shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell, through the manhole opening.

(b) The strength of the rivets in shear in the flange of a nozzle riveted to a drum shall be sufficient, on either side of any line parallel to the longitudinal axis, to equal the tensile strength of the material in the shell multiplied by the area given by the following formula:

$$A = t\,(D - d),$$

where A = area of drum shell on which strength shall be computed, square inches.

t = actual thickness of shell, inches.

D = maximum length, inches, of shell plate removed by the opening plus the rivet hoies for the reinforcement, on any line parallel to the longitudinal axis of the shell, through the opening.

Table 1. — Minimum Number of Pipe Threads for Connections to Boilers

Size of pipe connection, inches	1 and 1¼	1½ and 2	2½ to 4 inclusive	4½ to 6 inclusive	7 and 8	9 and 10	12
Number of threads per inch	11½	11½	8	8	8	8	8
Minimum number of threads required in opening	4	5	7	8	10	12	13
Minimum thickness of material required to give above number of threads, inches	0.348	0.435	0.875	1	1.25	1.5	1.625

d = largest diameter, inches, of unreinforced opening allowed by the rules in first paragraph.

The required strength of the rivets in shear in the flange of a nozzle may be computed by both (a) and (b) and the lesser of the two values used.

The strength of the rivets in tension in a flange frame or ring riveted to a drum, based on the minimum tensile strength, shall be at least equal to that required to resist the stress due to the maximum allowable working pressure with a factor of safety of five.

The tensile stress in the rivets due to the steam pressure shall be computed in the following ways:

(1) For outside calking the stress shall be equal to the area bounded by the outside calking multiplied by the maximum allowable working pressure.

(2) For inside calking (and with no outside calking) the stress shall be equal to the area bounded by the inside calking multiplied by the maximum allowable working pressure.

The rivets attaching nozzles shall be so spaced as to avoid the possibility of the shell plate failing by tearing around through the rivet holes.

Manholes in Dished Heads

When a head dished to a segment of a sphere has a 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, 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 minimum distance between the openings shall be not less than one-fourth of the outside diameter of the head.

A flanged-in manhole opening in a dished head shall be flanged to a depth of not less than three times the required thickness of the head for plate up to 1½ inches in thickness. For plate exceeding 1½ inches in thickness the depth shall be the thickness of the plate plus 3 inches. The depth of flange shall be determined by placing a straight edge across the outside opening along the major axis and measuring from the straight edge to the edge of the flanged opening. A manhole opening may be reinforced by a riveted manhole frame or other attachment in place of flanging.

(2) The minor openings:

(a) Steam:
- main outlet
- outlet for safety valves
- outlet for auxiliary steam
- outlet for injectors

(b) Water:
- outlet for gage cocks
- outlet for water gage
- outlet for blow-off valve
- outlet for scum cock
- inlet for feed water

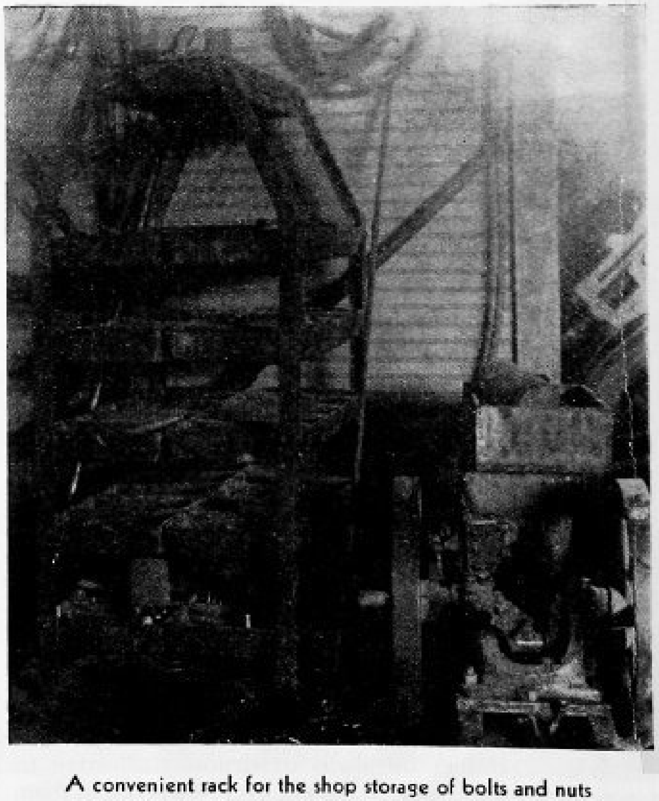
The above openings are usually threaded connections and should be reinforced under the following conditions:

All pipe threads shall conform to the American Pipe Thread Standard and all connections 1-inch pipe size or over shall have not less than the number of threads given in Table 1. For smaller pipe connections there shall be at least four threads in the opening. If the thickness of the material in the boiler is not sufficient to give such number of threads, the opening shall be reinforced by riveting to the shell or head a pressed-steel, cast-steel or bronze composition flange, or plate, so as to provide at least the required number of threads.

Catch-All for Bolts and Nuts

Every shop needs a handy catch-all rack for small bolts, nuts, etc. The one shown in the illustration is easily built from small metal baking pans. These are joined, five in a group, by bolting or welding the sides together near each end. Two groups are then joined. end to end, in the same way. A small strap is applied to the outer ends of each double group by welding or bolting and each group is then bolted to the inside of four uprights of 1½-in. by 1½-in. angles. These angles are bent and forged a few inches from the top so that a single group of five pans just fits at the top end.

There are almost innumerable kinks that add to convenience and safety in the shop. The one here described does both in that it provides a suitable receptacle for all odd bolts, nuts, rivets and the like that might otherwise be carelessly thrown on the shop floor.



A convenient rack for the shop storage of bolts and nuts

The Problem of Boiler Corrosion

By T. Millican

At a meeting of the North-East Coast Institution of Engineers and Shipbuilders, held some months ago at Newcastle-on-Tyne, the subject of boiler corrosion as experienced in England was thoroughly discussed. An abstract of the paper presented at that time is published herewith. While work on corrosion prevention in England has to a certain extent paralleled that in this country the method of approach to the problem and the results obtained offer lines of investigation with which our readers may not be familiar. Corrosion is considered in relation to the types of boilers most commonly met with in practice, special attention being given the consideration of caustic embrittlement

In the study of the causes, effects and prevention of corrosion, it will be as well to consider first what is the nature of corrosion. If the theory is correct it should cover both the corrosion of iron and that of non-ferrous metals and alloys and, actually, the recent work on the fundamentals of corrosion has shown that in many respects the same laws hold for all metals. It is intended, however, for the purpose of this paper, to consider the subject chiefly in respect of steam boilers, the term "iron" being used in a general sense and not referring to commercial forms of iron as distinct from steel. Dealing then primarily with the corrosion of iron in contact with water containing various gases, salts, etc., from traces to several percent under such circumstances the corrosion is, in effect, a solution of the metal and it is the dissolving of the metal which causes the pitting and wasting. This wastage of metals has now become such an important engineering problem that in recent years it has probably received more specialized attention than any other source of material waste.

It may be said that iron is insoluble in water, but it is found, upon investigation, that water, being the most universal solvent known, has a slight solvent effect even upon iron. It is not possible to obtain pure water by any means known to science to-day, and the presence of even minute traces of dissolved gases and inorganic salts can decidedly accelerate the corrosive action of the water.

In general it may be said that corrosion in steam boilers is brought about by two sets of opposing forces. The first of these is the solution tension, which supports solution and the initial corrosion thus started is maintained by the depolarizing effect of free oxygen and by the hydrogen-ion concentration (acidity) of the boiler water. The second is the osmotic pressure which tends to retard solution, and when these two pressures are balanced a state of equilibrium exists, stopping any further solution from taking place but, in the case of iron corrosion, unless special preventive measures are taken this equilibrium is not established because the products of corrosion of the iron are insoluble. Accordingly, more iron is free to go into solution in an effort to establish the equilibrium.

The effects of corrosion in steam boilers, feed-pipe lines, power units, bridges and other ferrous metal structures, are too well known to need description. In boiler practice the life of boilers can be reduced by many years by the use of an unsuitable and corrosive feed water, and even in periods of two or three weeks corrosion can be commenced, thus destroying the original bloom or surface skin on the metal which may act protectively. Among the types of attack most frequently met with in boilers are isolated pitting, honeycomb pitting, grooving, uniform wasting, and channeling. Pitting is probably the most destructive of boiler metal as, the action being localized, it penetrates more deeply, in a given time than does uniform wasting. The danger of the latter type is the difficulty of detecting it without drilling the plate, although it is recognized that the hammer test, in the hands of a skilled person, can detect it.

A number of theories have been advanced in explanation of the causes of corrosion, some of which have been supplemented or altered in light of recent work. Any theory, to bear investigation, must take into account the important established facts regarding corrosion, such as:

(1) That, as is well known, iron will not corrode if air is excluded, that it will not corrode in the absence of moisture, nor will it do so in the presence of moisture if the temperature is such that no moisture can condense upon its surface.

(2) The presence of oxygen is also essential if appreciable corrosion is to take place in ordinary water. Oxygen and water alone will cause corrosion even in the absence of carbon dioxide or other acids. In natural water corrosion is almost directly proportional to oxygen concentration if other factors do not change. Oxygen also accelerates the corrosion of iron in dilute acid solutions.

(3) Corrosion in acid solutions is much more rapid than in neutral solutions and in the latter corrosion is more rapid than in alkaline solutions.

(4) It is usually found that hydrogen gas is driven off from the surface of iron when corrosion takes place in acid solution, but this evolution is considerably less in neutral or alkaline solutions.

(5) The products of corrosion are chiefly ferrous oxide (black oxide) which forms next to the metal, and ferric oxide (rust) which forms the outer layer. When iron corrodes in the atmosphere, the amount of ferrous oxide is small, but when the action takes place under water this often amounts to 60 to 70 percent of the corrosion products.

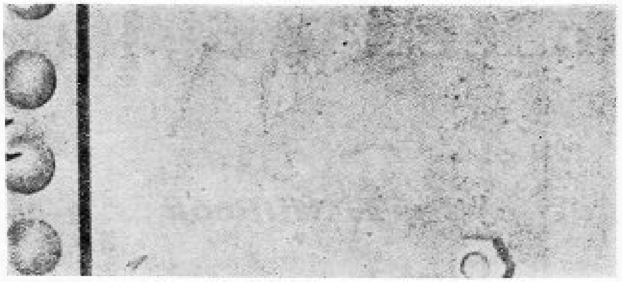
(6) Generally, the initial rate of corrosion is much greater than the rate after a short period of time, except in the case of a highly polished surface, when the initial rate is very slow. The high initial rate of corrosion is most noticeable in natural alkaline waters.

(7) The rate of corrosion tends to increase with higher rates of velocity of the water over the metal surface.

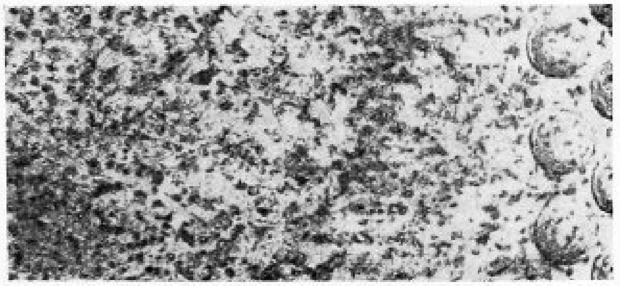
(8) The condition of the surface of the metal may not affect the total corrosion, although it may have a decided effect on the localization of the action and corrosion is infrequently uniform over the entire surface.

(9) Dissimilar metals in contact with each other, either direct or through the medium of an electrolyte, tend to accelerate local corrosion.

(10) Variation in concentration of the solution in contact with the metal tends to localize or accelerate corrosion at certain



Example of plate in a new boiler



Same boiler plate after 12 months run on untreated canal water, showing pitting

areas of the surface. When a portion of the metal is protected from the dissolved oxygen it becomes anodic to other areas which are in contact with the solution richer in oxygen, and corrosion is more pronounced at such protected areas. The smaller these protected areas, the greater is the rate of corrosion, and the result is deep pits, or even holes.

Briefly the theories advanced as an explanation of corrosion are the acid theory, the electrolytic theory, the colloidal theory and the differential aeration theory.

It was previously considered that corrosion or rusting of iron was a purely chemical action, the active agents being water, carbon dioxide and oxygen. The carbon dioxide dissolving in the water formed carbonic acid, which, by attacking the iron, formed a basic carbonate. This basic carbonate was then hydrolized by the water, forming ferrous hydrate, which, by the action of the oxygen, was oxidized to ferric hydrate, and subsequently dehydrated to ferric oxide or rust.

The electrolytic or electro-chemical theory is now generally accepted as the one which best explains the important established facts. It has been definitely established that iron is, to some extent, soluble in water; but it can only enter solution by displacing some other element already in solution. As an example, we may place a piece of iron in copper sulphate, and find it goes into solution, but it is also found that copper appears on the surface of the iron. This copper has been replaced in the solution by iron. In the ordinary case of iron immersed in water, hydrogen is the element displaced and this hydrogen gathers on the surface of the metal to form a thin protective film. The presence of this film prevents the continuance of the reaction by sealing the metal from the solution, and if it could be retained in this form, then corrosion would proceed no further than this first and very limited stage. Unfortunately, however, this hydrogen film is readily dissipated either by combination with oxygen or by escaping as a gas. Dissolved oxygen is invariably present, and it removes the hydrogen film by combining with it to form water, thus enabling more iron to go into solution. The process can continue at a rate proportional to that at which the oxygen removes the hydrogen.

Dr. Newton Friend has put forward an interesting theory, known as the colloidal theory of corrosion, which postulates that ferrous hydrate formed from the ferrous carbonate exists in colloid sol form and is still in sol form when oxidized to ferric hydrate. These hydrates of iron being alternately oxidized and reduced, act as a carrier of oxygen to the metal, or, we might say, as a catalytic agent. As colloidal ferric hydrate carries a positive charge, it is suggested that a good way of dealing with it would be to add a colloid of negative charge to the water, thereby causing mutual precipitation.

Coming now to the work of U. R. Evans, who has done much to extend our knowledge of the corrosion of ferrous metals, it is of interest to consider the action of the dissolved oxygen content of the water in setting up potential differences in different parts of the same boiler plate. It has been found that in cases where the dissolved oxygen content of the boiler water varies, electrolytic action is commenced, that portion of the metal in contact with the water having the greatest dissolved oxygen content acting cathodically. The metal with which the least oxygen is in contact being the anode, is dissolved or corroded, and in this connection the importance of thorough circulation in a boiler will be appreciated.

A case of corrosion due primarily to overheating of the metal in a Scotch marine boiler has recently been investigated by Professor C. O. Bannister, who finds that the corrosion took place through the excessive temperature causing decarburization of the surface of the metal.

The analysis of the steel tubes was satisfactory, and microscopical examination of portions of the tubes away from the deeply corroded portions confirmed this. A certain amount of sulphate scale had formed on the tubes and this, no doubt, would encourage heavy firing causing overheating of the metal. The carbon in the steel was oxidized or burned, the removal of this carbon being followed by the oxidation of the iron of the tube, causing its failure.

The various types of boilers, such as marine, stationary, and locomotive are subject to corrosion in fairly well-defined places, in connection with which must be considered mechanical stress and thermal effects on the metal, it being well known that stressed metal is more likely to corrode than metal in its normal condition. Marine boilers are attacked usually along the line of fire bars, at the ends of the tubes where joining the tube plate, along the tops of the combustion chambers, and on the screw stays. Such boilers are working under particularly severe conditions when any salt leakage is occurring from the condenser, as salt water contains large quantities of magnesium chloride, which is decomposed, as explained when considering the acid theory of corrosion.

In fire-tube boilers, when replacing tubes it is usual to find that the new tubes are protected at the expense of the old. In Lancashire boilers corrosion is most usually observed at the roots of flanges, at the points where furnace flanges are joined to end plates, and at the toes of gusset stays. In watertube boilers, steam drums and tubes may be attacked, but the conditions of circulation in these boilers vary so greatly with boiler design that the points of attack are not so definitely localized.

In locomotive boilers, conditions are somewhat similar to those obtaining in marine practice and are influenced by the metal used in the construction of fireboxes and tubes. In recent years the use of steel fireboxes and tubes has developed and, although this seems to be affected by the desire to reduce the cost of manufacture, there is much to be said in favor of this practice from the point of view of eliminating potential differences due to the use of dissimilar metals.

In connection with the corrosion of superheaters and power units, the purity of the steam is of first importance, as the presence of any electrolytes is liable to act adversely on the metal in accentuating corrosion, particularly at points where the steam is saturated. Attack of superheater tubes occurs as a rule in the first few inches of the tube on the saturated steam side, while the attack of turbine blades is most noticeable in the lower-pressure stages. This is due to the fact that as the steam becomes saturated slight condensation occurs, the condensed water dissolving traces of any salts which may have been carried over mechanically with the steam and also gases which are chiefly responsible for the corrosion.

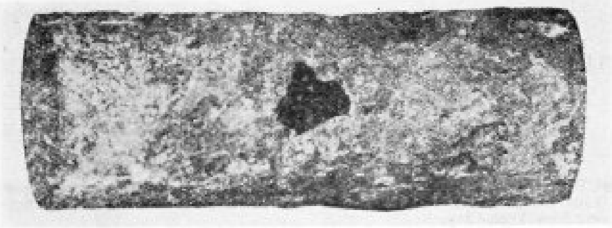
The multiplicity of conditions which favor the tendency to corrode and the numerous factors controlling the rate and extent of corrosion are so great that it will be readily agreed that there can be no universal specific remedy for the prevention of corrosion in boilers, and it can be further suggested that almost every case of corrosion may be a law unto itself, warranting individual and thorough investigation. Dealing with those forms of corrosion most commonly encountered, there have been numerous methods of treatment adopted with varying measures of success, but whatever the remedy adopted, it has in general been considered that oxygen should be dealt with effectively.

While considering this question of modern high pressure it has to be remembered that pressures of 400 pounds to 800 pounds per square inch are quite common and in a number of instances boilers are in commercial operation at 1200 pounds per square inch. The first consideration in such cases, of course, must be the elimination of any deposit on the heating surfaces, whether such deposit might be considered as a protection against corrosive action or not, as such deposit would interfere with the flow of heat through the metal and cause disastrous failure.

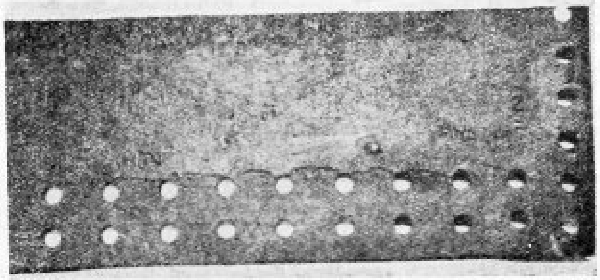
Practically all materials with which natural water comes in contact are soluble and their solubility is greatly increased by the presence of carbon dioxide or alkalies in the water. Consequently, most natural waters are impure, many entirely unsuitable as feed water without proper treatment. In some cases a satisfactory water cannot be produced by treatment and there is no alternative but to use distilled water. In a few localities, natural water is good enough to use without treatment in so far as scale deposits are concerned, but no water can be safely used without treatment for the prevention of corrosion.

The amount of oxygen which will support excessive corrosion may vary between 0.5 cubic centimeters to 1 cubic centimeter per liter, and, as natural waters contain up to 6 cubic centimeters per liter, it is evident that some method of either removing the oxygen or of rendering it innocuous must be provided. This may be accomplished either by installing a de-ærating plant or by introducing a substance having an avidity for oxygen. In this latter case, however, care must be exercised in choosing the corrosion inhibitor as, if the older methods dependent merely upon high degrees of alkalinity are adopted, there may be serious danger of producing conditions which will give rise to caustic embrittlement.

Acid boiler feed water usually originates from the drainage of mines, swampy land and industrial waste, or results from the decomposition of magnesium chloride, especially under high boiler temperatures and pressures. Occasionally, when the water comes from marshy land covered with vegetation, the water is polluted with mixtures of organic acids. These are volatile and, unless neutralized by the addition of alkaline reagent, result in impure and corrosive steam.



Badly corroded tube showing pitting and wasting



Shell plate from locomotive boiler, showing failure caused by caustic embrittlement

Fatty acids derived from lubricants containing animal or vegetable oils may be carried over to the feed water by returned steam from auxiliaries, and since the animal or vegetable constituent is responsible for the corrosive action of lubricating oils, it is preferable to use lubricants having a pure mineral oil base.

Various parts of a boiler plant are subject to external corrosion, this being due in the majority of cases to sulphur compounds present in the fuel. Such attack is particularly evident in the case of economizers, where cold water entering is liable to cause a condensation of water vapor on the outside of the tubes at the cold end, the vapor thus condensed dissolving sulphur gases and ultimately forming sulphuric acid. This, of course, brings about rapid deterioration of the metal, and it is to avoid this condensation that economizer manufacturers recommend that the water fed to the economizers should be at as high a temperature as possible, in any case not less than 100 degrees F. Where the temperature of the feed water entering an economizer is not considered to be sufficiently high, matters may be improved by the installation of a circulating system.

Having regard to the modern tendency of increasing boiler pressures and the previous mention of the danger in employing old methods of guarding against corrosion merely by the addition of alkaline substances, it is proposed to outline briefly the defects which may arise due to excessive concentration.

The effect of maintaining in the boiler high concentrations of hydrate or caustic alkalinity is to loosen the crystals of the metal, probably by the removal of the sulphides and oxides from the grain boundaries, forming minute hair-line cracks in portions of the metal where the crystal structure is such that a crack can readily be formed. These cracks, of course, follow the grain boundaries, and do not split across the crystal face as in the case of fractures caused by stress. These cracks usually occur where caustic soda may become more concentrated than in the body of the boiler water, in such places as riveted seams or perhaps in small cracks around rivet holes, and where the plate is subject to stress these cracks may widen and extend until they eventually cause failure.

In conclusion, there is no doubt that engineers who are responsible for the maintenance of boiler plants are recognizing with increasing conviction the necessity for wider knowledge of the subject of corrosion, its causes and effects.

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Communications

Replacing Rivets

To the Editor:

I have been very much interested in reading the two articles on replacing rivets below the waterline, one by Mr. Joseph Wilson on page 241 of the November issue of The Boiler Maker, the other by Mr. James F. Hobart, page 259, December issue.

For Mr. Hobart's information I will explain the system used by myself in replacing a rivet in a frame 15 feet below the waterline on the steamer *Paulette* in the Williamette River at Portland, Ore., seven or eight years ago.

I had a ⅞-inch countersunk head bolt made about 1 inch longer than required and threaded. I had the threaded end turned down to ⅝ inch diameter for ¾ inch back and a 1¼-inch hole drilled through the ⅝-inch end, through which I attached a string. I cut a piece of sheet lead ⅛-inch by 3 inches by 3 inches and punched a hole in the center of the lead to fit the body of the bolt snugly. I took a piece of template wood ¼ inch by 4 inches by 18 feet, and, placing the bolt in lead washer stood the bolt on its head at one end of the template wood and tacked down the four corners of the lead washer thus holding the bolt perpendicular. Now with the string attached to the bolt I was ready to "fish" the bolt in—which was accomplished with some difficulty on account of the swift river current twisting the long strip of template wood. After the bolt was drawn up I pulled the template wood loose from the washer.

My system for floating the string was similar to Mr. Wilson's.

Portland, Ore. W. H. Aldridge.

Safety Stirrup for Plate Slings

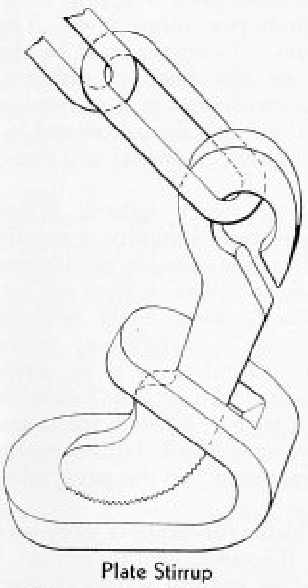

Plate Stirrup

To the Editor:

The writer designed the plate stirrup shown for the safe and quick gripping and lifting of plates. A study of the sketch will show how simple it is to make and practical. It has no pins or bolts to shear or wear. It is rugged and safe, being made of course from boiler plate steel in sizes to suit the loads to be lifted.

We made our stirrups out of ⅝-inch plate and find that they stand severe service. Hardly any description is needed as the sketch shows the idea plainly.

Penacook, N. H. C. H. Willey.

Opening Pipe Ends

To the Editor:

A simple method of clearing pipe of the inside flanges left by various methods of pipe cutting, when reaming is not specifically called for, is to drive a tapered pin of the proper size into the end of the pipe. The pin will loosen and remove part of the cuttings and smooth out the more stubborn, clearing the interior of the pipe practically to normal diameter.

Alhambra, Cal. C. B. Dean.

Questions and Answers Pertaining to Boilers

By George M. Davies

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.

Pressure on Safety Value

Q.—A boiler has 2½-inch safety valve; what pressure is under the seat when the valve is blowing 100 pounds steam pressure?—G. M.

A.—The pressure is 100 pounds per square inch. At the popping point a properly designed spring valve will lift its maximum, say 0.15 inch, and this lift will decrease approximately 0.01 inch per pound that the pressure in the boiler falls below the setting point, until the closing point, which is at from 4 to 5 pounds below the popping point. Other pressures may force the lift slightly with such a valve, but not sufficiently to make these pressures necessary to obtain the full valve efficiency. In specifying spring valves, therefore, an over pressure should not be allowed, at least not over 1 or 2 pounds.

Blow-Down Tank

Q.—What is a blow-down tank? Where is it located? What connections has it? Name all and why?—C. C.

A.—A blow-off tank, Figs. 1 and 2, is a cylindrical vessel made of boiler plate and set in some convenient location below the level of the boiler blow-off orifice. The boiler blow-off pipe is connected directly to it. Its

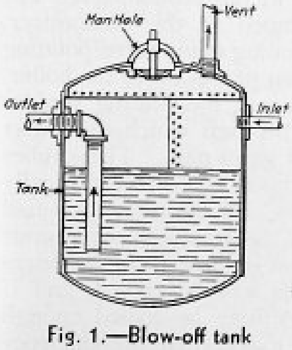

Fig. 1.—Blow-off tank

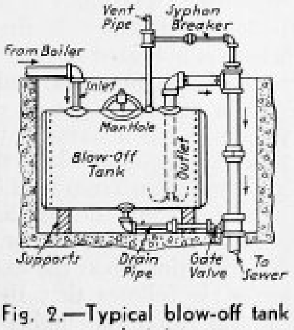

Fig. 2.—Typical blow-off tank and piping

function is to trap the hot discharge from the boilers. The entrapped water cools in the interval following a blow-down of the boilers. The water thus cooled is displaced by the hot water discharged from the boiler in the next succeeding blow-down. By this means the damage to sewer which would result from discharging the hot water directly into it is avoided. The syphon breaker, Fig. 2, prevents a syphoning action through the outlet extension into the tank.

The piping connections to a blow-off tank should be so proportioned and arranged that the pressure within the tank cannot become excessive. Blow-off tanks are not designed as pressure tanks and hence are liable to explosions if subjected to considerable internal pressure. To protect a blow-off tank from explosion, a vent pipe of a size greater than that of the blow-off pipe inlet should be provided direct to the atmosphere. Also, the water connection to the sewer should be of a size larger than the steam inlet to the tank.

Boiler Working Pressure

Q.—A boiler 60 inches diameter, ⅜ inch thick, tensile strength unknown, sixty 3-inch tubes. What would be the allowable working pressure according to the regulations? Boiler built in 1920.—J. C.

A.—The A. S. M. E. Boiler Construction Code gives the following rules for determining the maximum allowable working pressure on existing installations:

A-22. The maximum allowable working pressure on the shell of a boiler or drum shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength of the plate, the efficiency of the longitudinal joint, the inside diameter of the course and the factor of safety allowed by these rules.

$$\frac{TS \times t \times E}{R \times FS} = \text{maximum allowable working pressure, pounds per square inch.}$$

where:

TS = ultimate tensile strength of shell plates, pounds per square inch.

t = minimum thickness of shell plate, in weakest course, inches.

E = efficiency of longitudinal joint, method of determining which is given in Par. P-181.

R = inside radius of the weakest course of the shell or drum, inches.

FS = factor of safety allowed by these rules.

A-23. Boilers in service one year after these rules become effective shall be operated with a factor of safety of at least 4 by the formula, Par. A-22. Five years after these rules become effective, the factor of safety shall be at least 4.5. In no case shall the maximum allowable working pressure on old boilers be increased, unless they are being operated at a lesser pressure than would be allowable for new boilers, in which case the changed pressure shall not exceed that allowable for new boilers of the same construction.

A-24. The age limit of a horizontal-return-tubular boiler having a longitudinal lap joint and carrying over 50 pounds pressure shall be 20 years, except that no lap joint boiler shall be discontinued from service solely on account of age until 5 years after these rules become effective.

A-25. Second-hand boilers, by which are meant boilers where both the ownership and location are changed, shall have a factor of safety of at least 5½, by the formula, Par. A-22, one year after these rules become effective, unless constructed in accordance with the rules contained in the Power Boiler Section, when the factor shall be at least 5.

A-29. *Tensile Strength.* When the tensile strength of steel or wrought iron shell plates is not known, it shall be taken as 55,000 pounds per square inch for steel and 45,000 pounds per square inch for wrought iron.

The data given in the question is not sufficient for computing the allowable working pressure on the boiler, as there is no information given for determining the efficiency of the longitudinal joint.

Feed-Water Heaters and Economizers

Q.—What three types of feed-water heaters are there and how are they connected?—W. L.

A.—*Feed-water Heaters.* In most plants, all or some of the steam is exhausted at atmospheric pressure. If this steam is exhausted to the air all of its heat is wasted. Some of this heat may be used to heat the boiler feed water by running the exhaust steam through a feed-water heater and extracting its heat of vaporization. There are two types of heaters, the open and the closed.

In the open feed-water heater the steam comes in direct contact with the feed water, which is made to flow over shallow pans, thus exposing a large area to the steam. The temperature of the water is thereby brought near the boiling point. If the water is hard, a large part of the scale-forming materials will be deposited on the pans, which may be easily removed and cleaned. Fig. 1 shows a common form of open heater and its connections. A skimmer is provided to remove the oil that comes in with the exhaust steam and there is also a filter to purify the feed water. The purpose of the open heater is thus seen to be twofold—to utilize the heat that would otherwise be wasted, and to purify the water.

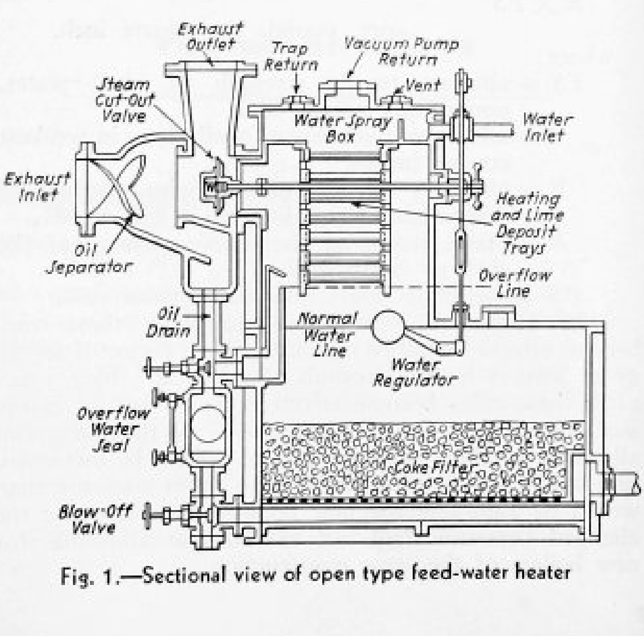

Fig. 1.—Sectional view of open type feed-water heater

In the closed type, Fig. 2, the steam is led through tubes around which the feed water is forced to flow. If the water is very hard, the tubes are liable to collect scale, which hinders the operation of the heater.

Economizers. In the ordinary steam plant, the flue gases pass up the stack at a temperature of about 500 degrees F. This temperature usually will be higher than that of the steam and water in the boiler, since the latter gets its heat from the gases. Moreover, the higher the steam pressure and its temperature, the hotter will be the flue gas. The tendency during the past few years has been to use higher pressures, which means a greater loss of heat up the stack than with low pressure.

In order to utilize a part of this heat that otherwise would be wasted, economizers are sometimes installed between the boiler and the stack. The economizer is simply an added heating surface in the form of water tubes about which the products of combustion pass on their way to the stack. At best the feed water will be at a temperature of only 212 degrees as it enters the boiler, if it has been heated with exhaust steam at atmospheric pressure. Considerable heat can be added before it reaches the boiling point when under high pressure. This heat is added in the economizer. The boiler feed water is first pumped to the economizer, where it is heated to near the boiling point corresponding to the boiler pressure, and it then passes on to the boiler.

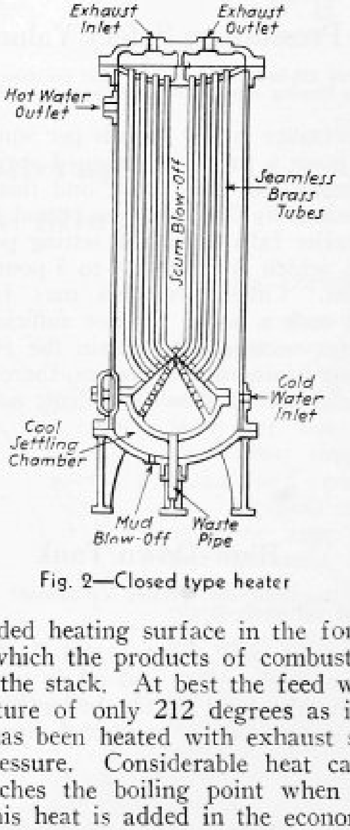

Fig. 2—Closed type heater

In a common type of economizer, the heating surface is composed of vertical tubes through which the water flows and around which the hot gases pass. These tubes are kept clean from soot by scrapers that are continually moved up and down the tubes, by means of a small engine or electric motor. As the economizer depends for its action upon the extraction of heat from the burnt gases, it follows that the gases will be cooled, and if natural draft be employed they may be cooled enough to reduce the draft to such an extent that the efficiency of the whole plant may be lowered. If forced draft is used this objection does not hold to so great an extent. In any case, the economizer offers some resistance to the gases, with a corresponding lowering of the draft.

Whether or not an economizer will effect enough of a saving to pay for itself must be determined in each individual case.

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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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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
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

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.		Tampa, Fla.

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

States

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

Cities

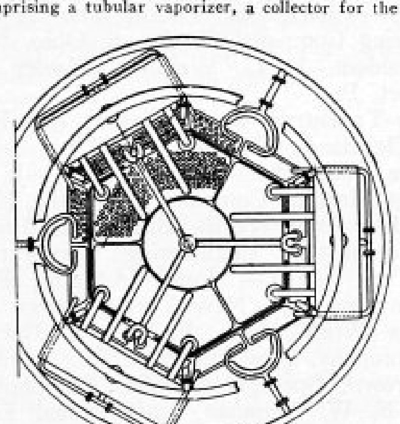
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

Selected Boiler 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.

1,793,867. STEAM GENERATOR. JULES NICLAUSSE AND ALBERT NICLAUSSE, OF PARIS, FRANCE.

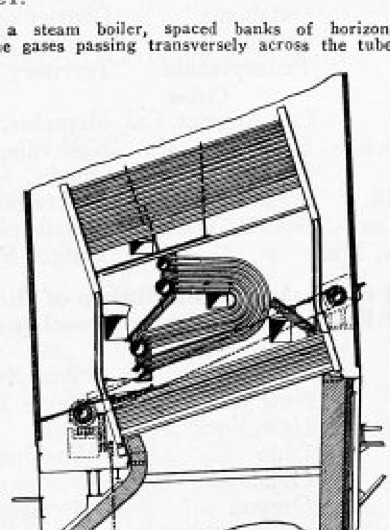
Claim.—In a steam generator including a combustion chamber, the combination of a plurality of units, each forming in itself a complete steam generator comprising a tubular vaporizer, a collector for the said vaporizer,



a superheater and a feed-water heater, the walls of the said combustion chamber being formed by the said vaporizers and the ceiling of the said combustion chamber being formed by the said collectors, means for causing the products of combustion, after passing the vaporizers, to pass to the superheaters and from thence to the feed-water heaters and means for protecting the said collectors against the direct action of the heat due to combustion. Two claims.

1,776,835. SUPERHEATER STEAM BOILER. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

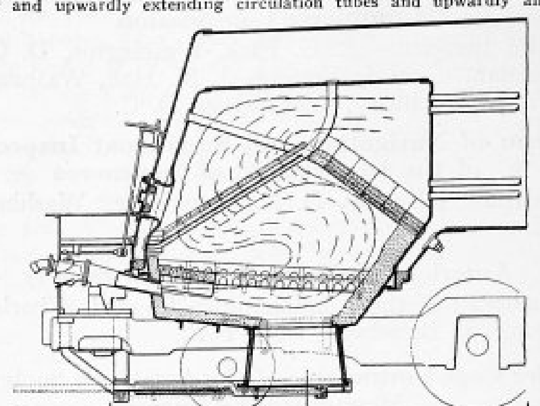
Claim.—In a steam boiler, spaced banks of horizontally extending watertubes, the gases passing transversely across the tubes of the lower



bank for substantially their entire length, a steam heater located in the space between the two banks and extending short of the side wall of the space between the banks, and a damper for regulating the relative amounts of gases flowing over said steam heater and through the space between said steam heater and said wall. Eighteen claims.

1,789,697. PULVERIZED COAL-BURNING LOCOMOTIVE. VIRGINIUS Z. CARACRISTI, OF BRONXVILLE, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS TO VIRGINIUS Z. CARACRISTI.

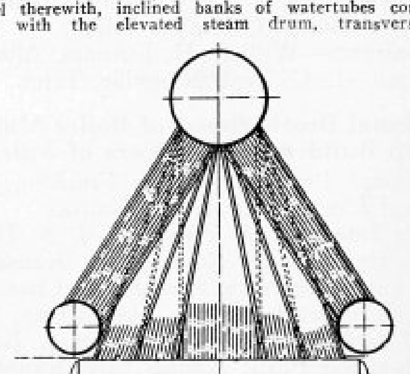
Claim.—In a pulverized fuel burning locomotive, a firebox having rearwardly and upwardly extending circulation tubes and upwardly and for-



wardly extending circulation tubes crossing one another, burner means at the rear of the box for admitting fuel beneath the tubes in a forward direction, an arch carried by the first tubes and extending for the width of the box part way from the front to the rear leg, and an arch carried by the second tubes and extending from the first arch part way to the rear leg. Nine claims.

1,789,799. WATERTUBE BOILER. HAROLD EDGAR YARROW, OF GLASGOW, SCOTLAND.

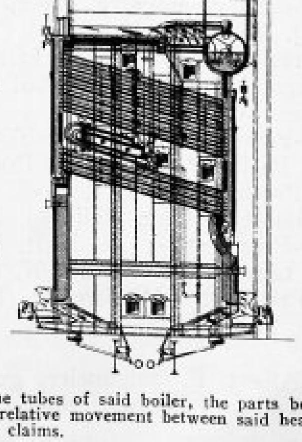
Claim.—In a watertube boiler, an elevated steam and water drum, water drums parallel therewith, inclined banks of watertubes connecting said water drums with the elevated steam drum, transversely disposed



auxiliary water drums arranged parallel and adjacent to the lower parts of of the side walls of the furnace, and water tubes connecting said auxiliary drums with said elevated steam and water drum, said watertubes consisting of straight tubes arranged in groups, said groups being arranged fanwise and converging from each auxiliary water drum towards the elevated steam drum and the tubes of each group being parallel with each other but inclined with respect to the tubes of adjacent groups. Two claims.

1,775,079. SUPERHEATER BOILER. WILLIAM A. JONES, OF WEST NEW BRIGHTON, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J.

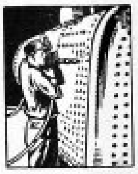
Claim.—In a superheater watertube boiler, a superheater having a header extending beneath some of the watertubes and means to suspend



said header from the tubes of said boiler, the parts being constructed and arranged to permit relative movement between said header and said watertubes. Thirty-four claims.

The Boiler Maker

Reg. U. S. Pat. Off.



There Will be a 1933 Convention

Changed conditions make necessary a different approach to problems in order to obtain any desired result. This principle is being adopted by the Master Boiler Makers' Association to maintain the interest of its members at a time when it is not possible to hold its usual convention. Through the co-operation of the officers of the association, and the active work of the secretary, the plan was conceived that every phase of the convention but personal contact could be carried out in a special issue of The Boiler Maker.

The plan contemplates addresses by prominent railroad officers, by the president of the association, by the president of the Boiler Makers' Supply Men's Association, the publication of papers on topics of particular importance to the conduct of shop work and a complete descriptive exhibit of new tools, materials and equipment developed for the boiler shop. This convention issue of The Boiler Maker will be used as the basis for discussion of committee reports by members of the association, and after the lapse of two months written comments from members will be published.

If the plan is well supported, the complete proceedings with the discussion, description of tools and equipment, and special advertising will be published in reprint form and distributed to all members and important railway mechanical officers. As further details are developed they will be commented upon in these pages.

The foregoing briefly outlines the basic plan. Below the surface, however, the idea goes far towards correcting the major difficulty confronting members of the association, namely, that of maintaining their morale and interest in their chosen trade. In this direction the convention in the pages of The Boiler Maker will keep alive the spirit that made meetings of the Master Boiler Makers' Association outstanding among those of the railroad groups in sincerity of purpose and in practical value. It will offer members of the association an opportunity to prove to their superiors that, in spite of adverse conditions, the association is striving to contribute its share towards rehabilitation.

The supply trade will have the opportunity through the exhibit in the pages of the convention issue to present all of the developments in tools and equipment for boiler work that have occurred during the past two years, and permanently to place them on record before not only members of the association but the entire industry as well. With a sustained upward trend in railroad income, the issue should prove to be opportune for carrying the supply trade message before the field.

In order for this convention to be successful, it must have the full co-operation and support of officers of the association, of members appointed on committees for preparing reports, of members in discussing reports and upon the support of the supply companies.

The secretary of the association and all others on whose shoulders the burden of carrying out the details will fall solicit that support.

Is Railroad Business Improving

Several articles in this issue on the subject of business improvement and preparing for it might offer a cause for skepticism in the minds of many readers. From day-to-day developments, there would seem to be little reason for optimism but the general picture of the last six months of 1932, particularly in the railroad industry, tells a different story.

It is generally conceded that railroad activity is one of the more important measures of current business conditions. Possibly few of our readers are aware of the improvement in net operating income of this basic industry in recent months.

Beginning with the comparison of July, 1931, and July, 1932, figures, the net operating income of the railroads showed a loss in 1932 of about $45,000,000. The actual figures are for July, 1931, $56,960,200 and for July, 1932, $11,596,852. The August comparison shows a difference roughly of $28,000,000; September, $5,500,000; October only about $500,000; November, less than $3,000,000, and in December the net operating income for 1932 exceeded that for 1931 by over $5,000,000. This was the first month since September, 1929, that an increase over the corresponding month of the previous year had been apparent. While official figures are not available for January, the upward trend shows no sign of abating.

Another extremely important indication that conditions actually have improved becomes evident in the amount of railroad employment. In August, 1932, there were approximately 967,000 individuals employed by the railroads. In September the number had increased by 14,000; in October by 40,000 and, in spite of a slight decline for November, the number was still better than August.

There can be no question as to the necessity for rehabilitating the physical equipment of the railroads. Certainly from the foregoing, evidence is not lacking as to the gradual improvement of railroad financial conditions. Further, more men employed means more materials to work. Conservatively, every branch of the industry from the executive officers and personnel to the supply group should feel encouraged that the road to recovery is open.

Advantages and Disadvantages of Higher Locomotive Boiler Pressure

In order best to determine the economic value of the higher pressure locomotive in the scheme of future boiler developments, the American Railway Association, Mechanical Division, has consistently followed the advances made towards increased efficiency by raising pressures. The data presented in its last report on this subject constitute a concise review of records made with such power. It is obvious that future locomotives will be designed on the basis of the experience gained by individual railroads with the power outlined in this report

At the last annual meeting of the American Railway Association, Mechanical Division, the committee on locomotive construction in its report presented a survey of the experience a number of important railroads were having in the use of power operating under boiler pressures higher than was customary practice a few years ago. The replies to inquiries of the committee furnished a wide range of information on this important development of comparatively recent designs. Table 1 contains the data submitted by individual roads covering the number, type, date built and working pressures of locomotives coming under this category.

Summarizing all locomotives listed of conventional fire-box type, of the 2889 total, there were:

378 carrying 220 pounds pressure
713 carrying 225 pounds pressure
21 carrying 230 pounds pressure
51 carrying 235 pounds pressure
103 carrying 240 pounds pressure
25 carrying 245 pounds pressure
1416 carrying 250 pounds pressure
37 carrying 255 pounds pressure
21 carrying 260 pounds pressure
31 carrying 265 pounds pressure
90 carrying 275 pounds pressure
2 carrying 300 pounds pressure
1 carrying 325 pounds pressure

In 220 pounds pressure there were 378 locomotives covered.

In 225 pounds pressure there were 713 locomotives covered.

In 250 pounds pressure there were 1416 locomotives covered.

The committee report in 1928, mentioned that for radial stayed boilers, the practical limit of high pressure would be 250 pounds; since, the pressures have been stepped up to—

265 pounds—1926, 1928, 1930
275 pounds—1927, 1930
300 pounds—1927, 1930

The railroad commenting on the 300-pound pressure locomotives advises "Our experience indicates that the use of 275 and 300-pound pressure has enabled the reduction of the total weight of the locomotive per horsepower developed, comparison having been made with locomotives of 220 pounds pressure and less.

* * * Indications are that the greatest difficulty found is with the lubrication, maintenance of piston valves and valve gear * * * and it may be desirable and probably necessary to discard the piston valve in favor of some form of valve, such as the poppet valve, which does not require lubrication."

Following is a digest of the reports of the several railroads:

Canadian Pacific Railway

4-8-4 type locomotives used in heavy passenger service, trains operating between Montreal and Toronto.

2-10-4 type locomotives, operating in Mountain Sub-Division on B.C. District, both passenger and freight service. Maximum speed restrictions 45 to 50 miles per hour.

4-6-4 type locomotive in general use, fast passenger service—Eastern and Western Lines.

All the boiler shells built of nickel steel to save weight in boiler.

Arch tube location, air admission and ash pan construction received careful attention.

These locomotives have been in service since 1928 and demonstrate that they require less maintenance than carbon steel boilers operating at 200 pounds pressure * * *.

The performance of the 275-pound pressure locomotives have been improved, both mountain and high-speed service, that is, added capacity due to reduction in drop of the admission pressure and added economy through higher pressure * * *.

Engines on eastern lines operating in flat passenger schedule run 69 miles per hour * * *.

The engines have demonstrated a reserve capacity to work at average speed of 10 miles higher than scheduled. * * *

Common method employed by the engineers in operating these locomotives in most severe service is to carry a pressure of 260 to 268 pounds and for unusual, adverse conditions or with extra heavy trains, the pressures are increased to the maximum. * * *

Canadian National Railways

Has, beginning with 1927, used on 136 locomotives, high-tensile silicon steel in barrel courses, dome liners and welt strips; this allowed the use of thinner sheets and reduced the weight of boiler; all staybolts were made of steel.

New York Central Lines

During the past year, we placed in service two 4-6-4 type 225-pound pressure locomotives with nickel-steel shell courses for experimental purposes, and there is nothing at this time which we can give you regarding this material comparatively.

Chicago and North Western Railway Company

Used both in freight and passenger service and in order to obtain the greatest economy, the locomotives should be built with steam pressure not less than 250 pounds. At present have the following engines operating:

12—2-8-4 type 240 pounds pressure—freight service.

35—4-8-4 type 275 pounds pressure—freight and passenger service.

Lehigh Valley Railroad Company

These two locomotives are practically duplicate with the same size boilers and details, one has a boiler pressure of 250 pounds and the other 255 pounds. One was built by the Baldwin Locomotive Works and the other by the American Locomotive Company.

The entire boiler is made of nickel steel with the exception of the syphon and smoke box sheet * * * .

The firebox and combustion chamber have a complete installation of a two-piece hollow drilled flexible staybolt. The seat for the head of the bolt is made in the wrapper sheet and the shell sheet, and the cap welded on to the wrapper and shell sheets.

Crown and side sheets of the firebox are made in three pieces, with a longitudinal weld on either side.

The wrapper sheet is made in three pieces, the upper portion, the crown of the wrapper sheet being made thicker than the sides, so as to provide plenty of thickness to obtain a good seat for the staybolts, on account of some of the angles at which the staybolts pass through the wrapper sheet.

Another feature of these boilers is that the firebox and combustion chambers are welded in.

There are no rivets used in the application of the firebox.

Insofar as maintenance is concerned, we have had no trouble to date—these locomotives were designed to haul 3000 tons in fast freight service, Buffalo to Jersey City, and on the test runs, they have more than exceeded our expectations.

Chicago Great Western Railroad Company

These 2-10-4 type locomotive, 84,600 pounds T. P. increased to 97,900 pounds T. P. with booster, operate in freight service and handle trains up to 3000 gross tons on 1 percent ruling grades approximately five miles long with maximum of 1.3 percent.

The Pennsylvania Railroad Company

There were 10 radial-stayed boiler locomotives built with 225 pounds pressure and 991 Belpaire firebox locomotives built with 250 pounds pressure.

All locomotives with the exception of two are more than 10 years old and all have given good service from the repair standpoint, and we can see no difference in the

Table 1.— Higher Pressure Locomotives

Railroad	Number Locomotives	Boiler Pressure	Type	Year
Canadian Pacific Railroad	2	275	4–8–4	1928
	20	275	2–10–4	1929
	20	275	4–6–4	1929
Canadian National Railroad	60	250	4–8–4	1927
	17	250	4–8–4	1929
	15	250	2–10–2	1929
	18	250	2–10–2	1930
	1	265	2–8–2	1930
	5	275	4–6–4	1930
	20	250	2–8–0	1931
	45	220	2–8–0	1931
New York Central Railroad	300	225	4–8–2	1925 1930
	205	225	4–6–4	1927 1931
	20	240	4–6–4	1928 1930
	55	240	2–8–4	1926 1930
Great Northern Railroad	14	225	2–8–8–2	1930
	16	240	2–8–8–2	1931
	6	250	4–8–4	1930
	14	225	2–8–4	1930
Chicago Northwestern Railroad	12	240	2–8–4	1927
	35	275	4–8–4	1929
Bessemer & Lake Erie Railroad	10	250	2–10–4	1929
Lehigh Valley Railroad	1	250	4–8–4	1931
	1	255	4–8–4	1931
Chicago, Burlington & Quincy Railroad	12	250	4–6–4	1930
	18	250	2–10–4	1927
	8	250	2–8–4	1930
Chicago Great Western Railroad	36	255	2–10–2	1929
Southern Pacific Railroad	10	250	2–6–0	1928
	4	250	4–8–0	1930
	49	225	4–10–2	1925
	26	235	4–8–8–2	1928 1929
	25	250	4–8–8–2	1930
	10	250	4–8–4	1928
Delaware, Lackawanna & Western	6	250	4–8–4	1927
	20	235	4–8–4	1929
	1	220	4–8–2	1925
Pennsylvania Railroad	90	250	0–8–0	1922 1930
	598	250	2–10–0	1922 1930
	1	250	4–6–2	1922 1930
	1	250	4–6–2	1922 1930
Pennsylvania Railroad	201	250	4–8–2	1922 1930
	100	250	4–8–2	1917 1919
	10	225	0–8–8–0	1919
Atchison, Topeka & Santa Fe	6	275	2–8–4	1927
	9	220	2–8–4	1927
	1	300	2–10–4	1930
Wabash Railroad	25	245	4–8–2	1930
	25	250	4–8–4	1930
Chicago, Rock Island & Pacific Railroad	65	250	4–8–4	1930
Union Pacific Railroad	81	220	4–6–2	1920
	88	220	4–12–2	1930
Chesapeake and Ohio Railroad	20	260	2–10–4	1930
	20	265	2–10–4	1930
	10	225	2–8–8–2	1926
Erie Railroad	21	225	2–8–4	1927
	4	235	2–8–4	1927
	25	250	2–8–4	1929
	35	225	2–8–4	1928
	20	250	2–8–4	1929
Delaware and Hudson Railroad	10	265	2–8–0	1926
	1	275	2–8–0	1927
	1	300	2–8–0	1927
	1	260	4–6–2	1929
	1	275	4–6–2	1930
	1	325	4–6–2	1929
Kansas City Southern Railroad	1	225	0–6–6–0	1912
	1	250	2–8–8–0	1918
	1	250	2–8–8–0	1918
	1	250	2–8–8–0	1924
	1	225	4–6–2	1919
Baltimore and Ohio Railroad	11	225	4–6–2	1924 1926
	1	230	4–6–2	1924
	20	230	4–6–2	1927
	139	220	2–8–2	1920 1931
	1	225	2–8–2	1923
	2	220	4–8–2	1925 1926
	1	250	4–8–2	1930
	1	235	0–6–6–0	1904
	37	225	2–8–8–0	1911 1920
	58	220	2–8–8–0	1916 1920
	1	225	2–8–8–0	1917
	1	250	2–6–6–2	1930
	1	225	0–8–8–0	1928

life of the staybolts, flues or fireboxes as compared with locomotives working at pressures of 205 pounds.

We have experienced no difficulty in maintaining any of these boilers and fireboxes steam tight under their working pressures.

With the exception of two of the locomotives referred to above, both of which have been built more recently, have carbon-steel sheets and wrought iron staybolts—the two exceptions, Class K-5 have nickel steel in the barrel courses and the remaining portions are carbon steel.

The Atchison, Topeka and Santa Fe Railway

Boilers of all locomotives for the past 25 years were designed for 225 pounds pressure or more with factor of safety required by the I. C. C., although the full pressure rating of these boilers has been used only in a few instances.

We have in service 15 locomotives with 2-8-4 type which have boilers designed for working pressures at 275 pounds per square inch with carbon steel throughout and staybolts of wrought iron. Six of these locomotives have been operating at 275 pounds working pressure for five years, while the remainder are operating at 220 pounds.

In December, 1930, we placed in service one locomotive of the 2-10-4 type, T. P. 93,000 pounds with 69-inch drivers, 300 pounds working pressure, with barrel course and roof sheets made of nickel steel, firebox and other sheets made of carbon steel and staybolts of wrought iron, the performance has been satisfactory.

Have not experienced any particular difficulty in the design and construction or maintenance of these radial stayed boilers covering pressures up to and including 300 pounds.

Experience in operating locomotive carrying 275 to 300 pounds pressure, the greatest difficulty is expected to be found in the lubrication and maintenance of piston valves, as well as the valve gear.

Kansas City Southern Railroad

Kansas City Southern Locomotive No. 750 is equipped for the pulverizing and burning of coal or lignite in pulverized form, as well as for the burning of fuel oil, either independently or in combination.

Slack or screenings is supplied to the tender of this locomotive in the usual manner, and the feeding of the pulverized fuel to the furnace is regulated by the feed of the raw coal to the pulverizer, from which, after pulverization, it is introduced into the locomotive furnace direct. In other words, the coal is pulverized as it is fired, and no pulverized coal is stored on the tender.

The report was submitted by a committee composed of George H. Emerson, chairman, R. M. Brown and A. H. Fetters.

(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 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.

Case No. 734.—*Inquiry:* When a jacketed vessel is under consideration and the interior chamber is not subject to pressure, does the volume V in the formula in revised Par. U-1 refer to the jacket volume only, or to both the jacket and the interior chamber of the vessel?

Reply: It is the opinion of the committee that when the interior chamber of a jacketed pressure vessel is open and not subject to pressure, the factor V applies only to the jacket. When both the interior chamber and the jacket are subject to pressure, the factor V applies to the entire volume of the vessel.

Case No. 737.—*Inquiry:* Is it necessary, in applying the rules of the Code to pressure vessels, to consider that the exemption in Par. U-1 of the Code applies to the working pressure up to the setting of the safety or relief valves; or must the static head that may result in any part of the vessel by contained liquid be included?

Reply: It is the opinion of the committee that the pressure referred to in Par. U-1 is that on which the safety-valve setting is based and not that resulting in certain parts of the vessel by possible static head. The Code provides limiting stresses for use in the design of pressure vessels, and it is necessary to take account of the effect of static head that may be produced in any part in order that such stress limits be not exceeded.

Case No. 738.—*Inquiry:* Do the exemptions in Par. U-1 of the Code apply to single vessels only, or to assembly of vessels in a system?

Reply: It is the opinion of the committee that the exemptions apply to each single vessel and not to an assembly of vessels.

Case No. 739.—*Inquiry:* Par. U-70 of the Code states that Class 3 vessels may be used for the storage of gases or liquids at temperatures not materially exceeding their boiling temperature at atmospheric pressure and at pressures not to exceed 200 pounds per square inch, and/or not to exceed a temperature of 250 degrees F. In the case of water and steam, what is the maximum temperature at which Class 3 vessels may be used?

Reply: It is the opinion of the committee that the maximum temperature that should be applied to water and steam in interpreting Par. U-70 is 250 degrees F., which corresponds with the temperature of steam at a pressure of 15 pounds per square inch above the atmosphere, which is the maximum allowed in steam-heating boilers.

Case No. 741.—*Inquiry:* Pars. H-55 and H-108 of the Code require each steam gage to be connected to the boiler by means of a syphon or equivalent device exterior to the boiler. Will a steam gage meet these requirements if the syphon is incorporated within the gage casing?

Reply: It is the opinion of the committee that the location of the syphon inside of the steam-gage casing will not conflict with the requirements of the Code provided it is of sufficient capacity to keep the gage tube filled with water and there is visible evidence of the presence of the syphon in the gage casing.

Case No. 743.—*Inquiry:* Is it permissible, under the requirements of Par. U-71 of the Code, to use pipe material conforming to Specifications S-18 of the Code to form the shells of pressure vessels, to the ends of which heads of plate material conforming to Specifications S-2 will be attached by forge welding?

Reply: It is the opinion of the committee that lap-welded, open-hearth pipe, or low-carbon seamless pipe under Specifications S-18, may be used for the construction of forge-welded vessels under the rules of the Code.

CASE No. 744.—*Inquiry:* Is it permissible, under Par. U-96 of the Code, to apply or insert heads in ends of shells by shrink fits in place of driven fits when they are to be brazed?

Reply: It is the opinion of the committee that the shrinking of the heads into the ends of the shells is the equivalent of drive fits.

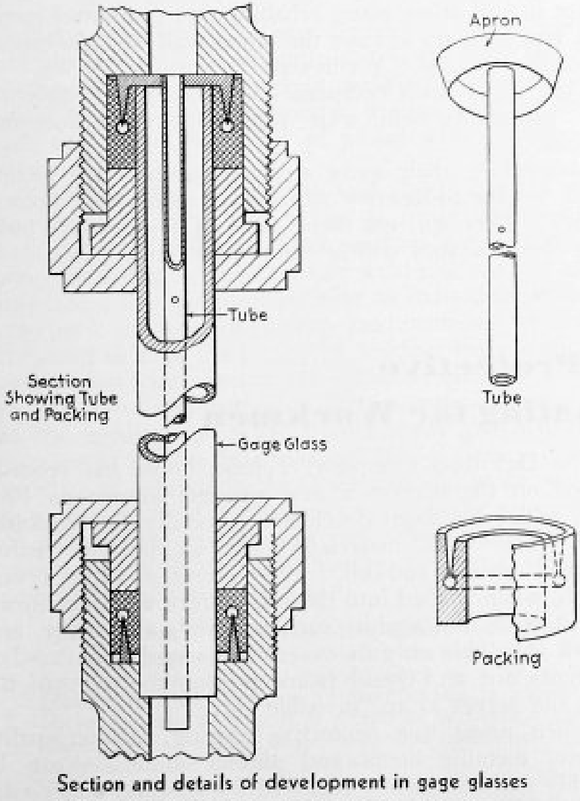
New Packing Lengthens Life of Water-Column Gage Glass

*By Frank A. Rumatz**

During my many years of experience in the operation of power plants, I have always considered the water-column gage glass breakage and wear as inevitable. Several years ago, excessive gage glass breakage made the cost of replacements prohibitive in the particular power station which I was operating. Glasses of various composition were tried in an endeavor to lengthen the life of a glass, but were attended with small success. Accordingly, the writer was prompted to make an investigation to determine the contributing causes of gage glass breakage and, if possible, to eliminate them.

My investigation and research work disclosed two prominent contributing causes of gage glass breakage:

* Chief engineer, Tecumseh Power Station, The Kansas Power & Light Company, Topeka, Kansas.



Section and details of development in gage glasses

1. That portion of the upper end of the glass projecting beyond the packing devitrified quickly. The glass dissolved very rapidly up to the upper end of the packing and from thence the process was somewhat slower due to the encasement of the glass by the packing. This was due to high temperatures, condensation, and presumably to the fact that the boiler water is chemically treated.

2. The periodic blowing down of the water column with the attendant impingement of steam, grooves the glass internally and weakens it considerably.

In order to overcome these two objectionable factors, a novel packing combination was conceived consisting of the integral nozzle, wedge, and packing as shown in the illustration.

The purpose of the nozzle is to prevent steam impingement. It is apparent that since the nozzle extends beyond the bottom of the glass the steam will never come in contact with the glass. The purpose of the apron and the special packing is to seal hermetically the upper end of the glass and thereby prevent erosion. The apron wedge also permits a more uniform compression and a greater packing contact area with the walls of the stuffing box and the glass. Rubber packing will be used for pressures up to 250 pounds and asbestos and rubber for higher pressures.

After several years of experimentation, the water-column gage glass design as shown was developed. A patent was applied for on April 17, 1931, and granted September 24, 1932. Upon searching the Patent Office records, it was discovered that attempts have been made as far back as 1889 to develop a satisfactory water-column gage glass, but that the efforts of the designers were not attended with success. Hence it will be apparent to the reader that although the design is original with the writer, the problem is not new.

This new invention has been tested under 400 pounds steam pressure and under all operating conditions. The results obtained show that the life of glasses will be materially lengthened. Undoubtedly, in many cases, the glasses should last indefinitely unless broken by other causes. This device is practical and can be applied to all stationary, locomotive, and marine boilers and will also find a practical application in connection with refineries, unquestionably becoming a very keen competitor of the flat gage glass. The installation and operation of this new type of water-column gage glass is not different from the ordinary types of gage glasses now in use.

Are You Ready For a Business Upturn?

This is a question put to manufacturers by A. W. Robertson, chairman of the board of the Westinghouse Electric & Manufacturing Company, and who is also chairman of the Industrial Rehabilitation Committee.

Writing in *Forbes,* Mr. Robertson answers this question negatively for many concerns, and gives reasons which are worthy of consideration by every manufacturer who hopes to get his share of increased future business.

"If business should suddenly rise to higher levels, now or this Spring," states Mr. Robertson, "thousands of manufacturing plants would be unable to fill the orders sent in by their salesmen."

Still more surprising: there are today hotels and apartment houses and stores representing millions of dollars in investment which are unable to share in a demand which actually exists at this moment—to say nothing of that which may arise in 1933.

All this in spite of our much-vaunted over capacity, and ability to produce more than we can consume.

A certain steel plant has two furnaces. For more than two years, only one has been operating. Recently the head of this plant told a salesman: "If we should get one big order, it would be six months before we could ship our first carload."

The reason? For two years and more, all repairs and replacements in the active furnace have been made by robbing the inactive furnace, instead of through new purchases. For any possibility of immediate use, the second furnace is crippled.

The manager of a large cement plant, now idle, reports that when time comes to start again, he will have to spend a million dollars before the first wheel turns.

But it is not the large plants alone which will be vulnerable to more alert competitors when 1933 business volume begins to pile up.

One plant of moderate size may, in normal times, use a half-dozen pumps in its processes. For the last few years, only two of these pumps have been in operation. When repair parts were needed, capital expenditure has been saved by "borrowing" from the other four—not one of which is fit to do its share on sudden notice.

These are examples of incapacity that is due to lack of normal upkeep and repairs. Besides repair parts, other details essential to proper operation have been almost universally skimped in these three years of super-economy: paint, lubrication, roofing, lights, floor repairs, power maintenance.

But there is an even greater potential source of trouble for 1933 managers, when business opportunities come their way.

This is *obsolescence*.

In organization after organization, it is going to be discovered that the gigantic ogre Obsolescence has taken greater toll in past three years than in the previous ten or fifteen.

For this there are several reasons.

One is changed conditions. Owners of more than one New York apartment house completed in 1930 are discovering that their property is today *obsolete*, because its rooms and suites were scaled to 1929 incomes. Only drastic changes can make it now profitable.

Another obsolescence cause is technical progress. Machine makers, eager to restore their business, have been feverishly active in designing new production marvels—every one of which makes older machines *obsolete*.

Again, there is necessity for lower costs. In many lines, enterprising newcomers have bought bankrupt plants for a song. To meet their costs, plants capitalized on a pre-1930 basis will have to adopt every possible cost-saving expedient. In competition, their 1929 machines are *obsolete*.

This amazing situation, so full of serious possibilities for those organizations which are still following the "Don't spend a cent till you have to" policy, is now being brought to the attention of business men in several hundred cities by the Committee on Industrial Rehabilitation and its local branches. From one standpoint this committee is a gigantic sales promotion organization for fundamental American industry. The makers of machinery, paint, roofing, building materials, elevators, delivery trucks, office equipment, water softening apparatus, control instruments, power plant equipment and other "capital goods" who are giving their time to industrial rehabilitation work hope it may pay them in dollars and cents to do so.

But for once their self-interest is also a matter of public service, and the success of this business men's committee is possible only because there are several good reasons why business men in every community should make capital expenditures, large and small, now.

One is that the company which does not put its plant and equipment in first class shape now may be caught napping by its competitors.

Another is that repairs, replacement, physical revamping, and new equipment are liable to cost more next year than now.

A third is that in many cases an investment in equipment to-day will earn immediate profit.

A fourth, often most potent of all, is that equipment purchases made to-day will create a pyramid of employment, and indirectly enlarge the purchaser's own market.

Well organized in some communities, inadequately organized (as is natural) in some others, the rehabilitation committee's first line of attack is to advise with organizations which need equipment and have cash but are unwilling to spend it, or by whom the benefits of spending now have not been realized. Sometimes it persuades such companies to make, now, purchases scheduled vaguely for "next year." Sometimes it brings about the liberalization of equipment-purchase policies, so that companies which have recently been buying only items which will pay for themselves in one year are now buying on a two-year or three-year basis. Occasionally it is helpful to a local manager of a branch plant in getting company headquarters to authorize needed expenditures previously held back under blanket instructions.

In many cases, companies or individuals willing to make capital expenditures really lack funds. The committee has no money to lend, but sometimes is able to put the prospective purchaser in touch with available capital. In some cases local bankers co-operate. And a surprising number of companies are springing up whose sole business is to finance the re-design and re-equipment of obsolete hotels, apartments, and offices which can be made rentable, or to assume the entire load of financing productive, 'self-liquidating' factory equipment.

But in still other cases, rehabilitation committee members run bang-up against the stone wall of "No capital expenditures now. We'll wait."

That many such companies and boards of directors and presidents will wait too long, is a foregone conclusion.

Meanwhile, their more alert competitors are getting ready for the to-morrow which may at any time become to-day. They will get their share of to-morrow's business—because they will be equipped to deliver it.

A Protective Coating for Workmen

The DeVilbiss Company, Toledo, Ohio, has recently placed on the market a new product known as Pro-Tek, which has been developed especially for workmen who work with materials such as lacquer, paint, varnish, grease and oil. Pro-Tek is a white cream which, when rubbed into the skin before working, forms a protective film against such materials as lacquer, and which is soluble only in water. It is said that Pro-Tek prevents dirt and liquid from entering the pores of the skin and serves as an "invisible glove."

When using this protective coating, lacquer, paint, grease, metallic dusts and similar materials can be quickly and completely removed by washing under running water.

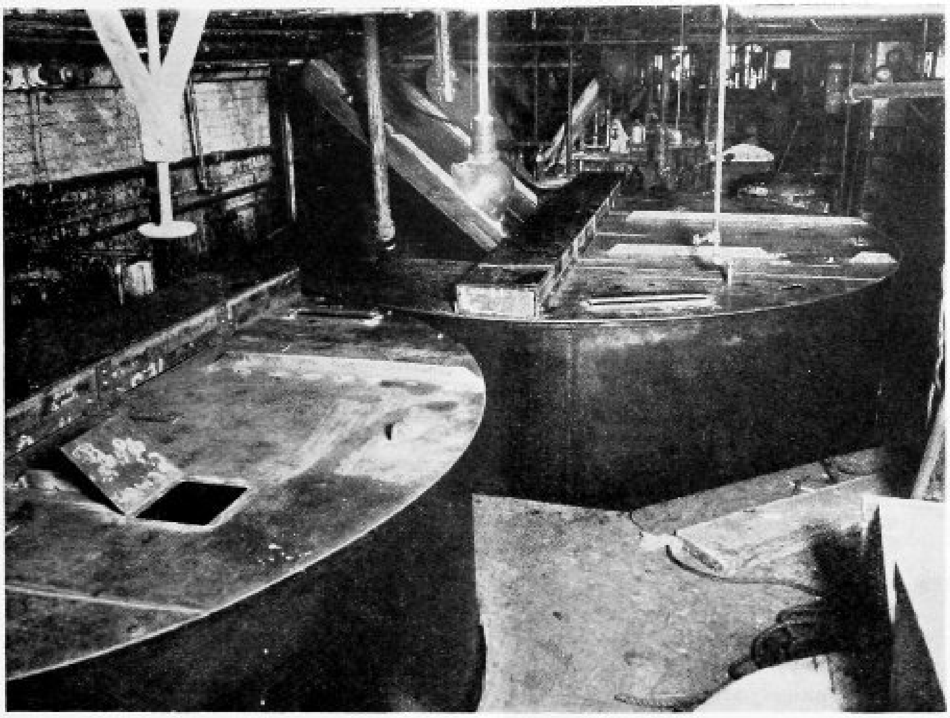


Fig. 11.—Industrial kettles with nickel-clad steel top sections

Methods for the Fabrication of Nickel-clad Steel Plate*

By F. P. Huston

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. Most types of welds consist of a steel weld on the one side and a finishing bead of nickel weld on the nickel side.

The steel weld is usually laid down first to almost the full section of the plate, plus the required reinforcement. The accustomed practices prevailing in the shop, including size and type of weld rod, current adjustment, and manipulation peculiar to individual operators, are used without important modifications in welding the steel side of the plate. In welding the nickel, however, satisfactory welds are obtained only by adhering to closely defined methods. The operators inexperienced in the welding of nickel should study the instructions distributed by The International Nickel Company on the welding of solid nickel, and they should make welds on properly prepared test pieces to adjust the manipulation to suit the characteristics of nickel welding. The skilled operator will have no difficulty in doing this. The principal points to observe are:

1. The joint must be cleaned free from "icicles," slag, and heavy oxide resulting from welding the steel side. Chipping the seam with a round nosed chisel to a depth slightly greater than the thickness of the cladding is advisable.
2. Nickel electric welding wire should be procured. This wire should be flux coated under controlled conditions and carefully tested for welding qualities.
3. The operator should make trial welds with both straight and reversed polarity at several current values, and select the polarity and amperage that best suits the nature of the work and his own manipulative methods. Good welds can usually be made either with straight polarity or with reversed polarity, and the several inter-related factors make it difficult to devise a rule to cover all conditions.
4. The short arc—1/16 inch to 1/8 inch long—is an absolute necessity. The efficiency of the flux in protecting the molten metal in its transfer through a long arc stream is seriously lowered.
5. The selection of the size of electrode and the adjustment of the welding current must properly balance the penetration and rate of electrode fusion.

Plate Thickness, inches	Weld Rod Diameter, inches	Amperage
3/16-1/4	1/8	90-150
5/16-3/8	5/32	140-160
3/8-1/2	5/32	160-190
1/2 and heavier	3/16	180-225

The beveled butt joint, Fig. 12, 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. 13. The various joints, Figs. 14 to 17, are used to meet the particular needs of the construction.

Carbon-arc welding is a highly desirable 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 closer control over rate of fusion and placement of deposited metal.

* Second instalment of an article issued by the Development and Research Department of The International Nickel Company, Inc., New York.

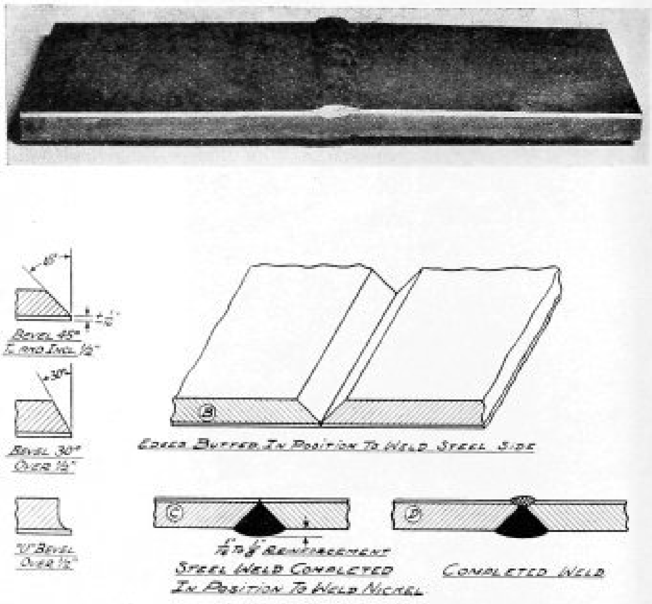


Fig. 12.—Butt-welded joint, metallic-arc welded

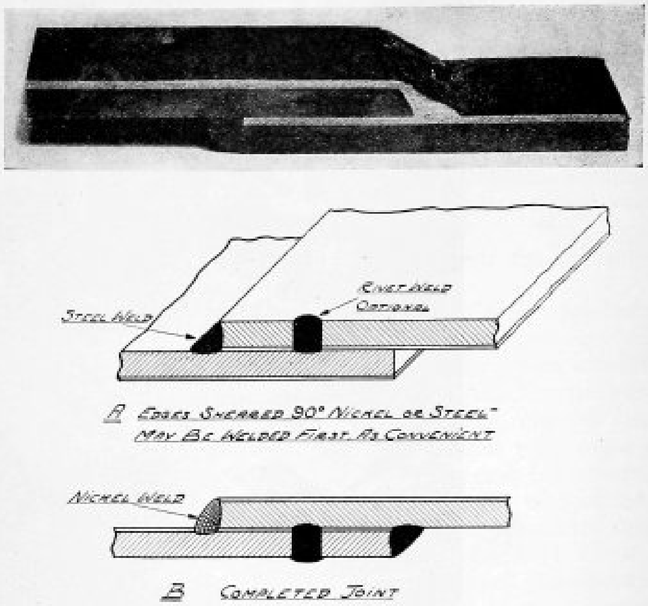


Fig. 13.—Lap-welded joint, metallic-arc welded

Inco nickel electric welding wire 3/32 inch or 1/8 inch diameter is 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 inch 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. See Fig. 18.

Straight polarity, i. e., carbon negative, is used and 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 weld 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 Inches	Carbon Diameter Inches	Amperage	Filler Rod Diameter Inches
.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

The results of an investigation recently completed in the Research Laboratories of the Linde Air Products Company on acetylene welding nickel-clad steel plate, establish gas welding as an excellent method of welding and one particularly well adapted to vertical welding.

The results of tensile and bend tests (average of two tests) on 1/4-inch plate clad 10 percent are as follows:

Yield Point	Tensile Strength	Elong. Convex Side Weld Metal, percent Nickel	Steel
39,300	64,500	20	30

(Fracture occurred 1½ inches outside of weld)

The iron content in the nickel weld metal in joints

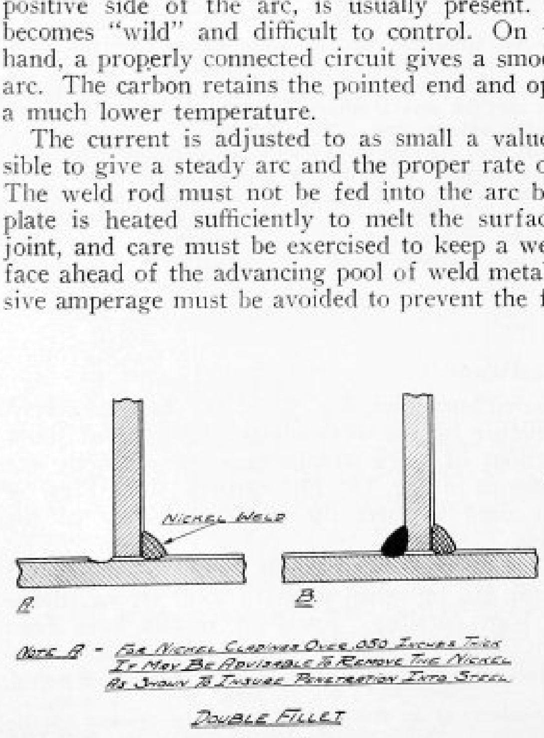


Fig. 14

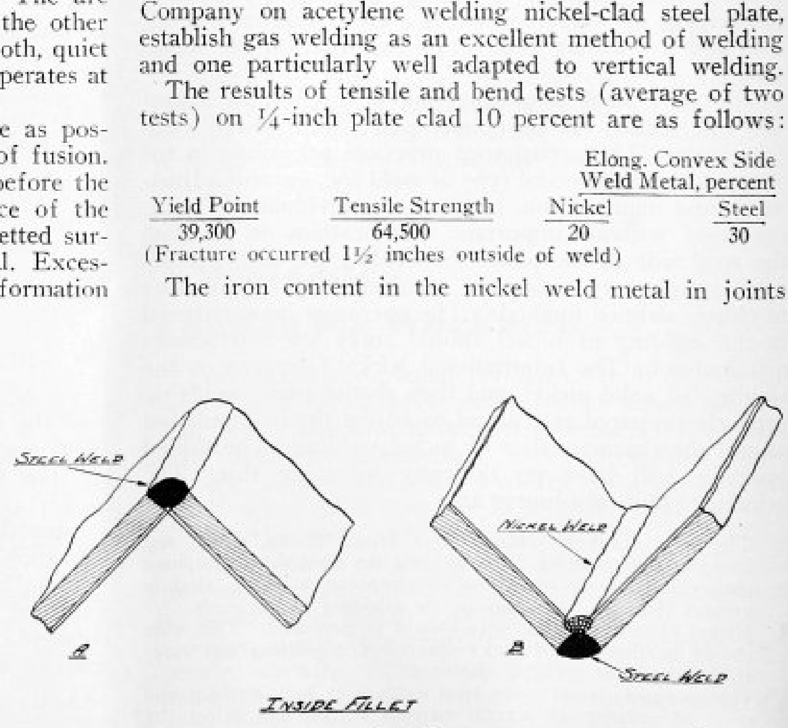
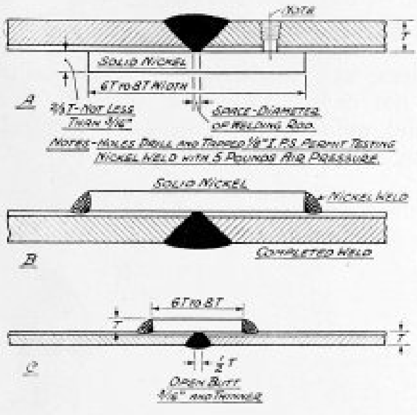
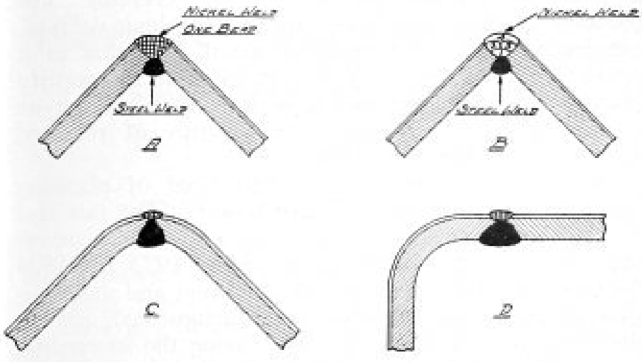


Fig. 15



STRAP JOINT

Fig. 16



A- NOT ADVISABLE ON ACCOUNT OF LARGE IRON CONTENT OF NICKEL WELD METAL
B- MULTIPLE BEADS WILL SHOW LOW IRON IN COVER WELD
C&D- PREFERABLE METHODS

OUT SIDE CORNER WELD

Fig. 17

beveled from the steel side and welded steel first then nickel was found to be 15 percent maximum.

The beveled butt joint shown in Fig. 12 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. 17A, due to excessive iron contamination. An analysis of the weld metal should be made to determine the suitability of this joint for the intended service.

The steel weld is usually made first, then the nickel weld as described. No change is made in welding the steel side over the accustomed practice in welding solid steel plate. The welding of the nickel requires observance of an all important rule—"Maintain a slightly reducing flame." The sharp flame that yields entirely satisfactory welds in steel will give brittle and spongy welds in nickel. The reason is the high melting point of nickel oxide and the absence of the free fluxing action of the molten oxide obtained in welding steel.

Inco nickel gas welding wire is used. This wire is supplied in 36-inch lengths and is used bare. Flux is not required but some operators may prefer to use a flux. Inco gas welding and brazing flux should, in this case, be used sparingly, but the flux must not be relied upon to correct a careless adjustment of the welding flame.

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.

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, its use is highly desirable.

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 gas welding rod or the flux-coated electric welding wire. It is the writer's 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 diameter or $\frac{3}{32}$ inch diameter is desirable except for plate over ½ inch thick, or for heavy fillet welds when the larger ⅛ inch diameter or $\frac{5}{32}$ inch diameter rod can be used.

(To be continued)

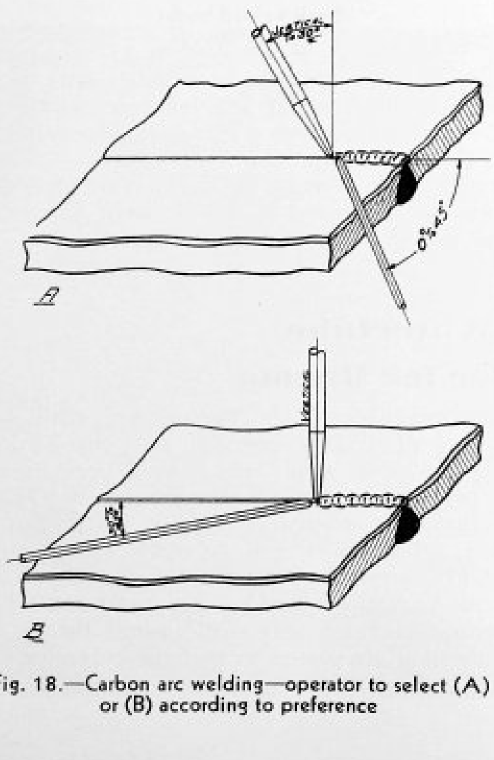


Fig. 18.—Carbon arc welding—operator to select (A) or (B) according to preference

Plan Now for Business Revival

It is characteristic of humankind to form its vision of the future by a short look backward. At the height of the speculative boom of 1929 the commonly accepted vision of the future was based on a forward projection of the trend of events we had experienced during the immediate past. Furthermore, while that trend was of limited duration in the past, its future duration was believed to be limitless. As 1933 gets under way, we look back over a period of three years of declining business activity and, in far too many cases, our thinking is colored by the gloomy picture of a future made up of the present extended to eternity.

Few of us have a sufficiently clear understanding and quantitative knowledge of the processes involved in these economic swings to say with assurance just when the trend of business activity will be reversed. The probability is that the change will not be long delayed, if, indeed, it has not already occurred. Be that as it may, it is time for railway officers to cease to magnify a three-year depression into a period of eternal gloom and to begin to plan sanely for a future of renewed business and industrial activity.

One field in which there is great need of planning on a new basis is that of motive power. The last real attention this matter received from railway executives generally on a nation-wide basis was in 1923 and 1924 when the heavy programs of rehabilitation and modernization of existing locomotives were inaugurated, activity thus stimulated declining steadily during the succeeding years. From 4,360 locomotives installed in 1923, the number had dropped below 2,000 by 1925 and reached a low point of 1,017 in 1928, rising to 1,229 in 1929. The total number of installations during the seven years ending with 1929 was about 14,400. During this same period, however, only approximately 8,000 new locomotives were received from the builders. More than a third of the locomotives installed must be accounted for as old locomotives which had been retired from the accounts and reinstated following partial modernization.

During this same period occurred the culmination of a series of developments which have made obsolete locomotives built more than eight or ten years ago. The combination of the large firebox, the type E superheater, and the four-wheel trailing truck has converted the locomotive from a machine rated by its starting tractive force to one which is rated by its horsepower capacity. But the relatively small growth in traffic during the years following the close of the war as compared with the rate which had long prevailed prior to that time, and a growing intensity of utilization, had combined to remove the need for additional aggregate motive power capacity. During the six years from 1927 to 1932, inclusive, locomotive orders averaged only a few over 500 and, except for 1929, when over 1,200 locomotives were ordered, the largest number of orders placed in any year was less than 750. As the result of the depression, orders declined from 440 in 1930 to 235 in 1931 and practically none last year.

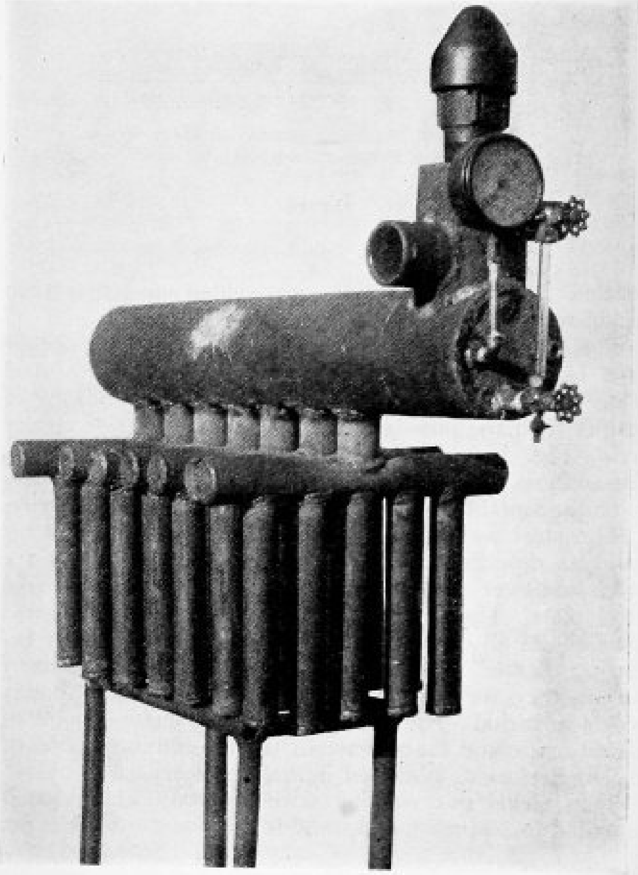
And yet the experience of those roads fortunate enough to have gone into the depression with recently purchased modern locomotives has clearly demonstrated the economic fallacy of continuing to own aged and out-moded locomotives. But with a relatively stable maximum volume of traffic in prospect for which the railroads have already provided ample capacity, a policy of purchases and retirements must be adopted which will control obsolescence if the steam railway is not to become obsolete as a whole. Advantage must be taken of the developments in the art which have steadily been accumulating and which will undoubtedly continue.

The relative business inactivity of the past three years has been used by many industries to carry out complete redesign of products preparatory to the keen competition which may be expected as the demand begins to increase. The railroads, probably more than any large industry in the country, need to be preparing for the new competitive situation which has so clearly come to light as the result of the depression. One of the conditions which this situation demands is the utmost in operating efficiency and reliability of service. The railroad management which does not have well considered plans for relieving its motive-power inventory of the tremendous accumulation of obsolescence which has taken place during the past seven or eight years will find itself pushed into ill-considered hysterical activity as its volume of traffic begins to build up.

Job Welder Builds Novel Boiler

New ideas, new methods and new products are the order of the day. With less work in the shop, job welders and welding departments of production plants are turning their thoughts to new uses of their arc welders.

Here's the result in one shop. This unusual boiler was



Small welded boiler

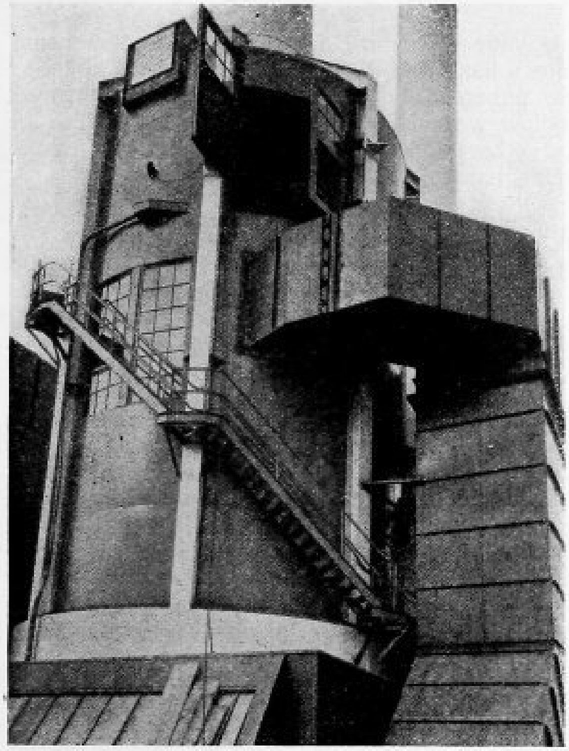
fabricated complete with the arc. It consists of thirty-five 1½-inch tubes, seven 2-inch nipples and seven 2-inch headers for the tubes. The steam chamber is made from 6-inch seamless tubing.

All welding was done by the shielded-arc process using equipment manufactured by The Lincoln Electric Company, Cleveland.

Big Watertube Boiler for Burma

A watertube boiler of the Yarrow type, with a normal evaporation of 25,000 pounds, and an overload of 31,000 pounds, to supply steam at a pressure of 190 pounds per square inch at a temperature of 500 degrees F., has just been ordered in Glasgow by the Burma Oil Company. The boiler will be made at Glasgow and shipped in pieces for re-erection in Burma. It will be fitted with Yarrow oil-burning equipment and air heater, the furnace having double steel casings through which the combustion air passes so that the refractory linings are cooled efficiently.

Mercury Boiler Plants Nearly Completed



The year has been notable for progress in the design and construction of mercury-steam power plants. After some years of semi-commercial experimentation in plants of the Hartford (Conn.) Electric Light Company, the General Electric Company started in 1931 to construct a $3,700,000 mercury steam plant at Schenectady to supply process steam to the General Electric Works and electricity jointly to the works and to the lines of the New York Power & Light Company.

Under the actual operating arrangement, the General Electric Company will build and own the plant, leasing it to the utility. The utility will sell steam and electricity to General Electric as required, and will deliver to its own lines any excess power produced from the steam demand.

By the end of 1932 construction of this plant was well advanced. Initial operation in the spring or summer of this year is expected.

Saturated mercury vapor, generated at 125 pounds and 958 degrees F. will be expanded to 28 inches of vacuum through a double-flow 20,000-kilowatt turbine. Unlike the Hartford unit, this turbine will have bearings at both ends. Mercury vapor admitted at the center will flow in both directions and will put the shaft seals under vacuum.

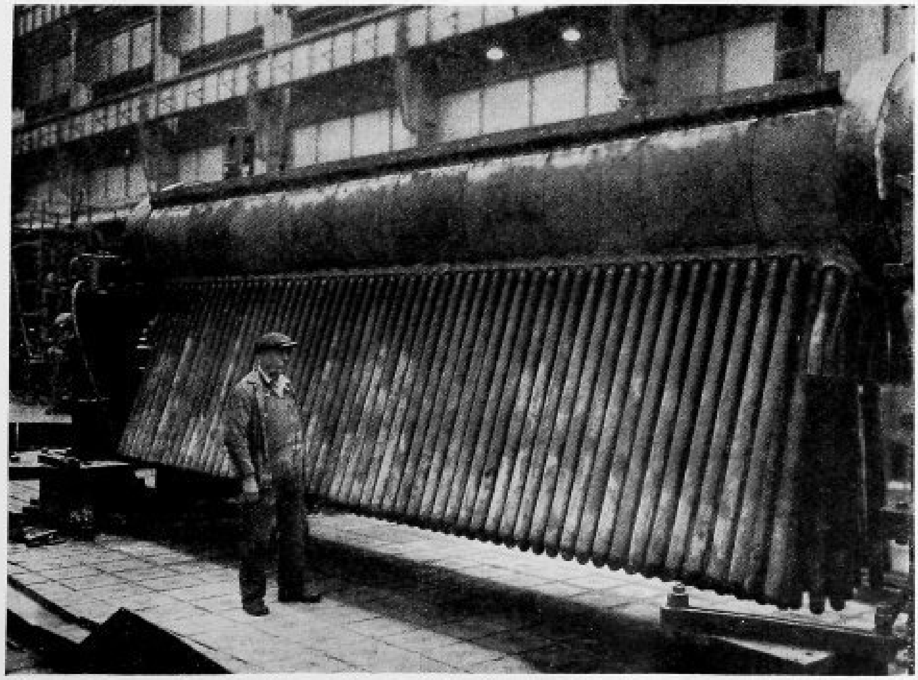
The mercury-condenser steam-boiler will generate steam at approximately 400 pounds per square inch pressure. This will be superheated to 760 degrees and expanded through a 6000-kilowatt outdoor steam turbine to 250 pounds pressure before delivery to the G. E. process lines. Condensed mercury will be returned to the boiler by a feed pump.

With full load on the mercury turbine, 300,000 pounds of steam per hour will be produced in the condenser boiler. An additional capacity of 300,000 pounds per hour will be provided in a steam boiler.

The Schenectady plant is unusual in many other respects. It is the first outdoor power plant. The two stacks (for mercury and steam boilers) are set on the coal silos.

By the end of the year considerable progress had also been made on the mercury installation at the Kearny Station of the Public Service (N. J.) Electric Light & Gas Company. Mercury will here be used to serve as a "top" on an old steam station. Mercury vapor will be generated at 125 pounds pressure and 958 degrees F., as at Schenectady. It will expand through a 20,000-kilowatt turbine to 28 inches of vacuum, and, in condensing, will produce steam at 365 pounds pressure. This superheated to 750 degrees will combine with steam generated by the low-pressure boilers.

Drums for the new mercury boilers are sealed up in nitrogen gas at the factory, shipped to the job and not unsealed until they are piped and filled with mercury. Tubes are calorized and heat-treated.—*Power.*



Top—At Schenectady, a duct carries gases to stack on coal silo. Open door shows fan rooms. Left—One of seven arc-welded unit sections for the Schenectady mercury boiler

To Detect Flaws in Chain Links, Hooks, Castings, Etc.

SATURATE them thoroughly with some light oil long enough to permit the oil to soak into any cracks or pinholes, then wipe off all traces of the oil on the surface. After this has been done, coat the entire surface with whiting. After the whiting has dried the oil will begin to appear thru it wherever there are deep-seated flaws having surface openings. A blow with a hammer will help bring the oil to the surface.

SAFETY INSTRUCTION CARD **No. 3**

Safety Instruction Cards for Shop Use

The National Safety Council has inaugurated an experimental service called "Safety Instruction Cards." These cards, which are 3 inches by 5 inches in size, on heavy white stock, are for distribution to operating executives, foremen and workmen. Each card carries a technical or semi-technical treatment of a specific accident hazard or a brief suggestion on the safe way of performing some particular job.

Cards also will be available giving tables of facts on subjects relating to the engineering application of certain occupations. Herewith are reproduced two of the cards from the group published in a special announcement bulletin of the National Safety Council. Fourteen cards will be reproduced in each issue of the *National Safety News*. Further particulars of the cost of these cards can be obtained by writing to the National Safety Council, 20 North Wacker Drive, Chicago.

Ask Yourself These Questions

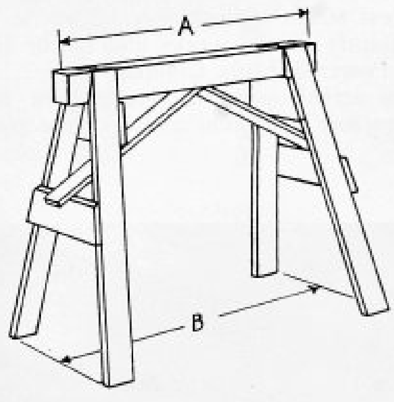
Did you ever:
1. Try to button your shirt with burned fingers?
2. Try to eat a meal with a fractured jaw?
3. Try to sleep with an infected hand as a bedfellow?
4. Try to see straight and clearly after an eye injury?

Imagine:
1. How your wife must feel when you come home minus a hand or foot.
2. How unheroic one must feel after having injured a fellow worker.
3. How others must look down on one who has a careless nature.
4. How utterly inglorious it must be to be killed because of thoughtlessness.

Then resolve:
1. To protect every part of your body.
2. To become safety-minded.
3. To spread the gospel of safety.
4. To use your head as a safety guard against all accidents.

And always remember:
1. That 95 percent of accidents are preventable.
2. That accidents and safety are a state of mind and not fate.
3. That an accident injures your prestige as well as your body.
4. That an accident can interrupt and change a whole life pattern. *National Safety Council.*

SAFETY RULE BOOK. Rule books covering operating or safe practices usually state a rule or company instruction on a certain subject, but these rules seldom explain "why" of such instructions. In other cases, the rules are not sufficiently specific. Experience indicates that some rule books try to cover too much—and fail. It is better to cover a few points well—and get them over—than to try to include all instructions and confuse the worker by doing so. *National Safety Council.*



A—Several inches less than B.

A Well Designed Horse

EVERY horse regardless of what it is to be used for should be constructed so that the legs spread in all directions. The top should be shorter than the base so that it cannot tip over. Good bracing is important. The illustration shows one good type of construction.

SAFETY INSTRUCTION CARD **No. 2**

Designing for Arc Welding

"Designing for Arc Welding" is the title of a book which is now being printed by The Lincoln Electric Company, Cleveland. It is a book of some 450 pages, nicely bound and containing 19 of the prize winning papers entered in the Second Lincoln Arc-Welding Prize Competition. Due to the length, it was of course necessary to brief some of the papers but it will be a book which should be read by everyone interested in welding.

It will contain 5 parts on the following subjects: machinery, ships, building, bridges, houses, large containers, piping and fittings.

Part 1, covering machinery, will include six papers as follows:

"Manufacture of Ordnance at Watertown Arsenal Revolutionizes Arc Welding."

"Five-Hundred-Ton Precision Press—Analysis of Design; Construction by Welding; Economies Effected."

"Electric-Driven Truck of Arc-Welded Tube Construction."

"Application of Arc Welding in the Manufacture of a Paper Box Machine."

"The Redesign of a Dough Mixer."

"Design Details of Arc-Welded Fan Structures."

Part 2, on ship construction, will include:

"Design and Construction of an Arc-Welded Naval Auxiliary Vessel."

"Special Ship of Welded Structure for the Direct Export of Bulk Cargoes from River Ports over Sea to Foreign European Ports."

Part 3, including buildings, bridges and houses, will be covered by five papers:

"Application of Arc Welding to the Design of Steel Buildings for the Resistance of Earthquake Forces."

"Strengthening of Weak Iron and Steel Bridges by Means of Electric Welding."

"The Arc-Welded Steel Frame House."

"Welded Steel Floors."

"An Arc-Welded Sheet Steel Floor Adaptable to Residence Construction."

Part 4, large container construction, is dealt with in three papers as follows:

"Arc-Welded Steel Plate Surface Condensers for Land Use."

"Arc Welding of Steel Cars."

"A Comparison Study of a Riveted Type and a Welded Type of Purifier."

Part 5, the final section, is on piping and fittings, and is covered by the following three papers:

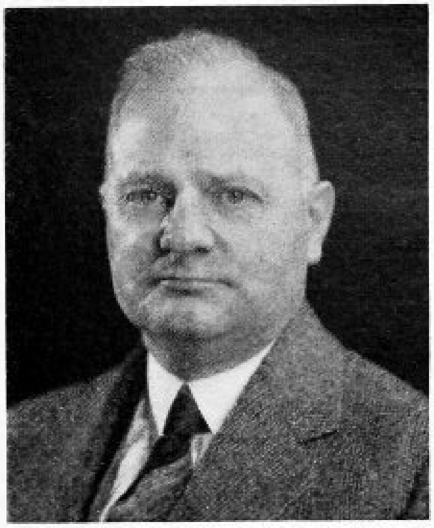
"Arc-Welded Piping and Pipe Fittings."

"Arc-Welded Steel Expansion Joints."

"The Use of Arc-Welded Alloys to Arrest Corrosion."

Further particulars on this book and its cost may be obtained directly from The Lincoln Electric Company, 12818 Coit Road, Cleveland, O.

Heating and Ventilating Guide.—The American Society of Heating and Ventilating Engineers Guide 1933 is now available. This 11th Annual Edition of the standard reference volume on heating, ventilating and air conditioning has been extensively enlarged and revised to include the latest results of research and modern engineering practice. The Text Section of The Guide 1933 contains 608 pages, supplemented by 180 pages of manufacturers catalog data with an index to modern equipment, also 64 pages of the A. S. H. V. E. roll of membership.



Ely C. Hutchinson

Editor of Power Becomes President of Boiler Concern

Ely C. Hutchinson was elected president of the Edge Moor Iron Company, Edge Moor, Del., at a recent meeting of the directors to succeed William F. Sellers, who has retired. Mr. Hutchinson assumed his new office February 1. For the past three years he has been editor in chief of *Power*, published by the McGraw-Hill Publishing Company, New York.

Born on the West Coast, in San Francisco, in 1882, he acquired his early education and experience in that city. His active career began in the pattern shop and drafting room of the Union Iron Works in the period 1898 to 1902. During the next year he was engaged in the installation of mining machinery and hydro-electric equipment in British Colombia. From 1903 to 1907 he was assistant manager of the Mining Department, Union Iron Works. Following this period he became Pacific Coast representative of the Power & Mining Machinery Company of Cudahy, Wis. From 1908 to 1929 he held the positions of sales engineer, sales manager, manager of engineering and sales, vice-president and general manager, and finally president and general manager of the Pelton Water Wheel Company of San Francisco and New York. In 1929 he left this office to become editor in chief of *Power*.

Mr. Hutchinson is a member and past manager of the American Society of Mechanical Engineers and a member of the American Society of Civil Engineers. He is also a member of the International Electro Technical Commission as well as of the American Committee of the World Power Conference. While in New York Mr. Hutchinson has been extremely active in affairs of the American Society of Mechanical Engineers and it was through his efforts that the A. S. M. E. Pure Air Committee, of which he is chairman, was organized. This committee is a central body through which all matters of air clarification or contamination touching upon or involving engineering responsibility, may be cleared, and before which all opinions on these subjects, technical or otherwise, may be aired. It is contemplated that in due time the Pure Air Committee will become the recognized authoritative body and its meetings a forum for the discussion of pure air problems by all those variously interested, or whose points of view are interlocked with, and related to, the air purification problem.

The Boiler Maker

VOLUME XXXIII NUMBER 3

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Communications

Crown Bar Spacing

To the Editor:

In reply to your recent letter I wish to thank you for the attention shown to my question of October 5. I also wish to state that I have further information which may be of interest to you.

To quote from Mr. Davies on page 262, December, 1932, issue: "Before proceeding to space the crown bars longitudinally, more than the staybolt pitch provided in Par. P-199, I would advise that a ruling be obtained from the A. S. M. E. Boiler Code Committee."

One of the members of the A. S. M. E. Boiler Code Committee has furnished the following information: D_1 represents the longitudinal spacing of the arch bars, and, therefore, the spacing of the rivets or staybolts securing the arch bars to the crown sheet, may be as much as twice the girthwise spacing of the staybolts or rivets attaching the sheet to the bars, as determined by the application of the formula in Par. P-199.

However, the staybolts or rivets securing the arch bar to the crown sheet would be considered as carrying a load equal to D_1 times the girthwise pitch, and the size based on the values given in Par. P212*d*. It is understood, of course, the bars and furnace combined (also rivets) figure suitable for the required pressure.

Oswego, N. Y. John A. Shannon.

A Leaking Air Receiver

To the Editor:

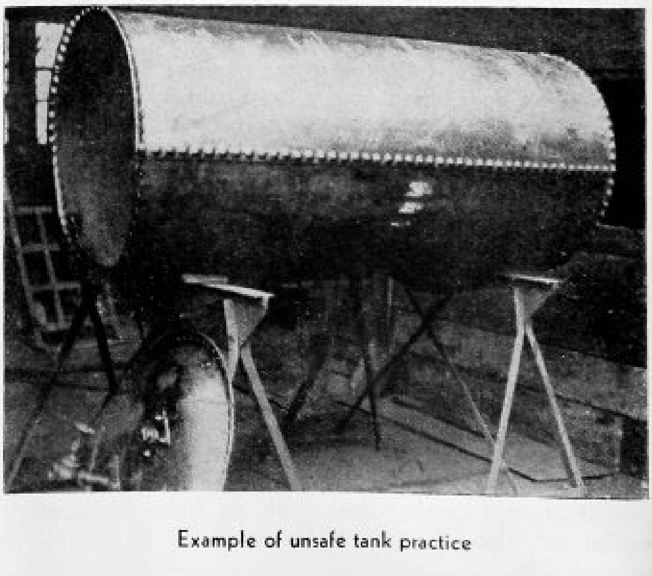
Recently a hurry call came from a galvanizing plant to the local boiler shop for someone to do an emergency calking job on a leaking air receiver.

From the illustration of the tank, it is evident what the boiler maker found wrong when he arrived at the plant. The party in charge of operating the compressor and looking after the air lines, etc., had not even noticed what had taken place. This tank was 30 inches diameter by 60 inches long, 3/16-inch shell, 1/4-inch heads, convex and concave, 1/2-inch rivets, single riveted lap joint, carrying 100 pounds air pressure. Why it did not completely rupture, and cause serious damage and injuries, was the cause of a lot of debate. The fact that the plate did not crush in front of the rivets nor tear, nor the rivets shear, was the means of preventing serious injury to the workmen in the vicinity, of which there were about 20.

As can be seen, the shell had been turned outward all around, approximately to 45 degrees; the flange on the concave head to the same bevel; and the dish reversed in the head, the whole a very uniform appearing job. The photograph was taken after the head was taken out, in the shop. The holes in the shell were elongated as much as 3/16 inch to 1/8 inch. There was considerable dirt inside the tank, and the shell pitted in numerous places. Over-pressure, could have been the only cause of the damage to the tank.

The consensus of opinions formed, was that the head in dishing out, had increased the area of the tank, the rivet holes going oval. The rivets and calking springing, caused enough leakage to offset the amount of air furnished by the compressor, and this prevented a complete rupture. The same thing has happened to tanks before, but is the writer's first experience and only chance to photograph one, after taking such a set. Other readers may have had similar experiences with air tanks.

Montreal, Can. A. J. McKay.



Example of unsafe tank practice

Questions and Answers Pertaining to Boilers

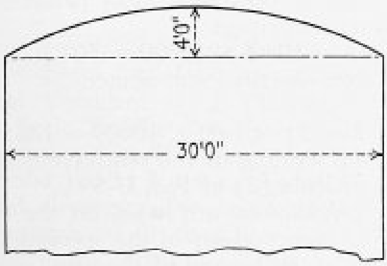
This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor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

By George M. Davies

Self-Supporting Tank Roof

Q.—Will you please show in THE BOILER MAKER the proper way to make a self-supporting roof for a tank as shown in the sketch.—J. H. M.

A.—A method of developing a self-supporting roof similar to the one submitted in the question is given in "Laying Out for Boiler Makers" under the title "Um-



Problem in tank construction

brella Roof for Oil Storage Tank." I believe this article answers your question. If you encounter any difficulties in developing the roof by the method shown, I will be glad to be of assistance to you if you will write explaining any such difficulty.

Dome Collar

Q.—Enclosed you will find a sketch of a section through a dome collar, which is double-riveted to the boiler shell. Please give us your interpretation of applying Par. P-261-d and Par. P-193-c of the 1931 edition of the A. S. M. E. Boiler Code, as applied to this particular joint.—H. M. W.

A.—The paragraphs of the A. S. M. E. Code referred to in the question are as follows:

Par. 261-d. The rivets attaching nozzles shall be so spaced as to avoid the possibility of the shell plate failing by tearing around through the rivet holes. This feature shall be checked by applying the rules given in Par. P-193 C which bear on the strength where a series of holes are placed in a drum.

Par. 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.

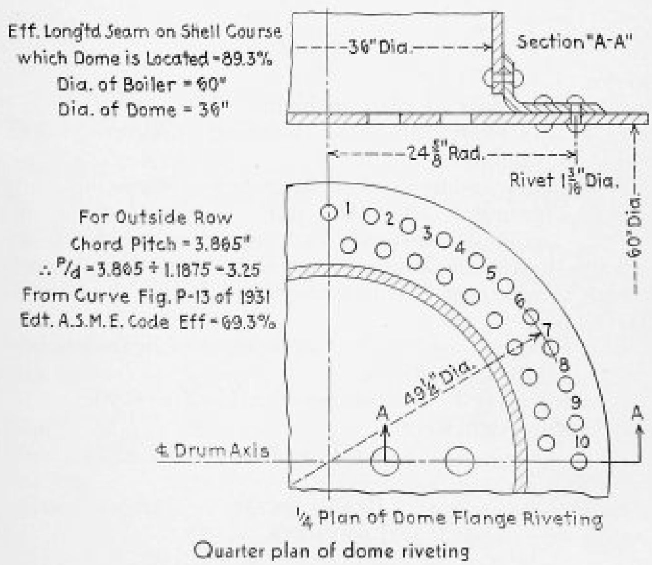
When tubes or holes are unsymmetrically spaced, the average ligament efficiency shall not be less than the following:

(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 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.



Quarter plan of dome riveting

I do not believe it is the intention of the code in this case, to base the efficiency of the shell upon the efficiency between any two individual holes as would be the case if the efficiency of 69.3 percent, as figured in the question, was taken to be the efficiency of the shell.

The last paragraph of P-193-c states that for holes placed longitudinally along a drum, but which do not come in a straight line, the above rules for calculating efficiency shall hold, i.e., (the rules in (1) and (2) of 193-c) except that the equivalent longitudinal width of a diagonal ligament shall be used. This equivalent longitudinal width is obtained by multiplying the longitudinal pitch of two holes having a diagonal ligament, by the efficiency of the diagonal ligament, which is obtained from Fig. P-13.

The efficiency of the shell should be computed in accordance with either (1) or (2) of Par. 193-c and compared with the efficiency on which the maximum allowable working pressure is based, as indicated.

Nozzle Design

Q.—Is the nozzle shown in the illustration suitable for the vessel with the given specifications?

Shell Data: Pressure, 300 pounds per square inch working steam pressure; inside diameter, 8 feet; thickness, 2 inches; shell opening, 10¼ inches; tensile strength, 55,000 pounds per square inch; temperature, 750 degrees F.; class 1 construction.

Nozzle Data: 6-inch series 30 forged steel nozzle; exact inside diameter of neck portion, 6 inches; inside diameter at the bottom of the neck, on account of radius of 1½ metal thickness, 8½ inches; outside diameter of bottom flange, 19 inches; thickness of bottom flange, $^{13}/_{16}$ inch; thickness of neck portion, $^{13}/_{16}$ inch; all as per sketch.

Strength of Attachment: Inside welds, ⅞ by ⅞ inch; outside welds, ⅝ by ⅝ inch; class 1 welding being followed.

A.—The nozzle construction is in accordance with illustration "L" and the welds comply with details (5) and (6) of Fig. U-16 of the Unfired Pressure Vessel section of the A. S. M. E. Code.

The reinforcement has been plotted in Fig. 1 in accordance with the specifications given in the question and Section (1) of Par. U-59, also as illustrated in Fig. U-3 of the above Code.

Cross-section I

$= 2 \times (17 - 10\frac{1}{4}) = 13.50$ square inches

Cross-section II

$= \frac{13}{16}'' \times (17 - 4\frac{3}{16}) = 10.41$ square inches

Cross-section III

$= 1 - \frac{7}{8}''$ fillet $= 0.76$ square inches

Total actual cross-section 24.67 square inches

The required thickness of the shell is computed as follows:

$$t = \frac{P \times R}{S \times E}$$

where

t = Thickness of plate in inches.

P = Maximum allowable working pressure = 300 pounds.

R = Inside radius of shell in inches = 48 inches.

S = Maximum allowable unit working stress in pounds per square inch taken from Table U-3.

Table U-3 gives value of S at 750 degrees F. for steel having a minimum tensile strength of 55,000 pounds as 10,000 pounds.

E = Efficiency of longitudinal joint or of ligaments between openings.

E = for class I construction Par. U-68 = 0.90.

Substituting, we have

$$t = \frac{300 \times 48}{10000 \times 0.90}$$

$t = 1.60$ inches.

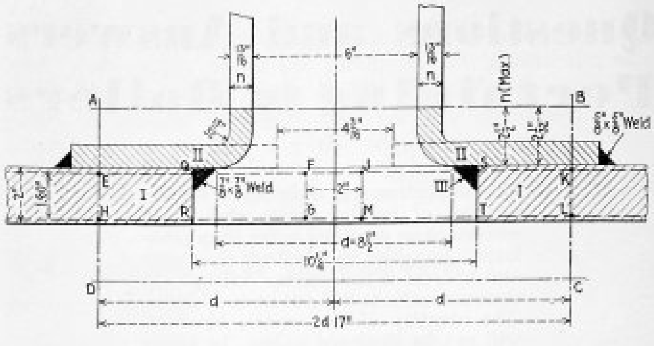


Fig. 1.—Details of nozzle design

The required cross-section equals

$1.60 \times (17 - 2) = 24.00$ square inches

Actual cross-section = 24.67 square inches.

Required cross-section = 24.00 square inches.

Therefore the design meets the requirements of Rule (1) of Par. U-59 based on 8½ as the actual inside diameter "*d*" of the opening in the shell in the finished construction.

Welding of the Manhole

Strength of welds in tension.

$[0.875 \times 0.5 \times 3.14 \times 10.25 + 0.625 \times 0.5 \times 3.14 \times 19] \times 0.90 \times 10000 = 294{,}480$ pounds, in tension.

Strength of welds in shear.

$[0.875 \times 0.5 \times 3.14 \times 10.25 + 0.625 \times 0.5 \times 3.14 \times 19] \times 0.90 \times 0.80 \times 10000 = 255{,}584$ pounds, in shear.

Strength of reinforcement =

Area II $\times$ s = $10.41 \times 10000 = 104{,}100$ pounds.

Strength of cross-section represented by

$(QFGR + JSTM) =$

$(10.25 - 2) \times 1.60 \times 10000 = 132{,}000$ pounds.

Therefore the welding of the reinforcement meets the requirements of Rule (2) of Par. U-59 b.

The above calculations are based on the diameter of opening as 8½ inches given in the specifications as the inside diameter at the bottom of the neck, on account of radius of 1½ inch metal thickness.

The Code states that the diameter "*d*" equals the actual inside diameter of the opening in the shell in the finished construction, which could be interpreted as shown in the specification.

The illustrations given in the Code Fig. U-3 (revised) would indicate that the diameter (*d*) in this example should be taken as the diameter of the nozzle, or 6 inches.

Taking (*d*) as 6 inches the nozzle would not have sufficient reinforcement.

Another interpretation would be to take (*d*) as the diameter of the hole in the shell for this type of construction.

Before proceeding to manufacture a nozzle in accordance with specifications, I would suggest that you request a ruling from the Boiler Code committee upon the application of Par. U-59 with respect to the diameter (*d*) *when same* is used in computing the distance each side of the center line to construct the rectangle *ABCD* shown in Fig. UA-1 for use with reinforcement illustrated in Fig. U-16 L.

Stainless Steel.—A brochure, just published by Republic Steel Corporation, contains a fund of comprehensive information on architectural applications of Enduro stainless steel, its fabrication, properties, and shapes and finishes available. The booklet includes the results of collaboration with leading architects and engineers who have specified Enduro in important projects.

Associations

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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
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

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.		Tampa, Fla.

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

States

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

Cities

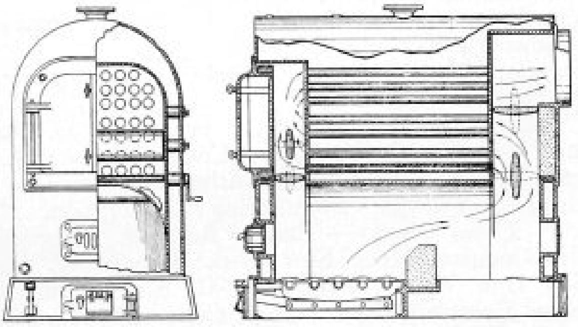
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

Selected Boiler 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.

1,837,534. BOILER. VERLE D. CONKLIN, OF ST. JOSEPH, MICHIGAN, ASSIGNOR TO COMBINATION BOILER CO., OF BENTON HARBOR, MICHIGAN, A CORPORATION OF MICHIGAN.

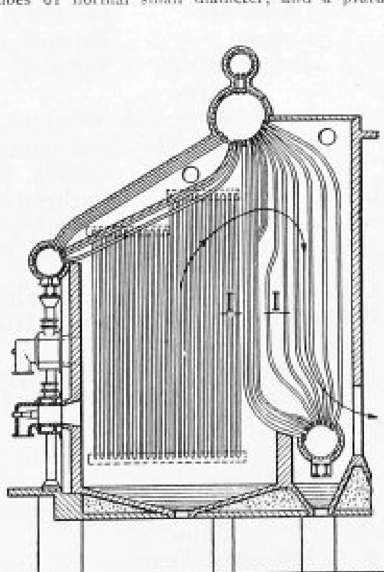
Claim.—In a boiler of the combination firebox and return-tube type, the combination of an outer boiler shell having a smoke outlet and a double furnace forming a firebox, an inner shell disposed in said outer shell, the front and rear ends of said inner shell being spaced from the ends of the



outer shell, to form water legs, tube sheets carried by said inner shell in spaced relation to the ends of said inner shell, the space between said tube sheets and the ends of said inner shell forming vertical extensions of the firebox, a plurality of open ended horizontal tubes carried by said tube sheets and a plurality of spaced baffle plates rotatably mounted in the vertical extension of the fire box, said baffle plates being adjustable to direct the products of combustion in the predetermined paths of travel through the fire tubes from the furnace in use to the smoke outlet. Ten claims.

1,836,119. WATERTUBE BOILER. ALFRED HUSTER, OF KIEL, GERMANY, ASSIGNOR TO FRIED. KRUPP GERMANIAWERFT AKTIENGESELLSCHAFT, OF KIEL-GAARDEN, PRUSSIA, GERMANY.

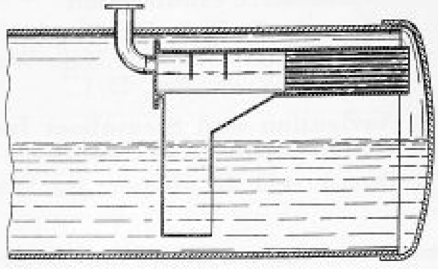
Claim.—In a watertube boiler of the class described a water tube wall composed of tubes of normal small diameter, and a plurality of rows of



spaced water tubes arranged in staggered relation to one another in front of said tube-wall and consisting of tubes having a greater diameter than those of said tube wall, and arranged to exclude from said wall at least all direct radiation substantially normal to the plane of said wall.

1,838,247. MEANS FOR BREAKING FOAM IN STEAM BOILERS AND OTHER LIQUID EVAPORATORS. SYDNEY BROOKS BILBROUGH, OF JOHANNESBURG, TRANSVAAL, SOUTH AFRICA.

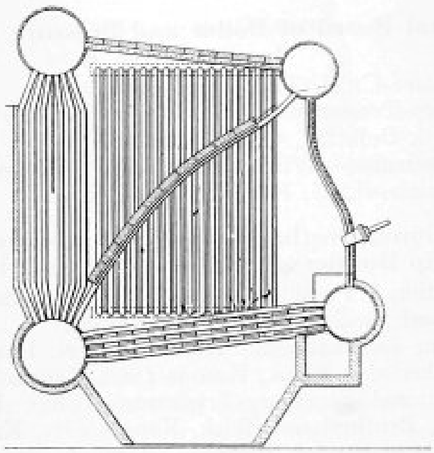
Claim.—Means for breaking foam including a device which provides a plurality of narrow straight passages through which the steam is caused



to pass and in which the foam is broken, a chamber with which the outlet ends of the passages communicate, an outlet from said chamber for the steam, and an outlet from said chamber for the separated water having a cross-sectional area equal to or greater than the aggregate cross-sectional area of the foam breaking passages, as set forth. Six claims.

1,792,068. STATIONARY BOILER. VIRGINIUS Z. CARACRISTI, OF BRONXVILLE, N. Y., ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y.

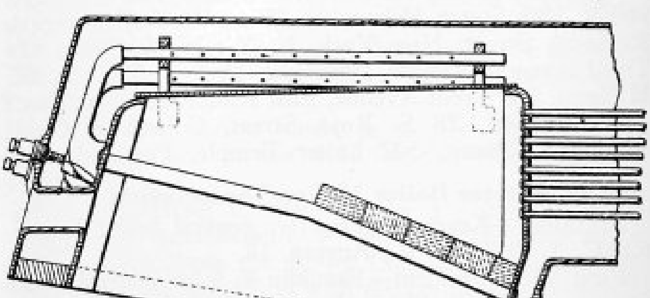
Claim.—In a stationary boiler furnace, boiler elements arranged to form the lower part of the boiler furnace substantially into a plurality



of lateral separately functioning combustion zones, and means for feeding finely divided fuel and air into the lower part of the combustion space for intense combustion. Six claims.

1,832,885. AUXILIARY CIRCULATING TUBE FOR BOILERS. EVAN H. WADE, OF OAK PARK, ILLINOIS.

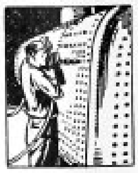
Claim.—In a boiler having a firebox, a firebox arch tube communicating at its ends with the boiler at the inside firebox sheet, and an auxiliary tube



located wholly within the pressure confine of the boiler and having one end in detachable communication with the upper end of said firebox tube and leading across and discharging water at a plurality of points upon the crown sheet. Five claims.

The Boiler Maker

Reg. U. S. Pat. Off.



Locomotives Unserviceable

Unserviceable locomotives reported by the Car Service Division, American Railway Association, in 1929 amounted to about 4500 at the end of March. At the end of 1930 this number had increased to about 5100. A year later it was over 6800. At the end of 1932 the number of locomotives in unserviceable condition had risen to more than 9300.

Decreased tonnage movement has been one of the principal factors in allowing this situation to develop without the railroads giving concern to the inevitable outcome of a policy of maintenance postponement. While conditions have necessitated laying up power, prudence and thrift should have prevented the robbing of such power of equipment and materials still in serviceable condition, to maintain locomotives in active service. Neither should major repairs on locomotives in service be postponed until they too become unserviceable.

Of locomotives capable of meeting the modern demand for long hauls, speed and heavy tonnage there is not an unlimited number. More than half the locomotives owned by the Class I roads are twenty years old or over. No freight locomotive more than ten years old, nor some less than that age can fulfil present requirements. Under the maintenance policy practiced widely today the life of the more modern power is rapidly being depleted. Heavy repairs actually necessary but not mandatory are too often postponed when round-house repairs will keep a locomotive running. Eventually this procedure will shorten the life of such power.

The situation has forced into the discard great numbers of locomotives that might have been continued in use, however inefficiently. In this respect there is being brought about a forced liquidation of obsolete equipment that never again can be considered usable. If the trend halted at this point it might be beneficial. However, the depletion of more modern locomotives for the sake of momentary economy has created the necessity sooner or later of renewing the motive power of the country on a wholesale scale.

In facing what inevitably will be a major operation to bring the railroad establishment back to a condition of physical efficiency, the motive power situation should have the earliest consideration. Waste, inefficiency and colossal expense that followed the close of the Railroad Administration in 1920, in attempting to rehabilitate equipment, can be avoided if definite maintenance policies looking to the future are established. While time is available and the costs of materials and equipment are still low, a general program of heavy classified repairs can be undertaken that will rapidly replenish locomotive miles run out and up to now not replaced.

Changing Shop Requirements

The fact must be recognized that methods of boiler shop practice, developed over a considerable period of time, must be greatly altered to meet the requirements of a new day. The mere fact that motive power demands have changed within the past two or three years would bring about this condition without the complication of other factors, such as mergers of railroads, centralization of repairs and the like.

Power that will haul 100 cars or more of 50 tons and over per car at an average of 40 to 50 miles per hour speed places an entirely new set of problems in the hands of the master boiler maker to solve. The obsolescence of older power on many roads has occurred within a comparatively short space of time. The average shop was organized to meet the maintenance requirements of a preponderance of such power. But with an ever-increasing change to heavier locomotives, shop standards, equipment, material requirements and methods have had to undergo a minor revolution. The master boiler maker has been forced rapidly to adjust himself and to organize his staff on a new basis, a situation difficult in itself but complicated by the serious condition of employment.

The merging of some roads into unified systems with the almost complete reorganization of mechanical departments has reacted against the ready adjustment of shop organizations. These conditions are likely to continue on an ever-widening scale in the process of modernizing the facilities of the railroads of the nation and placing them on an efficient basis.

The situation is a challenge to the ability of each master boiler maker to meet changes as they occur and by careful study of new requirements contribute his share towards the solution of a difficult problem.

Locomotive Boiler Maintenance Rules

In this issue publication is commenced of a series of articles dealing with the inspection and maintenance rules for locomotive boilers as developed by one of the leading railroads in the East. It is becoming increasingly essential under the stringent requirements of the present day that every shop on a given road follow definite standards of shop procedure both for the sake of uniformity and also to avoid waste and inefficiency. Where such rules have been adopted they have proven worth while. These rules are presented to indicate the scope covered and the detailed explanation necessary over the entire range of boiler work that is essential to meet the requirements of a standard of practice.

Rules for the Inspection, Maintenance and Repair of Locomotive Boilers

Continuing the policy of publishing details of representative locomotive boiler practice as conducted on the principal railroads of the country, a series of articles covering locomotive boiler inspecting and maintenance rules of the New York, New Haven and Hartford Railroad commences in this issue. Fundamentally the same requirements for safety and efficiency of motive power are in force on practically every railroad. Comparatively few lines, however, have reduced these requirements to a standard code of regulations and instructions for the guidance of all those engaged in the actual operations involved in the repair and maintenance departments. The Boiler Maker is privileged to present to its readers this practical contribution to the general subject of locomotive boiler work

The following rules are for the guidance of boiler inspectors, boiler makers and supervisors, in the proper inspection, maintenance and repair of locomotive boilers. The practices outlined must be rigidly adhered to. No changes from the practices specified may be made without written authority. The rules are intended to supplement the requirements of the I. C. C., and it is not intended that anything contained herein will conflict with the Federal Rules.

Steam pressure allowed on locomotive boilers is shown in the Locomotive Description Book, also on the badge plate on the back head of each boiler. The pressure shown in these plates shall correspond and must not be changed without obtaining authority from the mechanical engineer.

When a locomotive is to be placed in storage, all work reported by inspectors shall be done and the boiler shall then be thoroughly washed out. Firebox and grates shall be thoroughly cleaned of ashes and clinkers, especially behind grate bars. Wet cinders lying against firebox sheets cause rapid corrosion, so it is important that the firebox be kept clean and dry.

Prior to placing a locomotive in storage, the boiler shall be filled with water, 25 pounds of soda ash or Oakite being added and the boiler then drained in the usual manner. Warm water must be used for this purpose where it is available. The soda ash or Oakite must be thoroughly dissolved in hot water before being added. The water need be kept in the boiler only momentarily and it is not essential to dry out the boiler subsequently or to seal it by re-applying all plugs, etc. The purpose of this is merely to leave the interior of the boiler in an alkaline condition.

Front end, tubes, fireboxes, etc., shall be cleaned of cinders and soot and sprayed with oil; the oil removed from the crank cases of gasoline equipment will be satisfactory for this purpose.

Boiler Alteration Cards—Form 1082—must be made out, signed and sworn to by both the boiler foreman and boiler inspector, covering any of the changes specified in I. C. C. Rule No. 54-b, also for the application of thermic syphons or low water alarm. The original and one copy must be forwarded within 10 days to the mechanical engineer and one copy kept on file at the point where the alterations were made.

The word "flues" as used in these articles, is intended to mean fire flues, while the word "tubes" is intended to mean arch or other watertubes.

Maintenance and Inspection at Back Shop

All concerned with welding work on boilers, including supervisors and inspectors, must be thoroughly familiar with the requirements of welding, as regards the preparation of the work, detail methods to be followed, kind of wire to be used, and the proper care of welding equipment.

Welding on any of the following parts is strictly prohibited:

1. Any part of the boiler that is wholly in tension under working conditions (including staybolts, crown stays, round, rectangular and gusset braces).
2. Cracks or pits in shell of boiler.
3. Arch tubes.
4. Cracks in flange (knuckle) of tube sheet; except that in engine houses cracks up to 24 inches in length may be veed out and welded with the knowledge of the supervisor of boiler inspection and maintenance.
5. Building up or welding over plugs in cracked sheets; brace bolts; rivets except in mud ring corners; also, the welding of staybolts and crown stay heads to the sheet.
6. Application of several adjacent patches in firebox sheets. In such a case the defective part of the sheet shall be cut out and repaired with a single patch.
7. Cutting through line of rivet holes in seam and filling by welding.
8. Vertical welded seams in wrapper sheets or any welded seams in the roof sheet. Also, horizontal welded seams in the wrapper sheet between the mud ring and the lowest row of staybolts.

Whenever the flues are removed, the interior of the boiler must be cleaned by sandblasting or scaling and the boiler shall be thoroughly inspected for defects.

Patches on boiler barrels and domes shall be applied only in accordance with instructions from the mechanical engineer who will furnish a sketch or drawing showing the exact manner in which the patch is to be applied, no deviation from such sketches being permitted. The foregoing instructions also apply to the roof sheets on crown-bar boilers.

In welding a complete new firebox the flue sheets shall be butt-welded to the side and crown sheets. The seam on combustion chamber flue sheets shall be welded. Crown and sides shall be in one piece.

Door sheets shall be butt-welded to the crown and sides.

Inside throat sheets shall be welded to the firebox, the weld being supported along its edge by a row of staybolts.

Every opportunity shall be taken of reinforcing each welded seam on the water side of the plates.

In the application of part sheets for repairs, front flue sheets with oversize flue holes or with cracks adjacent to the flange may have new portions welded in.

The application of a part sheet to a back flue sheet is not recommended, except the top knuckle, or the renewal of the portion above the mud ring in the stayed area. Other patches may be applied as covered by a later paragraph.

Whole or part sheets may be applied to door sheet and firebox side sheets by welding. The upper seam shall be located approximately ¼ inch above the center line between two rows of staybolts at the point decided to renew sheet. Edges of sheets shall be veed at an angle of 45 degrees. The opening on the water side shall not be more than ⅛ inch wide. Half side sheets applied to wide fireboxes or at the bottom of narrow fireboxes and welded by the oxy-acetylene method shall have the top edge arched ⅜ inch. The sheets may be riveted to the mud ring, either before or after welding, and all staybolts may be applied except those adjacent to the weld. Begin at the center and weld between two staybolts, followed by heating at the corrugation. Then weld between the next two staybolts and heat. Proceed in this manner until seam is completely welded.

The lower part of inside throat sheet may be renewed, but the horizontal weld must, in all cases, be between two horizontal rows of stays. If the upper portion is defective, the entire sheet shall be replaced, the seams being in approximately the old location. Care shall be taken to remove all of the old welding material.

The bottom of the combustion chamber may be renewed in one piece. The use of more than two horizontal welds shall be avoided.

Calking edges of riveted seams in the firebox may be sealed by welding but care must be taken not to overheat the plates. Edges shall be chipped and re-calked prior to welding.

All sheets applied in the side sheets that do not extend to both knuckle seams, and all sheets applied in the door and flue sheets which do not extend around the knuckles on both sides into the side sheet knuckle seam are considered as patches and will be governed by the instructions contained in the paragraphs immediately following.

Vertical welds and sharp corners must be avoided. Defective plate shall be cut out and patch plate fitted in place. New plate shall be boxed or slightly rolled to provide for contraction. Staybolts or rivets shall not be applied until weld is completed. The minimum height and length shall be 4 rows of staybolts. When applied to side sheets, the ends of the patches must be a minimum of 4 rows of staybolts from the vertical knuckle seams. When applied to door or inside throat sheets, the end of the patch must be a minimum of 2 rows of staybolts from the knuckle. If either defect extends nearer the knuckle, the patch shall be extended into the vertical weld at the knuckle. If the defect extends below the lowest row of staybolts, the mud ring rivets shall be removed and the new plate made to extend to the bottom of the mud ring.

Vertical cracks extending more than three staybolts shall not be welded, but a patch shall be applied. Vertical cracks extending three staybolts and less shall be welded. The electric method shall be used where available. If the oxy-acetylene method is used, and the plates are straight before welding, the necessary expansion and contraction shall be provided for.

In the door sheet, arch tube holes or other defective parts may be patched within the limits set up in the foregoing paragraphs. A patch at an arch tube hole must be large enough to include a complete row of staybolts at the inner edge of the weld. Arch tube holes in door sheets shall be built up to give a larger bearing area for the tube expander.

Cracks in the flange or knuckle of a back flue sheet shall not be welded at the back shop, but a patch shall be applied as covered by the following paragraph. Engine houses are permitted to weld cracks in flanges up to 24 inches long, with the knowledge of the supervisor of boiler inspection and maintenance, first drilling a ⅜-inch hole at each end of the crack, after which it shall be veed out and welded from both sides of the sheet.

When renewing the top portion of a back flue sheet, the defective part of the sheet shall be cut out and a new piece welded to the old flue sheet and crown sheet. On superheater locomotives, the weld shall be made on the center line of the superheater flue holes, and at no place shall it come closer than ¾ inch from the small flue holes. On saturated steam locomotives, welds shall be made through the second line of flues. The ends of the weld between the flange and the outside flue holes shall be as nearly horizontal as possible.

Cracked bridges may be repaired (after the flues in that area have been removed) by veeing the crack at 45 degrees and welding.

Cracks extending out from arch tube holes or other defects in the stay-bolted area may be patched within the limits set up in paragraphs directly above. Patch at arch tube hole must be large enough to include a complete row of staybolts at the inner edge of the weld.

Application of syphons shall be made in accordance with the manufacturer's standard drawings. Syphons, as received from the manufacturer, will be tagged with the class designation for proper identification. Special arch bricks are required for syphon-equipped locomotives and are shown on standard drawings. All syphon and arch brick drawings can be obtained from the assistant mechanical engineer, on request.

New syphon-equipped boilers and old boilers equipped with new fireboxes or new back ends with syphons shall be carefully cleaned before being placed in service. Refuse of all kinds must be removed from a boiler as far as possible before the firing up test. The boiler must be subjected to repeated thorough washing until borings or other foreign matter cease to appear. After the firing up test, the interior of the syphons must be inspected to detect and remove deposits that may have accumulated in the syphon barrel.

The principal cause of trouble from this source occurs when fine steel borings left in the boiler after tapping and reaming holes, are drawn into the syphon from the boiler barrel and throat by the rapid syphon-induced circulation when a boiler is fired. As the velocity of the water is reduced after passing through the syphon neck by reason of the larger area of the syphon body, the circulation is not sufficient to carry the heavy borings out over the crown sheet. The borings are therefore, deposited just back of the syphon neck, sometimes to a depth of 1 inch and from 4 inches to 6 inches across. If allowed to remain, the borings will cause over-heating and pocketing of the syphon.

Such defects in syphons as occur, ordinarily result either from expansion stresses improperly or incompletely removed, or from lack of thoroughness in washing the syphons.

Defects in diaphragms usually occur in the lower portion of the corrugation. Checks will appear on the water side and may gradually extend through the sheet to become a crack. Both sides of the diaphragm must be carefully inspected at every opportunity.

The treatment of the defect will depend on the nature of it and also on the length of time until the next shopping of the locomotive.

If the defect is minor and the locomotive within a few months of shopping, it may be veed out and welded with the knowledge and under the direction of the supervisor of boiler maintenance.

When the locomotive is at the back shop, whole or partial renewal of the diaphragms must be made, if there is a probability that trouble will be experienced before the next shopping by retaining the old diaphragm. Whenever major repairs, such as renewal of a syphon neck, are made, serious consideration must be given to the question of diaphragm renewal which should be done at the same time.

Details for the renewal of the whole diaphragm section or of the lower half are shown on special drawings from the mechanical engineer's office.

Renewal of the lower half of the diaphragm, only, is especially desirable, if the upper portion is flanged over into the combustion chamber, as the cost of renewal will be reduced by avoiding the flanging operation.

Combustion chamber diaphragms shall be welded or renewed in the same manner as was indicated in the case of firebox diaphragms.

Spare diaphragms, ordered to the syphon application drawings, must be carried in stock to protect such renewals on all classes.

The movement of firebox plates sometimes produces cracks in the upper portion of the syphon neck. Such defects, when of a minor nature, may be welded but each case must be reported to the supervisor of boiler maintenance. Before treating the crack, the welding between the syphon neck and the diaphragm shall be removed and the neck entirely freed. After the crack has been welded, the diaphragm will again be laid up to the syphon neck and rewelded.

Major defects, such as welds in the neck which have not held up in service and have progressed beyond a safe point, may require the application of new quarter syphons. Detail drawings, giving full information for ordering and applying quarter syphons, will be furnished by the assistant mechanical engineer, on request. A minimum stock of renewal parts shall be ordered to protect repairs to all classes. When quarter syphons are applied, the diaphragms must be carefully inspected. Their condition may be such that immediate renewal should be made to avoid again shopping the locomotive at an early date.

Defective upper corners which cannot be properly welded, must be replaced by new corners.

Fire checks which develop into cracks may, under some conditions, be veed out and welded. Pockets or bulges not over ¾ inch deep may at times be heated and laid up to their original contour.

In both of these cases, the matter shall be referred to the supervisor of boiler maintenance for decision as to whether such repair is permissible.

In extreme cases patches must be applied. Stock patches should be ordered and applied. Forward edge of the weld shall be at least 10 inches back of the front of the syphon.

Patches may be applied in front or back of the syphon body, but only upon authority from the supervisor of boiler maintenance in each specific case.

(To be continued)

Metal Industry to Participate in Engineering Week

Plans for the huge conference of engineers at Chicago, during Engineering Week, June 25-30, which is being sponsored by the Century of Progress Exposition, are making excellent progress. Engineers of the iron and steel industry will be particularly active in connection with meetings of the American Society of Testing Materials, American Foundrymen's Association, American Welding Society, American Institute of Mining and Metallurgical Engineers and the American Society of Mechanical Engineers. Some twenty of the national engineering societies will participate with sectional and national meetings.

During the week prior to Engineering Week the American Association for the Advancement of Science meets in Chicago. Many internationally known scientists and engineers will participate on the various programs. Dr. R. A. Millikan is arranging a session on the "Application of Physics to Engineering" which will be a joint meeting of a number of the engineering groups with the International Union of Pure and Applied Physics. This session will begin the activities of Engineering Week, Sunday evening, June 25.

Since most of the exhibits at the Century of Progress Exposition will be of a broad educational character the Midwestern Engineering and Power Exposition becomes an important part of activities of Engineering Week. At this Chicago Power Show engineering developments will be interpreted in terms of individual manufacturers products. Some 300 companies will show their latest equipment for the efficient production and utilization of power. There will be many exhibits of particular interest to the iron and steel industry where the use of new alloys and welding are features of the products.

The combined membership of the engineering groups participating in Engineering Week is 91,600. Preliminary estimates of attendance indicate the largest gathering of engineers in history.

Welding Saves in Repair of Large Presses

The Menna Welding Company, Toledo, O., has recently completed the repair of two large presses with considerable saving to the respective customers. In the first case, the welding company was called upon to repair the broken frame of a press that had been engaged in stamping operations. The job had to be done with the utmost precision inasmuch as the frame carried the guide and other mechanism that determined the accuracy of the operation of the press. A new frame for this machine would have cost about $300, while the total cost of repairing the old frame by welding was but little more than one-quarter of that sum. Seventy-five pounds of General Electric Type A ¼-inch welding electrode was used on the job. Since its repair, the press has resumed regular operation.

In the second instance, the Menna Welding Company was awarded the job of repairing the frame of a 12-ton press that had broken at the crankshaft bearing. The section to be welded was approximately 14 inches in thickness. About 250 pounds of General Electric Type A welding electrode was used and the total cost of the job amounted to only one-eighth of the cost of a new frame, a saving of over $2000.

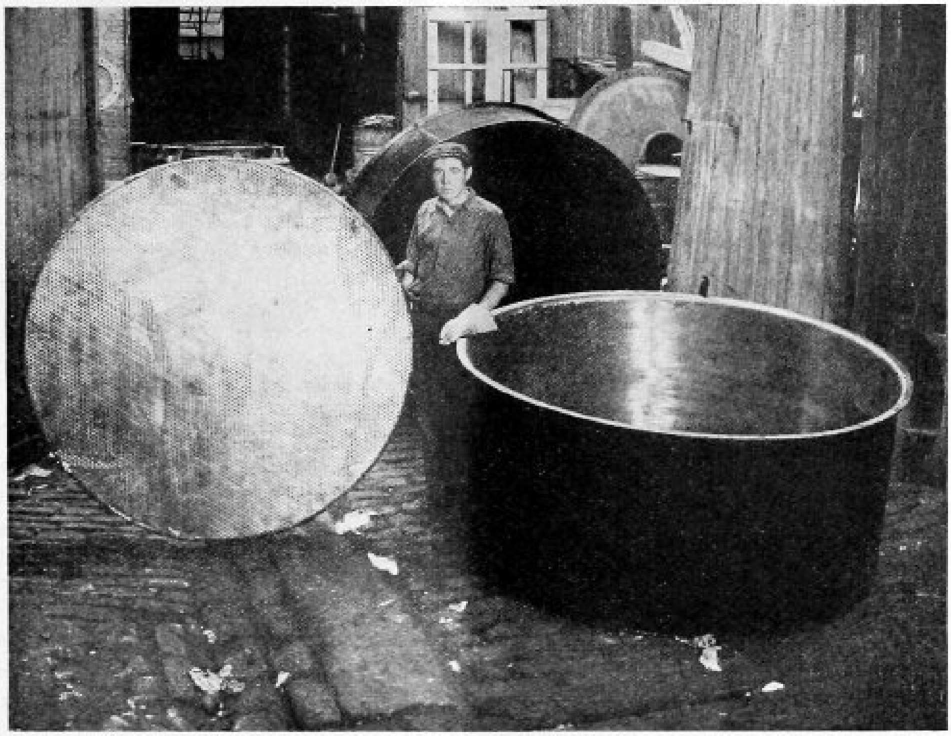


Fig. 19—Nickel-clad steel filter tanks

Methods for the Fabrication of Nickel-Clad Steel Plate*

By F. P. Huston

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 prepare himself 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 well organized 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.

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. 20, and fusion at the base of the weld is kept slightly ahead of the

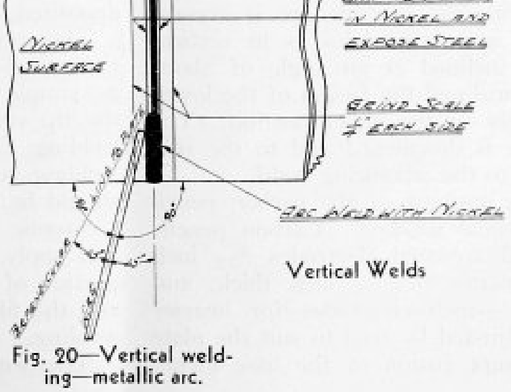


Fig. 20—Vertical welding—metallic arc.

Vertical Welds

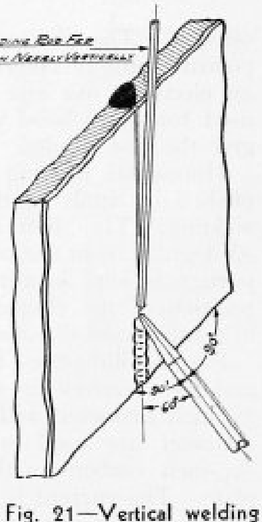


Fig. 21—Vertical welding—carbon arc.

* Third and last instalment of an article issued by the Development and Research Department of The International Nickel Company, Inc., New York.

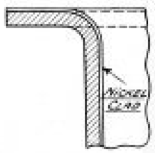


Fig. 23

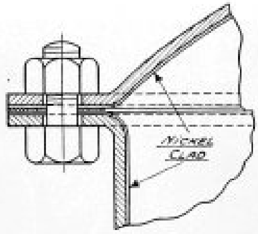


Fig. 25

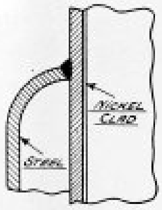


Fig. 27

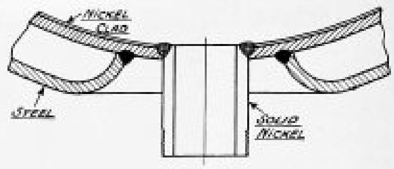


Fig. 28

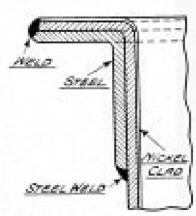


Fig. 24

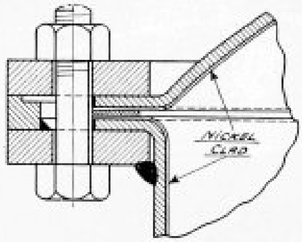


Fig. 26

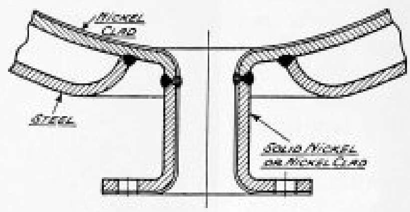


Fig. 29

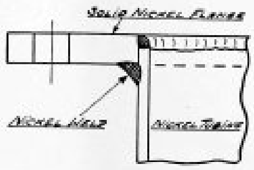


Fig. 33

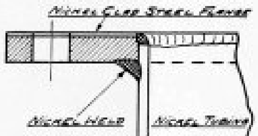


Fig. 34

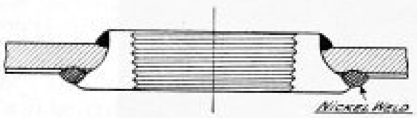


Fig. 30

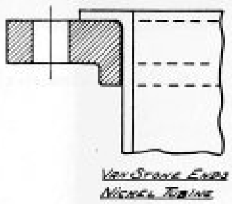


Fig. 35

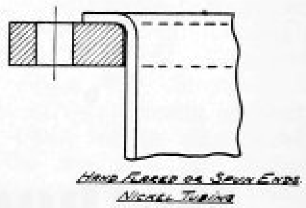


Fig. 36

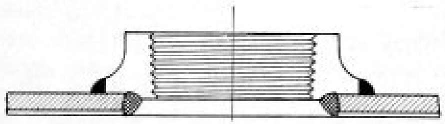


Fig. 31

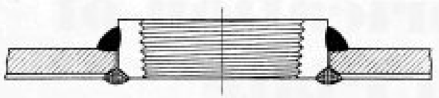


Fig. 32

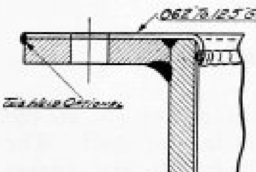


Fig. 37

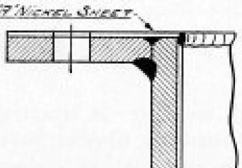


Fig. 38

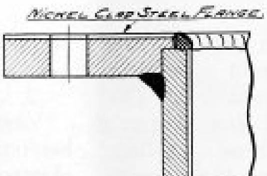


Fig. 39

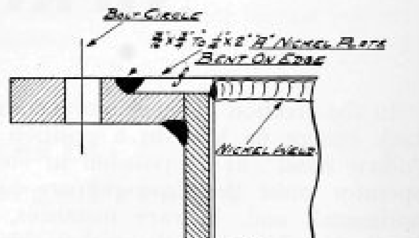


Fig. 40

outside. The size of electrode, current setting, and polarity must be determined by careful trial. Generally, an electrode one size smaller than would normally be used for down-hand welding and straight polarity will give the best results.

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.

Fig. 21 illustrates the position of the carbon pencil and the electrode in vertical welding. Carbon pencils 1/4 inch diameter with flux-coated electrodes 3/32 inch diameter are used on plates to 5/16 inch thick, and 5/16-inch carbons with 1/8-inch electrodes for heavier plate. The current is adjusted by trial to suit the plate thickness and effect prompt fusion of the base metal, but not so high that deep craters form on breaking the arc. The end of the weld 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.

The welding of vertical and horizontal joints with the acetylene or the atomic hydrogen torch is almost as simple as down-hand welding. The selection of the tip size, gas pressures, and weld rod in acetylene welding follows closely those given for down-hand welding with the exception that a smaller weld rod should be used, Fig. 22.

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.

The weld metal on the nickel side of a properly fused joint is not pure nickel but is a nickel-iron alloy containing, in normal welds, not over 15 percent of iron. The molten nickel takes iron readily into solution in all welds where penetration into the steel is had.

The presence of iron must be expected and, if kept within bounds by proper design and manipulation, the resultant nickel-iron alloy will have good corrosion resistance.

Analyses of acetylene butt welds show a maximum of 15 percent iron. No records are available on other

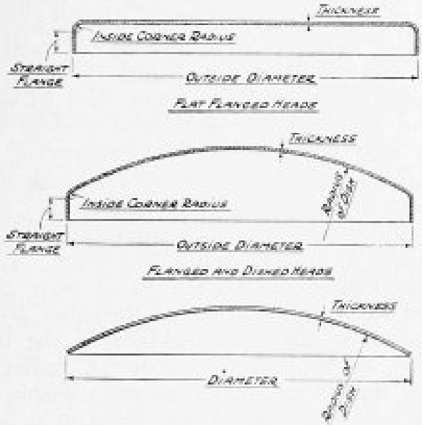


Fig. 41

types of gas welds or on any of the atomic hydrogen welds. Inspection, however, of cross sections of specimen welds indicates the iron content to be within safe limits.

The outside corner weld, Fig. 17 A, has been found to contain an excessive amount of iron—up to 45 percent—and this type is not to be recommended. Most constructions permit forming the corner to a radius as shown in Fig. 17 C, or flanging one side and butting the other as in Fig. 17 D. If either of these two are impractical, the multiple layer weld, all beads of nickel, should be used in preference to Fig. 17 A. By progressively diluting the iron in the successvie beads, the amount in the corner weld is easily reduced to a maximum of 15 percent.

Peening or bobbing to compact the nickel weld metal is a highly desirable operation. 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 by the methods used with steel cannot be accomplished with nickel-clad except by machining off the nickel to a width well outside the lap and, after joining the steel, autogenously welding a solid nickel plate over the exposed steel to provide continuity of nickel surface. The presence of nickel prevents the union of the steel under the oxidizing flame that must be used in steel welding. This is due to the fact that nickel oxide does not have the fluidity possessed by iron oxide and, therefore, fails to provide the fluxing action of the iron oxide. Also, the welding temperature is above the critical temperature where nickel loses its ductility.

Solid nickel can be forge welded and this method is used to a limited extent in Germany. The use of a highly reducing atmosphere and more than ordinary skill is required.

The experiments in forge welding nickel-clad steel have not been successful, and further thought in this direction can be discouraged unless the necessary changes in heating practice are planned. The need for forge welding is hardly apparent.

The maintenance of a continuous nickel surface is the only problem new to the design of pressure vessels and other types of equipment. The accompanying drawings, Figs. 23 to 36, show methods of construction to provide continuity of the nickel surface at top reinforcing curbs, flanges, outlets, and fittings.

Figs. 23 and 24 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 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.

Figs. 25 and 26 may be used for flared and dished cover plates on vessels that operate under pressure or vacuum.

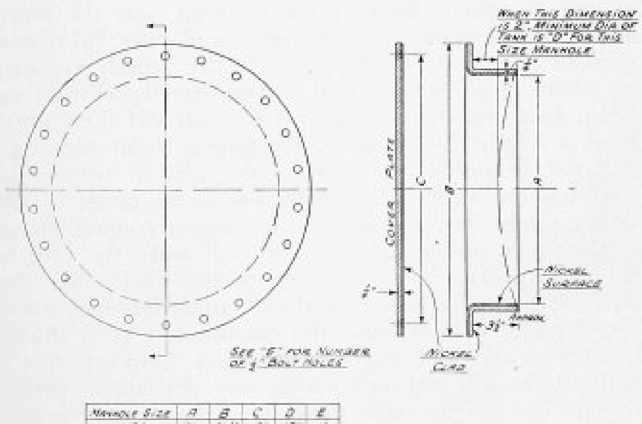
Jackets are readily welded to nickel-clad vessels as in Figs. 27, 28 and 29. Any type of bottom outlet, either in solid nickel or nickel-clad steel, may be attached.

Forged tapped welding flanges in solid nickel to 4 inches I.P.S. are available and may be applied either as shown in Fig. 30 or 31, with preference given to Fig. 30. Small tappings, about 2 inches I.P.S. and under, may be machined from solid nickel bars and welded as in Fig. 32.

Built-up flanged fittings shown in Figs. 33 and 34, or loose flanges shown in Figs. 35 and 36, are suitable for outlets to 6 inches I.P.S. Figs. 37, 38, 39 show suitable designs for large outlets, handhole, and manholes. Fig. 40 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.

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 obtainable in nickel-clad steel. The metal responds readily to hot spinning, hot and cold pressing, and hand shaping in the production of these various shapes.

The dimensions shown in Fig. 41 are essential for the production of hot spun heads. Cold pressed, flat flanged,



Manhole Size	A	B	C	D	E
16"	16"x10	20½"	19"	47"	16
18"	18"x10	22½"	21"	58"	18
20"	20"x12	24½"	23"	81"	24

Fig. 42

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, Fig. 42, are available for storage tanks. They may be used to advantage with flared and dished covers for low-pressure vessels.

Forged 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 be procured either from the sources supplying nickel-clad plate or from companies they may recommend.

Stresses in Boiler Tubes*

By W. L. De Baufre†

Attention has been called in recent years to the high stresses set up in the tubes of steam boilers due to high rates of heat transfer from burning fuel and products of combustion to water boiling within the tubes. It has been suggested that it would be desirable to use thinner tubes than called for in the A. S. M. E. Boiler Code in order to reduce the total stresses due to heat transfer and internal fluid pressure.

Previous investigations of these stresses have in general been based on approximate data and relations and on a constant ratio of stress to strain, although the calculated stresses have exceeded the elastic limit of the mild steel usually used in such tubes. In order to get a more nearly accurate picture of the stresses in thick boiler tubes subjected to high rates of heat absorption, an investigation was made in the Technical Research Department of International Combustion Engineering Corporation, using as nearly accurate experimental data as could be found for mild steel and employing theoretically correct relations for the stresses in thick tubes. After calculating the stresses by relations derived for a constant ratio of stress to strain, the results were corrected for plastic flow in the tube wall where the stresses exceeded the elastic limit of mild steel, and also for creep which occurs when mild steel is stressed for long times at elevated temperatures. The stresses were investigated for non-uniform heat absorption around the tube circumference as well as for a uniform rate of heat absorption.

The investigation has shown that where the stresses produced by heat transfer and internal fluid pressure exceed the elastic limit of the material near the inner and outer surfaces of the tube wall, the calculated stresses based on perfect elasticity are greatly reduced by plastic flow, but residual stresses are thereby set up when heat transfer ceases and the internal fluid pressure is reduced to zero. Every time a boiler goes into and out of operation, a stress cycle from tension to compression occurs of considerable stress range. This stress range is greatest for the circumferential stress at the inner surface of the tube wall when the tube is heated uniformly. When heated non-uniformly, the axial-stress range may exceed the circumferential-stress range under certain abnormal conditions. It is shown by comparison with experimental data, however, that a boiler tube will not fail within any reasonable period of time by fatigue from these repeated stress reversals.

Before a boiler tube can fail by bursting, all portions of the tube wall must be stressed to a point where more or less rapid creep will occur to rupture. The investigation shows that before this can take place, all heat-transfer stresses will be entirely neutralized by creep. Failure of the tube then occurs by the stresses due to internal pressure only. A measure of the safety of the tube is the ratio of the stress which will cause creep under the mean operating temperature of the tube wall to the mean stress caused by internal fluid pressure. The investigation shows that an increase in tube safety is secured by using thicker rather than thinner tubes than called for by the A. S. M. E. Boiler Code.

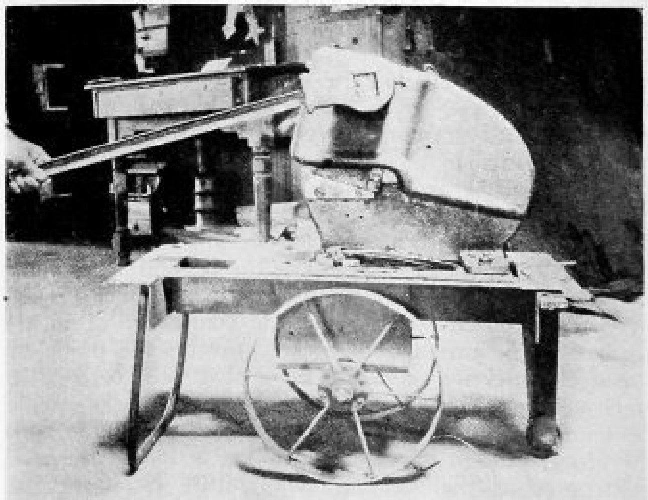
An increase in safety may also be obtained by using a material which will not creep until a higher stress is reached, such as a medium-carbon steel in place of a mild carbon steel. Even with mild carbon steel subjected to a very high rate of heat absorption, however, the investigation shows that failure can occur only when the coefficient of heat transfer from the inner surface of the tube wall to the water-steam mixture within the tube is reduced to an abnormally low value. Boiler-tube failures therefore occur by reason of poor circulation of the water-steam mixture within the tubes, by accumulation of scale on the inner surface of the tube wall, by corrosion, or by defective material, rather than by any stresses due to unequal expansion within the tube wall caused by a high rate of heat absorption.

*Abstract of paper presented before the Power Division at the annual meeting of the American Society of Mechanical Engineers, New York, December 5 to 9, 1932.

† Chairman, Department of Applied Mechanics, University of Nebraska.

A Portable Hand Shear

A small hand shear is more convenient if it can be moved to the work instead of bringing the work to the shear. The shear arrangement shown in the illustration was made by welding sections of 4-in. by 4-in. angles into a rectangular frame. The top is of ¼-in. plate and welded to the frame. The small shear is bolted near one end of the frame as shown. The shear and frame are transported on two wheels of ample construction. The front end is supported on a roller which is secured to the frame by two angles of small section which are welded to the front frame angle. The front end rests on a loop of 1-in. rod, the ends of which are held in two short sections of pipe welded to the end angle. This loop can be pulled up and used as a handle when moving the shear from place to place.



Hand shear mounted on a two-wheel truck for easy transportation

Advantages and Disadvantages of Higher Locomotive Boiler Pressure*

No railroad in the United States has been more progressive in the development of high-pressure locomotive boilers than the Delaware and Hudson Company. This portion of the locomotive construction committee report to the American Railway Association, Mechanical Division, presented at the last annual meeting, deals with the record of accomplishment which began in 1926 with experimental work on locomotive No. 1111. Details also are given of the New York Central adaptation of the Schmidt-Henschel double-pressure, high-pressure locomotive now in service and operating successfully

In the conventional field the Delaware and Hudson has in operation twelve consolidation locomotives, road numbers 1111 to 1122 inclusive, ten of which are operating at pressures of 265, one at 275 and one at 300 pounds; also three Pacific type locomotives, road numbers 652 at 260 pounds; No. 651, a poppet valve, at 275 pounds; and No. 653, a modified uniflow at 325 pounds boiler pressure, now in the development stage.

Experimental work began with locomotive road number 1111, which was placed in service December 29, 1926. These fourteen locomotives have to date a service mileage of 1,600,000 in round numbers.

Outstanding in the foregoing is locomotive number 652 which has about 215,000 miles. This locomotive has yet to have removed a broken or fractured staybolt, or a flue, and the flues are not welded in the boiler.

From a bolt standpoint, with a mileage of 1,594,785, a renewal of but two broken or fractured staybolts has been found necessary.

From a sheet renewal standpoint, the defects with our type boilers, irrespective of pressure, are first had in the firebox throat sheet at the root of the flange just below the tube sheet at or about its center. As an experiment, looking to an improvement in this condition, copper was used for the throat, flue and door sheets of locomotives 1111 and 1112. * * * After between 62,000 and 67,000 miles service, the flue sheets were removed on account of "V"ing out the tube sheet about the tube bead. The copper throat sheet was removed from engine 1111 after 168,650 miles, and from the 1112 after 137,251 miles. Each of these sheets developed a crack at the right and left side at the roll of the throat sheet flange around the bottom of the flue sheet connection. It is of more than passing interest to note, the cracks started on the fire side of the sheet, a reversal of the usual experience had with steel sheets. The door sheets are still in the two locomotives.

Before the flues were replaced in the boiler, a very careful inspection was made for evidences of deterioration, etc., due to the use of riveted dissimilar metals, but none such was found. Investigations in Europe of boilers similarly built having dissimilar firebox materials, gave experience in accord therewith.

Further studies have developed, but not yet to a conclusion, copper sheets are being very successfully welded in Australia and to some extent in Europe. The experiment, therefore, has not been carried to a conclusion for had our knowledge of the art of copper welding reached this advanced stage, the removal cause of these sheets was of such a nature that they could have been repaired, as the deterioration of fracture development was on the exposed or fire side of the sheet.

We are not without knowledge, with the raising of pressures in conventional locomotive boilers to 220 pounds and above, in some cases, boiler problems have increased both in America and Europe. In a report by H. N. Gresley, chief mechanical engineer of the London and North Eastern Railway to the International Railway Congress Association in 1929, Chapter 1 captioned "Increased Boiler Pressure," on page 2697 of this report, paragraph 5 we read:

General Remarks as to Raising Boiler Pressure Above Recognized Standard

The result of increasing the boiler pressure appears to have produced economy in fuel and water consumption. At the same time it is reported that there is an increase in the cost of maintenance of fireboxes which may go so far as to neutralize the economies effected in fuel consumption. It is desirable, therefore, that further experience as a result of increasing the boiler pressure should be obtained.

Higher pressures have resulted in more powerful locomotives being built within the loading gage limits and this is of special value when it is required to provide more powerful locomotives than those already in service which have been built to the extreme limits allowed by the loading gage.

Our experience with the locomotives here set out, with special reference to the stayed surfaces, is distinctively not in accord with the foregoing, our tentative conclusions leading to the belief, pressure is not a factor of maintenance. There are other phases which we feel deserving of parallel careful study before definite conclusions can be reached. Among these we might mention:

(1) Boiler design, with special reference to conditions obtaining in the water legs.
(2) Method of attachment to running gear.
(3) Materials.
(4) Workmanship and manufacture technique.
(5) Terminal attention.
(6) Service conditions, especially those of the water used.
(7) Circulation.

In this direction we have made several boiler expansion test measurements on Locomotive 1607, fitted with circulating nozzle located in the bottom middle course of boiler shell for admission of live steam to provide circulation during firing up period to test out what takes place when boilers are fitted up as at washout dates, as it lessens the effect of temperature stresses during such periods.

Briefly, let all phases and facts surrounding the problem be carefully studied before assignment as to the

* Second instalment of a report by the committee on locomotive construction, presented at the last annual meeting of the American Railway Association, Mechanical Division.

cause or an economic expense is made. It is only by this means may true progression be had.

The New York Central reports the use of high-pressure steam for the purpose of obtaining further increase in locomotive efficiency. This received their attention and study as early as 1925 and two separate personal investigations subsequently were made in Europe by members of the Equipment Engineering Organization in order to obtain first-hand information relative to the several systems then in progress of development and experimental service. In 1928, decision was reached in favor of the Schmidt-Henschel double-pressure, high-pressure system now known in America as the Elesco multi-pressure system in preference to medium high-pressure arrangement from which appears that less substantial efficiency gains may be expected. A working committee representing the American Locomotive Company, the Superheater Company and the railroad company was then formed and in May, 1929, actual design of the locomotive was started.

The fundamental principle consists of the utilization by a double-expansion engine of steam from a two-pressure boiler in which the high-pressure element of the boiler receives its heat from a super high-pressure, closed-cycle steam system.

The engine is of the three-cylinder type. The middle cylinder 13¼ inches in diameter by 30 inches stroke receives superheated high-pressure steam at 850 pounds per square inch and the two outside low-pressure cylinders 23 inches diameter by 30 inches stroke are supplied with a mixture of exhaust steam from the high-pressure cylinder and the balance of live superheated steam from the low-pressure boiler at 250 pounds per square inch.

The steam generating system is divided into three parts, viz., the closed super high-pressure indirect heat transmission system, the indirectly heated high-pressure boiler (drum), and the low-pressure boiler. The closed circuit consists of a watertube generator forming walls and crown of firebox connected into an arrangement of header drums and a firebox ring, also heat transfer or condenser coils forming a part of the closed circuit located in high-pressure drum. The steam passing through the heat transfer coils is condensed as the result of giving up its latent heat to the water in the high-pressure drum and it is returned through down-comer tubes to the firebox ring, thus again being made available for re-circulation.

The high-pressure boiler drum is located directly above the firebox but is insulated and receives no direct heat.

The closed circuit system in which distilled water is used operates at approximately 1350 pounds per square inch and the high-pressure boiler drum at 850 pounds per square inch.

The low-pressure section of the boiler consists of the barrel of a conventional firetube-type boiler and operates at a pressure of 250 pounds per square inch.

The locomotive is of the 4-8-4 type having 69-inch diameter driving wheels. Total weight of the engine is 435,000 pounds of which 252,000 pounds is carried on the drivers. The tender loaded weighs 312,700 pounds and carries 15,000 gallons of water and 28 tons of coal. Rated tractive power main engine 66,000 pounds and the booster 13,750 pounds making a total of 79,750 pounds.

Watertube Firebox Boilers

The three Delaware and Hudson watertube firebox locomotives are:

No. 1400—Horatio Allen, 350 pounds pressure.

No. 1401—John B. Jervis, 400 pounds pressure.

No. 1402—James Archibald, 500 pounds pressure.

These three locomotives represent three stages out of a total of four in connection with steam locomotive development work. The fourth stage will be represented by D. & H. 1403, "Charles P. Wurts," which is now under construction at the Schenectady Plant of the American Locomotive Company, which will be a 4-8-0 type with four outside cylinders of the triple expansion system. High-pressure cylinder will be located at the right rear end of the frame; the intermediate cylinder at the left rear of the frame and the two low-pressure cylinders, one each on the right and left sides, in the conventional location at the head end.

The front and back cylinders on each side will be connected to the same crank pin on the main driving wheels.

The arrangement is to distribute piston thrust stresses over the entire frame; to place all of the cylinders outside of the frame; to provide for triple expansion and substantially reduce low-pressure cylinder exhaust steam pressure; to provide for four instead of two, exhaust steam impulses per revolution of driving wheels when operating multiple expansion, and generally to produce a higher thermal efficiency in terms of the heat value of the fuel at the tender drawbar and which, for the other three locomotives when in road service is when they are using steam continuously with full tonnage rating on level track.

D. & H. No. 1400— 8.73 percent
D. & H. No. 1401— 9.35 percent
D. & H. No. 1402—10.4 percent

The 1403 will be equipped with Dabeg poppet valve system to all cylinders and with the Dabeg rotary cam valve gear. Provisions will be made for the admission, when required, of high pressure steam into the intermediate pressure low pressure cylinders receiver pipe for the purpose of increasing the tractive power, temporarily, when negotiating heavy pulls.

(*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 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.

Case No. 742.—*Inquiry:* Par. P-288*b* requires independently fired superheaters which can be shut off from the boiler to be provided with safety valves having a discharge capacity based on Par. P-270. How may the size of safety valves for such superheaters be more definitely determined, and would more than one safety valve ever be required?

Reply: It is the opinion of the committee that the intent of the reference to Par. P-270 will be met if the capacity of the safety valve or valves installed is equal to 6 pounds of steam per hour per square foot of superheater surface measured on the side exposed to the hot gases. The number of safety valves installed shall be such that the total capacity is at least equal to that required.

CASE No. 746.—*Inquiry:* Is it necessary, under the requirements of Par. P-310 of the Code, that pipe fittings in blow-off lines be of steel, or does Par. P-12 permit of the use of cast-iron fittings for this purpose?

Reply: Par. P-12 is a general rule pertaining to pipe connections and fittings, but the committee points out that Par. P-310 specifically requires all fittings in blow-off lines between the boiler and the blow-off valves to be of steel.

CASE No. 747.—*Inquiry:* Par. P-195 specifies which diameters shall be used in determining the radius of spherically dished heads attached by riveting. What corresponding diameter shall be used for heads attached by butt welding, when the heads and shell plates are the same thicknesses, and when they are of unequal thicknesses that require thinning as provided in Par. P-104?

Reply: It is the opinion of the committee that in all cases when dished heads are attached to shells by butt joints, the inside diameter of the thinnest portion of the shell plate shall be used in applying the rules of the Code.

CASE No. 748.—*Inquiry:* Pars. P-180 and U-20 provide that if the thickness of the weakest course of a shell is over 10 percent of the radius the outer radius of the shell shall be used in computing the maximum allowable working pressure. If a shell is so made that the thickness of a portion of the circumference exceeds 10 percent of the radius, while the thickness of other parts of the shell measured on the same circumferential plane is less than 10 percent of the radius, which thickness shall be used in calculating the allowable working pressure?

Reply: It is the opinion of the committee that the maximum allowable working pressure shall be the lesser of those calculated for each diameter and thickness in accordance with the requirements of Pars. P-180 and U-20, using the radius, thickness, and longitudinal efficiency in each case.

(To be continued)

Lincoln Arc-Welding Prize Papers Now in Book Form

Cutting costs by re-designing is the theme of a new book published this week. "Designing for Arc Welding" is the title of the book, which contains prize-winning papers submitted in the $17,500 Second Lincoln Prize Competition. The published papers are those judged the best from some 400 submitted in the competition and include the work of foremost engineers in the United States and abroad.

The book consists of approximately 450 pages, divided into five sections as follows: Part I—Machinery; II—Shipbuilding; III—Buildings-Bridges; IV—Large Containers; and V—Piping and Fittings. In every case, the fundamentals of the design are so explained as to make them applicable to other industries.

The use of arc-welded alloys to resist corrosion; the substitution of arc-welded steel for aluminum without weight increase; the welding of high-tensile steels; structural design for the resistance of earthquake shocks—are a few of the interesting new developments which are discussed.

Every chapter of the book is written by an authority in that particular field. The total of these chapters represents the outstanding contributions of welding to industry during the past two years.

One of the principal points on which the papers in the competition was judged was the savings in costs made by the use of arc welding. Each paper gives actual costs and shows how the savings were effected. A résumé of the possible savings in all industries represented by the papers submitted shows a total estimated savings of over one billion dollars a year, if arc welding were used as extensively as possible.

Among the contributors are Lt. Com. Homer N. Wallin and Lt. Henry A. Schade, United States Navy, winners of the first prize; H. H. Tracy, structural engineer, Southern California Edison Company; Major G. M. Barnes, Ordnance Department, United States Navy; H. J. L. Bruff, London and North Eastern Ry., London, England; William H. Zorn, The Detroit Edison Co.; Raymond Hoffman, The Standard Oil Company of New Jersey; Gustav Wahl, chief naval architect, Deutsche Werke Kiel, Kiel, Germany; K. T. Sorenson, designing engineer, Baldwin Southwark Corporation, and many others. The editor is A. F. Davis, vice-president of The Lincoln Electric Company.

The book is bound in cloth-covered boards and published by The Lincoln Electric Company, Cleveland, O. The price is $2.50.

In commenting on this work Robert E. Kinkead, consulting welding engineer, and an internationally recognized authority states:

"The outstanding impression from this book is that the information on the subject is authentic. While the mere citation of the names of the authors would seem to assure authenticity due to the fact that they are well known in the profession of engineering, the nature of the design data presented is such as to be acceptable on its own merits to experienced engineers.

"Re-engineering of industry must be carried on, during the coming reconstruction period, on a vast scale and this book is opportune and a valuable contribution to that work. We know what is likely to happen in shipbuilding from the data presented by Lieutenant Commander Wallin and Lieutenant Schade of the Navy showing 10.4 per cent more weight in a riveted vessel than in an equivalent vessel welded. T. F. Bright shows a saving of 34 percent in building a welded gas purifier box as compared with building a riveted one. K. T. Sorenson shows a cost reduction of 42 percent by building an arc-welded dough mixer. Major G. M. Barnes, U. S. A., found that arc-welded steel construction solved a problem in making anti-aircraft gun mounts which appeared impossible of solution with steel castings owing to the large number of shrinkage cracks and defects encountered in steel castings such as were required. The Watertown Arsenal practice of X-Raying steel castings and certain responsible welds seems to forecast more general adoption in industry of this practice where there must be no possibility of failure in service.

"An entirely new concept of structural design of machinery and equipment parts is evident in Everett Chapman's paper on the design and construction of a 500-ton precision press in welded steel construction. The implications of the paper are so far reaching as to shake the foundations of conventional mechanical engineering practices in respect to design.

"It is my prediction that this book will have a more profound influence on engineering practices than any engineering work that has been published in the last ten years."

Boiler Tubes Made by a New Process

Steel and Tubes, Inc., Cleveland, O., a subsidiary of the Republic Steel Corporation, has announced the development of electric resistance weld boiler tubes, to be marketed under the trade name of Electrunite boiler tubes. These tubes have been approved by the American Society of Mechanical Engineers for use in pressure boilers and bear the approval both of the United States Department of Commerce Steamboat Inspection Service and the American Bureau of Shipping.

The tubing is formed from strip steel continuously, the strip being passed through a series of forming rolls. The round butted tube thus formed then passes under

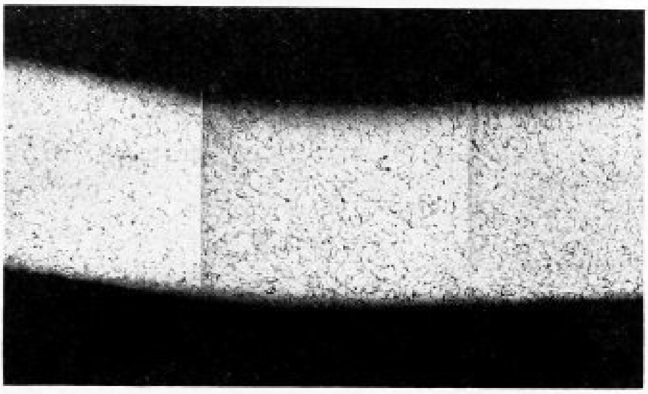


Photo-micrograph of boiler-tube wall at weld after normalize annealing—grain structure of weld same as the wall

revolving wheel-like copper electrodes where current travels from electrode to electrode through the butted seam of the tube. At the same time pressure is applied which, together with the heat which is below the fusion temperature and which is confined to an area no larger than a pinhead, completes the weld. The tubing is later normalized and fully tested in accordance with A.S.M.E. specifications.

This is the first departure in boiler-tube practice for many years, as heretofore only seamless and lapweld tubes have been acceptable for use in boilers. The manufacturer claims for this product extreme uniformity of diameter and wall thickness and a fine strip steel surface quality inside and outside the tubes.

This type of boiler tubing is available in all sizes up to 5 inches outside diameter, in copper-bearing nickel steel and Toncan iron, as well as in the usual open-hearth steel.

Another Example of Air-Water Tank Hazard

Two workmen on an estate in Lattingtown, Long Island, were severely injured on November 1 when they were caught in a pump house that was virtually demolished by the explosion of a hydro-pneumatic tank beneath it. The tank was used to supply water to the various buildings on the estate, pressure being obtained by forcing compressed air into the tank with the water.

The explosion ripped the roof from the building, hurled the two men 20 feet, and scattered the pumping machinery over a wide area. It was stated that the estate superintendent tried unsuccessfully to shut down the pump motor after he found that the automatic cut-off was not working, and that he attributed the explosion to failure of the safety valve to open when the pump built pressure up to the danger point.

The superintendent first suspected trouble when he saw smoke issuing from the windows of the pump house. He found the smoke coming from the motor, which was evidently overheated. An attempt to pull the switch resulted in his receiving a shock that hurled him several feet, so he telephoned for electricians. The latter had scarcely entered the pump house when the tank let go, and they were carried aloft by a muddy geyser that swept everything before it. Neither man had regained consciousness by the time an ambulance arrived, and it was feared that they had sustained internal injuries.

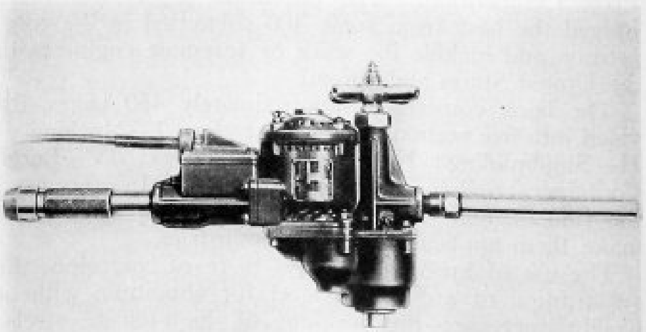
Many thousands of these hydro-pneumatic water supply systems are in use on estates, farms, and at hotels and clubs where no city water is available, and they have come to be used extensively in car washing garages. Numerous cases that come to our attention indicate that they are the source of frequent explosions, a fact that is not at all surprising when it is considered that apparently many persons fail to realize that a tank filled partly with water and partly with compressed air is more closely akin to the very hazardous air tank than it is to the ordinary tank for the storage of water.—*The Locomotive.*

Electric Drill And Reamer

The Independent Pneumatic Tool Company, 600 West Jackson boulevard, Chicago, has designed a type of drill and reamer, which is a departure from the usual straight design. As can be seen in the illustration the offset motor is separate from the frame and feed-screw post, which design makes a short machine and permits the use of a feed of greater range. This design also permits the use of a short spindle, which facilitates operating in close places.

Another feature is the switch handle, which is of the safety roll type. This switch cannot be operated except by a turn of the operator's hand, and automatically closes when the hand is removed from the grip. The new Thor switch handle is similar in appearance to the throttle used on pneumatic drills. It has no exposed slots or openings to permit the entrance of dust or dirt through the handle.

This new drill and reamer is made in five sizes, having drilling capacities from 7/8 in. to 1 3/4 in.; reaming capacities from 11/16 in. to 1 1/8 in. and weighing from 33 to 55 lb.



Thor high frequency electric drill and reamer

Layout of Sphere

By George M. Davies

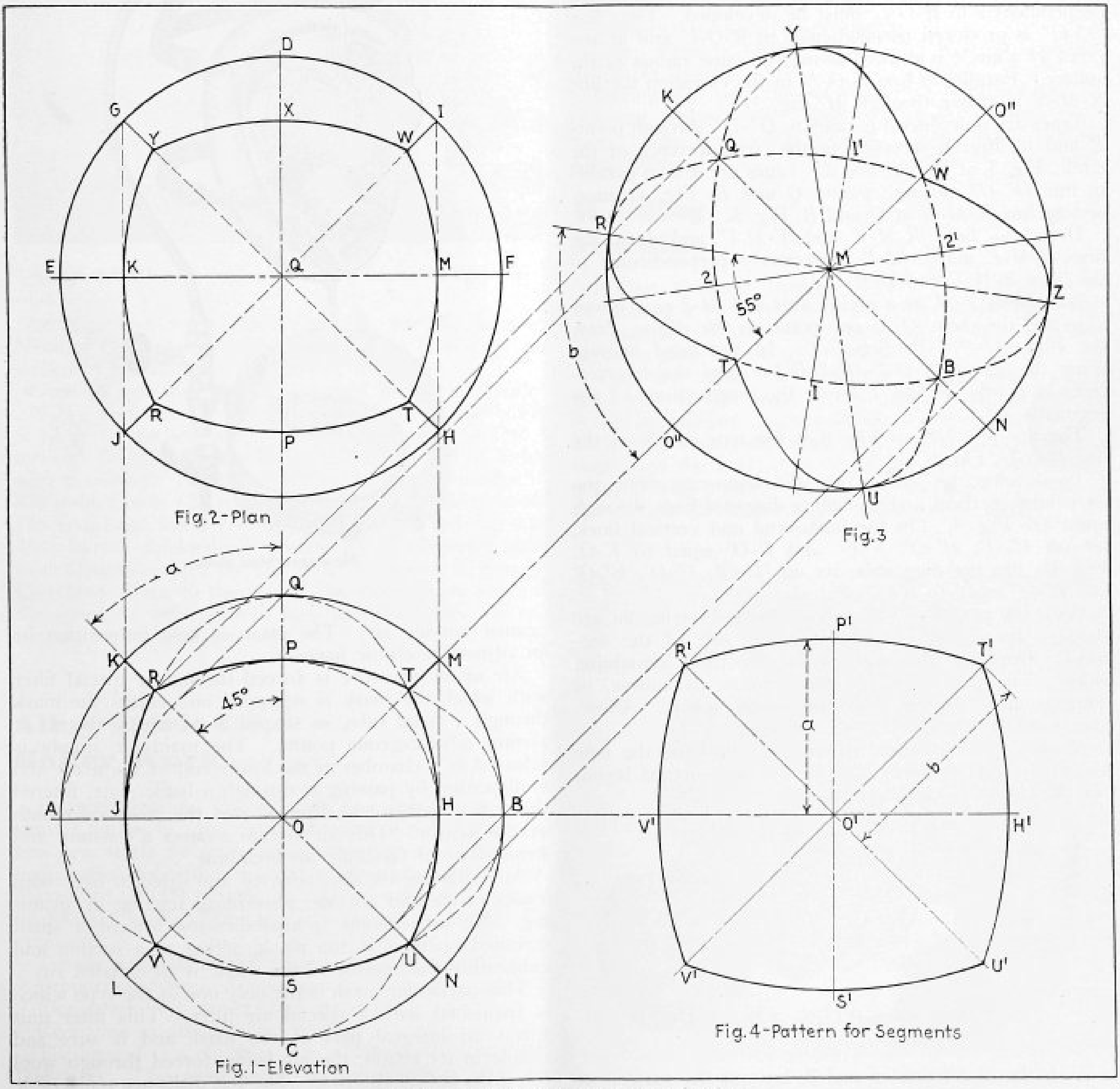
In reply to a recent question the following explanation is given for the layout of a sphere:

As the surface of a sphere or any other arched construction has a double curvature, a pattern for plates can only be approximate.

The following method of developing a sphere is different from the methods shown in "Laying Out for Boiler Makers," in that it divides the surface of the sphere into six segments, each segment being a duplicate.

The development of a sphere is accomplished by making a template of one of the segments and duplicating this six times to complete the sphere. With the point *O* in the elevation, Fig. 1, as a center, describe a circle with a radius taken from the center of the sphere to the neutral thickness of the metal. Draw the corresponding circle in the plan view.

In the plan view, Fig. 2, draw the diagonal lines *G-H* and *I-J* at an angle of 45 degrees to the line *E-F*. Draw lines through points *G*, *J*, *I* and *H* parallel to line *D-C* intersecting the circumference of the elevation at *K* and *M* and cutting the line *A-B* at *J* and *H*. With *O* as a center and *J-O* as a radius scribe a circle intersecting line *C-D* at *P* and *S*. Thus the points *J*, *P*, *H* and *S* on the boundary of the segment are located.



Plan, elevation and pattern for spherical surface

The next step is to locate the points *R, T, U*, and *V*. Since each boundary line drawn on the surface of the sphere is the arc of a great circle, any great circle other than the circumference of the elevation will appear as a true ellipse. Then with *Q-O* as a major axis and *J-O* as a minor axis, draw the ellipse *J-R-Q-T-H-U-C-V*. With *A-O* as a major axis and *P-O* as a minor axis draw the ellipse *P-T-B-U-S-V-A-R*. Thus the intersections of the two ellipses locate the points *R, T, U* and *V*. The sides of the segment *P-T-H-U-S-V-J-R* are sections of the ellipses.

The lines *K-R, T-M, U-N*, and *V-L*, Fig. 1, are taken at an angle of 45 degrees to the line *A-B* and indicate the intersections of the other segments. Thus *K-R*, Fig. 1, is the elevation of line *R-K-Y* in the plan view, Fig. 2; *T-M*, Fig. 1 is the elevation of *T-M-W* in the plan, Fig. 2, and *R-P-T* is reproduced at *R-P-T* in the plan.

The true length of the lines *J-O-H* and *P-O-S* is indicated by the length of arc *K-Q-M*, Fig 1. In order to obtain the true length of the line *R-O-U*, a view taken perpendicular to *R-O-U* must be developed. Thus line *O"-O"* is produced perpendicular to *R-O-U* and at any point *M* a circle is drawn having the same radius as the sphere. Parallel to line *K-O-N* in the elevation the line *K-M-N* is drawn through *M*, Fig. 3.

Lines are now drawn parallel to *O"-O"* through points *R* and *U*, Fig. 1, intersecting the circumference of the circle, Fig. 3, at *R-Y-U* and *Z*. Lines are drawn parallel to line *O"-O"* through points *Q* and *B*, Fig. 1, intersecting line *K-M-N* at *Q* and *B*, Fig. 3.

Draw the lines *R-M-Z* and *Y-M-U* and draw the lines *1-M-1'* and *2-M-2'* respectively perpendicular to the lines *R-M-Z* and *Y-M-U*.

Now with *Y-M* as a major axis and *M-2* as a minor axis and the point *Q* as one point on the ellipse, draw the ellipse *2-Q-Y-W-2'-B-U-T*. In the same manner draw the ellipse *R-Q-1'-W-Z-B-1-T* and the intersections at points *W* and *T* locate the intersections of the segments.

The arc *R-O"-U* in Fig. 3 is the true length of the line *R-O-U*, Fig. 1.

To develop the pattern for the segments, draw the horizontal, vertical and 45-degree diagonal lines through point *O'*, Fig. 4. On the horizontal and vertical lines, set off *P'-O', H'-O', S'-O* and *J'-O'* equal to *K-O*, Fig. 1. On the diagonals, set off *T'-O', U'-O', V'-O'* and *R'-O'* equal to *R-O"*, Fig. 3.

With the points *R', P'* and *T'* located, strike an arc through these points, completing one side of the segment. Duplicate this method for the three remaining sides. The pattern thus formed must, of course, be bumped out to the true curvature of the sphere. Allowance must be made for laps, if riveted.

A simple mathematical method of obtaining the true lengths of the segments without the necessity of laying out the circles is as follows:

Let, D = neutral diameter of the sphere.
a = true length of arc *K-Q*, Fig. 1.
b = true length of arc *R-O'*, Fig. 3.

then

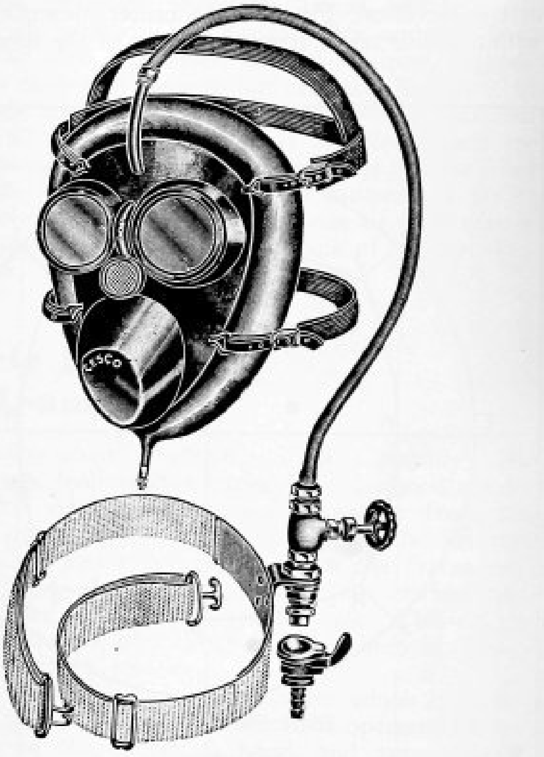
$$a = \pi D \times \frac{45}{360} = 0.125 \ \pi D = 0.3927 D$$

$$b = \pi D \times \frac{55}{360} = 0.1528 \ \pi D = 0.4799 D$$

With the dimensions a and b, lay out the pattern as previously described.

Mask for Sand Blast Operators

Sand blasting of the interiors of locomotive boilers has become one of the essential operations in repair and maintenance work. For safeguarding the operators, the Chicago Eyeshield Company, Chicago, has developed the Cesco health-guard mask, which is especially designed for sand blasting and other occupations where hurtful dust is encountered. With this new mask it is claimed that positive protection is assured. The mask consists of a rigid metal face piece on which is mounted a pure gum rubber pneumatic cushion which shapes itself to the contour of the face, sealing the interior of the mask against outside air. The mask is held in position by an adjustable elastic harness.



New sand blast mask

Air under pressure is forced through a special filter with which the mask is equipped and enters the mask through a metal tube, so shaped as to release the air at certain advantageous points. The main air supply is released in a chamber at the lower end of the mask and is dispensed by passing it through a baffle plate, filtered through a sponge and directed past the nose and mouth of the wearer. This air stream assures a constant and steady flow of fresh air for breathing.

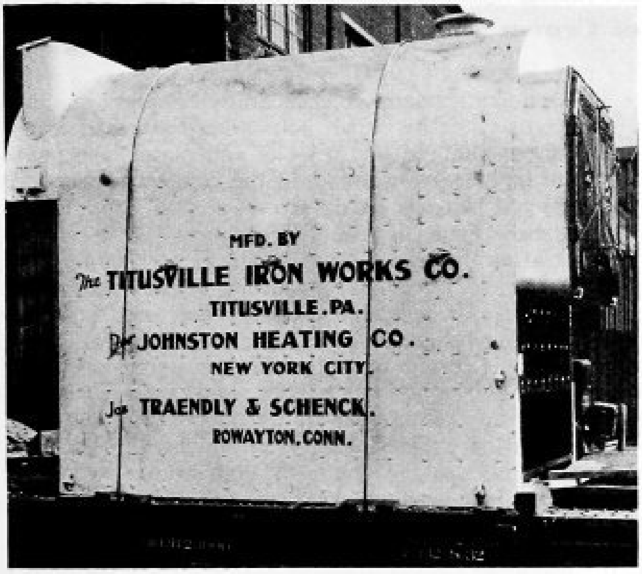
Air currents are also released and directed over both lenses inside and outside, preventing fogging or steaming. An air current is also directed toward a small screened opening in the mask, acting as a suction and exhausting the interior of the mask of all exhaled air.

This particular mask is the only one of the type which is furnished with a special air filter. This filter unit forms an integral part of the mask and is sure and simple in its action, the air being forced through wool felt disks before entering. The felt disks are replaceable and the unit may be cleaned in a few seconds.

Large Boiler Fabricated By Arc Welding Process

Construction of the boiler illustrated by arc welding reduced the amount of material required, lowered the weight and produced a stronger, safer boiler.

The boiler, planned for 42,000 square feet of radiation, weighs 35,000 pounds and was built by The Titusville Iron Works Co., Titusville, Pa., for the Johnson Heating Company of New York City. It will be installed in a building at Rowayton, Conn.



A total of 279 feet of welding was used in fabricating this boiler

Steel ½ inch in thickness was used for the side plates and $^{9}/_{16}$ inch for the heads. The length of the boiler is 12 feet 7 inches, width 7 feet, and height 13 feet 4 inches. To fabricate the boiler, 279 lineal feet of welds were necessary. A total of 419 staybolts were used with 814 welded ends (24 ends were threaded), making about 226 additional lineal feet of welding. All welding was done by the shielded-arc process using Fleetweld electrodes manufactured by The Lincoln Electric Company, Cleveland. Due to the use of the shielded-arc process, the speed of welding was high and the welds are extremely resistant to corrosion.

Alloy Steels for Boiler Work

In recent months The Timken Steel and Tube Company, Canton, O., has developed and is now promoting two new steels for high-temperature service. One is a manganese moly steel, having a creep strength at 900 degrees of 21,000 pounds at a creep rate of 1 percent in 100,000 hours. The physical properties at 900 degrees are:

Tensile strength, 69,000 pounds per square inch.
Proportional limit, 20,000 pounds.
Elongation in 2 inches, 27.5 percent.
Reduction in area, 26.9 percent.

The second is a chrome moly silicon steel, designated DM steel. This steel has a creep strength at 1000 degrees of 13,700 pounds at a rate of 1 percent in 100,000 hours. The physical properties at 1000 degrees are:

Tensile strength, 53,300 pounds per square inch.
Proportional limit, 17,700 pounds.
Elongation in 2 inches, 28 percent.
Reduction in area, 72 percent.

Oxidation tests at 1000 degrees F. show a loss of 0.30 on DM steel compared to a loss of 0.375, while 1100 degrees DM shows a loss of 0.95 percent as against carbon steel of 2.55. Both of these steels will enable the boiler engineer to design boilers and superheaters for use at higher temperatures and pressures than are now possible with ordinary carbon steel. These steels are not susceptible to temper brittleness. These steels are made with a proper grain size to develop the highest creep strength possible.

The company has also developed a high-temperature bolt steel which is named 17-22. This is a chrome tungsten vanadium steel and the physical properties at 1000 degrees F. are as follows:

Tensile strength, 105,000 pounds per square inch.
Proportional limit, 60,000 pounds.
Elongation in 2 inches, 24 percent.
Reduction in area, 75 percent.
Creep strength 18,000 pounds at a rate of 1 percent in 100,000 hours.

During this year the company will offer a corrosion resistant boiler tube. This will be of Timken nickel moly. This analysis is now undergoing tests and we soon expect to have some service data on this steel.

Welding Machine

Hobart Brothers Company, Troy, O., has placed on the market a new model constant-arc welder for which the company claims 600 percent more capacity than previous models costing as much.

This new welder is fitted for handling both coated rods with 42-volt requirements and 25-volt plain rods. A remote control feature allows the operator to weld 50 to 100 feet away from the welder, always having control of the current at his finger tips. The machine is made with a louvre-type casing making it waterproof and thus available for use in inclement weather.

Hobart constant-arc welder

The Boiler Maker

VOLUME XXXIII NUMBER 4

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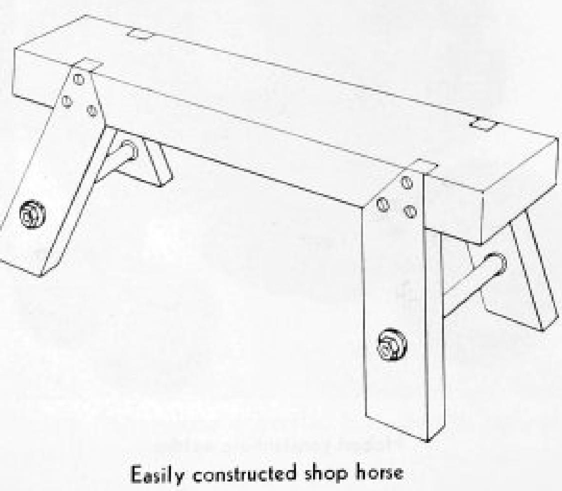
Communications

A Serviceable Shop Horse

TO THE EDITOR:

I think that this shop horse which is illustrated will appeal to those shop men who have cussed the ordinary flimsy rickety lightly constructed shop horse.



Easily constructed shop horse

The particular feature of this horse is the method of making the joint of the tops of the legs. The illustration indicates this construction.

Penacook, N. H. CHAS. H. WILLEY.

Holding Qualities of Crown Bolts

TO THE EDITOR:

The following relates to comparative holding qualities of different types of crown bolts where attached to the crown sheet, the end of the bolts and plates being subjected to high temperatures and the connection between the bolts and plate to steady stress.

Tests were made to note the condition of the remaining bolt after the bolt with most stress vacated the hole in the plate. The holding qualities of the bolts were tested in pairs, bolt against bolt, extra-stressed straight-thread hammered-head bolt against buttonhead bolt; again, lesser-stressed taper-thread hammered-head bolt against the straight-thread bolt, and heavier loaded straight-thread bolt against another straight-thread bolt. In all cases the extra-stressed straight-thread bolt came out of the hole in the plate; in all tests the remaining buttonhead bolt was in the best condition. In other tests of equally stressed bolts, but one type against a different type, the buttonhead bolt held against any other with which it was paired. Between a straight-thread hammered-head bolt and a taper-thread hammered-head bolt, equally stressed, there was no difference in the holding quality; at different times one or the other came out first. The upward bulge of the plate at the hole being the same, the top of the hole opens the same; a large head hammered-head bolt of either type will hold against a small head hammered-head bolt of its own or another type.

The stretching of the plate making these tests, as in a crown-sheet failure, enlarges the hole in the plate at the top side. Now in a really taper hole from this side, there is an acute angle at the lower edge of the hole; this angle in steel plate will not give way as readily as the hammered head of the iron bolt. The hammered head of the straight-thread bolt or tapered-thread bolt will mushroom down before the steel plate at the lower edge of the hole will open up.

When applying buttonhead or taper bolts in a new crown sheet the size of the bolt hole in the roof sheet governs the size at the lower end. There have been roof sheets renewed when crown sheets were applied, as a prohibitive size hole for the crown sheet was needed. A straight-thread bolt entered from the top is the only alternative, this bolt having a reducing re-thread on the lower end, a stud fit from the inside, this fit being the spring of the thread-cutting dies, the same fit that is used all over the boiler. A shoulder is formed where the dies cease cutting, the shoulder jams against the top of the crown sheet, the cutting dies being adjusted so that ¼ inch of bolt projects for hammering.

This shoulder on the bolt acts as a stop against any upward movement of the plate caused by expansion or drawing of the bolt when riveting the head on end and takes stress from the threads in one direction. A loose fit straight-thread bolt hammered to form the head will draw the bolt until part of the angle on one side of the bolt thread will come in contact with part of the angle on one side of the thread in the hole. As there will not

(*Continued on page 72*)

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 Spacing

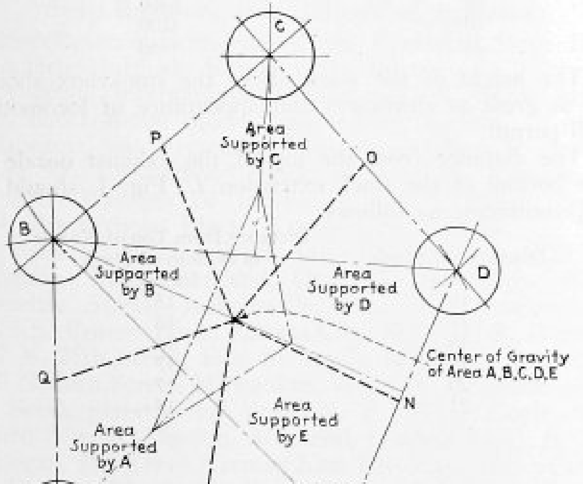
Q.—Will you kindly answer the following questions in your Questions and Answers column of THE BOILER MAKER:

(1) What part of the area inclosed by staybolts *A, B, C, D, E* is supported by each of the staybolts *A, B, C, D* and *E*, as shown on the attached sketch?

(2) How is the pitch of the staybolts measured when the staybolts are not located in straight lines?

(3) Is the staybolt spacing as shown on the attached sketch too large when $P = 250$ pounds pressure; $T = 5/16$-inch thickness; $C = 112$ constant; P (calculated) $= 3.345$ pitch.—A. B.

A.—(1) A practical method of determining the area supported by each staybolt is shown in Fig. 1. First obtain the center of gravity of the area *A-B-C-D-E*;



Staybolt problem

then from the center of gravity draw lines to the points *m, n, o, p* and *q*. The point *m* bisects the pitch line *A-E*, the point *n* bisects the pitch line *E-D*, etc.

(2) The following interpretation of Par. 199 gives a method of computing the load on staybolts unsymmetrically pitched:

Case 518.—Interpretations of A.S.M.E. Code.

Inquiry: Is it not permissible, in applying the formula in Par. P-199 for braced and stayed surfaces in boilers where the staybolts are not symmetrically spaced, to consider the load carried by each staybolt as the area determined by taking the distance from the center of the spacing on one side of the staybolt to the center of the spacing on the other side? Attention is called to the fact that the term *p* in the formula specifies the maximum pitch measured between straight lines passing through the center of the staybolts in the different rows, but that the formula is presented with a definite implication that the staybolts are symmetrically placed.

Reply: In cases where the staybolting of boiler plates is unsymmetrical for reason of interference with butt straps or other construction, it is the opinion of the Committee that in addition to the special provisions of Pars. P-205 to P-207, it is permissible to consider the load carried by each staybolt as the area calculated by taking the distance from the center of the spacing on one side of the bolt to the center of the spacing on the other side.

(3) Yes, the pitch *BD* is excessive.

Nozzle Application

Q.—We would appreciate a further interpretation of the last paragraph in section U-36, page 16 of the A. S. M. E. Code for Unfired Pressure Vessels. The exact part referred to reads as follows: "In the application of which the head shall be treated as a shell of the same diameter, thickness, etc."

Does this mean that in estimating the replacement necessary for a nozzle located on a head that the actual thickness of the head shall be used in the computations, or does it mean that the thickness of the shell that would be used on the same vessel should be used in the computations?

If the former interpretation is correct, it would have the practical effect of meaning that a heavier nozzle would be required on the head of a given vessel than would be required on the shell of the same vessel. As the nozzle would be subjected to the same conditions of temperature and pressure, this does not seem necessary, although the metal removed by the shell opening is greater in the head than it would be in the shell for the same nozzle.

It should be borne in mind that in bending a nozzle to fit a spherical radius, there is less strain set up than in bending a nozzle to fit a shell diameter and, consequently, the writer cannot see why a nozzle that is satisfactory for the shell of a given vessel would not also be satisfactory for the head of the same vessel. Of course, the question hinges on the interpretation of the paragraph mentioned above.—F. E. M.

A.—The part of Par. U-36, Unfired Pressure Vessels, A.S.M.E. Code, referred to in the question is as follows:

"All other openings which require reinforcement placed in a head dished to a segment of a sphere including all types of manholes, except those of the integral flanged-in type, shall be reinforced in accordance with Par. U-59 b, in the application of which the head shall be treated as a shell of the same diameter, thickness, working pressure and material. When so reinforced, the thickness of such a head may be the same as for a blank unstayed dished head."

In my opinion, it is intended that in computing the reinforcement, the head shall be treated as a shell of the same diameter (the diameter of the head), the same thickness (the thickness of the head), the same working pressure (the working pressure in the tank), and the same material (the material used in the head); and therefore in complying with Par. U-59 (1) I would use the actual thickness of the head when computing the actual cross-section in the rectangle *ABCD* and use the required thickness of a shell of the same diameter, working pressure and material in computing the required cross-section in the rectangles (*EFGH* plus *JKLM*).

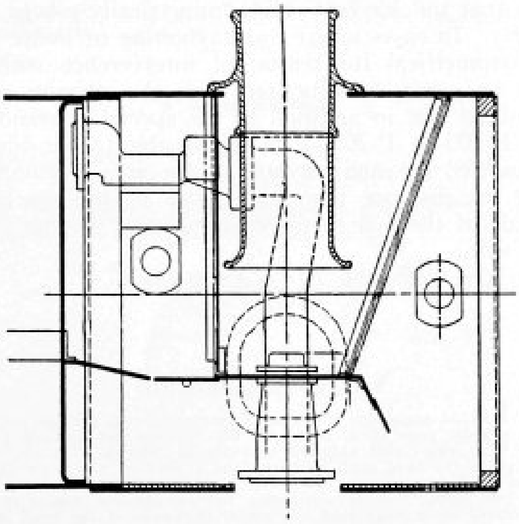
This paragraph could also be interpreted as indicated in the question; (i. e.), considering the head as a shell and using the thickness of such a shell as the thickness of the plate in computing the reinforcement.

It would be advisable for you to obtain a ruling on this point from the Boiler Code Committee.

Drafting of Yard Engines

Q.—The company by whom I am employed has a type of superheater coal-burning yard engine that does well under ordinary conditions, but when they are put to a long haul with a tonnage train they lag and lose steam. We think the trouble could be in the drafting of the engine, so we would like to know what the rules are for adjustment of the draft stack (commonly called petticoat pipe), damper, baffle plates, and the size of exhaust nozzle. I will thank you for any information you may give on this matter.—E. A. R.

A.—The diameters of exhaust pipe nozzles for simple superheated engines burning soft coal and using one



Correctly designed front end

plain circular nozzle per engine are as follows for boiler pressures under 210 pounds per square inch:

Cylinder Diameter Inches	Diameter of Nozzle Inches
17	3¾
18	4
19	4¼
20	4½
21	4¾
22	5
23	5⅛
24	5⅜
25	5⅝
26	5⅞
27	6⅛
28	6⅜
29	6½
30	6¾
31	7
32	7¼

Petticoat pipes are not a part of the smokebox equipment on modern locomotives. In a series of tests conducted by Professor W. F. M. Goss, of Purdue University, in conjunction with the American Railway Master Mechanics Association, the results of which are contained in the 1906 proceedings of that association, it was found that no combination of petticoat pipes would produce better draft than could be obtained with the use of a properly proportioned stack without the petticoat pipes. It also found that, while the presence of a petticoat pipe would improve the draft when the stack is small, it will not do so when the stack is sufficiently large to serve without it.

The height of the petticoat pipe above the exhaust tip or the length of the petticoat pipe was found not to be an important factor, and the total difference between minimum and maximum drafts under all conditions amounted to only 0.30 inch.

The best front end arrangement, and the one that is used on most all modern locomotives, is shown in Fig. 1.

The proper proportions of the modern front end as shown in Fig. 1 are approximately as follows:

The distance from the center line of the stack to the front of the smokebox *B*, Fig. 1, should be made great enough so that sufficient netting can be applied to afford at least 125 percent of the total gas area.

The distance from the bottom of the smokebox to the under side of the table plate *E*, Fig. 1, should be sufficient to provide clear gas area of at least 100 percent.

The adjustable draft plates should be arranged so that a clear gas area of from 60 percent, *F*, Fig. 1, to 90 percent, *G*, Fig. 1, of the total gas area can be obtained.

The inside diameter of the stack *J*, Fig. 1, simple engines is based on the boiler horsepower, as follows:

Diameter of Stack Inches	Boiler Horsepower—Superheated
16	1750
16½	1940
17	2140
17½	2370
18	2610
18½	2860
19	3140
19½	3440
20	3760
20½	4100
21	4460

The height of the stack above the smokebox should be as great as clearances and appearance of locomotive will permit.

The distance from the top of the exhaust nozzle to the bottom of the stack extension *L*, Fig. 1, should be approximately as follows:

Diameter of Stack Inches	Distance from Top of Nozzle to Bottom of Stack Inches
16	15
17	16
18	16
19	17
20	17
21	18

Holding Qualities of Crown Bolts

(*Continued from page 70*)

be a bearing at the other side of the thread, water will come through to the outside of the plate at the bolt head, and the threads will deteriorate, so that all that prevents leaks and holds the pressure is the bolt head. The threads on the bolt and in the bolt hole must carry all the way through the plate to resist this opposite stress in the same manner that a rivet head resists the drawing effect of the forming head at the point of the rivet.

The thread of the taper hammered-head bolt does not resist expansion stress and hammer-drawn stresses as well as a straight-thread bolt. The angle of the thread side to resist this stress is more acute on the taper bolt. There have been instances of bolts after breaking coming through into the firebox.

Louisville, Ky. W. Harris Mitchell.

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

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.		Tampa, Fla.

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States

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

Cities

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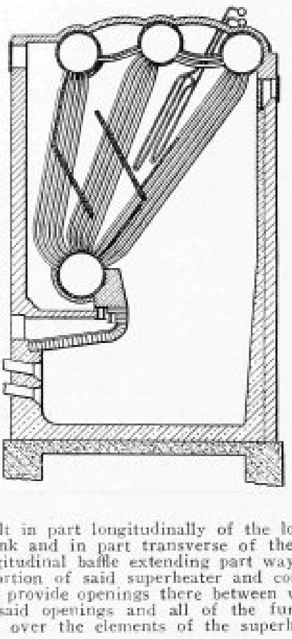
	Parkersburg, W. Va.	

Selected Boiler 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.

1,777,674. WATERTUBE BOILER. KINGSLEY L. MARTIN, OF MONTCLAIR, N. J.

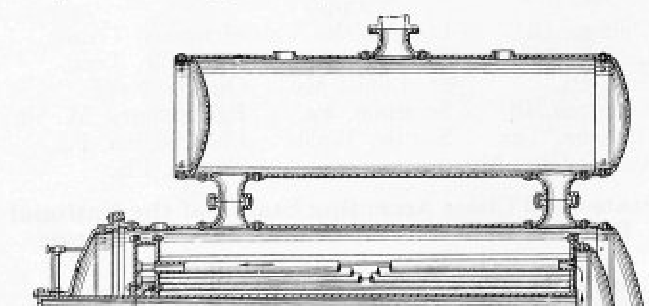
Claim.—In combination in a vertical watertube boiler, comprising a plurality of steam and water drums, a mud drum and a plurality of banks of tubes connected between said steam and water drums and said mud drum, a superheater located between the first and second banks of tubes



and a baffle wall built in part longitudinally of the lower portions of the tubes of the first bank and in part transverse of the said tubes and an extension of the longitudinal baffle extending part way to the upper drum and in front of a portion of said superheater and comprising a plurality of spaced portions to provide openings there between whereby some of the gases pass through said openings and all of the furnace gases are distributed more evenly over the elements of the superheater. Two claims.

1,835,500. BOILER. WILLIAM A. J. KREAGER, OF DENVER, COLORADO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO BARQUE ROYALTY, INC., OF DENVER, COLORADO, A CORPORATION OF COLORADO.

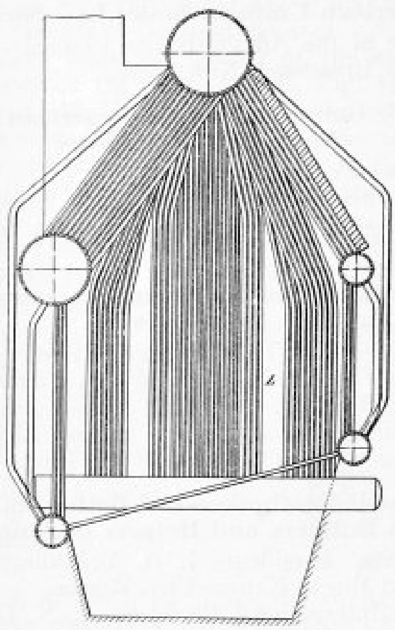
Claim.—A boiler having a readily removable combustion chamber and flue assembly, comprising, in combination, a cylindrical shell portion having means for closing both ends, one of the ends being removable, a



hollow cylindrical member secured to and extending through the removable end and into the cylindrical shell, said member forming a combustion chamber, a plate secured to the inner end of the last mentioned member, a concave end member secured at its edges to the plate and forming therewith a flue chamber, a plate extending across the flue chamber below the combustion chamber and dividing it into two compartments, a manifold surrounding the other end of the combustion chamber, a plate extending across the interior of the manifold at a point below the combustion chamber and dividing the manifold into an upper and a lower compartment, a group of flues extending from the upper compartment of the flue chamber to the upper compartment of the manifold, another group of flues connecting the lower portion of the upper compartment of the manifold with the upper portion of the lower compartment of the flue chamber and a third set of flues connecting the lower compartment of the flue chamber with the lower compartment of the manifold. Four claims.

1,836,251. STEAM BOILER. DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

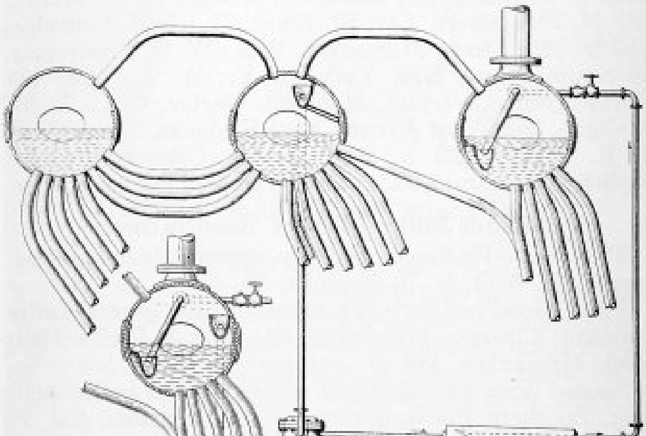
Claim.—In a boiler, a plurality of steam and water drums, tubes connecting each of said drums to a lower water drum, connections between



said drums above and below the normal water levels therein, a steam outlet on one of said drums, and means in one of the other drums to prevent the level of water in said first drum rising sufficiently to cause priming. Seven claims.

1,839,074. WATERTUBE BOILER. HAROLD EDGAR YARROW, OF SCOTSTOUN, SCOTLAND.

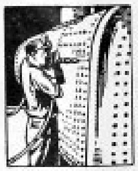
Claim.—A Yarrow type watertube boiler comprising a steam drum, two main water drums, one at each side of the combustion space, a pair of additional water drums situated within the boiler setting at a considerable distance below the main water drums, downcomer water tubes and upriser



water tubes connecting the said additional pair of water drums with the main water drums, a second additional pair of water drums arranged substantially at right angles to the first-mentioned pair of additional water drums, the individual drums of one of said pairs of additional water drums being at different levels, water tubes connecting the said second pair of additional water drums with the steam drum, and inclined water tubes connecting the individual drums of the pair of additional water drums which are at different levels. Two claims.

The Boiler Maker

Reg. U. S. Pat. Off.



The New Deal for the Railroads

As a result of emergency railroad legislation about to be enacted by Congress, there is at least some degree of hope that the railroads of the United States will commence their recovery. There is no royal road to prosperity for this or any industry, and unless an attempt is made to correct the evils blocking recovery, progress is impossible.

The major difficulties have been uncontrolled competition from truck and water carriers, the top heavy capital structures of many of the railroads and uneconomic competition between railroads themselves. Without reviewing the proposed legislation, it obviously is intended to make possible correction in two of these categories. The third, that of uncontrolled competition from other forms of transportation, is rapidly being remedied by state legislation, which eventually will be supplemented by federal regulation of interstate highway carriers.

The ultimate effect of these measures on the railroads will depend on the skill and integrity of those in whose hands will lie the authority for carrying out the provision of the legislation and upon their own efforts in correcting evils within their control in the industry itself.

On the financial side, the railroads must be placed in a position to earn a return sufficient to protect the millions of citizens dependent on their railroad investments. On the side of employment the means for gaining a livelihood by over a million workers must be safeguarded.

It has become increasingly evident as the result of three years of virtual stagnation that drastic action was necessary if the integrity of the railroads as the major arm of transportation was to be maintained in the future. Employment at any level of business depends above all on the healthy state of the industry and, with correction of barriers against the railroads' ability to keep solvent, employment ultimately would improve. Stabilization not only will mean more employment eventually but under conditions that will prevent the recurrence of the uncertainty of the past few years.

Within the industry itself, consolidation, elimination of duplicate services, concentration at centralized points of repair work, the general elimination of wasteful practices, and well organized planning are all necessary parts of the project to rejuvenate railroad transportation. A major feature of the President's legislation is designed through government direction and co-operation to make such a program possible.

The final measure of the return to healthy conditions in the industry will, of course, be a general improvement in business, which will require more of the railroads' potential capacity to accommodate transportation demands. There is evidence in the gradual improvement in car loadings, which now are but fractionally below the level of 1932, that better times are ahead for the railroads.

This trend upward has been sustained beyond seasonal fluctuations since last Fall. As pointed out in these pages, the number of unserviceable locomotives stands at the highest point since the American Railway Association, Car Service Division has maintained statistics covering the condition of power. Correction of the critical financial difficulties now existing, and which the legislation to be enacted among other things is designed to overcome, will make possible the repairs, renewals and replacement of equipment necessary to meet any appreciable gain in transportation demand.

The Manufacturer and the Supervisor

Lately, hope has been expressed by members of the boiler supervisory force that the time is not far distant when representatives of the supply companies again will be visiting their shops. At this time, there is more involved in this expression of concern over not seeing old and valued friends than would appear on first thought. There is an actual need of mutual education, if the problems arising from changing motive power requirements are to be solved. This thought is expressed in a letter from one of the most active and progressive members of this calling, the general boiler foreman of a leading railroad: "It has always been my idea that the salesman is as necessary to the supervisor or foreman, as the department head is to the salesman, in that they are co-partners and as such their interests are identical. This means mutual service. If you are using certain products the salesman wants to know whether his goods are giving complete satisfaction. If they are not, the reason why can be developed and necessary corrections made. I have very much missed these fine men in the past three years, as have all others who hold positions similar to mine. I am looking forward to the time when again they will be calling frequently as they once did, and we can again do our share to bring about a return of confidence in the future of the railroads."

If new materials are to be successfully specified and applied and if new and efficient equipment is to find its place in the modern shop, mutual education to enable the manufacturer to meet the requirements and for the supervisor to become aware of and use his products successfully is needed. It is opportune to plan definitely such a campaign of education and to pick up lost ground, while there is yet time to do so.

All-Welded Cotton Seed Storage Tanks*

By M. L. Rogers

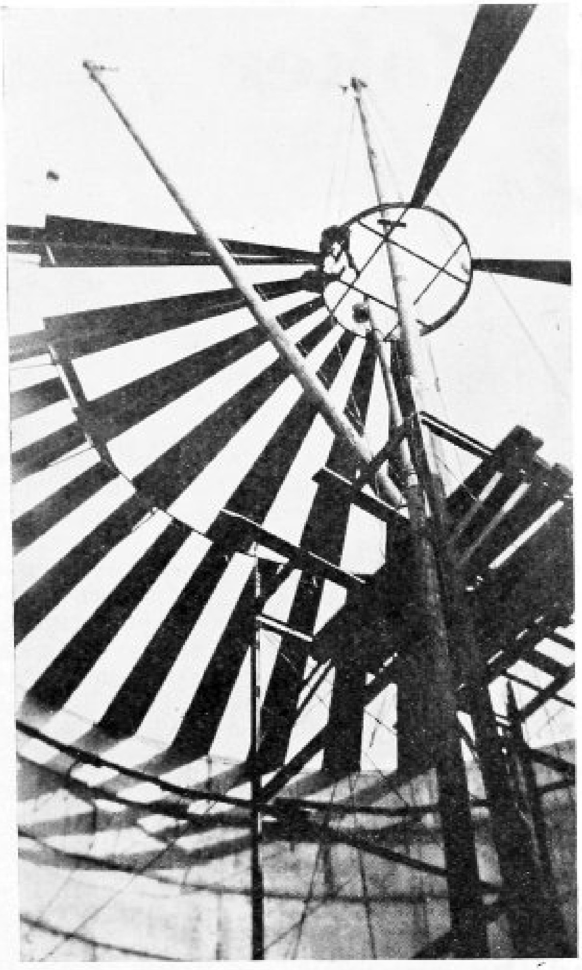


Fig. 1.—The tank during construction

The erection of large storage tanks for cotton seed has opened up a new field for welding which bids fair to become very active. Two such tanks have been completed by the J. B. Klein Iron Works, of Oklahoma City, Okla., for the Chickasha Cotton Seed Oil Company. These tanks are 80 feet in diameter and 79 feet 2 inches extreme height, all welded, with the exception of a concrete base.

Several cotton seed storage tanks of smaller dimensions than these have been in use for a number of years. They were not fabricated by welding, but were riveted, and some were constructed of concrete.

In the construction of the welded tanks, approximately 150 tons of steel was used; to hoist this into place a guide derrick was installed, of the boom type. A gin pole would not be practicable for a job of this height. None of the welders hired were subjected to tests, but they were men of reputation in tank welding. The welding was of a nature that required a welder to be quite skilled in putting on the proper weld, as the sheets were not prepared for welding. A butt weld was used with practically no spacing or none; therefore a great deal of heat was necessary to burn through, which is very difficult when making a vertical or horizontal weld on plates of the thickness used. All seams were welded inside and out with the exception of the two top rings and seams, which were covered by a channel-iron band, and also the roof.

* Published through the courtesy of *The Welding Engineer*.

In fabricating, first the 12-inch channel was laid in place on top of the concrete foundation; lugs were then welded on, then bolted into place and leveled; then the ends of channels were welded together to make a solid ring. After this was completed, the first ring of the shell was ready to put into place.

All channel iron was rolled in the plant to the proper radius before shipping, but all flat material was shipped just as it had come from the mills—in other words, the shell and the roof were not rolled to radius but had to be sprung into place. The roof lay so nearly flat that the effect was hardly noticeable, also it was of light gage (10 gage).

The sheets for the shell of the tank were 18 feet by

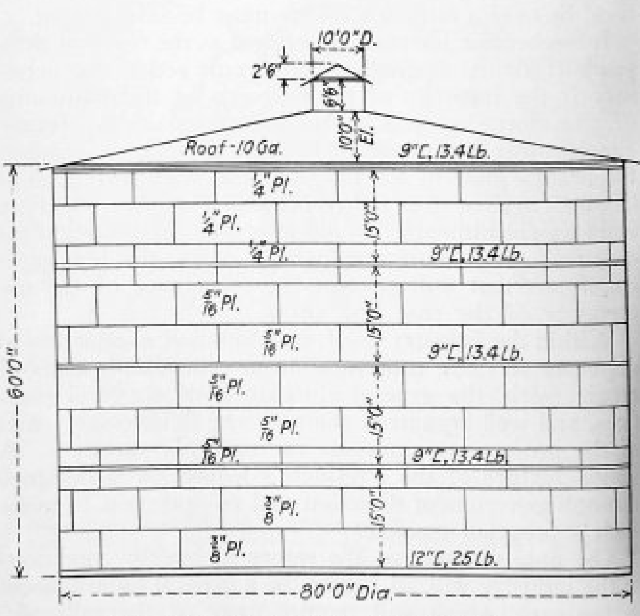
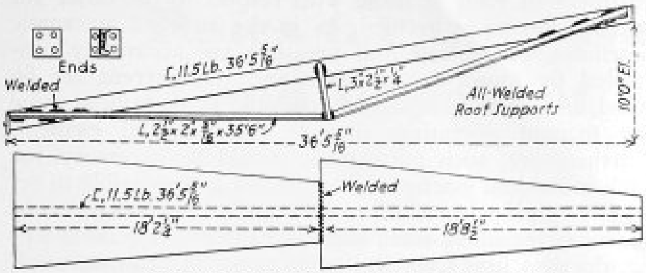


Fig. 2.—Details of construction and dimensions



Two plates are tacked to roof supports before erecting

Fig. 3.—Arrangement and details of roof supports

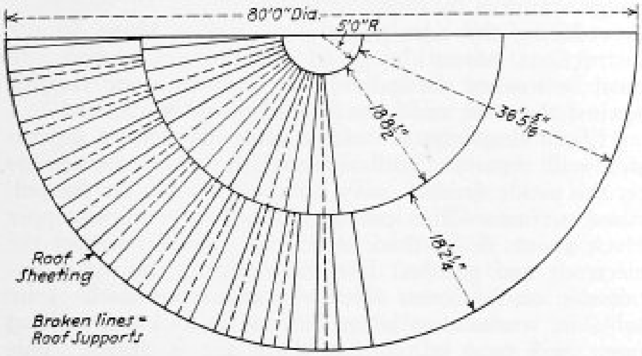


Fig. 4.—Layout of roof supports

6 feet. The first two rings were 3/8-inch ply; third to seventh rings 5/16-inch ply; and eighth, ninth, and tenth rings 1/4-inch ply. All sheets were checked for length and squared before erecting. If necessary to trim, an acetylene torch was used, and all holes were cut by torch.

The sheets for the first ring were checked for length, squared, and sprung to radius, and then hoisted into place. The first sheet is set inside the 12-inch channel, 4 inches from the bottom, and then tack welded at as many places as the sheet sets up to the channel. Then the second sheet is set into place, and also tack welded. Sheet after sheet is set in place in this manner, until the ring is completed. Then by means of a U-plate and wedge the sheet is drawn up into place, and after the tacking is completed the ring is welded inside and out. All rings are erected in the same manner, with the exception that the first ring is seated inside the bottom channel, and each of the remaining rings is seated on top of and is butt welded to the ring underneath.

Bands or rings of 9-inch channel iron of 13.4-pound material were used for reinforcement to guard against wind stress and inside impact loads. These bands were spaced 15 feet apart, as shown in Fig. 2, and were welded solid on top, using about a 3/8-inch full bead, and on the bottom of the channel a 3-inch tack weld was placed about every 18 inches. For scaffolds, brackets were bolted to the shell at 10-foot intervals, using 1/2-inch bolts, then 2-inch by 12-inch planks were laid to walk on. Holes in the shell were plugged from a sling attached to a block and tackle.

The roof supports were constructed as shown in Fig. 3.

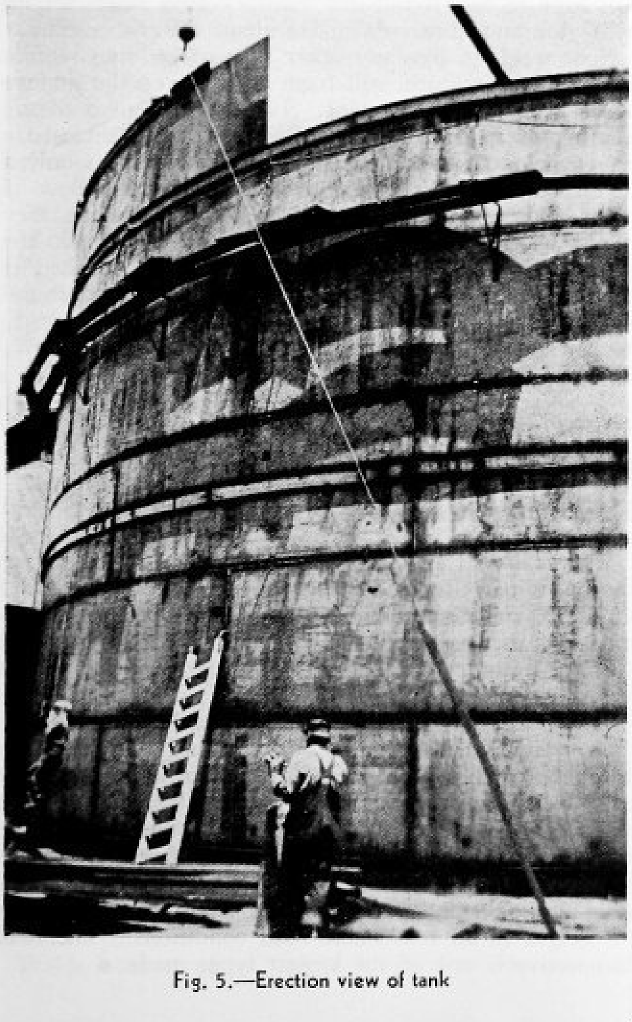


Fig. 5.—Erection view of tank

Fig. 6.—View of finished roof

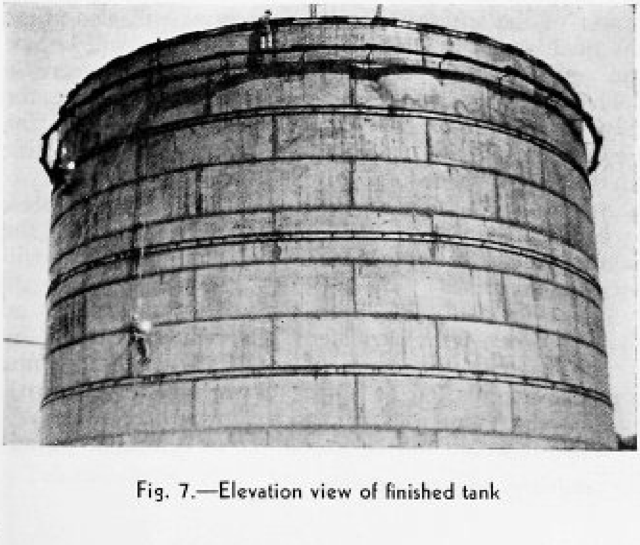


Fig. 7.—Elevation view of finished tank

These supports were fabricated in the plant and sent out ready to erect. The roof plates or sheets were tacked in place on the ground before erecting.

Fig. 4 shows how the roof supports were placed, also how the sheets were laid. The roof sheeting, being only 10-gage metal, was very easily pressed into place with the foot while tack welding. The roof supports were bolted into place, then made secure with heavy tack welds. The cupola, which sets on top, was erected on the ground and set into place and then welded.

For welding vertical seams, we used approximately 50 volts and 150 amperes; for horizontal, 60 volts and 175 to 200 amperes. There was approximately 14,000 feet of welding besides the tacking and plugging holes.

Spot Welding the Stainless Steels

*By V. W. Whitmer**

Stainless steels are particularly well adapted to spot welding due to their clean surface, freedom from any oxide or scale and because of the absence of any coating such as zinc or lead, as on galvanized or Terne Plate stock.

Spot welding, in principle, is nothing more than holding two sheets in close contact between two copper electrodes about an inch or so in diameter with the contact ends tapered to about ⅛ in. in diameter, and passing a current low in voltage but high in amperage through the circuit for a short period. Fusion immediately takes place between the two sheets, while the excess heat is rapidly carried away from the outside surfaces by the water-cooled electrodes. The low voltage, about 2 to 4 volts, is obtained from a step-down transformer wound in sections, each being connected with a stop on a rotary control switch by which the current or heat can be increased or decreased by turning up or down respectively.

While the total heat applied will be determined by the rotary adjustment, the area of the electrode points should be maintained as near constant as possible. Any increase in area will tend to reduce the heat per unit area, resulting in an improperly or poorly fused joint. A decrease in area will increase the unit heat and will usually burn a hole entirely or partly through the sheet to be welded, other factors remaining constant.

The pressure exerted by the electrodes is generally produced by the compression of helical springs and can be adjusted by a lock nut on a shaft through the center of the spring. Variable pressures will also affect the quality of the weld. Too much pressure will reduce the resistance of the joint and hence tend to decrease the heat generated. The pressure generally determines the amount of up-set displacement directly following the fusing period, producing an indentation on each side of the sheets welded.

In addition to these variables, the time of current flow is of great importance. Too long a period gives the same result as too much heat. Too short a contact will produce no weld.

It is evident, therefore, that spot welding depends on the following four variables: Current (controlled by rotary switch), diameter of electrode contact points, pressure (controlled by spring or pneumatic pressure), and length of time the current is allowed to flow.

While it would not be impossible to determine an adjustment of each of these with respect to the other for each gauge to be welded, as in the case of automatic machines where time and pressure are accurately controlled by motor-driven cams and the current set by hand, it would be next to impossible to determine same for manual operation, due to the personal element. Furthermore, such adjustment would be necessary for each individual machine. This makes it impossible to set up any specific procedure to follow for this class of work. However, stainless steel, such as Enduro, in general will require less heat than the same gauge in common steel, due to its lower heat conductivity (tending to concentrate it in one spot), its lower melting point and better contact due to a scale-free surface. Consequently, if an operator is producing good work on say 20-gage black steel, he could, in general, change to the same gauge stainless by either dropping the switch one point or reducing the time slightly, or both. More definite instructions cannot be given but the exact procedure must be worked out individually, balancing one variable against the other until the desired result is obtained.

If both electrodes are of the same diameter, a depression will occur on both sides which, while not serious on the pickle finishes, may be objectionable on the polished surfaces. This can be reduced by using a copper block about ½ in. thick and 2 in. square between the electrode and polished side, thus putting the major depression on the lower side. An aluminum block ⅛ in. to ¼ in. works even better but due to its lower melting point, will tend to pit if a slight arc is drawn. This procedure will reduce the depression but will not eliminate it entirely, as it is due to shrinkage of the molten metal in the center and, hence, pulls from both surfaces. The indentation remaining, if the work is to be polished, will have to be ground out with a cotton wheel set up with glue and abrasive. (Use about 80 grit or finer.)

Spot welding, like any other type of welding requiring high temperature, will form an oxide on the surface which will be blue in color. If this is exposed to the weather or moist conditions, it will slowly change to a brown color resembling rust. This, however, is only a surface condition, affecting the original oxide only. If such welds are to be exposed to the atmosphere, they should be cleaned either with acid as in pickling in the case of No. 1 finish sheet, or ground and polished if No. 4 or higher finishes are employed. In the ground and polished state, spot welds are just as resistant to the salt spray as the original metal.

* Metallurgist, Republic Steel Corp.

British Boiler Creates Transportation Problem

The boiler of the huge Beyer-Garratt locomotive recently built by Beyer, Peacock & Co., Ltd., to the order of the Soviet Government, was of such exceptional dimensions as necessitated its transport by road from the Gorton Foundry, Manchester, to the Liverpool docks for shipment to Leningrad.

The boiler, the largest ever built in the United Kingdom, weighs approximately 50 tons, and is 35 feet long, 14 feet 2 inches high, and 8 feet 6 inches wide. The road transport was carried out in ten hours, use being made of a 16-wheeled crocodile-type trailer, the wheels of which were fitted with twin rubber tires. By means of the cantilever and oscillating principle, each wheel rises and falls independently and bears an equal share of weight in all reasonable road conditions. The road locomotive is one of the largest types made.

Rules for the Inspection, Maintenance and Repair of Locomotive Boilers

In the April issue, publication was commenced of the standard rules developed by the New York, New Haven and Hartford Railroad, governing the practices prevailing in the shops of that railroad on locomotive boiler work. The rules continue as follows:

Repairs to Outside Firebox Sheets

The use of patch bolts is permissible only under conditions where rivets cannot be applied. Patch bolts must fit tightly in the hole so as to be tight in the taper thread and at the same time, draw the patch up to the sheet. The best plan for securing true holes is to drill them slightly smaller than required for tapping, first in the patch, then bolt up the patch and drill through the sheet, the correct size for tapping. Tap holes in both sheets; then take down the patch, drill the holes in the patch $\frac{3}{32}$ inch larger than the thread of the bolt and countersink for the heads of the patch bolts. Care must be taken to know that the bevel on the bolt head fits the counter-sink perfectly. Use a light hammer and flat punch to lay up the patch around the patch bolts, and continue laying up and pulling the patch bolts tight until all slack has been taken up. Then nick and twist off head of one patch bolt, finish and calk it. Then repeat this process with each of the other bolts in order until all have been finished.

All welds, either on the back head or wrapper sheet, which come inside the cab must have a patch applied over them by one of the methods described in the paragraphs immediately below. In areas outside of the cab, patches must be applied to the welded cracks in the knuckle; between the stays in the vertical outside rows; or over cracks extending out from a mud plug hole.

When firebox is not removed, a crack shall be chipped and veed on outside to 45 degrees, then welded, preferably by electricity. The weld shall be chipped flush and the patch applied over the entire welded surface with patch bolts.

When inside firebox sheet or entire firebox is removed, a crack shall be chipped and veed on both sides to 45 degrees, then welded on both sides by electricity. The weld shall be chipped flush on the outside and the patch applied on outside with rivets.

Cracks in other areas may be welded without patching.

When renewing a part wrapper sheet, the horizontal welded seam must be a minimum of 12 inches below the highest point of the crown sheet and it must not fall between the same rows of staybolts as the horizontal welded seams in the firebox side sheets. When it is necessary to renew a portion of the wrapper sheet in such a manner that the welded seam would fall within four rows of staybolts from a horizontal riveted seam, the new section shall be extended to the old joint and riveted. Vertical welds in a wrapper sheet are not permitted. No portion of a horizontal weld shall come between the mud ring and the lowest row of staybolts, but in cases where same would be required, the sheet shall be removed to the bottom of the mud ring. No welding will be permitted in the wrapper sheets located inside the cab without covering the welding with a riveted or bolted patch.

Welded seams of all patches applied to the wrapper sheets must be reinforced on the water side where possible.

If the sheet is worn by rubbing of wheels not to exceed one-half the thickness of the plate, staybolts in the worn region shall be removed, the surface cleaned and the worn portion built up by electric welding. If worn over one-half the thickness, the worn part of sheet shall be cut out and a patch applied by welding in a new sheet.

No welding will be permitted in the roof sheet, except to close in staybolt holes or to weld the calking edges of riveted or patch-bolted seams after they are properly cleaned and calked.

No patch plates need be applied over welds or welded patches in the throat sheet.

Cracks not exceeding 2 inches in length in the throat sheet, if wholly within the stayed area, may be welded or if larger may have a welded patch applied.

Cracks in the vertical or horizontal knuckles of the throat sheet or between staybolts in the outside rows shall have the defective plate cut out and a new plate applied. One edge of the patch shall include the riveted seam at the edge of the throat sheet and the inner edge shall extend into the stayed area so that the welded seam will be properly supported. The welded edge of any patch shall be at least 10 inches from any other weld.

Holes shall not be reduced by welding process more than $\frac{1}{4}$ inch diameter to permit the use of plug, stud or staybolt. Holes larger than $1\frac{1}{4}$ inches in diameter when entirely closed by welding shall have the welding properly stayed.

Repairs to Mud Ring and Corners

Whenever a mud ring is broken, it shall be welded. Pieces shall be cut from the wrapper sheet and from the firebox sheets. The mud ring shall be veed at an angle of 45 degrees on both sides. The weld shall be reinforced $\frac{1}{4}$ inch on top, and a patch plate applied on the bottom. The pieces of firebox and wrapper sheet, which were cut out shall be welded back in place if in good condition, otherwise new sheet shall be applied.

Boilers of locomotives receiving general repairs in shops shall have all four mud ring corners welded by the electric method, the work being done as follows:

Corners shall be riveted, cleaned thoroughly by chipping and calked.

The calking edge of the seams in both inside and outside sheets shall be welded and both sheets welded to the mud ring. The welds shall extend for a distance of 10 inches along the sides and ends of the mud ring and 10 inches vertically along seams inside and outside. Heads of all patch bolts and rivets in mud ring corners shall be welded to the sheets around the entire edge of the head.

When sheets become thin at mud ring corners, they shall be patched.

Renewal of Staybolts

All staybolts and radial stays up to and including 10 inches measured outside of sheets, except flexible staybolts of the cap and sleeve type shall be drilled with tell-tale holes, in the outside end.

Tell-tale holes shall be drilled in the outer end of staybolts to a depth of not less than 1¼ inches, using a $\frac{7}{32}$-inch drill.

Tell-tale holes shall be drilled before bolts are applied, care being taken to have the end of the hole open full size after the bolts are hammered up.

Gages shall be used to check the proper depth of hole in each staybolt, after application.

On locomotives on which staybolts are already drilled with tell-tale holes, care shall be taken that these holes are kept open at all times.

In case defective staybolts are to be removed, the acetylene torch shall be used. Care must be taken not to injure the sheets unless they are to be removed and renewed. When bolts are adjacent to studs, they shall be drilled out to avoid loosening the studs by the heat of the torch. Parts of old bolts which fall into water legs or on to crown sheet must be removed.

Care shall be exercised to see that all staybolt holes are true to alinement and that threads are good in both sheets. Rigid staybolts must be applied from the firebox side and shall enter hole by a steady pull and fit tightly in the firebox sheet without stripping the threads. Two and one-half threads projecting beyond the sheet at each end of the bolt is sufficient for forming head. Excess length of bolt on firebox end is to be cut off with a torch. To form the heads use an air hammer, heading the outside end first and holding a bar of a minimum weight of 25 pounds on the firebox end of the bolt. Do not rivet the heads flat and thus make thin edges.

When applying flexible staybolts, the bolts shall be screwed in with the sleeves attached. When the sleeve is fully drawn into position, it shall be welded onto the shee . The bolts shall be turned tight to the sleeve and then turned back ¼ turn and the inside end burned off. To avoid improper application, due to bolts moving from the vibration of adjacent riveting, not more than two bolts should be worked at a time. Screw two bolts against their sleeves, back off ¼ turn and rivet, using a special holding-on tool for this purpose. Then repeat the operation with the next two bolts.

When reaming or tapping holes for all flexible type and expansion stays, the guide shall be not more than $\frac{1}{16}$ inch smaller than the hole. When applying the expansion stays, careful measurements shall be taken for each bolt and the bolt cut to length, so that when the KN nut is seated in the sleeve, the bolt will project through the nut two threads. The KN nut shall be fitted on each bolt before it is applied and no bolt shall be used if the KN nut fits it loosely.

Wash-Out Plugs

Male plugs shall be used wherever possible. When clearances, etc., will not permit use of this plug, a recessed flush plug shall be used.

Wash-out plug taps shall be made to enter to one of the fixed size marks whenever re-tapping becomes necessary. The allowable projection of the threaded portion of the plug outside of the boiler sheet is ⅛ inch minimum and 1 inch maximum.

When over-size wash-out plug holes are adjacent to the mud ring and boiler plate is wasted, the plate may be replaced by a new section welded to the old sheet.

Grates, Ashpans and Tender Tanks

It is of vital importance that grates, ashpans and tender tanks be put in first-class condition on all engines leaving the back shop. When this is done, it will require a minimum amount of work on these parts at engine houses between shoppings.

All broken, sagged or otherwise defective grates or bearers shall be renewed. When it is necessary to apply washers to take up slack they shall, if possible, be applied at the center bar to avoid excessive opening at the side bars. Grate pins and connecting rods shall be renewed to keep lost motion to a minimum. On open side ashpans, the grate pins shall be applied with the keys to the outside so that they are easily visible for inspection. All grate pins shall be properly secured with split keys. Shaker levers and handle shall be checked to gages and must conform to them. Travel shall be checked to insure full dump opening and the handle must have ample clearance over all obstructions when in the extreme travel. Safety pins for shaker levers and handle must be applied.

All defective ashpan sheets or castings shall be renewed. All rigging for ashpan doors or slides shall be checked for lost motion and thorough repairs made if required. Ashpan doors and slides must allow full opening and must shut tightly in the closed position. Rail clearance must be checked. Ashpan shall be amply supported in position and no openings permitted which will allow fire to drop outside the pan.

The interiors of tender tank must be thoroughly cleaned. All defective plates, etc., shall be patched or renewed as may be necessary. Tank valve lift shall be made 1¼ inches on all classes. Tank valves and strainers must be put in first-class condition and renewal made of pins, bolts, rivets and cotters where they are defective. Splash plates and braces shall be re-riveted if loose. Manhole covers shall fit properly and cover hinges shall be renewed if defective.

The height of the crown sheet of the boiler shall be checked on all locomotives having new boilers or fireboxes applied and to other locomotives when changes are made to the back flue sheet or crown sheet, which would in any way affect the height thereof.

Reconditioning Flues

All flues removed from boilers shall be shipped to Readville for cleaning and safe-ending.

After cleaning, flues which on examination are found to be pitted or worn one-third of the original thickness of the flue, shall be scrapped.

Serviceable flues shall be safe-ended and used by Readville Shops either to fill orders or to apply to locomotives at these shops. Arch tubes or watertubes shall not be safe-ended.

Two-inch and 2¼-inch flues shall not contain more than three welds on any one flue. All safe ends shall be of new tubing.

When an entire end is necessary, it shall be of new tubing of sufficient length but not exceeding 60 inches to bring the flue up to the required length. No flue shall ordinarily have more than one of these pieces, except as may be essential in using up surplus second-hand flues.

Superheater flues 5½ inches in diameter shall not contain more than two safe ends nor more than two welds. Safe ends shall be of new tubing 4½ inches and 5½ inches outside diameter and shall be applied only to firebox ends of flues.

A 4½-inch safe end 6 inches long shall be applied at the first removal and, at each succeeding removal, the old safe end must be entirely removed and a new one applied of sufficient length to bring the flue back to proper dimensions.

On the second application of safe end, the straight and tapered portion shall be entirely cut off and a piece of new 5½-inch flue applied of sufficient length but not exceeding 60 inches to bring the flue back to the required length. The flue is then to be swaged in accordance with standard practice.

A 3½-inch flue shall, ordinarily, not contain more than two safe ends or two welds. Safe ends shall, ordinarily, be applied only to the firebox end, and shall be of new tubing. With the application of each new safe end at the firebox end, the flue shall be swaged. The length of the swaged portion must not exceed 7 inches.

Flues in the two lower rows shall have the front end safe-ended using No. 10 gage tubing, 9 inches long.

MATERIAL FOR TUBES AND FLUES

All tubes and flues shall be of steel to railroad specifications. Safe ends shall be the same gage as the flues to which they are applied.

2-inch and 2¼-inch flues to be ordered No. 12 Min. BWG.
3½-inch flues to be ordered No. 11 Min. BWG.
5½-inch flues to be ordered No. 10 Min. BWG.
3-inch and 3½-inch arch tubes to be ordered No. 8 Min. BWG.

Tolerances allowed are to be 3 gages over and no gages under.

Ferrules for flues shall be made of seamless copper in accordance with railroad specification. Ferrules shall have the following outside diameters and thicknesses:

Ferrule Sizes In Inches

Nom. Size of Flue, Inches	Original Diameter	Original Thickness	Second Diameter	Second Thickness	Final Diameter	Final Thickness
2 O. D.	2	0.065	2¹/₁₆	0.095	2⅛	0.125
2¼ O. D.	2¼	0.065	2⁵/₁₆	0.095	2⅜	0.125
3½ Type E	3⅛	0.065	3³/₁₆	0.095	3¼	0.125
5½ Type A	4⅝	0.065	4¹¹/₁₆	0.095	4¾	0.125

All ferrules shall be ⅝ inch long.

On all flues the ferrules must be the same outside diameter as the flue hole in the sheet.

(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 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 given records of the interpretation of the Committee in Cases Nos. 740, 745, and 749, 750, inclusive, as formulated at the meeting of February 16, 1933, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 740.—*Inquiry:* Was it the intention of the Boiler Code Committee, in revising Par. U-59 of the Code, to eliminate the use of cast-iron nozzles riveted to pressure vessels as was formerly permitted by Case No. 494? Par. U-59 specifies that materials for riveted openings shall be of rolled, forged, or cast steel.

Reply: In revising Par. U-59, the Committee overlooked the reply in Case No. 494, which indicates that the use of properly designed cast-iron nozzles riveted to air tanks is permissible. Where vessels are to be operated at working pressures not to exceed 160 pounds per square inch, or at temperatures not to exceed 450 degrees F., the Committee is of the opinion that cast-iron nozzles and fittings may be used under the Code. Riveted cast-iron fittings may be considered as reinforcement as permitted by Par. U-59b provided the thicknesses of the cast-iron parts are not less than ⅝ inch, and that the total area of the cast-iron reinforcement is at least twice that required for steel.

CASE No. 745.—*Inquiry:* Will a flange which is fusion welded to a cylindrical shell or nozzle neck as shown in

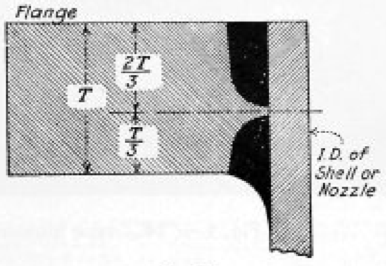


Fig. 29

Fig. 29, so that at least nine-tenths of the depth of the flange is welded to the shell or neck, meet the Code requirements?

Reply: The Committee considers that the proposed method of connecting the flange to the shell or neck will meet the Code requirements provided (1) Class 1 welding is used for nozzles of power boilers (with the exception of the X-ray examination); (2) that Class 1 or Class 2 welding with stress relieving is used for nozzles on unfired pressure vessels; (3) that the throat of the fillet back of the flange is not less than shown in L of Fig. PW-5 (P-6 of 1931 Combined Edition) or Fig. U-5; and (4) that the flange thickness is not less than specified in Table A-6. (The Committee has under consideration the requirements for flange thicknesses of sizes larger than provided for in Table A-6.)

CASE No. 749.—*Inquiry:* Do not the provisions of Par. U-77, which require hydrostatic testing of all welded pressure vessels, conflict with those of Par. U-64, which provide for testing by air pressure if the size is too great for the foundations to withstand the weight of the water used in testing?

Reply: It was the intent in the revision of Par. U-64 to make an exception of large fusion-welded vessels for gas-storage purposes. To provide for this it is proposed to revise Par. U-64 as follows:

U-64. *Hydrostatic Test.* Each vessel constructed under these rules shall be tested under hydrostatic pressure to not less than 1½ times the maximum allowable working pressure. For vessels of fusion-welded construction the requirements of Par. U-77 shall apply with the following exceptions: For enameled vessels the test pressure need not exceed the working pressure; for gas-storage vessels which are too large to withstand safely the weight of the large mass of water required to fill them for hydrostatic test, they may be tested by compressed air at a pressure not to exceed the maximum allowable working pressure of the vessel.

CASE No. 750.—(Annulled.)

MONEL METAL AND NICKEL.—Under the title "Grinding, Polishing and Buffing Monel Metal and Pure Nickel," the Development and Research Department of The International Nickel Company, Inc., New York, has issued Bulletin TS-5 to industries wherever these metals are employed. It treats comprehensively of the methods and tools used with specific instructions for finishing all types of surfaces.

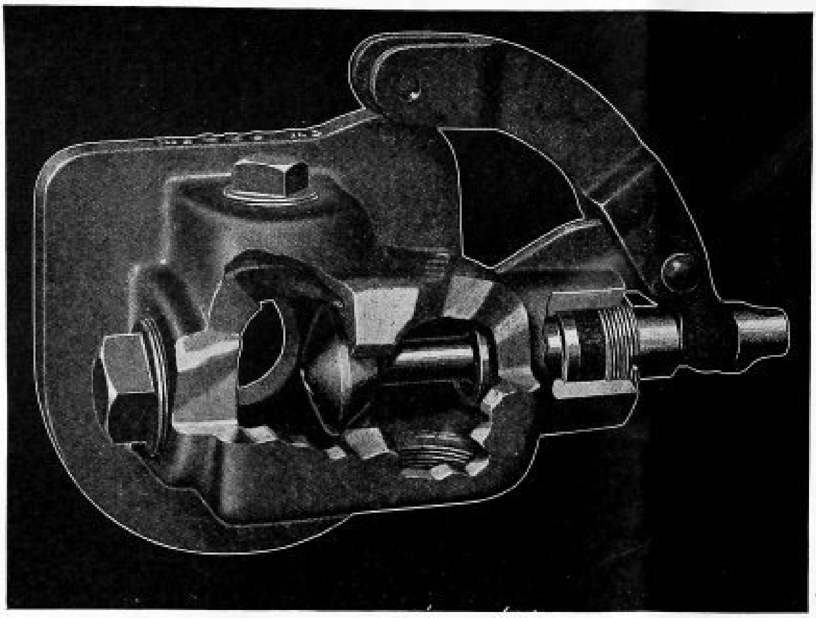


Fig. 1.—"NC" type blow-off cock

Locomotive Blow-Off Equipment

The boiler blow-off equipment, in modern locomotive operation, is of great and increasing importance. Positive and safe functioning is a necessity. Railroads, the locomotives of which, up to recently, were able to operate from terminal to terminal without use of a blow-off cock, now find themselves forced to give this matter intensive attention. The reason lies with a combination of longer locomotive runs, and the extension of water treatment.

The blow-off equipment must not only discharge the sludge precipitated in the boilers, but must also be depended upon to keep the alkaline concentration below the foaming point. This calls for more or less frequent operation by the engine crew on the road. If the blow-off apparatus is difficult to operate, if the discharge is embarrassing, or if closing is not sure, results will be poor and train service may be seriously affected.

The Wilson Engineering Corporation, of Chicago, has developed its "NC" (narrow clearance) type blow-off cock for either hand or power operation by the simple addition of a metallic bellows expansion and contraction unit to the standard assembly. It is carried entirely on the present flange studs of the valve.

A small cab valve operates either to open, or close, by admitting air from the main reservoir to either the interior or exterior of the bellows respectively. The design of the blow-off cock is such as to assure its being held in a closed position, even with complete failure of air power.

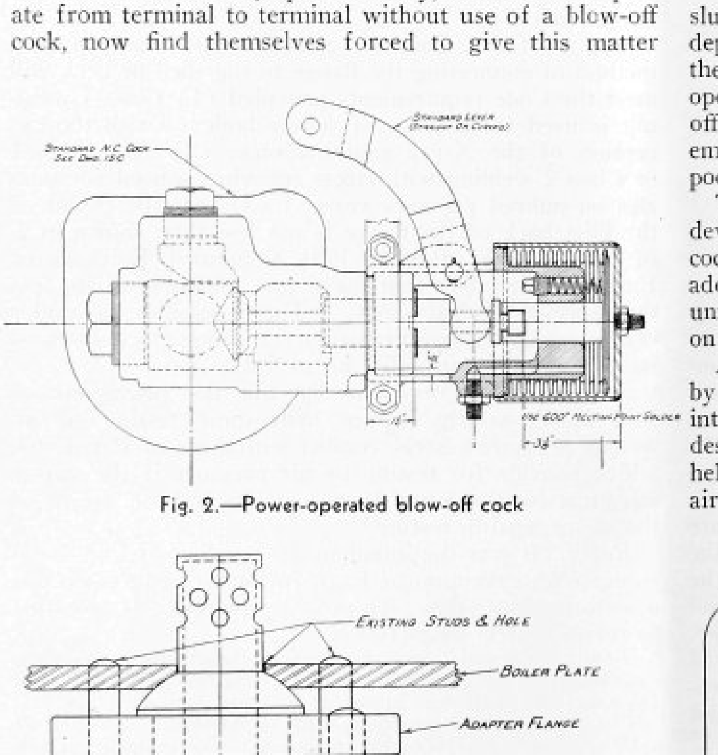


Fig. 2.—Power-operated blow-off cock

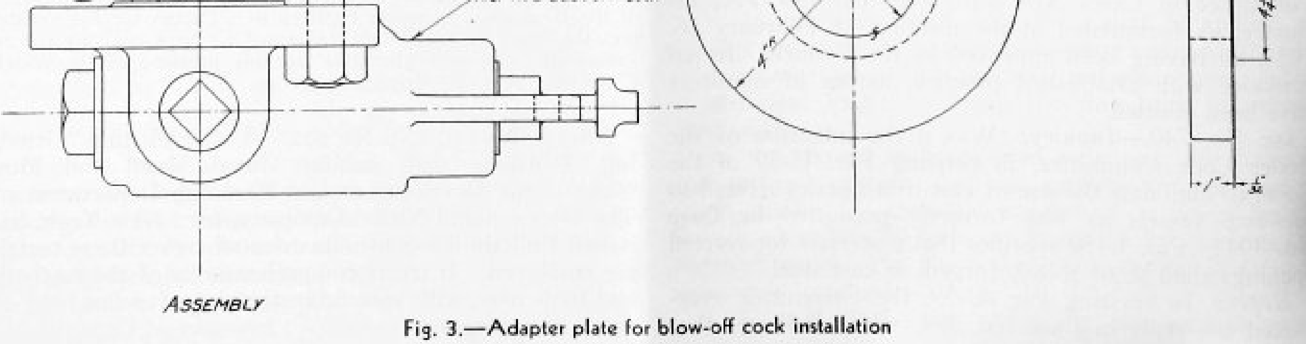


Fig. 3.—Adapter plate for blow-off cock installation

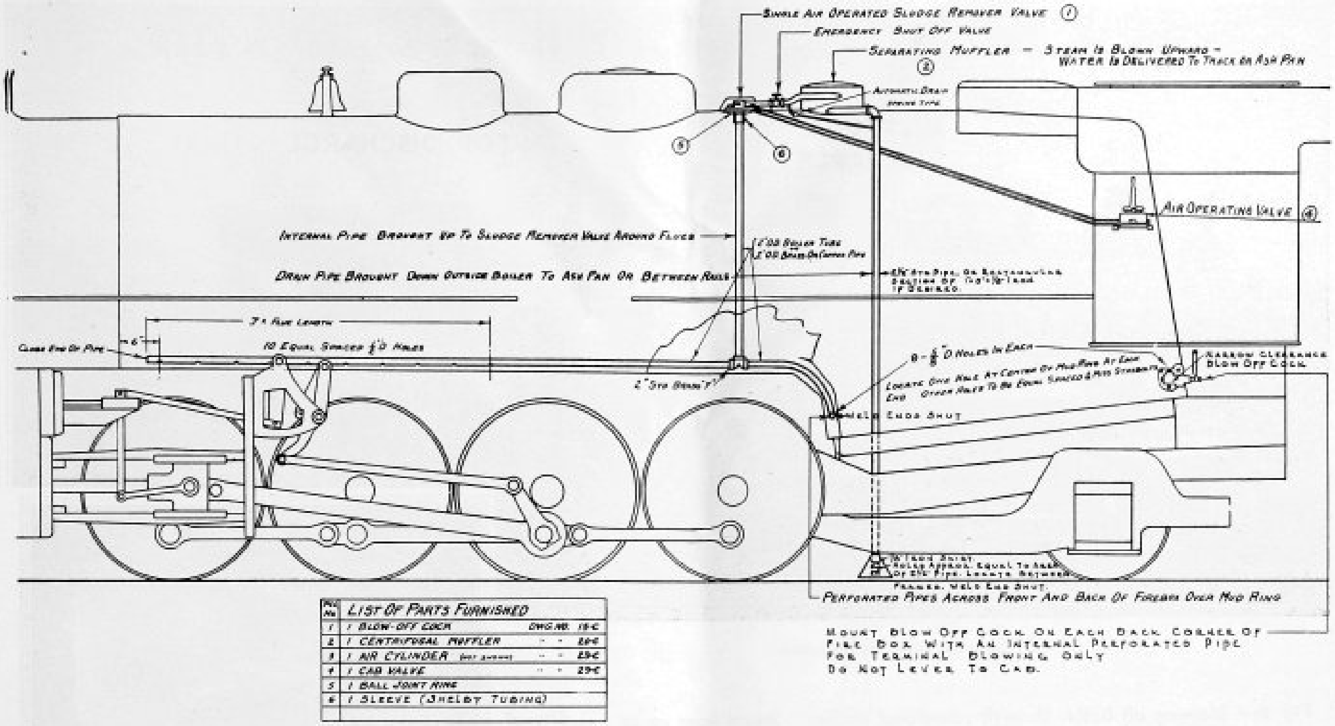


Fig. 4.—Type "C" sludge remover; a typical installation

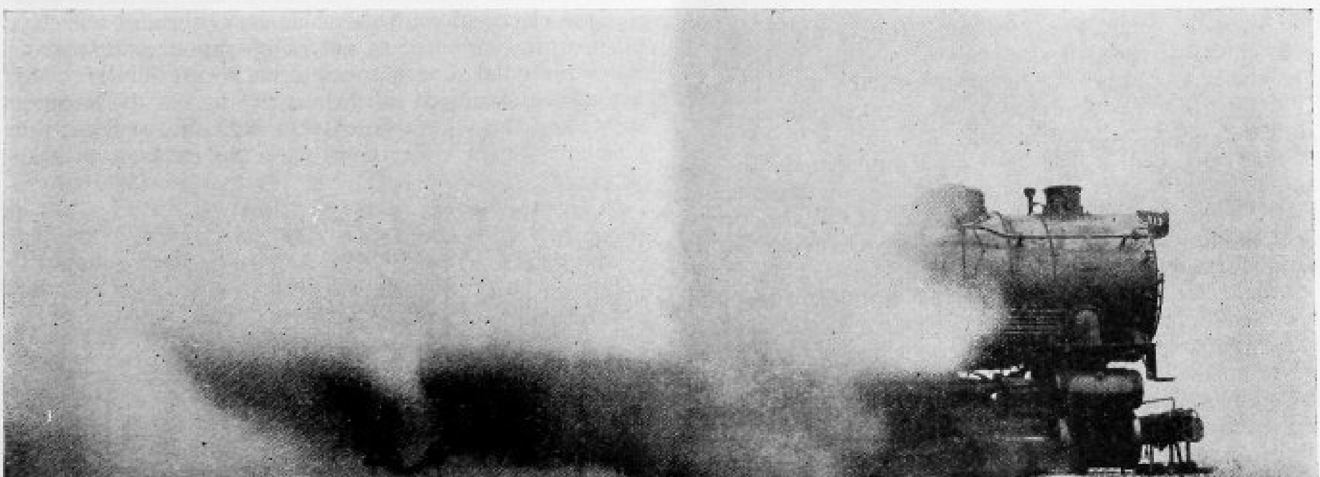
The blow-off cock as presently supplied is practically indestructible and no spare parts need be carried. As shown in Fig. 1, the valve-stem unit is a one-piece stainless steel forging, the body and lever are of high-tensile strength malleable, and the packing is semi-metallic. There are no seats, springs, disks or delicate parts. The bellows used in the attachable power operating unit, which is shown in Fig. 2, is of four-ply copper alloy, which has been tested, under full pressure, to many times the number of movements of a long period of service. The advantages claimed over a cylinder and piston are several, one of them being economy in the use of air. It forms a dead end and only sufficient air is required each time the blow-off cock is opened, to fill the ¼-inch pipe lead and the small cavity of the bellows.

A further and important innovation is the adapter plate, which can be supplied, to make possible the use of any existing boiler stud and hole arrangement. Fig. 3, shows how this plate, with its special combination joint-ring strainer adapts the existing studs to the new requirement.

In changing standards, any expense involving existing equipment and spare parts is important during the transition stage. This expense is completely obviated in this equipment by using this adapter plate, and by the fact that no spare parts need be stocked.

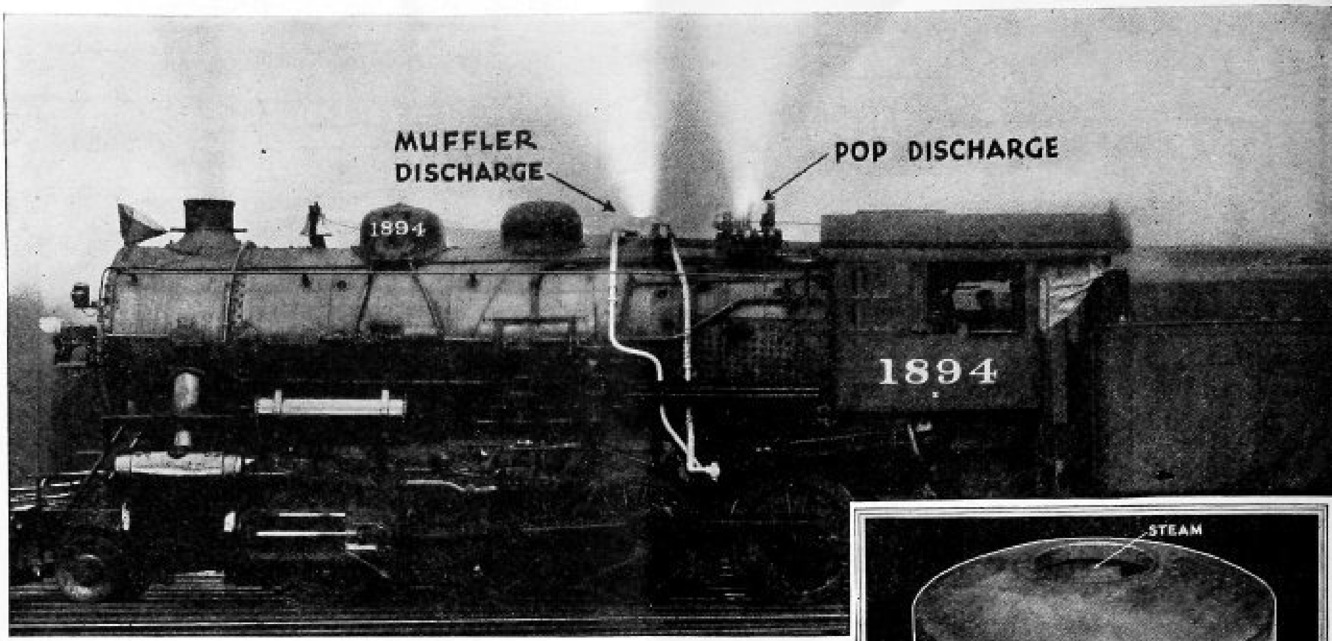
Even with perfectly dependable blow-off operation, there still remains the problem of disposing of the discharge to avoid embarrassments, due to obscuring of vision, danger of striking personnel or cars and buildings, or of injuring property adjacent to the right of way. This problem is best met by the use of the centrifugal muffler, illustrated, Fig. 6.

This muffler separates the steam from the water and sludge of the blow-down stream. It is mounted on top



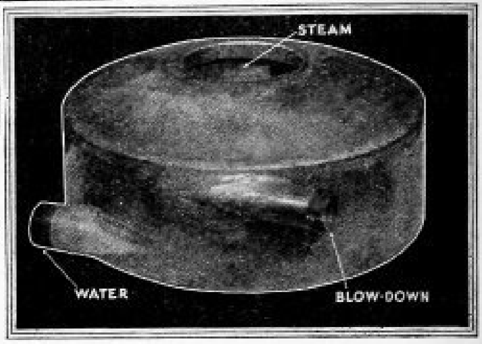
(Courtesy I. C. C.)

Fig. 5.—Blow-off cocks being used without centrifugal muffler



Blow-off Muffler in Operation

Fig. 6.—Blowing off boiler through centrifugal muffler. Steam goes up to clear; water and sludge fall to track



Blow-off Muffler

of the boiler, and the steam is ejected upwards in a dry jet like the discharge of the safety valves. The water and sludge flow to the track by gravity only. There is no obscuring of vision, no danger of injury, and no damage to property possible. In fact, a locomotive thus equipped can be blown down in a passenger station without embarrassment.

By means of interior piping the blow-off cock may be mounted in any convenient location, and the discharge taken from any part of the boiler interior. It is, in fact, mounted on top of the boiler in most modern application.

The Wilson Engineering Corporation recommends the combination of the power operated blow-off cock, mounted with its centrifugal muffler, on top of the boiler; the interior connections leading from bottom of the belly and waterlegs of the firebox; and the cab operating valve, as completing the most modern road blowing equipment. The combination is termed the Type C sludge remover, shown in Fig. 4.

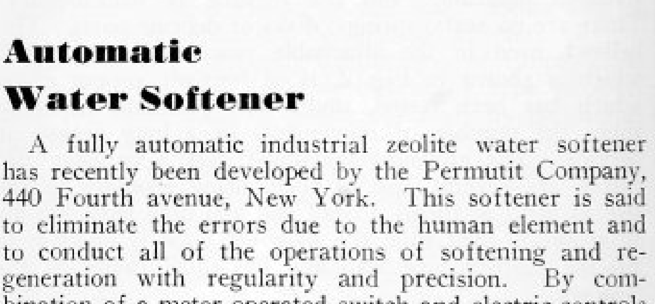
The equipment is standard on a number of railroads and large passenger power, successfully operating more than 1800 miles per round trip (12,000 miles, or more, per month) through the worst water districts in the United States.

While the performance of the equipment is most spectacular on these long-run passenger locomotives, its value is even greater in freight service, the runs of which, while normally shorter, are still being greatly extended, throughout the country.

The Interstate Commerce Commission report of last year carried a reproduction of vision obscuration, due to boiler blowing without muffler. This photograph is reproduced in contrast with that of a photograph taken under similar conditions with the Wilson centrifugal muffler in service, Figs. 5 and 6.

Automatic Water Softener

A fully automatic industrial zeolite water softener has recently been developed by the Permutit Company, 440 Fourth avenue, New York. This softener is said to eliminate the errors due to the human element and to conduct all of the operations of softening and regeneration with regularity and precision. By combination of a meter-operated switch and electric controls with a motor driven single valve, each operation of the water softener is conducted under precise control. Briefly, at the end of the softening run, the meter actuates the electrical controls which carry through the steps of: Cutting the softener out of operation; backwashing it for a regulated period; admitting a carefully regulated amount of saturated salt brine; rinsing out the hardness salts; and throwing the softener back into service; thus placing it again under control of the meter.



Diagrammatic arrangement of the Permutit water softener

Advantages and Disadvantages of Higher Locomotive Boiler Pressure

This is the concluding instalment of a report by the committee on locomotive construction, presented at the last annual meeting of the American Railway Association, Mechanical Division.

BALTIMORE AND OHIO RAILROAD

The Baltimore and Ohio to date has watertube fireboxes applied to 8 locomotives, beginning early in 1927, with mileage from 62,000 to 986,444 consisting of:

3—2-8-0 type 215 pounds boiler pressure 55,300 pounds T. P.
1—2-8-2 type 205 pounds boiler pressure 50,200 pounds T. P.
2—4-6-2 type 230 pounds boiler pressure 50,000 pounds T. P.
1—4-8-2 type 250 pounds boiler pressure 65,000 pounds T. P.
1—2-6-6-2 type 250 pounds boiler pressure 90,000 pounds T. P.

The Baltimore and Ohio Railroad in 1927, due to the ever-increasing cost of firebox maintenance, made a record survey of their system of the cost of stripping boilers for the purpose of testing and renewing broken and leaky staybolts and radial stays, including labor and material cost and net cost incident to the delay of power amounting to $720,000 per annum.

This excessive cost led up to the development and experimenting with a back end for locomotive boilers, designed with as many self-supporting shapes as possible to avoid the use of staybolts and radial stays, and designs of watertube firebox were developed with the double wall of side tubes extending from a hollow mud ring in the bottom as a manifold and connected at the top end to a header located alongside and connected by cross circulating tubes with the steam drums, which form the firebox crown and with inspection plugs located in the mud ring and in the header opposite the ends of the side wall tubes, this arrangement giving access for turbining the tubes without the removal of lagging.

To eliminate the staybolts entirely, the design of firebox with front and back end dead sheets protected by refractories was developed, with refractories against the outside of side wall tubes for enclosing firebox and also between drums and between header and drum. After 100,000 miles inability to find refractories that would stand up in service on the dead sheets and between the drums led to the re-design using front and back water legs. The sheets of these legs were vertical and paralleled to equalize difference of expansion between the inside and outside sheets to reduce deflection in the staybolts as much as possible.

The first locomotives were built with double steam drums. In a short time, however, cracks developed in the flange connecting the tube sheet with the steam drums, the design changed by turning the flanges to the water side, and the trouble corrected.

The designs were further modified by replacing the double by the single drum and overcoming cracks developed in the hip sheets and correcting the firebrick maintenance trouble between the drums. Air leaks and refractories are not now a consideration.

Side-wall air leaks have been overcome by grooving the firebrick to fit over the side-wall tubes and interlocking with tongue and groove top and bottom edges and ship lap ends. End bricks at the tube and door sheet grooved and fitting over high heat-resisting sealing strips and sealed with plastic asbestos; the outside of brick covered with plastic asbestos as an additional seal and acts as a cushion for ¼-inch reinforced supporting plates against the brick which is followed by the usual asbestos lagging and jacketing course.

The staggered spacing of double row of side wall tubes protects the bricks from receiving direct heat, giving a life for several shoppings.

Comparison on Identical Locomotives of Number of Staybolts in Conventional Staybolt Type Firebox and Water Tube Firebox

E-27	Eng.	2504	Conventional type firebox......	1502 staybolts
E-27x	"	2504	Water legs	226 staybolts
Q-1	"	4045	Conventional type firebox......	2032 staybolts
Q-1x	"	4045	Water legs	389 staybolts
P-7	"	5300	Conventional type firebox......	3266 staybolts
P-9a	"	5320	Water legs	378 staybolts
KK-1	"	7450	Conventional type firebox......	3554 staybolts
KK-2	"	7400	Water legs	574 staybolts

In the watertube firebox boiler, large reduction in the number of staybolts is eliminated by disposing with the side, throat, crown sheets and combustion chamber.

Experiments made by Mr. Fowler and reported to the Master Mechanics Association give the firebox heating surface value eight times greater for heat transfer than for the firetube heating surface in the shell of the boiler due to the efficient heat transfer together with the very satisfactory water circulation, and is reflected in higher evaporation and fuel economy. Watertube firebox gives from 50 to 150 percent increase in heating surface, increasing evaporation.

The continued growth of increasing cost of the conventional locomotive firebox maintenance, since the introduction of higher pressure locomotives, has been observed after the survey of 1927, further stressing this pertinent factor of a design of firebox that will eliminate the excessive staybolt maintenance, which unless overcome will not be compensated for by the saving of operation of high-pressure locomotives.

In 1931, the Baltimore and Ohio Railroad built four experimental locomotives with 250 pounds boiler pressure; two 4-8-2 type, 65,000 pounds T. P. and two 2-6-6-2 type, 90,000 pounds T. P. These are identical in all detail with the exception of the fireboxes, one of each type having the watertube firebox and one each with conventional staybolt firebox. Careful record is being kept of their performance finally to determine the relative value.

The elimination of the side and crown sheets in watertube firebox design which is responsible for a great maintenance cost due to cracking from staybolt holes and coupled with the elimination of side and crown sheet staybolts will result in much economy in boiler maintenance. This points to a necessity for substitution of tubes or an improvement in materials for plates, bolts, stays and braces or improvement in their arrangement or both.

Advantage within reasonable limits of high steam pressure for locomotives is that the amount of energy that can be stored in a given quantity of steam is increased by increasing the pressure and temperature of the steam, consequently less water is required to develop a given amount of power. The increasing power developed is obtained by expanding the steam to a greater degree in the cylinder, greater capacity engines for the same weight and more efficient use of the steam through smaller cylinders, valve chambers, steam pipes by reduced area through which the heat is lost to the atmosphere by radiation.

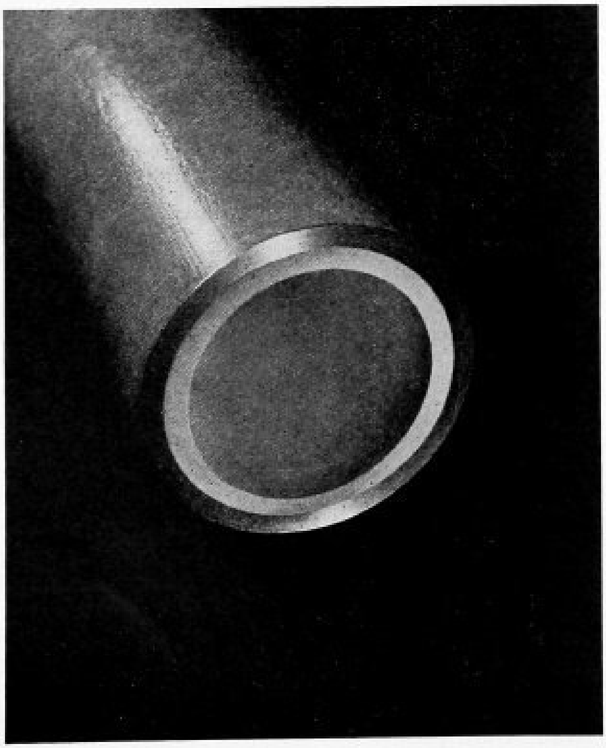
Difficulty with cylinder and valve lubrication causing increased maintenance, stronger globe valves, pipe and cab fittings, etc. It may be desirable and probably necessary to discard the piston valve in favor of some form of valve, such as the poppet valve, which does not require lubrication.

Advantages may be attained only by progress in the state of the art by designers developing boiler and machinery parts capable of meeting higher pressure without undue cost of maintenance.

The report was submitted by a committee composed of George H. Emerson, chairman; R. M. Brown, and A. H. Fetters.

National Duroline Cement-Lined Pipe

The remarkable success of cement-lined pipes in resisting corrosion for a period extending over one hundred years, some little time ago led the National Tube Company, Pittsburgh, in its search to improve the serviceability of pipe to develop a modern type of cement-lined pipe. Not until the technical and scientific developments incorporated in Duroline pipe, as it is called, had been proved over a period of years was this new pipe formally put on the market. The National Tube Company has up to this time deliberately withheld publicity regarding this product until, aside from all laboratory and small-scale tests, the outstanding resistance to corrosion and the unusual physical properties of the new pipe had been rigorously tested in actual commercial installations.



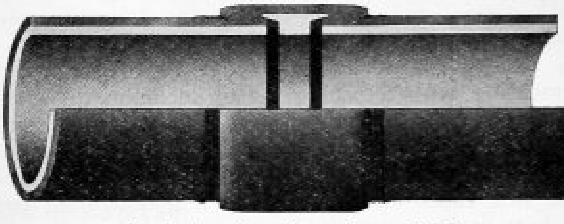
Duroline cement-lined pipe

The problems involved in developing Duroline included extensive research on the composition of special cements, methods of lining pipe, curing processes and convenient and reliable methods for making joints. This cement as developed has only about one-third the solubility of ordinary Portland cement mixtures. Special methods of curing combine with the chemical composition to reduce to a minimum the shrinkage occurring during setting. With these features have been combined highly improved methods for introducing Duroline into pipe, the resulting pipe offering an effective and economical means of controlling corrosion.

The pipe to be lined is produced from the same high quality steels and by the identical manufacturing processes used for regular black or galvanized National wrought pipe. Prior to the lining operation it must pass the same rigid inspection and hydrostatic and manipulating tests normally applied to unlined material of similar size and grade. In the composite product the sole purpose of Duroline is to protect the metal from corrosion while the metal in turn supplies the necessary strength and protects the lining from mechanical damage.

In the lining operation care is exercised to secure a uniform distribution of the Duroline from end to end of each length of pipe, a special lining machine developed for the purpose being used.

An important feature in the manufacture of this



Typical section of coupling and joint

pipe is the careful mill curing given the lining. This process involves moist air, steam and hot and cold water treatments extending over a period of several days. These treatments promote the rapid development of high strength in the lining and further reduce the inherently low shrinkage of the Duroline to a point where this is no longer a factor of any importance. In addition the curing treatment leaches out the surface line compounds thereby improving the resistance to chemical attack and eliminating the objectionable increase in alkalinity frequently observed in city waters for a period of time after the installation of water pipe with ordinary cement linings.

Duroline pipe is intended primarily for carrying waters or solutions which rust, corrode or otherwise attack unprotected metal pipe. The insoluble compounds formed in the lining surface prevent corrosive action, thus making this pipe particularly resistant to those waters (frequently called tuberculating waters) which tend to clog pipe with rust. Experience has also demonstrated the serviceability of this pipe when exposed to salt water and many dilute chemical solutions and industrial liquids which corrode unprotected metal pipe.

Champions Both.—Under this title The Champion Rivet Company, Cleveland, has issued a folder outlining the qualities of Champion-Victor rivets and the complete line of Champion welding electrodes. Illustrations are given of typical physical specimens of welds made with Champion Red Devil electrodes, which show a tensile strength of 64,900 pounds per square inch and an elongation of 27.2 percent in 2 inches.

Improving Weld Characteristics

*By G. G. Landis**

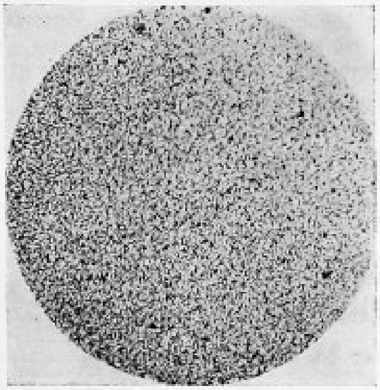


Fig. 1.—Photomicrograph showing fine grained structure of shielded-arc weld

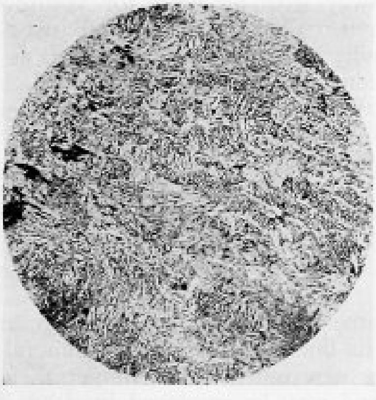


Fig. 2.—Photomicrograph of weld made by unshielded arc

In considering weld characteristics it must be borne in mind that three things affect the composition of the weld, i. e., the welding machine, the electrodes and the operator. In this article we shall assume that a welding machine of proper size and characteristics is used in all cases.

Before the introduction of the shielded-arc process of welding, the highest average tensile strengths were not far above 55,000 pounds per square inch and even this strength was unusual. It was not until the innovation of methods which acted to control the chemical reactions within the arc and its surrounding atmosphere that welds of 65,000 and 75,000 pounds per square inch tensile strength and of good ductility became possible.

Any one familiar with electric welding knows that poor welds may be caused by the presence of gas holes, oxides, etc., in the weld metal. A microphotograph of a sound weld made by the shielded-arc process is shown in Fig. 1. In Fig. 2 can be seen a weld containing undesirable slag inclusions, oxides, etc. It is obvious that such a deposit will not possess as great physical qualities as a weld which is free from these impurities.

One of the principal causes of porosity is the attraction of steel in its molten state for certain gases. In order to secure welds free from gas holes it is essential that the capacity of the steel for absorbing the various gases at the temperature of solidification shall be much greater than the gases then held in solution. If not, the steel may become saturated and some of the gases be given up, forming holes in the solid metal.

If during the welding, any of the elements in the steel such as manganese, silicon, aluminum, etc., are oxidized, further reducing the capacity of the steel to hold gases in solution, the formation of gas holes will be further facilitated. The capacity of steel for holding some of the principal gases such as carbon monoxide and hydrogen in solution varies inversely with the carbon content. The rate of elimination of carbon from the molten metal is increased by the high temperature of the arc. Oxidation of this carbon during solidification will probably cause gas holes containing carbon monoxide in the weld metal. It is obvious then, that to insure welds free from gas holes, none of the so-called deoxidizing elements be oxidized to any appreciable extent and oxidation of the carbon take place only at the higher temperatures.

This explanation of what is to be avoided may sound very complicated but metallurgists have found a way to achieve the desired result in a very simple way. That is through the use of a heavily coated electrode—a shielded-arc electrode. The coating of such an electrode burns in the arc less rapidly than the electrode melts, forming in effect a crucible around the arc, shielding it for most of its length. The edges of the coating, burning in the arc, give off gases which further protect the molten metal from oxygen and nitrogen. The cooling metal is protected by a layer of slag, the residue from the burned coating. Such welds have a tensile strength of 65,000 to 75,000 pounds per square inch and ductilities as high as 20 to 30 percent in 2 inches. On bend tests this ductility runs from 30 to 50 percent.

The improved quality of welds made possible by advance knowledge of phenomena within the arc has increased welding speeds 200 to 500 percent, bringing not only greater strength but greater economy to the manufacturer.

Still there are some who, while admitting such results, claim that many poor welds are made in the field and that no one can know what is inside any given weld unless that weld is tested—and then it has to be remade. Of course, there is a human element in welding as there is in every industry. But remember that one of the greatest advantages of the welding process as a means of joining members is that the workman sees the *inside of the joint* while it is being made and knows its composition. With no other type of joint can you see inside that joint and know definitely its characteristics.

With the establishment of schools designed to train men in the art of the arc, the supply of good welding operators has been greatly increased. There is no neces-

* Chief engineer, The Lincoln Electric Company, Cleveland.

sity for being skeptical of the work done by these trained men. In a recent article W. D. Halsey, assistant chief engineer, Boiler Division of the Hartford Steam Boiler Inspection and Insurance Company, says: "It is now generally recognized that if a welder has been properly trained and has demonstrated his ability to obtain acceptable test results in the tensile, free bend and nick-break specimens, his work may be considered reliable. In fact, it is felt that the employment of such qualified welders is all that is necessary to assure a safe pressure vessel for Class II or Class III service."

The use of the shielded-arc electrode then, in the hands of experienced operators, will provide welds far superior to anything obtainable with bare electrodes. Furthermore, under proper procedure the welds will be of uniform quality.

The observance of certain precautions will insure the best welds possible. With the use of heavily coated electrodes, there is an increased amount of metal in the molten state. It is, therefore, best to keep the point where the welding is being done in approximately a horizontal plane.

Where it is impossible to do this, the weld should be made downhill to prevent the metal running back and undercutting at edges as is the case when the weld is made uphill.

On lap welds up to ¼-inch plate thickness, the arc should be played on the upper edge of the top sheet so that the metal will fill even with the plate surface.

On butt welds where plate is not thick enough to necessitate beveling, edges should be brought together with a very small opening. To have an opening of any great extent between edges will result in the dropping through of molten metal, whereas when edges are practically butted together, penetration can be determined by amperes used and speed of travel. Where edges are beveled, each bead should be thoroughly scaled and cleaned before applying a succeeding bead.

With practice any good operator can become proficient in the use of shielded-arc electrodes. His welds will then with proper procedure control become uniformly good and far superior to any produced with bare electrodes.

Industrial Safety Contests

As a means of stimulating the interest of employees in plant safety activities and encouraging them to make concentrated efforts to prevent accidents, friendly competition in the form of accident prevention contests often has proved effective. The practices of a number of industrial organizations in connection with this phase of safety educational work are presented in a report entitled "Methods of Organizing and Conducting Industrial Safety Contests," published by the Policyholders Service Bureau of the Metropolitan Life Insurance Company.

Safety competitions, according to the study, are considered of particular value in that they act as incentives to employees after the novelty of launching a safety program has dulled. The report analyzes the programs of representative industrial organizations with respect to organizing and conducting these contests. Particular attention is devoted to such subjects as planning the contest, methods of determining the standings between various units, types of trophies and awards provided and the methods followed in presenting them. Throughout the report are reproductions of forms used in connection with the conduct of safety contests, as well as photographs of trophies which have been awarded.

Copies of this book are available for distribution to industrial executives, safety engineers and others interested in the problem of accident prevention. The report may be secured by writing to the Policyholders Service Bureau, Metropolitan Life Insurance Company, One Madison Avenue, New York City.

New Method of Electric Welding

A new development in arc welding, particularly suited to the joining of heavy plates, is announced by the Metal & Thermit Corporation, New York.

Known as Murex straight-gap welding, the new process does away with all need for veeing or grooving of plate edges. Plates may be used just as they come from the mill. Greater welding speed, as well as appreciable reductions in cost, are claimed. In fact, the developers of the process say that it cuts welding time in half, and, by eliminating all preparatory work and reducing the quantity of weld metal required, achieves economy in welding heavy plates. In addition, it is stated, tests conducted by outside laboratories show that straight-gap welds are physically superior in many ways to those in which the usual "V" or "U" gaps are employed.

At the same time, the above company announces an addition to its line of Murex heavy mineral coated electrodes. The new unit, Murex universal, is for use on mild steel and may be employed in either flat, vertical, or overhead work. Smooth, clean deposits of unusually high tensile strength and ductility are obtained consistently, it is said, on any of these classes of work.

Independent Pneumatic Tool Company Officers

Neil C. Hurley, brother of Edward N. Hurley, was elected president of the Independent Pneumatic Tool Company, Chicago. He succeeds Ralph S. Cooper, who was named vice-president in charge of Eastern operations of the firm with headquarters in New York.

John A. McCormick was re-elected chairman of the board and Leonard S. Florsheim was named chairman of the executive committee. The directorate was reduced from eleven to seven, comprising, in addition to Mr. Hurley, Mr. McCormick and Mr. Florsheim, Raymond J. Hurley, Dr. Walter McGuire, Walter Gatzert and Ralph S. Cooper.

Frank B. Hamerly was elected vice-president in charge of the factory at Aurora, Ill., and Gordon H. McCrae, 40 Broadway, London, England, vice-president in charge of foreign business. F. W. Buchanan was named secretary and Edward G. Gustafson, treasurer.

Designed Piping.—The Taylor Forge & Pipe Works, Chicago, reprints a paper "Design Your Welded Piping" which was presented at a joint meeting of the New York Section, American Welding Society and the Petroleum and Power Division, American Society of Mechanical Engineers, by F. S. G. Williams of the company. Illustrations with detailed descriptions are included of various products of the company.

The Boiler Maker

VOLUME XXXIII NUMBER 5

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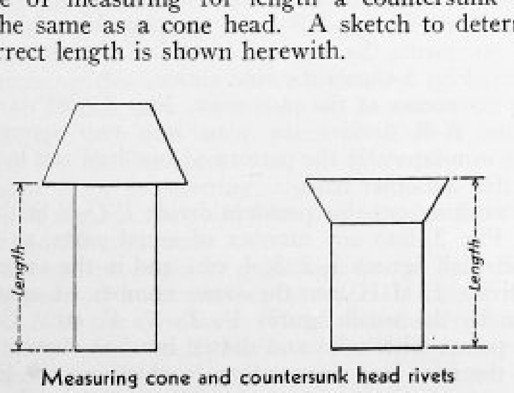
Communications

Measuring Rivet Lengths Before Drawing

TO THE EDITOR:

Rivets are a very important item in a boiler shop, and it does not seem possible that a man doing riveting work over a period of more than ten years would make the mistake of measuring for length a countersunk head rivet the same as a cone head. A sketch to determine the correct length is shown herewith.



Measuring cone and countersunk head rivets

All rivet manufacturers publish a list showing the length of rivets required for various grips including the amount necessary to form one head. We have found it necessary to increase the length given in the tables by ¼ inch to form heads at least equal in strength to the bodies of rivets.

A discussion would be a matter of interest to all on this point from the readers of THE BOILER MAKER.

Oswego, N. Y. JOHN A. SHANNON.

Marking Steel Plate Scrap

TO THE EDITOR:

At one time, having urgent need of a piece of tough steel plate about 2 feet square, the writer hastened to a boiler shop and asked the foreman if he had a piece of flange or firebox steel plate scrap anywhere from ⅜ to ½-inch thick, which he would sell? The foreman jerked his right thumb over his shoulder toward one end of the shop and said, "I reckon you can help yourself to something over there."

There were plenty of scrap pieces, "over there" and the writer dug out one about the right size, but, as to whether the piece of steel was shell, flange, firebox or tank steel, nobody seemed to be able to tell. However, a narrow piece of the steel was sheared off, bent double upon itself and straightened again without cracking, so it was presumed that the steel was tough enough for the purpose. The shop foreman said he could use much of that scrap if he could tell what kind of steel each pipe was made of, and, after some talk, the foreman said he was going to mark each and every piece of steel cut off and thrown on the scrap pile.

Accordingly, the foreman posted on the plate shear, a little notice which read as follows:

Shell .
Flange . .
Firebox . . .
Tank . . . .

The men were instructed that each and every time a piece of plate was cut off and stored in the scrap corner, the piece should be marked in one or more of its corners with a center-punch, making one punch mark on a piece of shell steel, two punch marks on flange steel, three on firebox steel, and four punch marks in the same corner on tank steel. Later it was found very convenient to have a set of the punch marks made in each of the corners of a piece of scrap steel as it saved a lot of time in finding the punch marks when a certain kind of steel was being hunted.

The foreman found the crude system of marking left over pieces of plate so convenient that he soon placed such marked pieces in another corner of the shop, then junked the entire pile of unmarked pieces of plate. Pretty soon the foreman got tired of hunting center-punch marks on a lot of steel plate pieces and procured four empty tomato cans about 3 inches in diameter. He had a friend turn three plungers from soft wood to fit easily into the cans. The plungers were shaped much like telephone receivers and the lower end was about 1 inch long and about ⅛ inch smaller than the diameter of the can. A piece of hair felt, about ⅝-inch thick was fastened to the large end of each plunger with large tacks which were driven far down into the felt so the tacks would not hit when the plunger was struck against a piece of steel plate.

Into one of these tin cans there was placed a creamy

(*Continued on page 92*)

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

Crystallization of Watertubes

Q.—What are the reasons for watertubes crystallizing at the ends, some doing so just where they extend through into the drum, while some crystallize into the seat and many times several inches beyond?—W. M. G.

A.—The probable reason for the watertubes crystallizing in the manner outlined in the question, is that the tubes have been expanded excessively in the drum.

Tubes that have to be expanded excessively become hardened, and if examined by a strong magnifying glass will show infinite stress cracks. They become sort of crystallized and if you have ever cut out a tube that has been excessively rolled you have noted how a piece will fly out of the end when cutting it out, or that it will crack for 3 or 4 inches.

Another cause of crystallization is the forming of scale in the tubes, a very thin layer of scale will cause the temperature of the metal to rise, which may result in the re-crystallization of the tube.

Also the fluctuations of pressure and temperature in the ordinary working of the boiler, by producing a succession of molecular stresses tend to crystallize the material. These are also an active cause of deterioration although the effects are never manifest to ordinary inspection.

Efficiency of Diagonal Ligament

Q.—Please advise me on the method for determining the efficiency of a diagonal ligament as given in the Marine Engineer's Handbook by Sterling, page 425, first edition.

My question is as follows: Rankine's Ellipse of stress gives intensity of tension on any plane as $p \cos^2\theta + q \sin^2\theta$, and intensity of shear on any plane as $(p - q) \sin\theta \cos\theta$. Since on a cylindrical sheet under internal pressure $p = 2$ and $q = 1$, the intensity of tension would be $2 \cos^2\theta + \sin^2\theta$ or $\cos\theta + 1$ and the intensity of shear would be $\sin\theta \cos\theta$.

Why are these values given as $\frac{\cos^2\theta + 1}{2}$ and $\frac{\cos\theta \sin\theta}{2}$.

This may be an unimportant point, but I would appreciate an explanation. R. M. T.

A.—The formulas as given in the *Marine Engineer's Handbook* are as follows:

From Rankine's ellipse of stress, we have

$$\text{Intensity of tension of any plane} = \frac{\cos^2\theta + 1}{2}$$

$$\text{Intensity of shear on any plane} = \frac{\cos\theta \sin\theta}{2}$$

Where θ = angle which the normal plane through centers of holes makes with the plane through the drum axis.

These formulas are for a cylindrical vessel closed at its ends, under internal pressure, as a boiler.

When a boiler is under pressure, the strain on the boiler is different in different directions, being greatest in a circumferential direction and least along the direction of the boiler's length. In fact, the strain on a boiler girthwise is precisely twice as great as the strain in a lengthwise direction.

Thus in Rankine's ellipse of stress formulas:

(1) Intensity of tension on any plane =
$$p\,(\cos^2\theta) + q\,(\sin^2\theta)$$

(2) Intensity of shear on any plane =
$$(p - q)\,\sin\theta \cos\theta$$

The longitudinal stress $q = \frac{1}{2}p$, and assuming $p = 1$,
$$q = \tfrac{1}{2}p \text{ or } \tfrac{1}{2}$$

Substituting these values in equation (1), we have

$$\text{Intensity of tension} = 1\,(\cos^2\theta) + \tfrac{1}{2}\,(\sin^2\theta)$$

$$= \cos^2\theta + \frac{1\,(\sin^2\theta)}{2}$$

$$\sin^2\theta = 1 - \cos^2\theta$$

Substituting, we have $\cos^2\theta + 1\,\frac{(1 - \cos^2\theta)}{2}$

$$= \frac{2\cos^2\theta + 1 - \cos^2\theta}{2}$$

$$= \frac{\cos^2\theta + 1}{2}$$

Substituting these values in equation (2), we have

$$\text{Intensity of shear} = (1 - \tfrac{1}{2})\,\sin\theta\cos\theta$$

$$= \tfrac{1}{2}\sin\theta\cos\theta$$

$$= \frac{\sin\theta\cos\theta}{2}$$

Developing Cone with Flat Side

Q.—Would you please show the method of developing a conical shape having a flat side.—G. M.

A.—A transition piece, having a conical shape with a flat side is shown in Figs. 1, 2 and 3. The elevation, Fig. 1 is shown by *A-B-C-D*, the plan Fig. 2, *F-Q-P-N-G*, represents the top and *H-M-L-K-J* represents the bottom; Fig. 3 shows the side view.

An inspection of the plan view, Fig. 2, will show that the line *E-L* divides the plan into two symmetrical halves, consequently the pattern of one-half can be duplicated for the other half.

In working out this problem divide *P-Q-F* in the plan view, Fig. 2, into any number of equal parts, as shown by the small figures 1, 2, 3, 4, etc., and in the same manner divide L-M-H into the same number of spaces, as shown by the small figures 1′, 2′, 3′, 4′, etc. Connect these points with solid and dotted lines as shown.

As the next step preparatory to obtaining the lines of

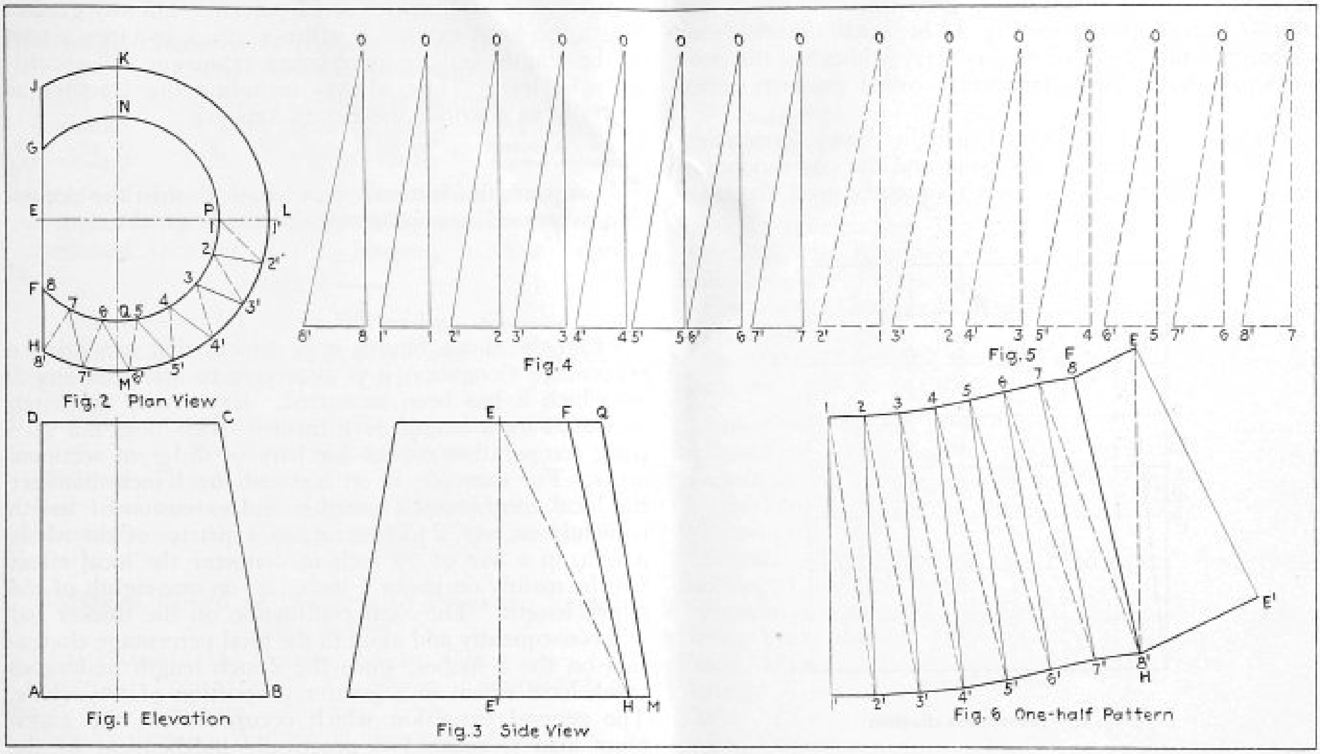


Fig. 1 Elevation Fig. 2 Plan View Fig. 3 Side View Fig. 4 Fig. 5 Fig. 6 One-half Pattern

the pattern construct triangles Figs. 4 and 5, whose bases are equal to the length of the lines drawn between *P-Q-F* and *L-M-H*, Fig. 2, and whose altitudes are equal to the straight heights of the article and whose hypotenuses will give the correct distance from the points on *P-Q-F* to the points on *L-M-H*.

The diagram of triangles represented by the solid lines is shown in Fig. 4. To obtain these triangles draw a horizontal line any convenient place, and from, 1 as shown, erect a perpendicular line, and make it the same height as *A-D* Fig. 1, represented by *O*, Fig. 4. Measure the distance 1-1′ on the horizontal line making 1-1′ equal to the solid line 1-1′ of the plan view. Connect 1′-*O* with a solid line. The hypotenuse of 1′*O* will be the true length of the distance 1-1′ of the plan view. In like manner construct the rest of the triangles of Fig. 4 using the solid lines 2-2′, 3-3′ to 8-8′ of the plan view as the bases and the distance *A-D* of the elevation as the altitude until the true lengths of all the solid lines are obtained.

In like manner obtain the true lengths of the dotted lines between *P-Q-F* and *L-M-H* of the plan, using the distances 1-2′, 2-3′, 3-4′ to 7-8′ of the plan view as the base and the distances *A-D* of the elevation as the altitude until the true lengths of all the dotted lines are obtained.

In marking this or any other article by triangulation it will be found very convenient to have two pairs of dividers, one pair for large spaces on *L-M-H* and the other for the smaller spaces on *P-Q-F*, thereby avoiding chances of error in resetting, also, if two sets of trams were used, one for the solid lines and one for the dotted lines, it would save time.

For the pattern, begin by drawing a line as 1-1′, Fig. 6, on which set off a distance equal to *O*-1′, Fig. 4, which equals *C-B* in the elevation. Then with the dividers set to the large spaces on *L-M-H*, and with 1′ as a center scribe an arc. Then using the point 1 as a center with the trams set equal to *O*-2′, Fig. 5, scribe an arc cutting the arc just drawn, locating the point 2′, Fig. 6.

Then use the dividers set to the small spaces on *P-Q-F*, Fig. 2, and using 1 as a center scribe an arc, as shown; then using the point 2′ as a center and with the trams set equal to the distance *O*-2′, Fig. 4, scribe an arc cutting the arc just drawn locating the point 2, Fig. 6.

Then use the dividers set to the large spaces on *L-M-H*, Fig. 2, and using 2′ as a center scribe an arc. Using the point 2 as a center and with the trams set equal to *O*-3′, Fig. 5, scribe an arc cutting the arc just made locating the point 3′ in the pattern.

Continue in this manner using the true lengths of the solid lines from Fig. 4 and the true lengths of the dotted lines from Fig. 5 until the points 8 and 8′ of the pattern have been located.

Then with 8 as a center and with the dividers set equal to the distance *E-F* of the plan, Fig. 2, scribe an arc, and with 8′ as a center and the trams set equal to *H-E* of the side view, scribe an arc cutting the arc just drawn locating the point *E* of the pattern.

Then with 8′ as a center and with the dividers set equal to the distance *H-E* of the plan, Fig. 2, scribe an arc, and with *E* as a center and the trams set equal to *E-E′* of the side view, scribe an arc cutting the arc just drawn locating the point *E*, Fig. 6.

Connect all the points located, completing the one-half pattern as shown in Fig. 6.

Elasticity of Steel

Q.—(1) What is the full meaning of proportional limit of steel?
(2) A standard full section test specimen of boiler steel shows an elongation of 2¼ in 8 inches. What is the percent of elongation?—W. G.

A.—(1) When a stress is applied to a solid body and then removed, the body returns to its original size and shape, provided the stress has not exceeded a certain limit. If the stress has gone beyond this limit, the body does not return to its original dimensions, but retains some permanent deformation or set. The unit stress at this limit is called the elastic limit of the material. Elastic limit is also defined as the unit stress at which the stress-strain diagram (see Fig. 1) begins to deviate from a straight line. Defined in this way, it is called the proportional elastic limit, frequently called proportionality limit.

The stress-strain diagram is usually drawn by plotting a curve with strains as abscissae and the corresponding stress as ordinates. The most frequently used diagrams

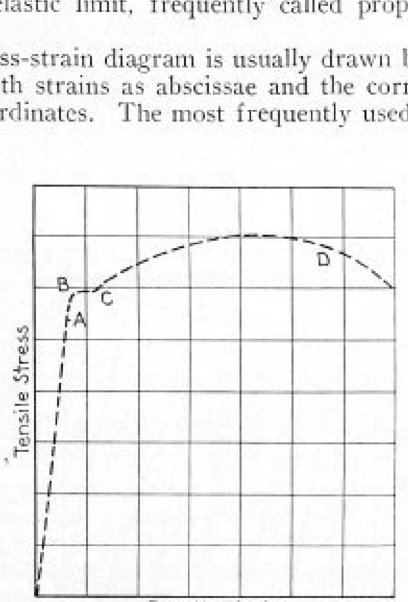


Fig. 1.—Stress-strain diagram

are those obtained from the extension of straight rods.

At first the graph is sensibly a straight line (since the material obeys Hooke's Law) as shown from O to A, the point A marking the "limit of linear elasticity" generally referred to as the elastic limit: it is the limit of proportionality between stress and strain.

(2) The percent elongation is as follows:

$$\text{Percentage of elongation for 8 inches} = \frac{10.25 - 8}{8} \times 100 = \frac{2.28}{8} \times 100 = 0.281 \times 100 = 28.1 \text{ percent}$$

Percentage Elongation: In fracturing a piece of mild steel by tension there is produced previous to the maximum load a fairly uniform elongation, and subsequently an increased local elongation about the section of frac-

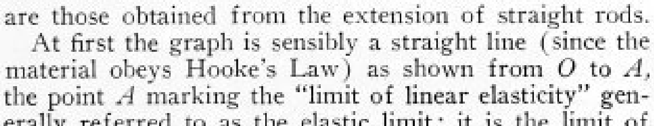


Fig. 2.—Tensile test specimen

ture (see Fig. 2). In such a case the extensions on each of 10 inches, marked out on a bar one inch diameter before straining were as follows:

Inch	1	2	3	4	5	6	7	8	9	10
Extension (inches)	0.20	0.21	0.22	0.25	0.30	0.52	0.52	0.28	0.27	0.23

Fracture occurs near the division 6 inches from one end of the marked length. Reckoning the percentage extension on the 2 inches nearest to the fracture, which include a large proportion of the local extension, the elongation is 1.04 inches, or 52 percent. On any greater length the local extension will not affect so large a part of the length, and the percentage extension will accordingly be less. Thus, always including the fracture as centrally as possible, the elongations are

Length (in inches)	2	4	6	8	10
Elongation percent	52	40.5	35.7	33.6	31.0

If any length l increases to a length l^1, then the elongation expressed as a percentage of the original length is

$$\frac{l^1 - l}{l} \times 100$$

From the above figures it is evident that in stating a percentage elongation it is necessary to state the length on which it has been measured. Extensions are often measured on a length of 8 inches. This does not give truly comparative results for bars of different sectional areas. For example, if on a round bar 1 inch diameter the local contraction of section and extension of length is mainly on, say, 2 inches, i.e., on a quarter of the whole length, in a bar of ½ inch in diameter the local effect will be mainly on about 1 inch, i.e., on one-eighth of the whole length. The local contraction on the thicker bar will consequently add more to the total percentage elongation on the 8 inches, since the 2-inch length undergoes much local strain in a greater proportion of the whole. The general extension which occurs before the maximum load is reached is practically independent of the area of section of the bar, and would form a suitable criterion of ductility were it not too troublesome to measure it just before any waist or local contraction is formed. It cannot be measured satisfactorily after fracture, as the contraction at fracture influences the ultimate extension for some distance from the fracture, the metal "flowing" in towards the waist. It is, however, sometimes calculated by subtracting the local extension on 2 inches at fracture from the whole extension, and expressing the difference as a general extension on a length 2 inches shorter than the whole gage length.

Marking Steel Plate Scrap

(Continued from page 89)

mixture of hydrated lime and water—regular whitewash, of considerable thickness. When a piece of shell steel was cut off and sent to the scrap corner, the plug from can No. 1 was pressed and twisted against a corner of the steel piston, leaving a nice spot of whitewash. This spot was placed uppermost so as to be seen easily, then that piece of scrap plate was stood on end at one end of the shop. The other cans were fitted with pastes made up for can No. 2 of dry yellow ochre and water. Can No. 3 was fitted with venetian red and water, while can No. 4 carried some ultra marine blue, ordinary laundry blue, or any other kind of dry blue which might be available. These colors were used on flange, firebox and tank steel plate respectively. The cans were painted with their respective colors and kept on a little shelf which was mounted on the plate shear. Pretty soon the tin cans showed signs of distress, as a boiler inspector would say, and were replaced by four pieces of old boiler tube of the same diameter as the cans, and cut to the same length and with a button in each cup welded in by the oxy-acetylene process. No more hunting for punch marks in that shop!

Indianapolis, Ind. James F. Hobart.

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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
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

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.		Tampa, Fla.

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

States

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

Cities

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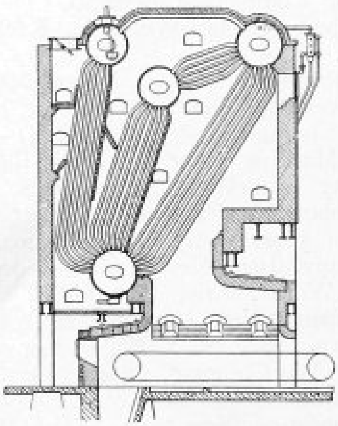
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

Selected Boiler 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.

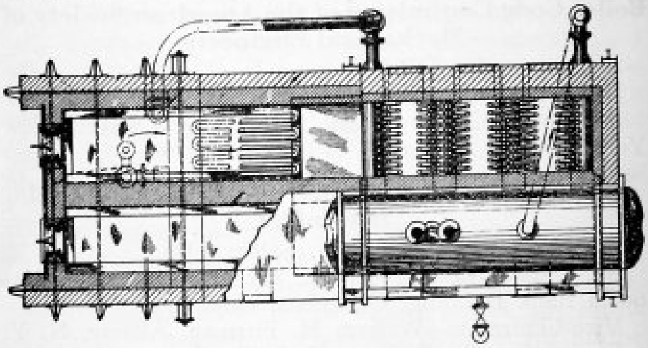
1,790,215. BOILER CONSTRUCTION. RALEIGH J. ADAMS, OF CHICAGO, ILL.

Claim.—In a device of the class described, a boiler including an enclosure having a combustion chamber at the bottom thereof, and a flue at the top thereof, a combined water inlet and steam outlet drum adjacent the flue, a second drum on a level with the said combined drum, a bank of tubes for feeding steam only from the second drum to the combined drum, a mud drum rearwardly of the combustion chamber, a bank of tubes connecting the combined drum and the mud drum for conducting incoming water directly to the mud drum, a relatively long bank of tubes connecting the mud drum with the second drum and being located above the combustion chamber to have contact throughout their lengths with the hot gases rising directly from the combustion chamber, a fourth drum located on a plane below the combined drum and the second drum and out of vertical alinement with both to permit hot gases to pass entirely around said fourth drum, a bank of tubes connecting the mud drum with the fourth drum, a relatively short forwardly inclined bank of tubes connecting the fourth drum with the second drum and arranged in the path of travel of the hot gases directly after they have passed through the said relatively long bank of tubes, and baffles for causing the gases to travel downwardly along the bank of tubes connecting the mud drum and the fourth drum and upwardly along the bank of tubes connecting the mud drum and the combined drum. Two claims.



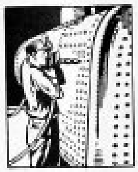
1,834,782. SUPERHEATER. DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim.—A furnace and a flue leading therefrom to a gas outlet and a superheater in said flue, said superheater being divided into two sections connected in series and arranged to be contacted serially by the hot gases from the furnace, the section farthest from the furnace comprising headers extending transversely to the direction of flow of the heating gases and tubes connecting said headers serially, and the section nearest the furnace comprising headers protected from the hot gases and tubes directly exposed to hot gases and extending across the flue with the headers and tubes arranged to cause the steam to flow back and forth between the headers, the flow area for the steam of the section nearest the furnace being less than that of the section farthest from the furnace. Eight claims.



The Boiler Maker

Reg. U. S. Pat. Off.



Measures for Recovery in the Boiler Industry

Recognizing the necessity for a complete reorganization of basic philosophy in the conduct of the boiler manufacturing industry to meet conditions which will be imposed on industry in general by President Roosevelt's Industrial Recovery Act, the American Boiler Manufacturers' Association at its forty-fifth annual convention devoted its energies to the formulation of plans designed to anticipate the passage of impending legislation. Almost without exception the new era in this business will be welcomed, with a full understanding, however, of the serious problems to be met and solved before the policies to be evolved can bring a return of prosperity to the industry.

The fullest co-operation between members is prerequisite to the solution of the industry's problems. There is full accord that every requirement when and as proposed by the Government must be met. These requirements must be provided for in a code to govern the industry, which is so formulated that it will receive the President's approval. They are:

That the association or group admits equitably to membership all who are engaged in the same trade or industry.

That the association or group is truly representative of the trade or industry for which it speaks.

That the code presented will not promote a monopoly.

That the code will not oppress or discriminate against small enterprises.

That employees will have the right to organize and bargain collectively through representatives of their own choosing.

That employers will comply with the maximum hours of labor and minimum wage of pay and standards for other working conditions approved by the President.

Applied to the boiler manufacturing industry, full compliance will automatically raise the level of service to the power-consuming public, and within the industry itself will improve employment, wage levels, and working conditions, and finally will bring about the possibility of better prices for products by permissive agreements and by the elimination of chiseling competition.

To accomplish the utmost from the program being developed by the Industrial Recovery Committee of the A. B. M. A., created at the annual meeting, it is essential that every manufacturer of boilers and allied equipment should become a member of the association. Manufacturers of over 90 percent of the volume of such equipment already are numbered in its ranks. The remaining 10 percent can by price cutting, by penalizing labor and by other unethical practices frustrate much of the work accomplished by the companies working through the association. Every effort must be made to induce such companies to join the association and at as early a date as possible. The stoker manufacturers and the pulverized equipment manufacturers at the present meeting amalgamated with the A. B. M. A.

In order to present a complete record of its program and the progress made in its development, the A. B. M. A. has established a public relations policy, which will make it possible for THE BOILER MAKER to co-operate to the fullest extent. In the light of changing industrial conditions this policy will prove of the utmost aid in maintaining a clear record within the industry itself, with the users of its products and with the Government. Full publicity of its activities will make impossible the chiseling tactics of the few. The morale of all workers can be maintained if they realize that what is being done is to their interest. Technically it will be possible to unify thought and practice throughout the industry as it never can be done individually and by infrequent personal contacts or by correspondence. Actually a new era of co-operation in the boiler manufacturing industry is at hand.

Organization of Class One Welding Industry

Following the American Boiler Manufacturers' convention at Skytop Lodge, Pennsylvania, the Class One Welding Association, Inc., 522 Fifth Avenue, New York, held a meeting on June 8 and 9 to formulate a code of fair competition for the control of the industry under the Industrial Recovery Act.

This organization of companies producing Class One welded pressure vessels under the American Society of Mechanical Engineers' Boiler Code was formed about a year ago. H. B. Kendall, president of M. W. Kellogg Company, New York, is president of the association; A. G. Pratt, president of Babcock & Wilcox Company, New York, vice-president; and S. N. Clarkson of New York is secretary-treasurer.

As stated in the constitution of the association, adopted January 9, the manufacturers of this group have organized with the following objects:

For the purpose of fostering trade and commerce, or the interests of those engaged in Class One welding.

To reform abuses relative thereto.

To secure freedom from unjust or unlawful exactions.

To diffuse accurate and reliable information as to the standing of merchants and other matters.

To procure uniformity and certainty in the customs and usages of trade and commerce, and of those having a common trade, business, financial or professional interest, in Class One welding.

To settle differences between members, and to promote a more enlarged and friendly intercourse between men engaged in the business of Class One welding.

Boiler Manufacturers Embark on Industrial Program at Forty-Fifth Convention

With a new era of service opening before it, the forty-fifth annual convention of the American Boiler Manufacturers' Association held at Skytop Lodge, Pennsylvania, June 5 to 7, served as an organization meeting of the industry in anticipation of the requirements to be met by this as by all industries upon the enactment of President Roosevelt's industrial recovery legislation. An invitation prior to the meeting had been extended to the Stoker Manufacturers' Association and to the Pulverized Fuel Equipment Association to amalgamate with the A. B. M. A. in one organization. This move was logical since the products of both groups combine with the boiler proper to form a modern power unit. The union of members of these organizations was completed and henceforth they will function in the same group arrangement of the A. B. M. A. as already exists for the watertube boiler manufacturers, horizontal return tubular boiler division, steel heating boiler builders and others. The philosophy back of this move, in addition to being a well advised move, because of the benefits to be derived from strengthening the association and co-ordinating otherwise conflicting and overlapping activities of the three groups, will result in a broader and more efficient service to the power-using public.

There were in attendance about 75 representatives of boiler manufacturing concerns, producing 90 percent of the boiler-building capacity of the country and of the allied supply industry.

At no meeting of the A. B. M. A. in recent years has there been displayed the earnestness of purpose to accomplish a co-ordinated working plan within the industry as was apparent at this forty-fifth convention. The motive is evident here as throughout industry today, to put into effect through the trade association serving this industry not only the letter of President Roosevelt's Industrial Recovery Act but the spirit as well. There was in every reaction to the plans being developed not only evidence of a willingness to co-operate but an anxiety for the new self-regulating proposals to be made effective at the earliest possible moment after the Act has become law.

To this end an Industrial Recovery Committee of the A. B. M. A. was appointed to formulate the regulations which, after the final approval of the Government, will be in force in the industry. The committee of nine members is composed of the ablest minds in the association and accurately represents a cross section of the entire field. The members of this committee are: Owsley Brown, president of the Springfield Boiler Company, Springfield, O., chairman; A. C. Weigel, manager of the Boiler Division, Combustion Engineering Corporation, New York, vice-chairman; H. H. Clemens, president of the Erie City Iron Works; Charles E. Tudor, president of the Tudor Boiler Manufacturing Company; A. G. Pratt, president of Babcock & Wilcox Company; W. F. Keenan, Jr., of the Foster Wheeler Corporation; S. H. Barnum, vice-president, The Bigelow Company; R. B. Mildon, general manager, Stoker Division, Westinghouse Electric & Manufacturing Company; A. W. Strong, president, Strong-Scott Manufacturing Company; H. E. Aldrich, of New York, secretary.

While plans could only be developed tentatively at this meeting, after active discussion on the question had brought out the ideas and interpretation of the requirements by the entire membership, the committee will lose no time in actually preparing an industrial code, which unquestionably will be required shortly for governmental approval.

This committee, having practically arbitrary powers within the industry, will act with the Government when and as occasion requires. The necessity for the closest possible co-operation in this connection will be apparent from a study of the provisions of the Industrial Recovery Act which in interpretative form appear on page 99 of this issue.

The attitude of the entire association is one of complete co-operation among the individual members of the industry in complying with the laws to be enacted. The spirit prevailing undoubtedly having its counterpart today throughout industry goes beyond this feeling of compliance, however, and looks for a resulting stabilization of the industry that has not existed for some years past. Such stabilization can only result in better service to the public and in a real improvement in the unemployment situation in boiler manufacturing plants.

The responsibility to labor in the stabilization of employment, better wages, and improved working conditions is fully recognized as the primary objective of the Government in promulgating the industrial recovery measure. The boiler manufacturing industry, through its special committee, will be assiduous in its duties.

One very important function will be to develop means for inducing all manufacturers of power equipment voluntarily to seek membership in the association. That such companies may be expected to affiliate themselves in the near future with the A. B. M. A., was attested to by the application of several boiler and allied equipment manufacturers for membership during the convention.

So important to the future welfare of the organization was the need for determining basic policies to govern recovery within the industry that practically all standing committee reports were foregone so that all sessions might be devoted to the discussion of this subject. Such reports will, however, appear in the published proceedings.

The convention formally opened with a meeting of the executive committee, June 4, while the business sessions opened Monday, June 5, and continued until June 7. The meetings were conducted by the president of the association, Charles E. Tudor, president of the Tudor Manufacturing Company, Cincinnati. An abstract of the president's annual address follows:

President's Address

I have attended meetings of the American Boiler Manufacturers' Association for a period of over forty years, my first attendance being at a meeting held in Buffalo in 1892.

If there is a thought in the mind of anyone that this association has not progressed and has not been responsible for outstanding accomplishments let him dispel that thought. A review of our yearly proceedings will reveal a preponderance of evidence to the contrary.

I can remember the time in the early days when a boiler correctly designed and honestly built, thoroughly inspected by authorized inspectors, representing the foremost inspection and insurance companies of that time was very apt to be condemned on arriving at its destination. This was especially true if it was shipped into some distant state.

Shortly after the American Boiler Manufacturers' Association was formed it was instrumental in putting a stop to such practices and others similar in nature. I have in mind many irregularities that were rectified under the persistent work of the officers of the association.

Then when we review the work during the past several years, bringing us into the era of high pressures, calling for exceptionally heavy riveted or welded drums, your officers with the support of the association, were in a position to break down and discourage adverse legislation as well as to support sound legislation which pertained to our industry. We could never have met with any degree of success single-handed, but organized we had strength and prestige.

There has been an expression that our association has failed to stabilize prices. Now anyone who has attended our meetings or studied the reports of our proceedings understands that our association has done everything possible to encourage better prices.

It is recalled, however, that we have kept in mind the fact that we are a law-abiding body and in all of our deliberation we have remained within the law.

We have been looking forward with hope and the expectation that the Sherman Act and the Clayton Law would be so modified that we would be permitted to ask and receive prices, commensurate with our investments, our engineering knowledge, our responsibilities; prices which in turn would enable us to pay living wages to our employees, to pay reasonable market prices for our raw materials without having to resort to the miserable practice of chiseling, thereby, assisting in breaking down other lines of industry and preventing them from paying living wages to their workmen.

Again I mention the fact that your officers, realizing the importance of practical cost systems, have repeatedly advised the use of some accepted system so that our members would know their absolute shop costs on each job, this being one of the fundamental necessities in arriving at fair selling prices.

You will also recall our efforts to stabilize the industry by discouraging the changing of any prices after an estimate was once tendered, unless some change had been made in the original plan and specification. Unscrupulous purchasing agents have cost your industry many thousands of dollars.

Low prices do not create boiler business. Boilers have a long life and repeat orders are not, in the best of times, plentiful, hence all the more reason why a boiler manufacturer is entitled to reasonable profits.

The below-cost business getter will wake up too late I am afraid, only to find his machinery worn out, his accounts in doubtful hands and his labors gone for naught.

The industry has suffered untold damage in the lean years through which we have been passing. While it is true that all industry is partially paralized, none has felt the shock any greater than the boiler business.

Let me call attention to the following:

In the year of 1932 the volume of watertube boiler business was only 19 percent in horsepower and 23 percent in number of units, when compared with the peak year of 1929 when 940,952 horsepower of watertube boilers were purchased.

The records of the census bureau show that the first quarter of 1933 is only 12½ percent in number and 12 percent in horsepower, when compared with 1927 and only 73½ percent in number and 65 percent in horsepower comparing with the first quarter of 1932.

The total business in boilers of all types in percent and number will check very closely with the watertube volume. Heating boilers and oil country boiler have been hit even harder than the watertube boiler business.

The small amount of boiler business available has brought about deplorable conditions in the industry, all of which are reflected in the annual statements, which we must admit are not very encouraging.

The boiler manufacturing industry with its millions of invested capital has slowly but surely sunken to a low ebb. The depression is largely responsible for the falling off in the volume of boiler business, nevertheless, the picture would be much more cheerful if reasonable prices were obtained for the boiler installations that have been sold within the past year.

The boiler industry itself is responsible for the chaotic situation in the price structure. Ridiculously low prices of manufactured equipment quite often go hand in hand with low wages and unsatisfactory conditions in general. The wage reductions in our industry while severe have not been as heavy as in some other lines, nevertheless, they reflect no credit to the industry.

If ever you needed organization you need it now. You are facing many changes, and whether you recognize this fact or not, this as all industry is headed for an uncharted course.

President Roosevelt has been given greater powers than any peace-time president has ever had, and he indicates that he proposes to use it to the greatest advantage for the benefit of the whole nation. We must, therefore, be ready and willing to support him in any constructive plans wherein industry, labor and the country at large will benefit.

The President has at times openly expressed himself as favoring the broadening of the Sherman Act and the Clayton Law, permitting manufacturers to sit together and take measures of stabilization for their industry, and he suggests the fullest co-operation of the government in bringing about economic recovery.

At the Capitol, work has already begun on a broad plan to establish a board which would function in cooperation with trade associations, so that proposals for hours of labor, minimum wages and unfair competition might be correlated in a comprehensive scheme to restore order in the industrial world.

In addition to aiding industry to regulate itself, the board might be granted power to enforce minimum prices and wages, as well as proper production schedules, as against a small minority of an industry that refuses to join in the efforts of the trade association to replace the industry on a sound basis.

Under the proposed plan, we can by prescribing sound trade practices under governmental guidance, that will include the elimination of cut-throat competition and murderous price cutting, bring our industry to the fore again and enable us to enjoy the fruits of our labor in the shape of living wages for our employees and reasonable profits to ourselves.

The move as outlined would, without doubt, meet with general approval. The public thoroughly palled, disgusted and discouraged to distraction is clamoring for action looking for a way out of the depression. Individuals everywhere are in a co-operative mood and are looking to industry for results.

Notwithstanding that some of the President's proposed changes are revolutionary, his attitude seems to be meeting with public favor. It would seem that the government is stepping in to do in an arbitrary way, what private enterprise, heretofore, was expected to do practically.

Proposed business regulation means that you, as a manufacturer, will continue to show your ability, your initiative, your enterprise, but you will not have quite the same freedom as you have had in the past. You will be compelled to play ball more closely with your competitors.

Your trade association must necessarily be a real working body, functioning to the mutual advantage of all.

We must get ready to accept the new order of things that lies directly ahead of us. We cannot think in the old terms. This is not necessarily due merely to changes in the political party, it is due mainly to changing economic conditions. The old order of things has broken down. Up until recently this might have been doubted, but it is surely evident now.

After business recovery takes place I am sure that all of us would rather see a period of moderate volume of business steadily maintained with a fair and reasonable return on our investment than to experience another runaway market, reeking with pitfalls and distress.

Monday evening two addresses on different phases of the industrial situation were delivered. The first speaker, J. Harvey Williams of J. H. Williams & Company, New York, had as his subject "Anti-Trust Laws." C. O. Wellington of Scovell Wellington & Company, New York, spoke on "Suggestions for Improving the Price Level."

On Tuesday evening the annual banquet was held at which various outstanding members of the organization spoke. The toastmaster for the occasion was George W. Bach, president, Union Iron Works, Erie, Pa.

On Wednesday, after a continuation of the discussion on the current situation within the industry, the election of officers for the coming year occurred. The complete list of officers for the year 1933-34 is as follows:

President, Charles E. Tudor, president, the Tudor Manufacturing Company, Cincinnati, O.; vice-president, Owsley Brown, the Springfield Boiler Company, Springfield, O.; secretary and treasurer, A. C. Baker, Cleveland, O. Executive Committee—J. G. Eury, the Henry Vogt Machine Company, Louisville, Ky.; M. E. Finck, Murray Iron Works, Burlington, Ia.; A. C. Weigel, Combustion Engineering Corporation, New York; Homer Addams, Fitzgibbons Boiler Company, Inc., New York; George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; R. B. Mildon, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.; A. W. Strong, Strong-Scott Manufacturing Company, Minneapolis, Minn., and R. B. Dickson, Kewanee Boiler Corporation, Kewanee, Ill. (*Ex-Officio*)—H. H. Clemens, Erie City Iron Works, Erie, Pa.

Registration at the Forty-Fifth Annual Convention of the A. B. M. A.

Addams, Homer, Fitzgibbons Boiler Company, Inc., New York.
Bach, George W., Union Iron Works, Erie, Pa.
Baker, A. C., Cleveland, O.
Barnum, George S., The Bigelow Company, New Haven, Conn.
Barnum, Starr H., The Bigelow Company, New Haven, Conn.
Bateman, W. H. S., 822 Commercial Trust Building, Philadelphia, Pa.
Blodgett, L. S., The Boiler Maker, 30 Church Street, New York.
Bradford, S. G., The Edge Moor Iron Company, Edge Moor, Del.
Broderick, J. H., The Broderick Company, Muncie, Ind.
Broderick, M. H., The Broderick Company, Muncie, Ind.
Brown, C. H., Lukens Steel Company, Coatesville, Pa.
Brown, J. Rowland, Reliance Gauge Column Company, Cleveland, O.
Brown, Owsley, Springfield Boiler Company, Springfield, Ill.
Cardwell, George A., Lukens Steel Company, Coatesville, Pa.
Carson, W. S., Globe Steel Tubes Company, Cleveland, O.
Cassidy, P. J., Babcock & Wilcox Company, New York.
Champion, D. J., Champion Rivet Company, Cleveland, O.
Chipman, F. W., International Engineering Works, Framingham, Mass.
Clemens, H. H., Erie City Iron Works, Erie, Pa.
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 Company, Worcester, Mass.
Diemer, C. P., Champion Rivet Company, Cleveland, O.
Dillon, Jr., J. T., Titusville Iron Works Company, Pottstown, Pa.
Eury, J. G., The Henry Vogt Machine Company, Louisville, Ky.
Felker, George F., Crosby Steam Gauge Company, New York.
Ferguson, William, Travelers Indemnity Company, Hartford, Conn.
Fish, E. R., Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn.
Gorton, Chas. E., American Uniform Boiler Law Society, New York.
Harston, L. W., Steel & Tubes, Inc., Cleveland, O.
Hogan, L. M., Steel & Tubes, Inc., Cleveland, O.
Humbert, B. L., Brownell Company, Dayton, O.
Hutchinson, Ely C., The Edge Moor Iron Company, Edge Moor, Del.
Huyette, Paul B., Paul B. Huyette Company, Philadelphia, Pa.
Huyette, S. Lewis, Paul B. Huyette Company, Philadelphia, Pa.
Keenan, W. F., Foster Wheeler Corporation, New York.
Lasker, Charles, Lasker Boiler & Engine Company, Chicago, Ill.
Locke, R. A., Coatesville Boiler Works, Coatesville, Pa.
Martwick, W. L., Foster Wheeler Corporation, New York.
McAllister, W. V., Stoker Manufacturers Association, Detroit, Mich.
McCreight, W. N., Vulcan Soot Blower Company, Dubois, Pa.
Metcalf, F. B., International Boiler Works, East Stroudsburg, Pa.
Mildon, R. B., Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.
Miller, C. W., E. Keeler Company, Williamsport, Pa.
Nagle, T. M., Pennsylvania Boiler Works (Nagle Engine & Boiler Company), Erie, Pa.
Nick, E. W., Northern Equipment Company, Erie City, Pa.
Obert, C. W., Union Carbide & Carbon Research Laboratories, Long Island City, N. Y.
Pratt, A. G., Babcock & Wilcox Company, New York.
Rea, W. H., Detroit Stoker Company, Detroit, Mich.
Royer, D. L., Ocean Accident & Guarantee Insurance Company, New York.
Santry, J. V., Combustion Engineering Corporation, New York.
Simon, Edw. F., Ohio Machine & Boiler Company, Cleveland, O.
Slate, George, The Boiler Maker, 30 Church Street, New York.
Stone, E. R., Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.
Strong, A. W., Strong-Scott Manufacturing Company, Minneapolis, Minn.
Thomas, W. P., Diamond Power Specialty Company, New York.
Trefts, John C., Farrar & Trefts, Buffalo, N. Y.
Tudor, C. E., Tudor Boiler Manufacturing Company, Cincinnati, O.
Tudor, M. J., Tudor Boiler Manufacturing Company, Cincinnati, O.
Van Brunt, I., Combustion Engineering Corporation, New York.
Voelker, J. A., Pittsburgh Steel Company, Pittsburgh, Pa.
Weigel, A. C., Combustion Engineering Corporation, New York.
Wellington, C. O., Scovell Wellington & Company, New York.
Williams, J. Harvey, J. H. Williams & Company, New York.
Wolf, Howard, The Broderick Company, Muncie, Ind.
Worker, Joseph, American Engineering Company, Philadelphia, Pa.
Wynkoop, N. O., McGraw Hill Publishing Company (*Power*), New York.
Yarnall, D. R., Yarnall Waring Company, Philadelphia, Pa.

Surveys Changes In Locomotive Boiler Design

By G. P. Blackall

Changes in locomotive boiler design were surveyed by Sir Seymour B. Tritton, K. B. E., famous British engineer, at the annual congress of the British Association for the Advancement of Science, which was recently concluded at York. Sir Seymour declared that the most radical changes in locomotive construction of late years were concerned with the design of the boiler. In spite of reduced consumption, the demand is yet for more steam and the use of higher pressures to promote economy. It would seem that a steam pressure of 250 pounds per square inch is about the limit that can be used in a locomotive boiler of the present type, whose size and weight have reached their limits and must lead to a radical change in design.

"There are several novel departures in high-pressure design for steam locomotives which may roughly be divided into two types; that which may be termed the three-stage or, perhaps, more happily, the multi-pressure boiler, and the watertube boiler. There are several variations of each," Sir Seymour explained, "and detailed descriptions would not come within the scope of my paper, but the Schmidt-Henschel, which is being tested on the London, Midland & Scottish Railway, is perhaps the most interesting of the multi-pressure boilers. In this boiler, steam

(*Continued on page 100*)

Provisions of President Roosevelt's Industrial Recovery Act

Ultimate passage of the Industrial Recovery Act sponsored by President Roosevelt is foreseen within a very short time. Differences of opinion that have arisen in Congress are rapidly being compromised and the bill in its final form is not expected to be altered vitally.

Since the basis on which members of the American Boiler Manufacturers Association must organize their business for the future, a brief abstract of the provisions of the bill as outlined by Phelps Adams, special staff writer of the *New York Sun*, is published through the courtesy of that journal.

The bill is made up of two separate and distinct measures combined for the sake of convenience—the one containing the "industrial control" provisions and the other providing for the public works program together with the tax increases necessary to meet the interest and amortization charges on the $3,300,000,000 which the Government will borrow for this purpose.

The "industry-control" section of the bill is the logical outgrowth of the popular demand for the correction of two fundamental economic difficulties in the industrial structure. For many years business men have insistently urged that the anti-trust laws be revised so that the individual manufacturers in any industry might get together and agree to limit production sufficiently to prevent the accumulation of price-depressing surpluses that not only glut the market but that force cut-throat competition of a kind that leads inevitably to wage-slashing and the employment of sweat-shop methods in the factories.

At the same time spokesmen for labor have demanded relief from the growing burdens of technological unemployment and have urged that Congress enact legislation requiring that hours of labor be decreased proportionately as the productive capacity of labor increased through the use of labor-saving machinery. The direct result of this plea, of course, was the "Black bill," which sought to bar from shipment in interstate commerce any article manufactured in a plant where an individual laborer worked longer than thirty hours a week.

The bill leaves the anti-trust laws on the statute books, applying alike to all industries and businesses without regard to their peculiar needs. It then sets forth a procedure through which, if industries or businesses wish to do so, they may exempt themselves from the operation of these anti-trust laws.

To do this the individual units in each industry must get together—through their trade or industrial association—and draft a "code of fair competition" which in reality is a new law that, when approved by the President, will govern the industry devising it in place of the existing anti-trust laws.

In this code, the industry must set forth an agreement as to minimum wages, maximum hours of work and the terms of any arrangements that it wishes to pursue in regard to curtailing production and maintaining price levels.

When the industry itself has agreed on such a code it may present it to the President, who will approve it if he finds:

1. That the association or group admits equitably to membership all who are engaged in the same trade or industry.
2. That the association or group is truly representative of the trade or industry for which it speaks.
3. That the code presented will not promote a monopoly.
4. That the code will not oppress or discriminate against small enterprises.
5. That employees will have the right to organize and bargain collectively through representatives of their own choosing.
6. That no employee will be required as a condition of employment to sign an anti-union contract. This outlaws the so-called "yellow dog" contract.
7. That employers will comply with the maximum hours of labor and minimum wage of pay and standards for other working conditions approved by the President.

Nothing is said in the bill about price fixing, and it remains for the President or those to whom he intrusts the administration of the measure to determine the extent to which the members of any industry may, in their code, enter into price-fixing agreements. It is regarded as certain, however, that the administration will permit any code to set forth the definite factors of cost which must be taken into consideration in arriving at a fair price and further to stipulate in the code that no member of the industry may sell his product at a price below cost.

The primary concern of the Government in all this, of course, is to see that in return for this privilege the industry agrees to pay higher wages and to shorten working hours, so that employment may be increased and so that the purchasing power of the industrial sections of the country may rise also.

Once a code is approved it becomes a law for the industry involved and a violation of the code is a violation of law, punishable in the Federal courts. Obviously, therefore, if the bill is to work at all, it must apply to every individual unit in a particular industry operating under a code, otherwise while 90 percent of an industry agree to raise wages, shorten hours and thus increase its costs, the other 10 percent which held out of the agreement could, by increasing hours of labor, cutting wages and indulging in other "unfair competitive practices," vastly undersell those units participating in the code.

It is for the purpose of regulating this 10 percent which is referred to here as the "chiseling fringe," that the licensing provisions have been written.

It should be said flatly that no one in the administration has any intention of attempting to license all the industries in the country or all the units in any one industry and it is entirely possible that the licensing provisions in this bill would never be used at all.

They are put there solely for the purpose of frightening the "chiseling fringe" into participation. In other words, after an industry has almost unanimously agreed to a code, if it is found that one or two units of the industry refuse to recognize and obey that code, the President may require that all the units of the industry in the particular area involved be licensed.

In order to ship their goods in interstate commerce the chiseling fringe would then have to take out a license agreeing to operate under the terms of the code already drafted and violations of the code are then punishable by revocation of license.

To sum up these voluntary code provisions, therefore, the bill simply gives to all industries a right to write a set of laws governing the business conduct of that industry, and it then imposes on the Federal Government the duty of aiding the industry in enforcing those laws.

In the event that an industry refuses to draw up a voluntary code and if it is found that abuses exist in that industry, the President has a right, after holding exhaustive hearings on the subject, to draft a code which in his opinion is fair to all units of that industry and to place that code mandatorily in effect.

Under the bill, also, the President may approve and put into force and operation, trade and labor agreements reached voluntarily between two or more parties within an industry or in separate industries. The difference between a voluntary code and these voluntary agreements is that a code applies to all units of an industry, while an agreement applies only to the contracting parties.

As a last resort the President also has authority to put into operation a "limited labor code" fixing maximum hours and minimum wages in any industry when all other means of accomplishing this have failed.

If the bill can command the voluntary support and co-operation of industry, tremendous benefits are foreseen. It will give to industry the opportunity, without losing money on the deal, to increase wages, shorten working hours, thereby increasing employment and enlarging the ability of labor to purchase the finished products that it manufactures. It will place an added premium upon efficiency in operating through fostering "fair competition" and will serve to prevent wasteful operation through over-production and over-expansion.

It is further designed to flatten out the prosperity curve, avoiding dangerous peaks like that of 1929 and preventing the resulting depressions. It will also give to industry the advantage of dealing with organized labor as an organized industry where at present organized labor deals with an individual factory or mill owner.

New Furnace for Treating Steel Plates

The latest refinement in the production of quality steel plates has just been introduced by the Worth Steel Company in one of its mills at Claymont, Delaware. This consists of a continuous heat treating furnace located in the mill tables midway between the main rolls and the straightening rolls. All plates rolled on this mill may now pass through the furnace where they can be brought up to a uniform heat and delivered to the straightening rolls at the proper temperature to permit effective flattening.

This mill is devoted largely to the production of light gage plates from ¼ inch down to No. 10 gage inclusive and in widths up to 100 inches. In rolling these gages it is a well known fact that, by the time they have gone through the last pass required to bring them down to gage, their temperature has been reduced to such a point that it is extremely difficult if not impossible to iron out all the waviness and buckles at the straightening rolls. Furthermore, in finishing light gage plates at low temperatures, their physical properties are affected resulting in a reduction of the ductility and an increase in hardness and tensile strength. By the use of this new furnace, all plates may be brought up to the proper temperature to relieve all cold working stresses and restore them to a uniform high quality both as to physical properties and flatness.

The effectiveness of this heat treatment may best be shown by the following actual results obtained from a number of plates rolled from the same melt from which tests were obtained both before and after heat treatment:

Range of tensile strength	
As rolled	56600 to 64500
After heat treatment	55500 to 57000

Furthermore, the elongation was increased as a result of the heat treating from 1 to 4 percent depending on the finishing temperature.

These plates were rolled in accordance with standard mill practice with the usual variations in finishing temperatures and the resultant variations in physical properties shown above by the "As rolled" tests. As a result of the heat treatment, however, it will be noted that this wide variation has been corrected and all plates brought to a uniform grade.

The furnace is of the continuous through type, 50 feet in length. The plates are carried through the furnace on alloy chains driven from the exit end and supported on alloy rollers spaced regularly throughout the furnace. The speed of this chain may be varied from a minimum of 20 feet per minute to a maximum of 80 feet per minute. The furnace is oil-fired with five burners installed in each side wall. These burners are automatically controlled by means of thermo-couples installed through the roof so that a uniform furnace temperature is maintained at all times. A continuous record of the furnace temperature is obtained by means of two recording pyrometers.

In order to insure an even distribution of heat through the furnace, two propeller-type, alloy fans are placed immediately under the arch and spaced approximately 17 feet from each end. These are driven by vertical motors supported above the furnace.

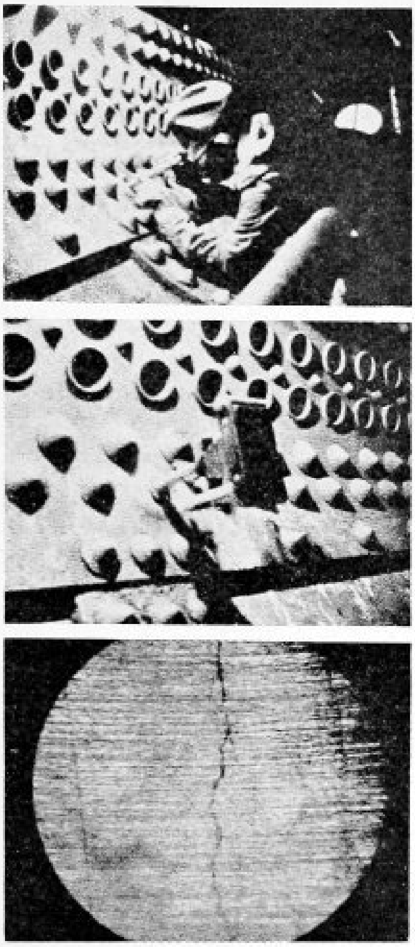
In addition to the recording pyrometers which provide a permanent record of furnace temperatures at all times, the furnace is equipped with a special recording meter which provides a permanent record of the progress of every plate through the furnace. This meter records the speed of the chain at all times and also the exact time each plate enters and leaves the furnace. This latter record is obtained by the use of photo-electric relays located at each end of the furnace.

Changes in Locomotive Boiler Design

(Continued from page 98)

is raised in a high-pressure drum by means of a closed circuit of tubes and headers (forming a firebox) and an evaporating coil in the high-pressure drum, the steam being generated by indirect heat. Steam is maintained in the closed circuit at about 1400 pounds pressure, and raises the pressure in the high-pressure drum to about 900 pounds. This steam is fed to the high-pressure cylinder, and the exhaust steam from this cylinder, supplemented by superheated steam from the low-pressure boiler heated by the flue gases, is taken to the low-pressure cylinders at about 250 pounds pressure.

"The watertube firebox has been experimented with extensively in America, but the most interesting example of the watertube boiler proper is that of the London & North Eastern Railroad locomotive No. 10,000. The pressure adopted is a more moderate one than that of the multi-pressure boilers already referred to, being 450 pounds per square inch."



(Top) Method of locating a crack. (Center) Micro-photographing a rivet hole with a magniscope. (Bottom) How the photograph looks

Improved Means of Studying Plate Embrittlement*

By J. P. Morrison†

At one time plate embrittlement caused little worry to boiler owners outside of the relatively few areas where natural feed water is of the "embrittling" sort, but that condition has changed.

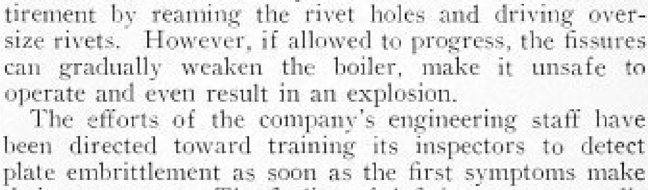
Higher boiler pressures have necessitated intensive feed water treatment, which under some conditions can result in water having unsatisfactory carbonate-sulphate ratios. The result is that embrittlement is now being found in areas hitherto not subject to the trouble. Consequently the matter is one to which this company is continuing to devote careful study, and which all engineers responsible for boilers should understand.

Several years ago the Hartford Steam Boiler Inspection and Insurance Company developed what is now known as the Hartford rivet hole magniscope, a sort of magnifying periscope that was described in detail in *The Locomotive* of July, 1930. This instrument has been found extremely useful by the experienced inspector in examining the walls of rivet holes for the microscopic indications of embrittlement in its early stages. However, adeptness in focusing the magniscope and in holding it steady while looking through it can be gained only by practice. In many cases the inspector has found difficulty in showing plant engineers and officials the fissures which, to his experienced eye, were clearly visible.

It was not until recently that the company succeeded in overcoming the difficulty by the development of a device which, when used in conjunction with the magniscope, permits making micro-photographs of the walls of rivet holes. The device is shown in accompanying illustrations.

Caustic distress, that is, fissures, caused by disintegration of the binder between steel crystals, is, like cancer, slow forming and insidious. In its early stages it impairs the strength of the boiler very little, and if detected in time a boiler may sometimes be saved from retirement by reaming the rivet holes and driving oversize rivets. However, if allowed to progress, the fissures can gradually weaken the boiler, make it unsafe to operate and even result in an explosion.

The efforts of the company's engineering staff have been directed toward training its inspectors to detect plate embrittlement as soon as the first symptoms make their appearance. The finding of definite symptoms calls for a thorough investigation to determine the extent to which the disease has progressed, and it is not uncommon for an inspector to spend several hours, or days in some cases, standing, kneeling, and lying in cramped quarters,



How the magniscope is used

This diagram shows how the Hartford magniscope is rigidly mounted in a rivet hole by means of a threaded sleeve and clamp nuts. The sleeve has an aperture through which the eye of the magniscope sees the surface of the hole. The camera rests on a bracket which affords accurate alinement.

* From *The Locomotive*.

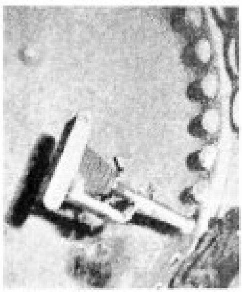
† Assistant chief engineer, boiler division, The Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

exploring with minute care for further evidence of the trouble. After the inspector has satisfied himself as to how far the embrittlement has progressed, he reports the matter to plant officials. The micro-photograph apparatus is most useful at this stage of the investigation, as plant men can almost always gain a better understanding of the trouble from pictures of the cracks, magnified so as to be clearly distinguishable, than they can by crawling into the boiler drum to look through the magniscope.

The photographing is made possible by means of a device which, after the magniscope has been focused on the crack, clamps the instrument securely in position. It also includes a bracket on which a camera can be mounted so as to focus on the eyepiece of the magniscope. The surface to be photographed may be lighted either by means of a small electric lamp fixed in the end of the magniscope, or by a larger lamp so placed as to illuminate the rivet hole.

The skepticism of some engineers about plate embrittlement was recently illustrated in two cases where large high pressure boilers gave evidence of the trouble. Applications for insurance had been made and "Hartford Steam Boiler" inspectors proceeded to make the initial inspections.

In one boiler the inspector found four rivet heads cracked off. He questioned the operators and found that leakage had occurred and that repeated calking had not eliminated the trouble. He immediately communicated with the engineer of the plant and also with his chief inspector.



Micro-photographing a head seam

The report that rivet heads had failed brought a comment from the engineer to this effect, "Well, what of it? We'll replace the rivets and go ahead."

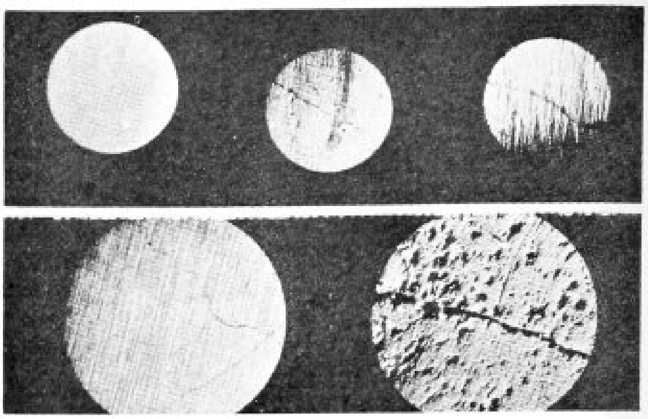
It required a great deal of argument to persuade the engineer to cut out not only the faulty rivets but also others along the same seam so that the walls of the rivet holes could be examined. When this was done it did not require a magniscope for him to see the cracks. In this case the embrittlement had advanced to the stage where a new boiler was necessary.

In the other instance, where only a small amount of the metal had become "diseased," careful reaming of the rivet holes and the use of larger rivets made it possible to continue the boiler in service.

It is generally understood that the caustic to which embrittlement is attributed enters the boiler as sodium carbonate and changes into a form of caustic soda in the boiler. A concentration sufficient to attack steel is never found in water that is fed into the boiler. If a concentration anywhere near that amount existed in the boiler, excessive priming and foaming would result. However, with these harmful ingredients in the water, even in small amounts, the theory is that a concentration does build up between the straps at seams, where it is somewhat segregated from the main body of water in the drum.

In tracing the development of embrittlement our experience of late has shown that even when feed water has been corrected after finding it faulty, the embrittlement action may continue, due to old deposits of the caustic in the seams.

It should be emphasized that by no means are all of the cracks which occur in boilers under high stresses



Caustic embrittlement cracks

How the microscopic caustic embrittlement cracks look through the eye of the camera connected to the Hartford magniscope. It is important to remember that these tiny hair cracks, while they develop slowly at first, may weaken the plate to a point where the boiler explodes. The upper three photographs were made with 20 magnifications and the lower two with 40 magnifications.

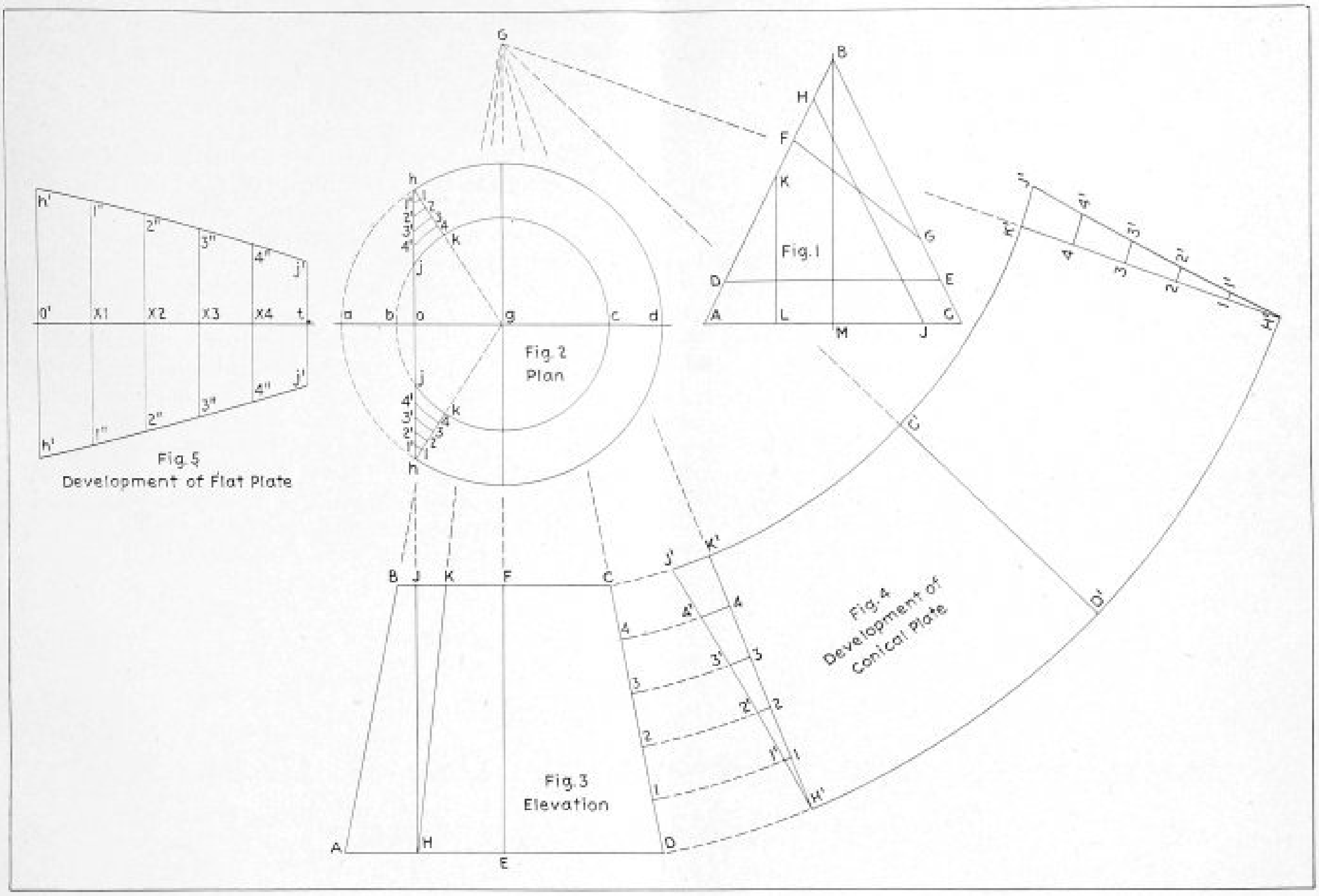
due to caustic embrittlement. It requires trained men to diagnose this difficulty, the chief symptoms of which are detached rivet heads, leakage which repeated calking does not stop, and evidence of soda near the seams. The trouble usually occurs below the water line and in the inaccessible portion of the plate beneath the strap at a seam, but there are cases of affected tube ends. Another characteristic is that embrittlement usually starts at a rivet hole and progresses into the plate in the direction of another rivet hole.

There is no definite length of time required for caustic embrittlement to get in its destructive work. New boilers have been found to be ruined after approximately a year's use. In other cases the phenomenon has not manifested itself until after several years of service. When this kind of trouble is suspected, it is best to call in authoritative counsel at once. There is too much at stake to permit any dependence on luck to keep high pressure steam "harnessed" under questionable conditions.

H. H. Moss Awarded Miller Medal

At the annual meeting of the American Welding Society, held at the Hotel Governor Clinton in New York on April 27 and 28, the Samuel Wylie Miller Medal was awarded to H. H. Moss of New York "for his achievement in the application of fusion welding and oxy-acetylene flame cutting." The Samuel Wylie Miller Medal is an annual award of the American Welding Society and is presented for meritorious contributions to the science and art of welding.

Mr. Moss is an engineer in the service of The Linde Air Products Company and in the course of his work has been engaged in a variety of problems on the use of oxy-acetylene welding and cutting in structural work, oil and natural gas transmission projects, and transportation equipment, particularly freight cars and shipping containers. More recently Mr. Moss has been giving careful study to advanced developments in oxy-acetylene cutting, particularly in the field of flame machining, in which process an oxy-acetylene flame is used for cutting, boring and shaping metal parts in a way similar to the machine tool operations used for fabricating metal parts up to this time.



Developing Cone with Flat Side

By I. J. Haddon

Before going into details as regards the development of a cone with a flat side, I would draw the reader's attention to Fig. 1. This represents the elevation of a right cone, with base *A-C* and apex *B*. The lines *D-E*, *F-G*, *H-J*, and *K-L* are what is known as the conic sections. The true face of any line, as *D-E*, drawn parallel to the base of the cone would be a circle. The true face of any line drawn oblique, as *F-G*, would be an ellipse. I may also here remark that *any* ellipse may be cut from *any* cone. The true face of any line drawn parallel to the side of the cone, as *H-J*, would be a parabola. The true face of any line drawn parallel to the center line, as K-L (parallel to the line *B-M*), would be a hyperbola.

A line drawn in a similar manner to *K-L* is what we have to deal with in the problem of developing a cone with a flat side. As it is not practicable to bend the cone on this *curved line,* it is necessary to make it in two plates as will be now explained.

Draw lines *E-G* and *a-d* at right angles to each other and intersecting at *g*. Draw the plan of the cone as shown by circles *a-d* and *b-c* (Fig. 2). Draw the elevation of the cone as shown in *A-B-C-D* (Fig. 3). Draw the line *h-h* (Fig. 2) to represent the flat side; this line is also shown in the elevation in *H-J*. Draw the line *h-g* cutting the circle *b-c* in *k;* this line is shown in the elevation as *H-K-G*.

Divide *C-D* (Fig. 3) into any number of equal parts, as shown in *D-1-2-3-4-C*. Divide the line *h-k* (Fig. 2) into the same number of equal parts as done in Fig. 3, and number them the same, thus, *h-1-2-3-4-k;* with center *g* (Fig. 2) draw arcs as shown to meet the line *h-j* in *1′-2′-e′-4′*.

Draw the line *G-D′* to represent the center line on the plate Fig. 4. With center *G* and radii *G-C* and *G-D* draw the arcs *C-J′* and *D-H′* crossing the center line Fig. 4 in *C′-D′*. Now measure along the line *D-H′* from *D′* the distance *d* to *h* in the plan Fig. 2, and mark it on the arc as at *H′* and *H′*. Draw the lines *H′-G* cutting the curve drawn from *C* to *J′* in *K′* and *K′* as shown.

With *G* as center and radii *G-4*, *G-3*, *G-2* and *G-1* draw short arcs to meet *H′-K′* in *4, 3, 2, 1*, as shown.

Now measure along each respective arc the same lengths as those shown in the plan Fig. 2, and cutting the small arcs Fig. 4, in *4′*, *3′*, *2′*, and *1′*. Now, lines drawn from *J′* through *4′*, *3′*, *2′*, *1′* and *H′* will be *curved* lines, and represent the ends of the conical part.

Draw the line *h′-h′* (Fig. 5) cutting *g-a* produced in *O′*. Make *O′-t* (Fig. 5) equal to *E-F* (Fig. 3). Divide

O'-t into the same number of equal parts as *C-D* (Fig. 3) was divided into, as shown in *O', X1, X2, X3, X4, t.* Draw lines through *X1, X2,* etc., parallel to *h'-h'*.

Make *O'-h'* (Fig. 5) equal to *o-h* (Fig. 2).
Make *X1-1"* equal to *O-1'*.
Make *X2-2"* equal to *O-2'*.
Make *X3-3"* equal to *O-3'*.
Make *X4-4"* equal to *O-4'*.
Make *t-J'* equal to *O-J*.

Now draw the *curved* lines *h'* to *J'* passing through the points *1", 2", 3", 4"* to complete the development of the flat plate. After the conical part is rolled to shape the flat plate may be welded to the cone, to complete the "cone with flat side."

If the apex of the cone, as *G*, is unattainable, the cone can be developed by the method as shown by the writer in a previous article of THE BOILER MAKER, and is perfectly accurate and very simple.

As regards developing the cone by triangulation, triangulation is a very nearly accurate solution to almost any problem, if the triangles are drawn correctly. To do so properly, the arcs *h* to *d* in the plan should be divided into equal parts, and lines drawn from the points obtained to *g* cutting the arcs *k* to *c* into the same number of equal parts; then these lines would represent rolling lines and would be *straight* lines in the plan, elevation, and development, and the dotted lines from the bottom of one to the top of the other (to form triangles) would be *curved* lines. These curved lines may cause a little inaccuracy in the development; but if the part *h* to *d* is divided as before, and the part *J* to *c* is divided into the same number of equal parts, and lines drawn from the large arc to the small arc, then these lines would be either elliptical, parabolical or hyperbolical, and none of them would be straight lines in the development except the line *c-d*, so that in triangulation it is as well to remember that your solid lines should always be straight lines (rolling lines) in the plan, elevation and development.

The *only* cone with flat side it is practicable to make in *one plate* is when the flat side is represented by the line *E-F* in the elevation, as in Fig. 3.

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.

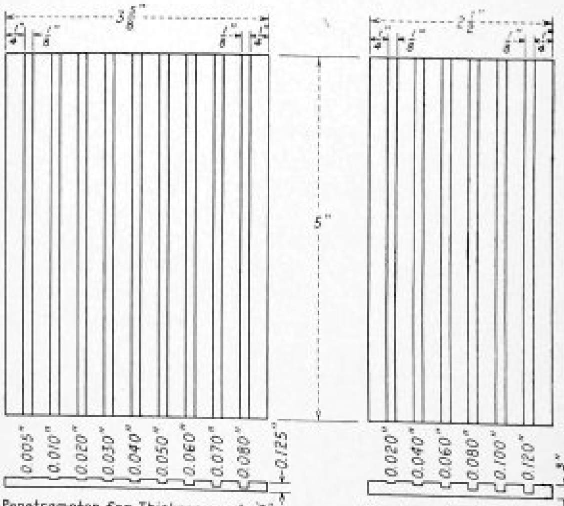
The following proposed revisions have been approved for publication as addenda to the Code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticism and approval from any one interested therein. 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-102*i* AND U-68*i*. Replace present paragraphs by the following:

P-102*i*. For wall thicknesses of 4¼ in. and less every portion of all longitudinal and circumferential welded joints of the structure shall be examined by X-ray or gamma-ray methods of radiography. Drums or shells of a wall thickness over 4¼ in. need not be subjected to radiographic examination until such a time as evidence is submitted to the Boiler Code Committee that greater thickness can be economically examined. In order to be permitted to construct boiler drums or shells with a wall thickness over 4¼ in. without radiographic examination, a manufacturer shall have demonstrated his ability to produce sound welds in boiler drums or shells of a thickness not less than 3½ in., the joints of which have been examined by X-ray or gamma-ray methods.

The films obtained by the use of X-rays shall be known as "exographs," and those obtained by the use of gamma rays as "gammagraphs." Both types of films shall be generally termed "radiographs."

The weld shall be radiographed with a technique which will determine quantitatively the size of defects with thicknesses equal to and greater than 2 percent of the thickness of the base metal. To determine whether the radiographic technique employed is detecting defects of a thickness equal to and greater than 2 percent of the thickness of the base metal, a penetrameter (universal penetration gage) of the type shown in Fig. 1 shall be



Penetrameter for Thickness up to 2"
3 for Each Radiograph

Penetrameter for 2" to 4"
3 for Each Radiograph

Fig. 1

placed over or alongside the weld at each end and in the center of the length of weld being radiographed during each exposure. The penetrameter shall be placed on the side of the weld next to the source of radiation. For each exposure the two end penetrameters shall be so placed that the smallest differential in the gages will coincide as closely as practicable with the ends of the section of the weld being radiographed. The images of depressions in the penetrameters, the depths of which are 2 percent or more of the thickness of the base metal, shall be obtained on the radiograph.

The film during exposure shall be as close to the surface of the weld as is practicable. The distance of the film from the surface of the weld on the side opposite the source of radiation shall not, if possible, be greater than 1 in. With the film not more than 1 in. from the weld surface, the minimum distance between source of radiation and the back of weld shall be as follows:

Plate thickness	Minimum distance from source of radiation to back of weld
Up to 1 in.	14 in.
1 in. to 2 in.	21 in.
2 in. to 3 in.	28 in.
3 in. to 4 in.	36 in.
4 in. to 4¼ in.	38 in.

If it is necessary to expose the film at a distance greater than 1 in. from the weld, the following ratio of:

$$\frac{\text{Distance from source of radiation to weld surface toward radiation}}{\text{Distance from weld surface toward radiation to film}}$$

shall be at least 7 to 1. These conditions are imposed so as to obtain a practical maximum allowable distortion and magnification of any defects in the welded seam.

All radiographs shall be free from excessive technical processing defects which would interfere with proper interpretation of the radiograph.

Identification markers whose images will appear on the film shall be placed adjacent to the weld and their location accurately and permanently stamped near the weld on the outside surface of the drum or shell, so that a defect appearing on the radiograph may be accurately located in the actual weld.

The radiographs shall be submitted to the inspector. If the inspector requests, the following data shall be submitted with the radiographs: (1) the thickness of the base metal, (2) the distance of the film from the surface of the weld, (3) the distance of the film from the source of radiation.

The acceptability of welds examined by radiography shall be judged by comparing the radiographs with a standard set of radiographs, reproductions of which may be obtained by purchase from the Boiler Code Committee. In general the standards of judgment shall be:

1. Welds in which the radiographs show elongated slag inclusions or cavities shall be unacceptable if the length of any such imperfection is greater than $\frac{1}{3}T$, where T is the thickness of the weld. If the lengths of such imperfections are less than $\frac{1}{3}T$ and are separated from each other by at least $6L$ of acceptable weld metal, where L is the length of the longest imperfection, the weld shall be judged acceptable if the sum of the lengths of such imperfections is not more than T in a weld length of $12T$.

2. Welds in which the radiographs show any type of crack or zones of incomplete fusion shall be unacceptable.

3. Welds in which the radiographs show porosity shall be judged as acceptable or unacceptable by comparison with the standard set of radiographs.

The radiographs shall be retained by the manufacturer, who shall keep them on file for at least ten years.

U-68*i*. For wall thicknesses of 4¼ in. and less, every portion of all longitudinal welded joints of the structure, including the intersections with girth joints, shall be examined by X-ray or gamma-ray methods of radiography. At least 25 percent of the length of each welded circumferential joint equally divided between not less than four uniformly spaced intervals around the circumference, shall be radiographed. Where any one radiograph fails to comply with these requirements, all parts of the circumferential seam represented by that radiograph shall be radiographed. Vessels of a wall thickness of over 4¼ in. need not be subjected to radiographic examination until such a time as evidence is submitted to the Boiler Code Committee that greater thicknesses can be economically examined. In order to be permitted to construct vessels with a wall thickness of over 4¼ in. without radiographic examination, a manufacturer shall have demonstrated his ability to produce sound welds in vessels of a thickness not less than 3½ in., the joints of which have been examined by X-ray or gamma-ray methods.

The second, third, and fourth sections of this paragraph are identical with the corresponding sections of Par. P-102*i*.

If it is necessary to expose the film at a distance greater than 1 in. from the weld, the following ratio of:

$$\frac{\text{Distance from source of radiation to weld surface toward radiation}}{\text{Distance from weld surface toward radiation to film}}$$

shall be at least 7 to 1. These conditions are imposed so as to limit the allowable distortion and magnification of any defects in the welded seam.

The sixth, seventh, eighth, ninth, and tenth sections of this paragraph are identical with the corresponding sections of Par. P-102*i*.

PAR. P-111 AND U-79. REVISED:

P-111. (U-79.) *Distortion.* The cylinder or barrel of a drum or shell OF UNIFORM THICKNESS shall be circular at any section within a limit of 1 percent BASED ON THE DIFFERENCE BETWEEN THE MAXIMUM AND MINIMUM DIAMETERS OF ANY SECTION, and if necessary to meet this requirement shall be reheated, rerolled, or reformed.

PAR. U-13*a*. REVISED:

U-13*a*. Plates for any part of a riveted vessel required to resist stress produced by internal pressure shall be of flange- or firebox-quality steel conforming with Specifications S-1 for Steel Boiler Plate, [and] S-2 for Steel Plates of Flange and Firebox Qualities for Forge Welding, OR S-25 FOR OPEN-HEARTH IRON PLATES OF FLANGE QUALITY of Section II of the Code, except as provided in (*b*).

PAR. U-71*a*. REVISED:

U-71. *Material. a* The materials used in the fabrication of any fusion-welded pressure vessel covered by this Code shall conform to Specifications S-1 for Steel Boiler Plate, S-2 for Steel Plates of Flange and Firebox Qualities for Forge Welding, [or] S-4 for Seamless Steel Drum Forgings, OR S-25 FOR OPEN-HEARTH IRON PLATES OF FLANGE QUALITY, of Section II of the Code. Shells fabricated from pipe shall conform to Specifications S-18 for Welded and Seamless Steel Pipe. The carbon content in all such material shall not exceed 0.35 percent.

Rules for the Inspection, Maintenance and Repair of Locomotive Boilers

Standard rules governing the shop practice of the New York, New Haven and Hartford Railroad have appeared in the April and May issues. The rules continue as follows:

Tools for Working Tubes and Flues

All tools for working tubes or flues in locomotive boilers shall be railroad company's standard, and in accordance with railroad company's drawings where available.

There are three forms of sectional expanders:

1. Form F straight gaging.—Used only on flues 3½ inches and smaller for preliminary setting and tightening of flues.
2. Form B modified.—Used for tightening new flues before flues are beaded.
3. Form C straight finger.—Used for tightening ferrules, also for tightening flues on old work to eliminate leakage, etc.

All new sectional expanders shall be checked to standard contour gages. No expanders shall be used which do not conform to gages.

The tool room foreman is made responsible for checking the expanders as they are returned to the tool room and under no circumstances shall an expander with any appreciable wear again be issued from the tool room.

For the initial application of flues, 2-inch and 2¼-inch Faessler roller expanders with flaring rolls and arranged for both hand and power operation, shall be used.

For re-working flues in the front flue sheet, hand-operated expanders, or combined power and hand-operated expanders shall be used, size to be 2 inches or 2¼ inches as required.

Faessler roller expanders with flaring rolls and arranged for both hand and power operation, shall be used for 3-inch, 3½-inch, 4½-inch and 5½-inch flues.

Roller expanders are used at points making classified repairs and to a limited extent at engine houses.

Arch tube roller expanders of Faessler make are used in sizes 2⅞ inches, 3 inches, 3⅜ inches and 3½ inches. They are used only at points applying arch tubes.

Beading tools are supplied in two sizes, namely, for 2-inch, 2¼-inch and 3½-inch flues and for 5½-inch flues. No beading tools shall be used which do not conform to gages shown on company drawings. The tool room foreman is made responsible for checking the beading tools as they are turned in to the tool room, and under no circumstances shall a beading tool with any appreciable wear again be issued from the tool room.

All the above-mentioned tools shall be purchased and furnished on requisition.

Preparation of Boiler for Application of Tubes and Flues

On new back flue sheets, holes for 2-inch and 2¼-inch flues shall be the same diameter as the nominal outside diameter of flues.

Holes for the type "E" superheater flues shall be 3⅛ inches diameter. Holes for the type "A" superheater flues shall be 4⅝ inches diameter.

All holes in the back flue sheet for tubes and flues shall have the inside and outside edges rounded to a radius of $\frac{1}{16}$ inch to prevent cutting of flues. When back flue sheet holes become ⅛ inch out of round, they shall be reamed. When, through service, 10 percent of the holes in the back flue sheet become enlarged $\frac{3}{16}$ inch above the original diameter of the flue holes, the sheet shall be removed and scrapped.

In the front flue sheet, holes for 2-inch or 2¼-inch flues shall be $\frac{1}{32}$ inch larger in diameter than the outside diameter of flues. Holes for type "A" flues shall be drilled $\frac{3}{32}$ inch larger or 5 $\frac{19}{32}$ inches diameter. For type "E" flues, holes shall be drilled $\frac{3}{32}$ inch large or 3 $\frac{19}{32}$ inches diameter.

All holes shall be cleaned and both the inside and outside edges rounded to a radius of $\frac{1}{16}$ inch to prevent cutting of flues.

In the preparation of firebox door and flue sheets for arch tubes, the holes for arch tubes shall be drilled the same size as the outside diameter of arch tubes. The water side of sheets shall be rounded to a radius of $\frac{1}{16}$ inch. On new sheets this shall be done while fabricating the sheet and before applying it to the boiler.

In applying 2-inch and 2¼-inch flues, clean the holes, if necessary, and place ferrules of proper thickness in the back flue sheet holes not more than $\frac{1}{16}$ inch in from fire side. The utmost care shall be taken to observe this requirement as it is essential to proper welding of the flues. Tighten with form "C" sectional expander.

Next clean the fire-box ends of the flues and place them in the flue holes in the back flue sheet, fitting them neatly in the copper ferrules.

Flues shall project through the back flue sheet $\frac{3}{16}$ inch and through the front flue sheet not less than ⅛ inch nor more than ¼ inch.

The preliminary setting and gaging shall be done with form F straight gaging expander.

Flues shall be tightened and flared in the back flue sheet with Faessler roller expanders, having flaring rolls.

Expanding flues in the back flue sheet shall be done with a form B modified sectional expander. With a No. 60 pneumatic hammer, drive the expander pin until it is fairly solid. Draw out the pin and give the expander a turn equal to one-half a section. Drive the pin a second time. Withdraw pin and turn the expander a distance equal to one quarter of a section. Drive the pin a third time and this will give the full set of the expander.

After expanding, examine flues carefully. Those which have split in the recess formed by the expander, and flues that have opened from the end into the sheet, shall be removed and replaced before beading.

The firebox end of all flues shall be beaded. This shall be done with a standard beading tool and a short stroke pneumatic hammer. Care must be taken to see that nothing enters between the bead and flue sheet. Hold the beading tool so as to give the bead an outward set and get it down to the sheet without raising a burr on the inside or marking the outside of the sheet with the heel of the beading tool. The center line of the beading tool shall always be inside the line of the flue. With a small chisel and hand hammer, remove any burrs that may be raised.

Two-inch and 2¼-inch flues on Classes A, C, G, K, T, and U shall not be welded except those behind the brick arch. Superheater flues on Classes A, G and K and all flues on Classes F, H, I, J, L, R and Y shall be welded.

The method to be followed is fully covered in a subsequent paragraph.

On old flue sheets, when it is necessary to shim the holes, at the smokebox end, galvanized iron shims ⅝ inch wide shall be used of a thickness to suit the enlarged flue hole. The shims shall extend completely around the flue with ends scarfed and lapped ¼ inch. Holes in new flue sheets shall not be shimmed.

Flues shall be tightened and flared in front flue sheet using a Faessler roller expander with flaring rolls.

Approximately 20 percent of all boiler flues shall be beaded in the front sheet. Care shall be taken to see that these are well distributed over the sheet.

The procedure for applying 3½-inch flues shall be exactly the same as described for 2-inch and 2¼-inch flues, except that all 3½-inch flues shall be beaded in the front sheet and welded to the back sheet.

In applying 5½-inch flues clean the holes, if necessary, and place ferrules of proper thickness in the back flue sheet not more than 1/16 inch in from the fire side. The utmost care shall be taken to observe this requirement as it is essential to proper welding of the flues. Tighten with form C sectional expander.

Clean the firebox ends of the flues and place them in the flue holes in the back flue sheet, fitting them neatly in the copper ferrules. Flues shall project through both front and back sheet ¼ inch and shall be secured in place by setting with a ball-pein hammer.

Flues shall be tightened and flared in the back flue sheet with Faessler roller expanders, rolling lightly.

The firebox end of flues shall be expanded with form B modified sectional expander. With a No. 60 pneumatic hammer, drive the expander pin until it is fairly solid. Draw out the pin and give the expander a turn equal to one-half a section. Drive the pin a second time. Withdraw the pin and turn expander a distance equal to one-quarter of a section. Drive the pin a third time and this will give the full set of the expander.

After expanding, examine flues carefully. Those which have split in the recess formed by the expander and flues that have opened from the end into the sheet, shall be removed and replaced before beading.

Beading shall be done in the same manner as described previously.

After beading, the flues shall be lightly re-expanded, using form B modified expander as described above.

The front end of flues, when holes in the flue sheet are oversize, shall be shimmed with galvanized iron shims ⅝ inch wide of proper thickness to suit flue hole. The shims shall extend completely around flues with ends scarfed and lapped ¼ inch. Holes in new flue sheets shall not be shimmed.

If flues extend more than ¼ inch beyond the front flue sheet, the surplus material shall be chipped off with a pneumatic hammer and chisel.

Flues shall be tightened and flared in the front flue sheet with a Faessler roller expander.

Application of Arch Tubes

Arch tubes shall be cut off in a pipe cutter or other suitable machine. The acetylene torch shall not be used for this purpose. Ends must be free from burrs and be neatly fitted into the firebox sheets.

Tubes shall be so bent that they will enter both sheets at right angles to the sheets. In bending, care shall be taken to prevent overheating, distortion, or kinking of the tube at the bend. The projection through the sheets must be uniform, for belling purposes, and must be ⅜ inch minimum to ½ inch maximum.

Tubes, before cutting, shall be at least 3 inches longer than the finished length. Tubes shall be bent and tried out in position in the firebox for marking off true cutting length. Tubes shall be set to gages shown on the firebrick assembly drawings. No tubes shall be expanded and belled until after they have been passed upon by the inspector and foreman in charge.

Both ends of arch tubes shall be tightened and flared or belled with a Faessler roller expander. The end of the tube, after being belled must comply with standard dimensions. The setting shall be checked with a gage.

When arch tubes have once been flared, no further flaring shall be done during the life of the particular tube involved.

When renewing arch tubes, if the holes in the sheets have become oversize or distorted, they shall be reamed to a true diameter and the radius restored on the water side of the sheet. Tubes shall then be fitted to the sheet by means of galvanized iron shims ⅝ inch wide and of proper thickness to fill the opening between the hole and the tube. The shims shall extend completely around the tubes with ends scarfed and lapped ¼ inch. Arch tube holes shall not be enlarged over ¼ inch by reaming. At this limit a patch shall be applied.

Welding of Flues

All flues shall be made perfectly tight and the sheet cleaned before welding is started, and the welding shall be done with the boiler empty.

Use ⅛-inch welding wire for 2-inch and 2¼-inch flues and 5/32-inch wire for 3½-inch and 5½-inch flues. Begin with the top row and progress downward, all superheater flues being welded first. Each flue shall be welded by starting near the bottom, welding first up one side, then up the other, completing the weld near the top center, care being taken to prevent welding material from piling up larger than the bead. Remove with wire brush all deposit of welding material adjacent to the bead being welded. If there is any indication of improper fusing, the metal shall be cut off immediately and rewelded.

Leaking through pin holes in the weld shall be calked with fuller and hand hammer. The pein of a hammer or a beading tool shall not be used. If the leak is under the weld, cut off the defective portion of the weld, re-set tube with form "C" sectional expander, bead down lightly, clean and reweld.

(To be continued)

Welding Courses Prove Popular

Completion of the recent one week condensed welding course given in Cleveland by the John Huntington Polytechnic Institute and The Lincoln Electric Company was marked by the largest attendance of any of the four similar courses given during the winter. Included in the registration were men from Germany, Japan and Sweden as well as from ten states. The success of these one-week courses in designing for welding has led to the decision to repeat the courses in the Fall, according to A. F. Davis, vice-president of The Lincoln Electric Company.

"Meanwhile our own welding school will continue to operate full time," said Mr. Davis. "Due to many recent developments in welding and to the fact that not a few manufacturers are using this slack period to train key men, we believe that the school is filling a pressing need."

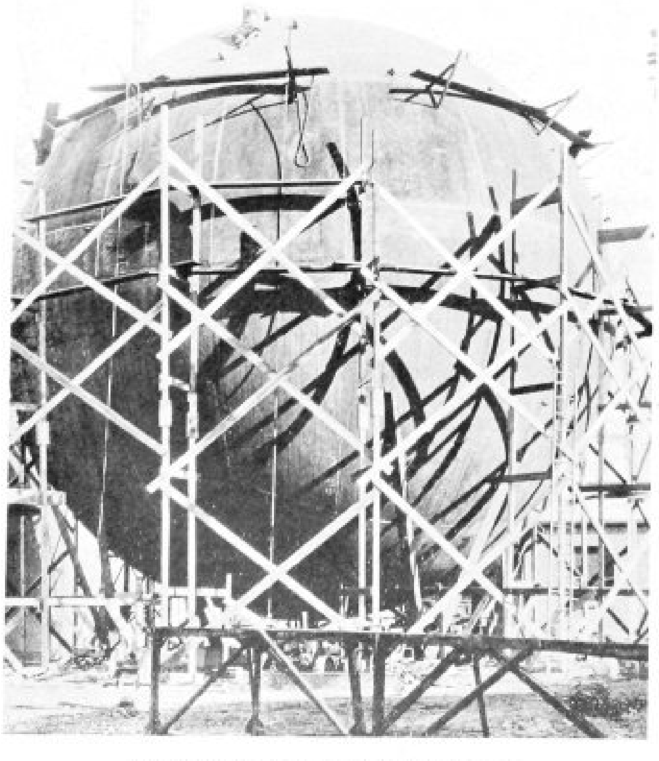
The Lincoln welding school not only trains operators but provides a background course for foremen, superintendents, engineers and others who desire to learn the practical side of arc welding and to familiarize themselves with the operator's problems. The usual length of the course is about four weeks.

Spherical Tank Built By Arc Welding

A new type of mixing tank for gas, the first of its kind, has recently been completed for the St. Louis County Gas Company at Shrewsbury, Mo. This tank, which is spherical in shape, is known as the Hortonsphere. It is 45 feet in diameter and has a rated capacity of 162,000 cubic feet of gas at 50 pounds per square inch working pressure. This installation was fabricated and arc welded in the field by the Chicago Bridge & Iron Works. The shell plates were dished and the edges prepared in the shop. The plates were then match marked and shipped to the field for erection.

A derrick was used to assemble the structure in the field. The plates were hoisted into position and tack welded. The welders then went over all the seams, using four beads on each joint. Each bead was thoroughly cleaned and peened before depositing the succeeding bead.

There is a total of approximately 1256 lineal feet of seam on a Hortonsphere of this size or a total of 5024 feet of welding. Each welding operator was assigned a definite portion of the work and required to mark his welding with a special stamp. This method of checking the operators assured the utmost in careful workmanship. With the highly developed welding technique and equipment now available, the question of strength of welds no longer is in doubt.

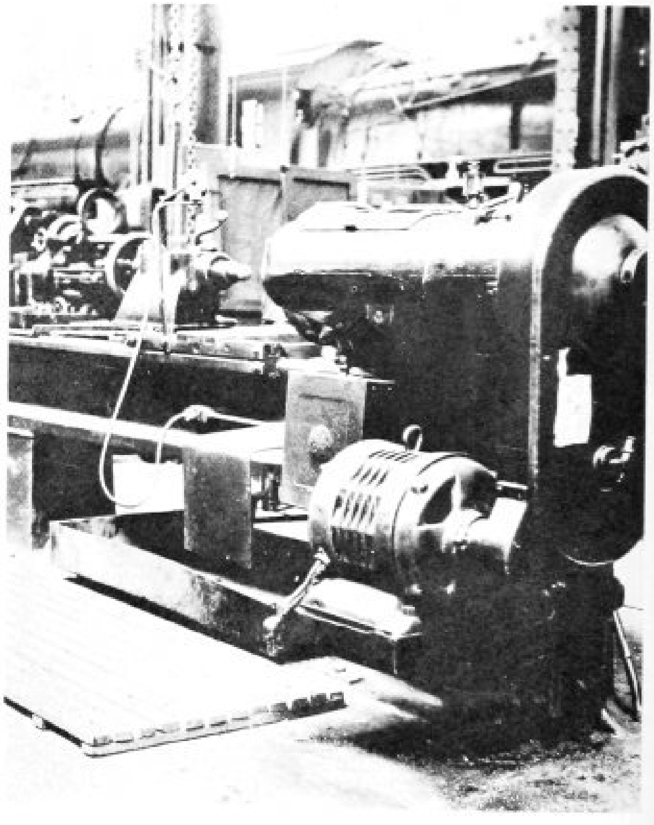


Arc-welded spherical mixing tank for gas

The welding was completed in approximately fourteen days. All welding was done by the shielded-arc process, using equipment manufactured by The Lincoln Electric Company, Cleveland. The tank was given a soap-suds test at 70 pounds air pressure. No leaks were discovered. This type of construction is particularly advantageous for gas storage as it practically eliminates the possibility of leaks in the joints.

Safe Platforms for Machine Operators

In the majority of cases the floors of machine shops are of concrete construction and when wet provide an excellent ground for the operator should he come in contact with the motor of the machine or a wire from either the electric light of the motor. There are also



Platform designed to minimize the danger from electric shock

more or less of an accumulation of borings or metallic chips from the lathe or drill press that drop to the floor and are likely to cause foot injuries to the operators of the machines.

The illustration shows a portable platform which has been provided for the machine operators on one of the larger railroads and which has prevented many accidents which formerly occurred from the above causes.

The platforms should be of sufficient size to provide access to all parts of the machine by the operator. They can be constructed from ¼-in. by 1½-in. strips of lightweight wood with cross strips of the same dimensions to prevent sagging. The platforms can be raised when cleaning the floor or the particles of dirt can be washed out easily if the cleaning is performed with a hose.

The Boiler Maker

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Communications

Head for Shortening Chain Hooks

To the Editor:

Fig. 1 illustrates the details of a "head" for a chain hook, used extensively in a boiler shop. The innovation consists in the diagonal and vertical grooves, which make it possible to shorten the length of chain hooks and in this way raise sheets of different widths while securing the maximum in safety. We know that when a sheet is raised, and the angle formed by the chain is very acute, the hooks may

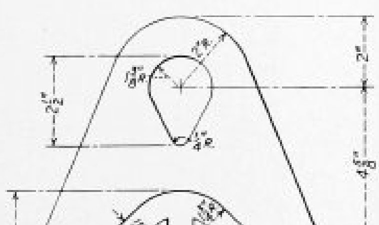


Fig. 1

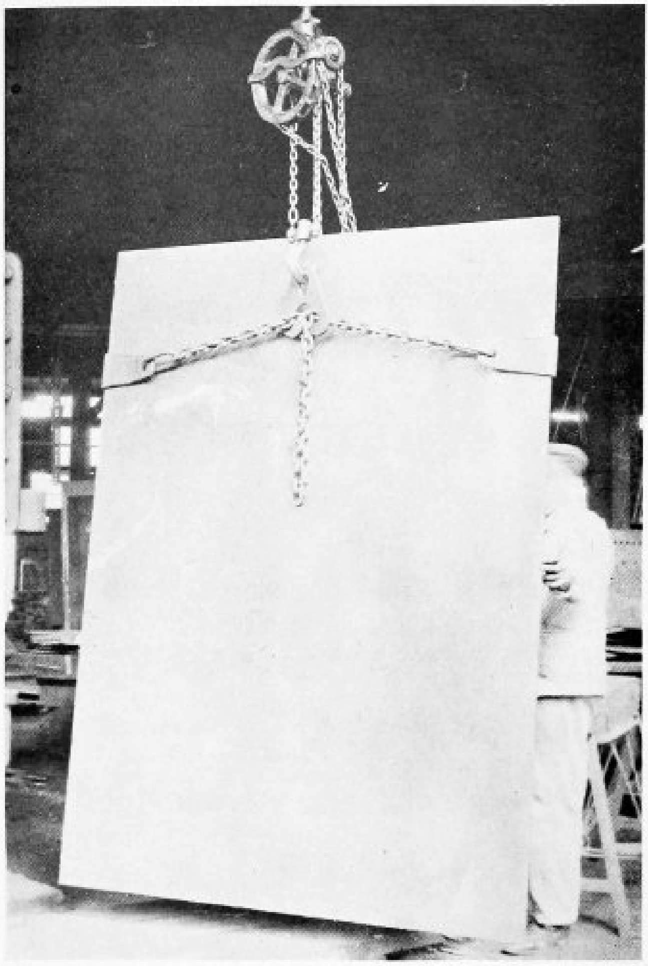


Fig. 2

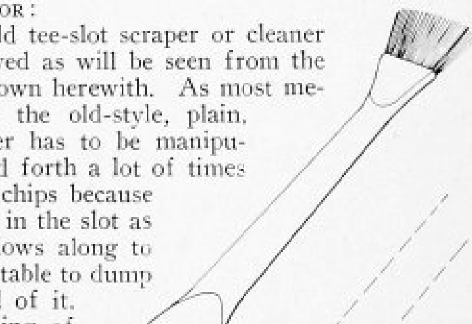
slip off. Fig. 2 shows clearly the efficiency of this hook, raising a plate upward bounding them by the upper extreme. The effect is the same as a clamp.

F. G. Robles.

Simple Tee-Slot Brush and Scraper

To the Editor:

Even the old tee-slot scraper or cleaner can be improved as will be seen from the illustration shown herewith. As most mechanics know the old-style, plain, tee-slot scraper has to be manipulated back and forth a lot of times to get all the chips because they fall back in the slot as the scraper plows along to the end of the table to dump what is ahead of it. By the widening of the section over the tee to form a scoop all the chips are removed as the scraper is advanced.



Chas. H. Willey.

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

Bending Angle Iron

Q.—In a recent number of The Boiler Maker you gave two good rules for allowances in bending of the angle iron. As I understand it, the rule is good if one of the legs of the angle iron is on the outside of the ring. Would the rule be good if one of the legs is on the inside of the curvature?

What rule would apply to an angle iron with unequal legs?

May I also ask you to give me information regarding the necessary allowances for T-iron and channel iron; that is, what would be the allowances in case the T-iron is bent when the flange is outside, and also if the flange is inside of the curvature.—J. H.

A.—The rules given in the August issue of The Boiler Maker for allowances in bending of angle irons were for both inside and outside angles.

The following illustrations clearly will indicate the use of the formulas:

Fig. 1.—Outside angle

Given

$D = 30$ inches, $T = 0.375$ inch, $W = 3$ inches,

$A = 0.6875$ inch.

To find

D' = diameter used in computing length in inches.

Using formula

$D' = D + \frac{1}{3}W + T$,

we have

$D' = 30 + (\frac{1}{3} \times 3) + 0.375$

$D' = 31.375$ inches.

Using formula

$D' = D + 2A$,

we have

$D' = 30 + (2 \times 0.6875)$

$D' = 31.375$.

Given

$D = 30$ inches, $T = 0.375$ inch, $W = 3$ inches,

$A = 0.6875$ inch.

To find

D' = diameter used in computing length in inches.

Using formula

$D' = D - (\frac{1}{3}W + T)$,

we have

$D' = 30 - (\frac{1}{3} \times 3 + 0.375)$

$D' = 30 - (1.375)$

$D' = 28.625$ inches.

Using formula

$D' = D - 2A$,

we have

$D = 30 - 2 \times 0.6875$

$D = 28.625$ inches.

These formulas should apply satisfactorily to angles of unequal legs. Care should be taken to see that the dimensions used in computing the required diameter are taken from the correct leg of the angle as illustrated in Figs. 1 and 2.

There are a number of methods applied in determining the lengths of tee iron, channels, etc., which give

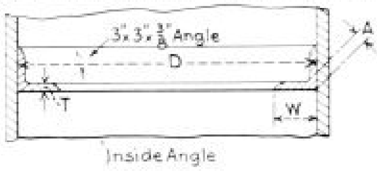


Fig. 2.—Inside angle

very close results. For irregular sections, the neutral axis—that is, the axis on the center of gravity of the section of the structural member—should be found first. The structural handbooks give this information; thus for a 7-inch channel weighing 9¾ pounds, the distance of the center line of gravity Y-Y, Fig. 3, measures 0.55 inch from the outside of the web of the channel, as shown in the illustration.

Fig. 3 shows a channel bent with the flanges inside the ring, the back of the flange being on the outside.

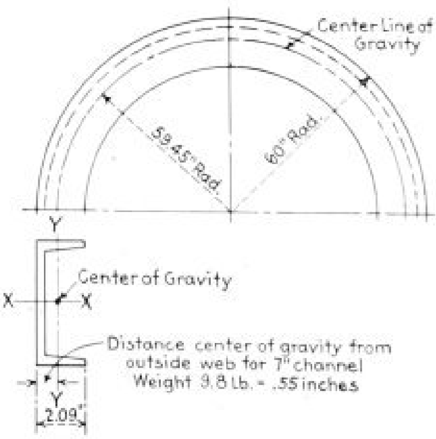


Fig. 3.—Inside channel ring

Such a ring is called an inside ring, as it would fit inside a cylinder.

The length of the stretchout is calculated by assuming that the length will not increase nor decrease along the neutral axis as taken on line Y-Y of the section. Basing the diameter from that viewpoint it equals $59.45 + 59.45 = 118.9$ inches. For a complete ring, the stretchout equals $3.1416 \times 118.9 = 373.54$ inches.

In Fig. 4 is shown a ring rolled so that the back or face of the channel would fit on the inside of a cylinder. The respective dimensions are indicated for this arrangement, and by noting the position of the cross section of the channel I believe the conditions will be readily understood.

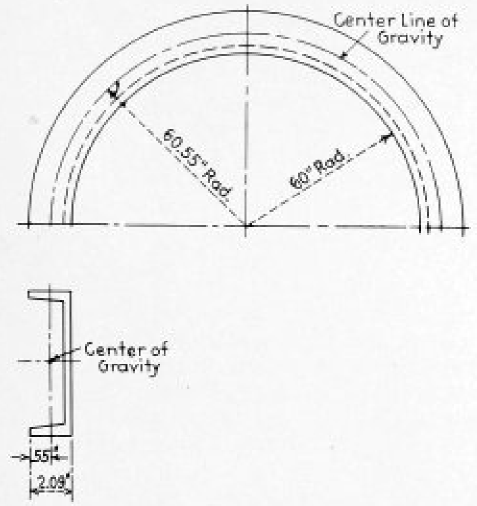


Fig. 4.—Outside channel ring

The length of the channel required is figured, as in the preceding example, from the neutral axis, thus $60.55 \times 2 \times 3.1416 = 380.44$ inches, is the required stretchout.

Development of Conical Connection

Q.—Please show method of calculating the development of a conical connection.—G. M.

A.—The calculations for a right cone development are illustrated in Figs. 1 and 2.

Given: $A = 60$ inches, $a = 30$ inches, $B = 50$ inches, $b = 25$ inches, $C = 72$ inches, $K = 5$ inches, and $L = 5$ inches.

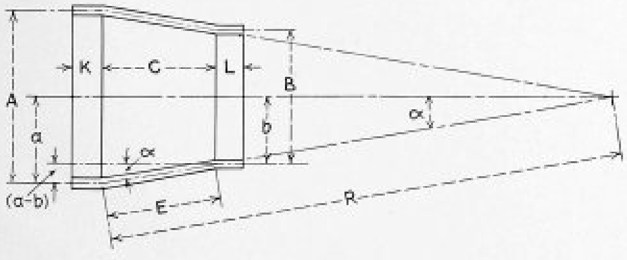


Fig. 1

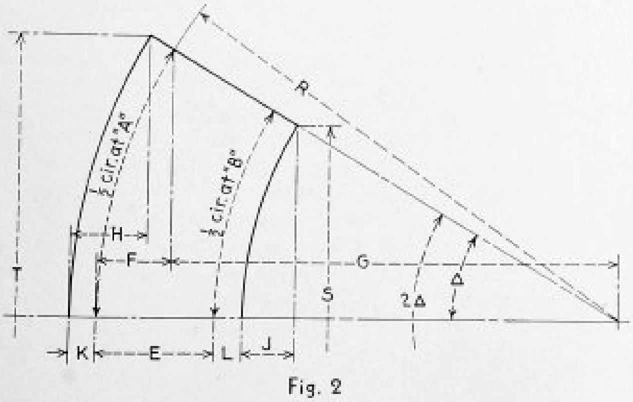


Fig. 2

To find:

(1) $E = \sqrt{C^2 + (a-b)^2} = \sqrt{(72)^2 + (30-25)^2} = 72.17$ inches.

(2) $R = \dfrac{Ea}{a-b} = \dfrac{72.17 \times 30}{5} = 433$ inches.

(3) $\Delta = \dfrac{90°A}{R} = \dfrac{90° \times 30}{433} = 12.47$ degrees $= 12$ degrees $- 28$ minutes.

(4) $G = R \cos \Delta = 433 \times 0.97642 = 422.79$ inches.

(5) $F =$ set at center $= R - G = 433 - 422.79 = 10.21$ inches.

(6) $H = \dfrac{F(R+K)}{R} = \dfrac{10.21\ (433+5)}{433} = 10.32$ inches.

(7) $J = \dfrac{F[R-(E+L)]}{R} = \dfrac{10.21\ [433-(72.17+5)]}{433} = 8.36$ inches.

(8) $S = 2[R-(E+L)] \sin \Delta = 2\ [433-(72.17+5)] \times 0.21587 = 153.62$ inches.

(9) $T = 2(R+K) \sin \Delta = 2\ (433+5) \times 0.21587 = 189.1$ inches.

Tank Design

Q.—We have an order to build a tank of the following specifications:

Furnish one horizontal pressure tank 5 feet diameter by 20 feet long in the shell having a net capacity of 3000 gallons constructed throughout of A. S. T. M.-A-7 steel specification of flange quality. Heads in single plate units dished and flanged for connection to shell of 11/32-inch steel weighing 14.03 pounds per square foot. Shell made up in three circular rings of 5/16-inch steel weighing 12.75 pounds per square foot. Tank to be supplied with the following accessories:

(1) 11-inch by 15-inch internal type manhead complete with cover, crabs and yokes;

(2) 3-inch and one ¾-inch boiler flanges threaded to receive standard pipe connections;

(3) The equivalent of four ½-inch extra heavy wrought steel couplings for water column and pressure gage connections.

Tank to be completely shop assembled, riveted, calked, tested to withstand 75 pounds S. V. P. and 125 pounds hydrostatic test pressure having a safety factor of 5, painted one coat of metal preservative paint on the outside.

We have had considerable controversy over the construction of this tank as to whether it should be single or double lap riveted.

We would appreciate receiving your comments, and showing in full detail the method you use in arriving at your figures. This tank will be set up on three supports, the supports being of concrete and suitable for carrying the load.—J. J. M.

A.—The A. S. M. E. Code (Section viii) Unfired Pressure Vessels gives the following rules governing longitudinal joints:

U-30—The riveted longitudinal joints of a shell which exceed ½ inch in thickness shall be of butt-and-double-strap construction. This rule does not apply to the portion of a shell which is staybolted to an inner sheet.

U-31—The longitudinal joints of a shell not more than ½ inch in thickness, with the exception given below, may be of lap-riveted construction: but the maximum allowable working pressure of such construction shall not exceed 200 pounds per square inch for vessels less than 24 inches in diameter, nor 150 pounds per square inch for vessels 24 inches in diameter or over.

When a vessel is used for a purpose that makes it necessary to provide in its construction for extraordinary wear, corrosion or other deterioration in service and plates of greater thickness are used than would otherwise be required, the longitudinal joints of the shells exceeding 48 inches in diameter may be lap-riveted, if the following conditions are met:

The operating pressure shall not exceed 50 pounds per square inch.

The plate thickness shall be at least 1.8 times the required thickness.

Telltale holes ⅛ inch to ¼ inch in diameter shall be drilled to a depth of at least 60 percent of the required plate thickness in those surfaces opposite the surfaces subjected to wear or other deterioration, with the spacing of the telltale holes not over 2 feet apart.

The spherical portion of vessels of any diameter, which are wholly spherical or partly hemispherical, may be constructed with lap joints provided that if the plate exceeds ⅜ inch, the several spherical sections of plate shall be hot pressed to the proper radius of curvature.

When the vessel cannot be completed in the shop, the whole structure shall be carefully and completely fitted up ready for riveting before shipment.

Assuming the tank does not come under the exception given in Par. U-31, it would then be satisfactory to use lap-riveted seams, and the efficiency of the seams could be computed from the formulae:

$$\frac{TS \times t \times E}{FS \times R} = \text{maximum allowable working pressure, pounds per square inch.}$$

where TS = ultimate tensile strength, pounds per square inch—assume 55000 pounds.

t = minimum thickness of shell plate in weakest course, inches.

E = efficiency of longitudinal joints.

FS = factor of safety.

R = inside radius of the weakest course of the shell, inches.

Substituting the values in the question, we have

$$75 = \frac{55000 \times 0.3125 \times E}{5 \times 30}$$

$$75 = 114.5\, E$$

$$E = \frac{75}{114.5} = 65.5 \text{ percent required efficiency of seam.}$$

Using tables found in "Design of Steam Boilers and Pressure Vessels," by Haven and Swett, we have

(1) The critical rivet diameter for 5/16-inch plate for steel rivets in single shear to be 0.849 inch, which would require either a 13/16-inch or 7/8-inch rivet.

(2) The maximum pitch on calked rows of rivets consistent with tightness for a working pressure of 100 pounds per square inch for 5/16-inch plate with 13/16-inch diameter rivets to be 3.64 inches and for 7/8-inch diameter rivets 3.70 inches.

(3) The maximum values of pitch and efficiency for a single-riveted lap joint for 5/16-inch plate with 7/8-inch rivets are:

Pitch	2.40 inches
Efficiency	63.6 percent

(4) The maximum values of pitch and efficiency for a double-riveted lap joint for 5/16-inch plate with 13/16-inch rivets are:

Pitch	3.53 inches
Efficiency	77 percent

The rivet sizes given in (3) and (4) are driven rivets.

From the information taken from the tables as shown in (1), (2), (3) and (4) it is evident that in order to obtain the required efficiency a double-riveted lap seam would have to be used.

Methods of Boiler Feed

Q.—State advantages and disadvantages of feeding a boiler through the bottom blow.—C. C.

A. Advantages: (1) Where boilers are operated at low pressures for steam heating, it is permissible and advisable to feed boilers through the blow-off connection. Heating boilers are fed with the condensed water returned from the radiating surface, then, since the temperature differences are not great, both the circulation in the systems and the return of the condensate will be facilitated by feeding through the blow-off.

(2) Feeding boilers through the blow-off connection is a protection for the blow-off pipe. When a very large amount of scale matter is deposited by the feed water, there is a tendency for sediment and scale to form in the blow-off pipe, and when the sediment becomes hardened and attached to the metal, overheating follows, since the blow-off passes through about the hottest part of the boiler setting, where it receives the direct impact of the hot blast from over the bridge wall. When there is a constant flow of feed water through the pipe, the sediment is kept well stirred up and has much less chance to settle and bake on with disastrous results.

Disadvantages: Feeding water through the blow-off connection, which is generally located at the lowest point of the boiler, is poor practice, because the water so introduced is of necessity colder than the water already in the boiler even when a heater is used. The temperature difference runs anywhere from 50 to 60 degrees to 100 degrees F., depending on the pressures carried and the efficiency of the feed-water heater. Of course much greater differences could be obtained if a high-pressure boiler were fed with cold water.

The feed water introduced in this way at the bottom of the boiler, colder than the water already inside, is of course always denser than the boiler water. Hence it cannot rise with the natural circulation until it becomes heated to such a temperature that its diminished density makes it usable. It follows, then, that the feed water must spread out on the lowest part of the boiler surface, displacing the hotter and lighter water until it has taken up enough heat from the metal of the boiler to rise naturally and take its place in the circulation. The metal of the boiler is certain to become appreciably cooled by this enforced heating of cold water, and it will cool rapidly, because the rate of heat transfer from hot metal to cold water depends on the temperature difference, and will be greater the colder the water. The cooling is also assisted by the fact that it takes much more heat to raise the temperature of a pound of water one degree than is given up by the cooling of a pound of steel through a like temperature range, moreover, since the heating is so rapid, by far the greater portion of the heat given to the cold feed must come from the store of heat already in the metal, and not from the heat being transferred through the metal from without.

Therefore, a cooling of the boiler metal through a considerable range at each entrance of fresh, cool feed water is to be anticipated.

It is perhaps well to consider the magnitude of mechanical stresses which may be involved when a structure like a boiler shell is locally cooled.

Experiments were conducted using a steel boiler with a working pressure of 100 pounds per square inch into which feed water at 100 degrees F. was introduced. It was shown that under such conditions the plate would experience a drop in temperature of some 200 degrees F. and also that if the plate could be conceived of as held rigidly at the edges by unchilled portions of the boiler, stresses of 37,700 pounds per square inch might be developed in the chilled portions of the boiler plate. This stress is great enough seriously to damage the plate, or to rupture the girth seams, but it is unlikely that so great a stress is produced, because the cooled portion of the plate is not held at its edges by an absolute rigid structure, but is part of a shell which is elastic and yields under the pull of the cooled portion.

Calculations which took account of this sort of action in the chilled boiler plate led to the conclusion that stresses of 8000 to 10,000 pounds per square inch might be expected to occur in the particular boiler considered. This of course would be in addition to the pressure stress which a working boiler is always called upon to carry. It is therefore easy to see that a boiler plate, when stressed by the admission of cold feed water must bear stresses too close to the elastic limit of the material for safety, and cracks, ruptures and leaking joints are certain to follow the continued discharge of cold water directly on the shell of a high-pressure boiler and they frequently occur in a surprisingly short space of time.

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.
Secretary—C. W. Obert, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—C. D. Thomas, Salem, Ore.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—William H. Furman, Albany, N. Y.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, 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.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.
Executive Board — Charles J. Longacre, chairman, division boiler inspector, Pennsylvania Railroad, Baltimore, Md.

Boiler Makers' Supply Men's Association

President—Irving H. Jones, Pittsburgh Crucible Steel Company, Pittsburgh, Pa.
Vice-President—Reuben T. Peabody, Air Reduction Sales Company, New York.
Second Vice-President—E. S. FitzSimmons, Flannery Bolt Company, Pittsburgh, Pa.
Treasurer—George R. Boyce, A. M. Castle & Company, Chicago, Ill.
Secretary—Frank C. Hasse, Oxweld Railroad Service Company, 230 N. Michigan Avenue, Chicago, Ill.

American Boiler Manufacturers' Association

President—Charles E. Tudor, The Tudor Boiler Manufacturing Company, Cincinnati, O.
Vice-President—Owsley Brown, The Springfield Boiler Company, Springfield, O.
Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland, O.
Executive Committee—(Three 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. (Two years)—J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.; M. E. Finck, Murray Iron Works, Burlington, Ia.; A. C. Weigel, Combustion Engineering Corporation, New York. (One year)—Homer Addams, Fitzgibbons Boiler Company, Inc., New York; George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn. (*Ex-Officio*)—H. H. Clemens, Erie City Iron Works, Erie, Pa.

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
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

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.		Tampa, Fla.

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

States

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

Cities

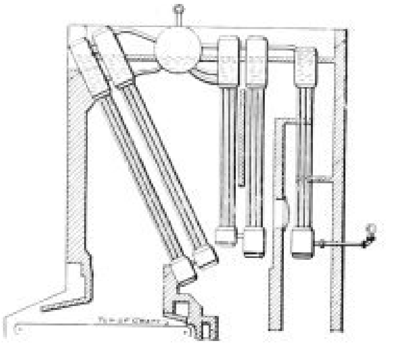
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

Selected Boiler 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.

1,830,776. STEAM BOILER. AMYUIT L. WILSON, OF ELIZABETH, NEW JERSEY, ASSIGNOR TO STANDARD OIL DEVELOPMENT COMPANY, A CORPORATION OF DELAWARE.

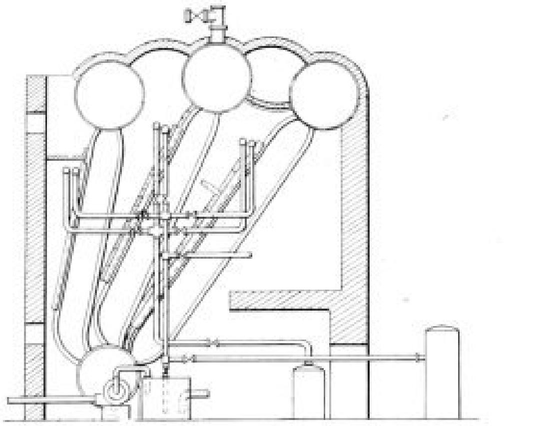
Claim.—In a steam generator, a furnace setting having a chamber through which hot gases are adapted to flow from a source of combustion, a steam and water container, an economizer in the chamber connected to



said container and through which feed water can be passed to the container, a steaming section in the chamber intermediate the source of combustion and economizer.

1,838,008. BOILER CLEANER. NORMAN L. SNOW, OF NEW CANAAN, CONNECTICUT, ASSIGNOR TO DIAMOND POWER SPECIALTY CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

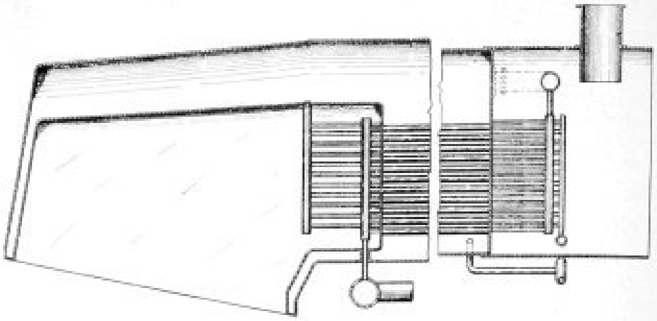
Claim.—The method of changing the character of soot deposits in boilers, furnaces and the like whereby such deposits may easily be re-



moved, which consists in bringing a supply of substantially pure oxygen gas into association with the deposits while such deposits are so heated in the normal use of the boiler, furnace or the like as to cause combustible elements thereof to ignite in the presence of the oxygen gas. Nineteen claims.

1,834,214. SHIELDED SUPERHEATER. WALTER DOUGLASS LA MONT, OF LARCHMONT, NEW YORK, ASSIGNOR TO LA MONT CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

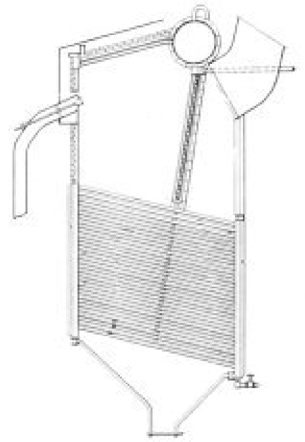
Claim.—In a steam generator and superheater system, steam generating elements situated in the path of the heating gases and arranged to absorb heat by convection, superheater elements situated among the steam generating elements, intake and discharge headers for said steam generating elements and superheater elements, and means for supplying and distributing water to the steam generating elements through their intake headers in quantity greater than the steam generating capacity of the elements whereby excess water enters the discharge headers, the intake headers of both the steam generating elements and superheater elements being located at the ends of the respective elements remote from the zone of hottest gases, whereby the flow of fluid through both the steam generating elements and superheater elements is counter to the direction of flow of the heating gases, the discharge headers for the steam generating elements being located such distances beyond the discharge headers for the superheater elements that the gases are cooled by contact with the steam generating discharge headers and the steam generating elements before



coming into contact with the superheater elements and superheater headers. Eight claims.

1,780,220. STEAM GENERATOR. HENRY H. BAUMGARTNER, OF BELLEVILLE, N. J., ASSIGNOR TO DRAKE NON-CLINKERING FURNACE BLOCK COMPANY, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

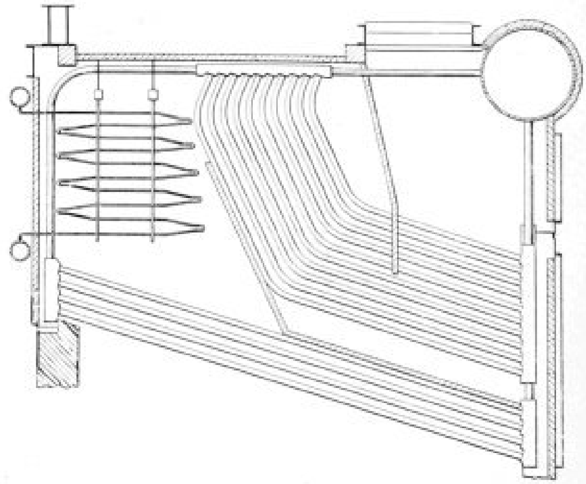
Claim.—Steam generating apparatus comprising a bank of boiler water-tubes, a baffle wall therein establishing a down-travel first boiler pass and



an up-travel second boiler pass, with the gases traveling beneath such baffle wall from the first to the second boiler pass. Six claims.

1,829,885. BOILER AND SUPERHEATER. CLARENCE F. WIGREN, OF TEANECK, NEW JERSEY, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

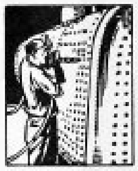
Claim.—The combination with a boiler having a tube bank all the tubes of which extend between lower vertical headers and upper horizontal



headers, means for causing thermal circulation in said bank when heated, a slag screen below said bank and projecting laterally therefrom at one end. Seven claims.

The Boiler Maker

Reg. U. S. Pat. Off.



Boiler Production Gains Rapidly

From the latest official figures available, namely, those of the Department of Commerce, Bureau of the Census, for May, covering the production of steel boilers of all types, there is ample evidence of a revival in this industry. During the month of May, 328 steel boilers were ordered having a total heating surface of 395,601 square feet. As compared with 235 boilers of 225,124 square feet in April, this constitutes a gain in one month of 43 percent. As compared with the month of May, 1932, when 263 boilers of 244,645 square feet were ordered, the gain is 38 percent. Early reports for the month of June indicate a still greater number of orders placed. With the industry organizing under the Industrial Recovery Act to take advantage of incentives created for the stabilization of production and employment, and with prospects for the profitable conduct of this industry, there is every reason for the boiler manufacturing fraternity to look to the future with confidence.

In the fabricated steel plate industry a comparable upturn occurred. In May, 16,243 tons were ordered comprising oil storage tanks, tank cars, gas holders, pressure vessels, blast furnaces and miscellaneous production, a gain of 41.5 percent over the 9502 tons ordered in April. Compared with the 11,788 tons ordered in May, 1932, the gain was 27.5 percent.

Range boiler production increased from 38,716 in April to 70,042 units in May. In this field the unfilled orders at the end of May covered 36,799 units as compared with 9163 at the end of April.

In the steel barrel fabricating plants the gain was from 29.2 percent of the capacity of the industry to 33.9 percent of the capacity.

Increasing Shop Employment

Reports from representative railroads in all parts of the country indicate an ever-increasing level of employment in locomotive repair shops. On some roads the renewal of shop activity commenced in May, but now the increase in the demand for power is so general that there is no section but is finding it necessary to undertake the long-delayed locomotive-conditioning program.

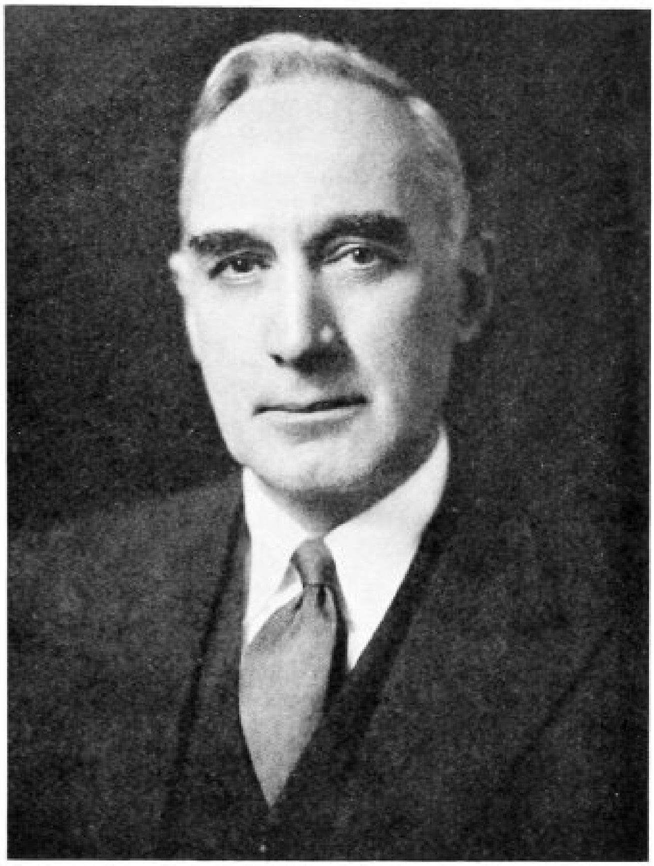
Space permits the mention of but a few high spots which demonstrate this trend. Since June 1, work scheduled on the Erie increased 125 percent in man hours, benefiting 1700 employees. The Great Northern opened four shops on July 10, employing a total of nearly 1000 men. On July 5 the Rock Island increased its forces at various shops by nearly 1200 men, while the Norfolk & Western increased the work time of 7000 employees in all shops. An outstanding gain in shop operation is that of the New York Central. In July, sixteen shops are in operation as against thirteen in March, with a total now employed of 6350 men as compared with 3502 in March. In locomotive repair work, the man hours utilized in July will exceed those in March on this road by approximately 100 percent. Nearly 3000 men on the Southern Pacific have been placed on a five-day week, where for many months the shops had been operating on a three-day basis.

Practically every important railroad in the country is reflecting the improvement in general business. Increasing revenue for the railroads combined with the sustained traffic demand and the high proportion of unserviceable power could have but one result. The railroads have now been obliged to embark on the long-delayed rehabilitation program, which means employment not only in their own shops but in every plant producing materials and equipment in the railroad supply field.

Locomotive Design

On another page in this issue appears a description of the fourth in a series of locomotives developed by the Delaware & Hudson in an effort toward a progressive increase in thermal efficiency. In the matter of steam generation this locomotive does not differ materially from its three predecessors in the series. It carries a boiler pressure of 500 pounds per square inch, which is the same as that of the last of its three predecessors. In the matter of steam utilization, however, it involves, so far as is known, the first attempt at the employment of triple expansion in locomotive service. An overall thermal efficiency from the coal as fired to the drawbar of 12 to 13 percent is anticipated under the same road-test conditions under which the thermal efficiencies of the three predecessor locomotives have been established.

While the design of this particular locomotive can by no means be considered final, nevertheless it does meet many of the essential requirements that will have to be considered by the railroads in coming years. The locomotive of the future must meet demands not only for high tractive capacity, but also for the high horsepower capacity needed to move freight at relatively high speeds. The demand is, therefore, not entirely for economy in operation, but for a type of motive power which will help in restoring traffic to the railroads which they have lost to the highways. Where both revenue and economy are involved, getting revenue is the factor which must take precedence.



James D. Andrew

Boiler Manufacturers Appoint Manager for Industry

Since the annual meeting of the American Boiler Manufacturers' Association last month, the Industrial Recovery Committee of the association, headed by Owsley Brown of the Springfield Boiler Company, chairman, has been active in organizing the working group whose duty it will be to administer the Code of Practice for the industry. At the annual meeting H. E. Aldrich of New York, formerly with the Watertube Boiler Association, was made secretary of the committee.

More recently the committee has selected as manager of the industry James D. Andrew, a well-known engineer and executive, who has had over thirty-five years contact with the steam generating equipment field. Administrative offices for the association have been established at 15 Park Row, New York.

Mr. Andrew after technical training began his active career in the transit field. During the electrification of the Metropolitan Street Railway Company, New York, he served as mechanical engineer. Following this he was for four years chief engineer of the New York Edison Company. During the next ten-year period he was superintendent of power for the Boston Elevated Railway system for six years, and superintendent of engineering with the Edison Electric Illuminating Company of Boston. More recently Mr. Andrew has been connected as an executive with miscellaneous industrial projects principally with American International Corporation interests. This work included the post of manager of ship construction of the Hog Island Shipyard, president of the American Balsa & Balsa Refrigerator Company, New York, and president and general manager of the Standard Tank Car Company, Sharon, Pa. Later he became vice-president of Stevens & Wood in charge of design, construction and operation of power plants in Ohio and Pennsylvania. For three years following this he was general consulting engineer of Armour & Company, Chicago.

His latest connection before engaging in consulting engineering was with the Niagara Hudson Power Corporation as chief engineer.

At the annual meeting also the association was broadened to include in its membership other affiliated industries such as superheaters, stokers, pulverized fuel equipment, air heaters and the like.

The Code of Fair Competition for the boiler manufacturing industry is rapidly nearing completion. Within a short time a general meeting of the entire industry, members of the American Boiler Manufacturing Association and non members, will probably be held, to consider the provisions of the code. After this it will be submitted by the committee to General Hugh S. Johnson, Industrial Administrator, for hearings.

The machinery for administering the code within the industry, once it has been approved and signed by the President, is rapidly being organized under the able direction of Mr. Andrew, and will give every aid to individual companies in meeting the requirements set up by the Industrial Recovery Act.

For the information of our readers, the personnel of the American Boiler Manufacturers' Committee of Industrial Recovery is again published, as follows: Owsley Brown, Springfield Boiler Company, chairman; A. C. Weigel, Combustion Engineering Corporation, vice-chairman; Starr H. Barnum, The Bigelow Company; H. H. Clemens, Erie City Iron Works; W. F. Keenan, Jr., Foster-Wheeler Corporation; R. B. Mildon, stoker department, Westinghouse Electric & Manufacturing Company; A. G. Pratt, the Babcock & Wilcox Company; A. W. Strong, the Strong-Scott Manufacturing Company; and C. E. Tudor, the Tudor Boiler Manufacturing Company.

Various general principles that are being developed throughout industry under the Industrial Recovery Act for the conduct of business and which apply equally well in the boiler manufacturing industry will be outlined in the following articles for the information of the executives in the fields covered by The Boiler Maker.

Basic Principles of Recovery Act

Basic principles which will guide the National Recovery Administration in consideration of "codes of fair competition" were announced recently by Administrator Hugh S. Johnson in an official bulletin.

The bulletin emphasizes the fact that the initiative in the recovery program rests upon industry itself and that "it is not the function of the National Recovery Administration to prescribe what shall be in the codes. . . . or to compel the organization of either industry or labor."

"Basic codes" the bulletin continues, "containing provisions respecting maximum hours of labor, minimum rates of pay and conditions of employment, which are in themselves satisfactory, will be subject to approval, although such conditions may not have been arrived at by collective bargaining."

Again emphasizing the purpose of the Act to encourage "a voluntary submission of codes," the bulletin points out the penalty provisions of the law applicable to industries which fail to comply voluntarily.

The bulletin invites the immediate submission of simple basic codes by the ten largest industries, as suggested by the President when he signed the Act, the codes to cover "only such agreements" as meet at once the three objectives of the Act, namely, "Maximum hours of labor, minimum rates of wages, and such means as each industry may find necessary to protect its constructive and cooperating majority from the wasteful and unfair competition of minorities or recalcitrants."

The basic codes, it is suggested, should propose an "average work week. . . . designed so far as possible to provide for such a spread of employment as will provide work for employees normally attached to the particular industry."

Likewise codes should propose a minimum wage scale "sufficient *in fact* to provide a decent standard of living in the locality where the workers reside."

Broad protection for the interest of the public as consumers is assured by specific provision for representation at all hearings, to the end that the effect of increased money wages shall not be offset by too rapidly mounting prices.

General Johnson's Conception of the Function of Administrator

In an interview with the press a short time ago Gen. Hugh S. Johnson stated that he did not regard the National Recovery Administration as czaristic.

"I want to avoid any czaristic appearances," he said. "It is industrial self-government that I am interested in."

He pointed out the difference between the National Recovery Administration and the War Industries Board.

"There our problem was largely administrative. It came to be a centralized administration of American business. This will be different."

It took England, he explained, 120 years to arrive at the "law merchant" which was a codification of commercial practice, thereafter accepted as a part of the common law. In this country, the same thing is being accomplished almost overnight.

"Will you bring in anybody to work particularly with you in connection with Oil?" the Administrator was asked.

"I will have to do that sooner or later," he answered. "My thought about this thing is—it's a little bit different than the War Industries Board. On that board we had a continuous problem, because we were trying to keep the industries producing. Every day there was some difference in demand—some area had been wiped out and suddenly the demand for barbed wire then becomes 10 times more than it had been the day before."

The present system is being organized almost as you would organize a business. The President calls this act industrial self-government.

"The first move of an industry is to bring in a code. I am trying to develop the technique of this new thing. Therefore I have certain deputy administrators, just a few at first. A man will come in and deal in a preliminary way with the problem of the industry up to the point of a hearing. I am going to conduct these hearings myself.

"It will be a new procedure—nothing quite like it has ever been seen before. I don't know how it will turn out but I have definite ideas as to how it is to be carried on. After a hearing and the code has been approved it becomes a sort of 'law merchant' for that industry.

"Then complaints will start to come in and will have to be treated. As the deputies become adept in treating with this business we will have other men come in. The deputy going on to another industry will have to leave behind him a small organization to receive complaints. To what extent it will grow in administration is a matter of what will actually happen. There will be no administrators of an industry, as such, in the early stages."

"What progress is being made in iron and steel?"

"Those people are working night and day, and their code is nearing completion. We are being asked questions all the time about technical matters in connection with this industry. They will go ahead as far as they can. I think that is true of all industries. Some have better trade associations, more closely organized and have been organized over a longer period of time. This whole thing is coming in much faster than I ever thought it would."

"Are you going to permit price fixing in these codes?"

"No general rule has been laid down. They don't have to put it in their codes. In these codes it will be proper to have a provision that they are not going to sell products at less than the cost of production. When they go beyond that in price fixing I would have to step in because that leads to monopoly—and prevention of that is part of what this Administration is here for. It is not here to institute the organization and operation of these industries. We are here for the purpose of seeing that what they propose to do does not bear unfairly upon the public. That is where the Consumers' Advisory Committee comes in."

"When do you expect to invoke the licensing power?"

"I do not expect to invoke it if I can avoid it."

"Will you license all units in an industry or just those that will not go along?"

"No—you would have to license them all. I mustn't talk hypothetically—Nobody can imagine these things until they confront them. In most cases industries will come in with codes because of the benefit that there is in the code. The code goes out with every assumption of good faith of execution. Complaints will come in. When they do come in it is because they are accused of doing something in violation of the code. Sometimes they are justifiable and sometimes not. If this code isn't working out the President can modify it or withdraw it under terms of the Act. If he withdraws it—they have lost the benefit of the code. I don't want to use the license power in *any* circumstances unless I absolutely have to."

"Is there any thought of placing men in various parts of the country to watch price situation?"

"I had an opportunity of watching the same sort of thing during the draft. Everybody told me you can't make draft boards go without force. We intended to make it police itself because in a particular community people who were not playing the game would be taken care of by other people of the community. We want to avoid inquisitorial powers and police functions. Whoever begins to violate codes will be complained against by the people in the industry itself."

"In the matter of price fixers—how about retailers?"

"The retailers have various reasons for wanting to come in on this thing. They have suffered a great deal from bad practices. As they come in here with their association and their codes, they have a subject that has to be attended to."

"If you can strike at a manufacturer for price fixing can you also strike at a retailer?"

"If the code is set up in the way I described. Nobody can say that something was done that is going to hurt any group. If there is anywhere in this a chance for extortion or exploitation it has got to be carried before the President and approved and he couldn't approve of a code that permitted this thing."

"Are you setting up a Consumers Advisory Board?"

"Yes, it is going to be a committee and we are setting it up right now."

"How will the same industry in different areas get together on a code?"

"When anybody brings a code in we recognize the ordinary economic differences that have been built up and the basic rates on which pay has been based. When they become conditions of regional extortion they will have to be dealt with. The purpose of this act is to iron out disparities—this is what makes depression."

"Isn't the coal industry the biggest example of disparity?"

"Yes."

"You used the word extortion as applying to commodity—does it also apply to labor prices?"

"I used the word extortion and probably it was a harsh one. Every minority group will have an opportunity to a hearing."

"Will the labor people try to insist on sitting in with the manufacturers in working out these codes?"

In answer to this question the Administrator detailed the steps through which a proposed code will pass before it reaches the President for approval.

"An industry brings in a code. That industry is represented by an association. In these trade associations—there are big and little ones—the interest is not always the same. The code has probably been voted on by the majority and the dissenting minorities will be represented at the hearing. They come up to the table where sits the Administrator.

"Always in the agreement there are three principal interests that we have to consider (1) the industry itself (2) labor in that industry (3) the consumer public.

"One of our first rules is that the advisor can't have any interest in that industry. At one side of the table sits an Industrial Advisory Board for the Administrator. At the other side of the table are representatives of every element of labor in that industry in an advisory capacity. A third board will represent the consumers. The purpose there is when you get through with the hearing that everybody affected by that code has been represented and that every conflicting point of view of the different interests has been heard.

"There is a question of statistical data that is one for our own organization to answer. We cannot accept all figures that are brought in because they may be self-serving. We must have our own.

"After a hearing is complete and the code has been modified to the extent that they are willing to modify it, it goes up for a very thorough study in this organization that we are setting up and after it has been approved it goes to the President.

"It then becomes a sort of the law of that industry. It took them 120 years in England to build up the law merchant idea and we are building it up in an hour and a half."

"Do those Advisory Groups draw pay from the Government?"

"They will serve on a per diem and expense basis."

"When these trade associations are working out their code is labor to be represented around that table with the industry?"

"Industry will present a code and in that code the law requires under Section 7a that the right of collective bargaining be accorded the employees in that industry."

Aid Pledged to Labor Organized or Not

The Industrial Recovery Act and its administration are designed to benefit all labor, organized or unorganized, according to General Hugh S. Johnson.

This statement was made in connection with intense activity on the part of the "regular" unions to get more members, and a renewed organizing of "company" unions. The recovery administration, General Johnson said, pledged itself "to obtain a fair deal for labor in any industry presenting a code, whether the employes are organized or not."

The statement read:

"Circulars and other literature purporting to come from labor union agents have intimated or openly stated that it is a purpose of the National Recovery Act and administration to unionize labor, or that the only way labor can secure benefits under that act is to join this or that union.

"Similar statements purporting to come from industrial concerns have intimated that this or that newly formed company union is the only organization through which labor can get a fair deal under this act.

"Both statements are incorrect and such erroneous statements of the act and its administration tend to foment misunderstanding and discord.

"It is the duty of this administration to see that all labor—organized as well as unorganized—gets a square deal, and the administration is organized to do and will do that duty.

"The improved labor conditions proposed in the textile industry, which is largely unorganized, are an example of this. It is not the duty of the administration to act as an agent to unionize labor in any industry and, as has repeatedly been stated, it will not so act. It is the duty of this administration to require the inclusion in codes of the mandatory conditions of Section 7, and to see that these conditions are complied with, and it will perform that duty.

"The policy of the National Recovery Administration respecting the rights and obligations of both organized and unorganized labor is based on the declaration of policy in Section 1 of the act itself, which clearly stated the objectives of this legislation, and which reads in part as follows:

"'To induce and maintain united action of labor and management under adequate government sanction and supervision.'

"Manifestly the purpose of the act is to create and preserve harmonious relationships and to prevent industrial strife and class conflicts.

"Labor in any industry has the right to organize and bargain collectively; the law also recognizes the right of individual workers to bargain for their own conditions of employment. But in the execution of this new social policy to which the government stands committed, it is the obligation of the National Recovery Administration to require the payment of living wages by industry as a condition of continued existence, and to prevent excessive and unreasonable disparities, in the interest both of social justice and a balanced economy.

"Collective bargaining under adequate government sanction and supervision should hold no fears for the fair-minded industrialist; on the other hand, the National Recovery Administration pledges itself through its Labor Advisory Board to obtain a fair deal for labor in any industry presenting a code, whether the employes are organized or not. It is not the function or the purpose of the administrator to organize either industry or labor."

General Johnson quoted from the President's statement of June 16, on signing the National Industrial Recovery Act, which General Johnson termed "the Magna Charta of this administration." In this statement, Mr. Roosevelt pledged better conditions for industry and labor in general, regardless of classification.

Numerous Codes Submitted for Simultaneous Action

Prospects of early submission of numerous codes necessitating a score or more of simultaneous hearings were disclosed early in July by Administrator Hugh S. Johnson of the National Recovery Administration.

"Many groups have consulted with us informally and we have advised them," said General Johnson. "There would be more speed if they all did that. Failure to consult us is a chief cause of delay. But, it must be remembered that this law is only about two weeks old and that these industries are engaged in writing constitutions for that is what a code will be for the industries. It takes time to write a code."

General Johnson asserted that the Administration anticipates no difficulty in dealing with companies charged with "firing" employees because the latter join labor unions.

"I look to this new industrial self-government to be self-policing," he said. "We had a somewhat similar experience in executing the draft law during the war. The basic thing now is that these industrialists agree among themselves as to the acceptance of a code. If there are violations, there will be complaints. If, for example, it is complained that men have been fired because they joined a union, and that is brought to us and upon investigation it is found to be true, the government could step in and withdraw the company from the benefit of the code."

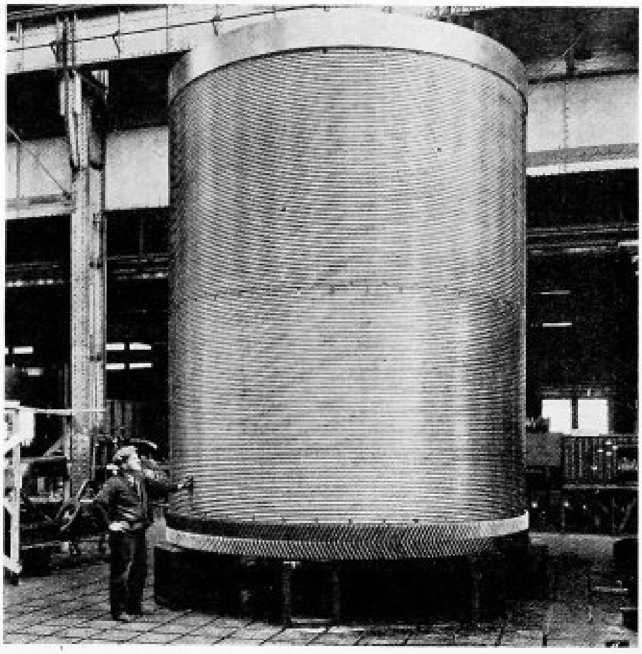
If complaints of coercion are brought against a union, he added, "then under section 4 of the Recovery Act we would have to investigate that."

In response to queries as to the Administration's attitude toward prices, General Johnson asserted that in his opinion so-called "open price associations" disclosing currently quantities sold and prices obtained, "would be one of the cleanest ways of dealing with that."

"If prices are found to be extortionate," he continued, "and complaint is made and the prices are found to be unjustified, the offending company could be withdrawn from the benefits of the industry's code and that company would then be subject to all the penalties of the Sherman Act."

Unusual Drums

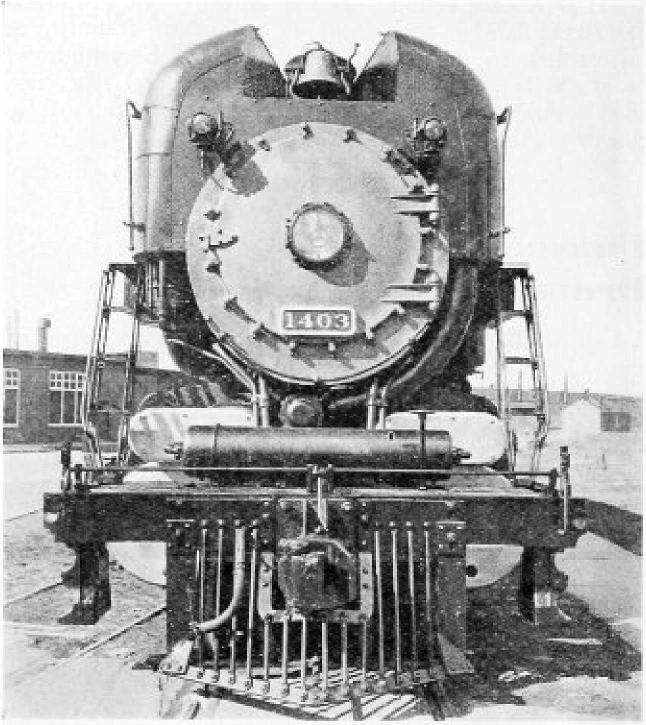
One of two huge lifting-hoist drums, the largest of the kind ever built, will be used for the cableway which is now under construction at Hoover Dam. The cableway, designed to carry weights up to 150 tons, is to be



a permanent installation and will be used for handling equipment and supplies between the top of the river gorge and the dam, a distance of approximately 600 feet.

Each of the two drums was rolled from steel plate 2 inches thick, 42 feet long and 8 feet wide. The drums weigh 90,000 pounds apiece, and will be wound with more than a mile of 1⅛-inch wire rope. General Electric arc-welding machines and electrodes were used to weld the seams and internal strengthening structure of the drum.

Manager Appointed Ryerson St. Louis Plant.—R. B. Wilson, sales manager of the St. Louis Plant of Joseph T. Ryerson & Son, Inc., has been made manager of the St. Louis Plant of that Company. Mr. Wilson, who has had long experience in the steel business, first became associated with the Ryerson Company in Chicago. He was a member of the Shipping and Sales Departments for some years and was then transferred to St. Louis in charge of the City Sales Department. Later he was made sales manager and assistant to H. B. Ressler, who was then manager of the St. Louis Plant and now vice-president in charge of sales of the Ryerson Company. The position of plant manager of this important unit of the Ryerson Company comes as a well earned reward for over twenty years of service.



Delaware & Hudson Develops Triple-Expansion Locomotive

A high-pressure locomotive with water-tube firebox, in which for the first time, so far as is known in the history of the steam locomotive, the triple-expansion principle has been utilized, was recently delivered to the Delaware & Hudson by the American Locomotive Company. This locomotive now constitutes part of the D. & H. exhibit at the Century of Progress Exposition, Chicago. It is the fourth of a series of notable locomotives which have been developed by this railroad at intervals since 1924.

The first three of these locomotives, which are of the 2-8-0 type, were fitted with cross-compound cylinders supplied with steam at working pressures of 350 lb., 400 lb., and 500 lb. per sq. in., respectively. The new triple-expansion locomotive is of the 4-8-0 type and operates with a boiler pressure of 500 lb. per sq. in. All of these locomotives are fitted with water-tube boilers of the same general type of construction which was first applied on the "Horatio Allen," built in 1924. A comparison of the principal dimensions and data pertaining to the four locomotives is presented in the table.

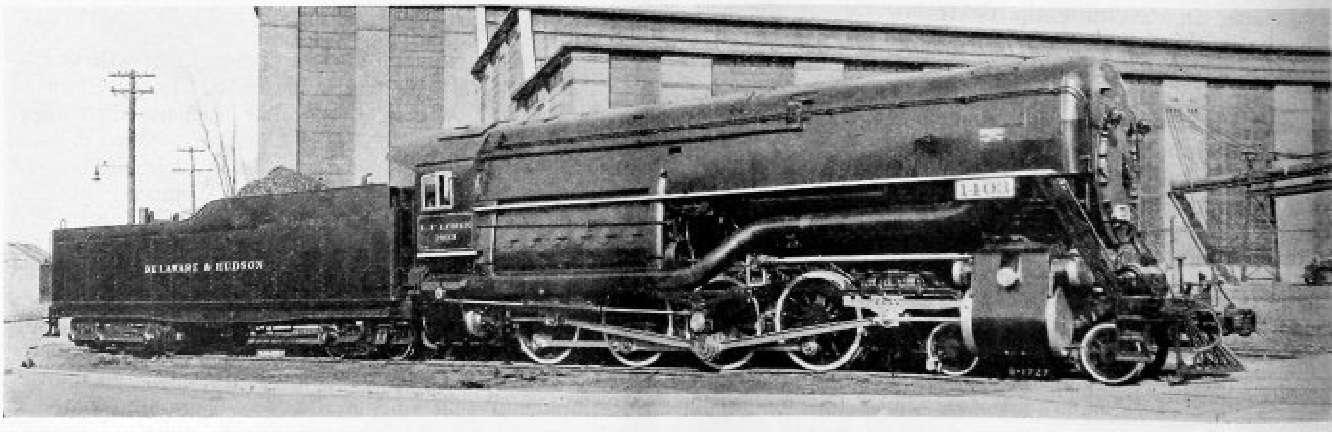
The first three of these locomotives have all been subjected to efficiency dynamometer tests over the same section of the line, northbound between Oneonta, N. Y., and Dante, over a .5 per cent compensated grade. The thermal efficiency at the tender drawbar based on coal as fired was as follows:

Horatio Allen, No. 1400	8.73 per cent
John B. Jervis, No. 1401	9.35 per cent
James Archbald, No. 1402	10.4 per cent

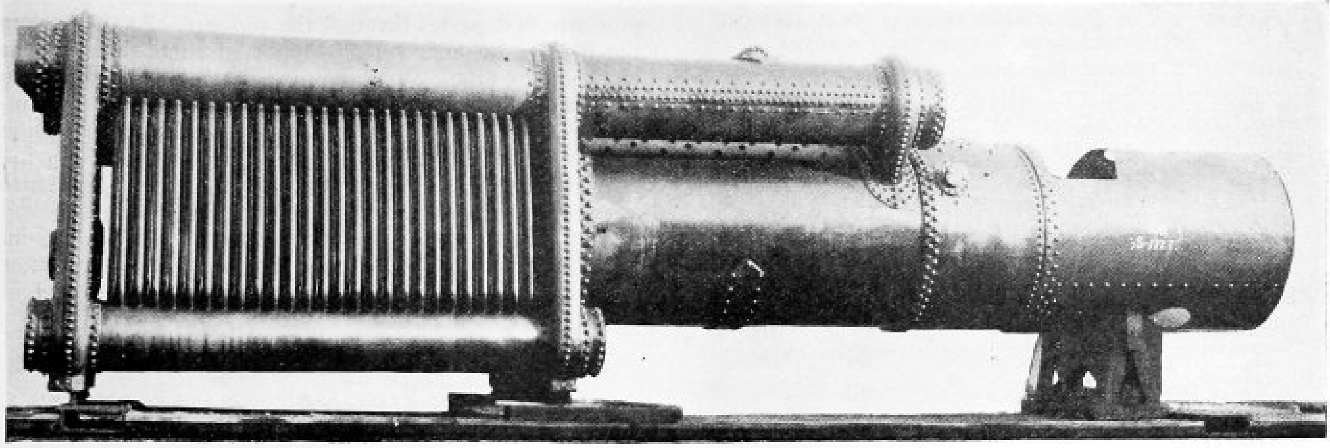
While no data are yet available for the "L. F. Loree," No. 1403, it is expected that after all adjustments have been made this locomotive, under comparable conditions, will develop an overall thermal efficiency of between 12 and 13 per cent.

The boiler has a water-tube firebox and a fire-tube barrel, the latter of relatively small diameter and completely filled with water. The steam space is in the steam drums of the firebox which are carried forward well beyond the firebox and connected to the barrel near their front ends.

The heating surface in this firebox is not entirely of water tubes. The back head and rear fire-tube sheet connections are water-leg headers, each built of parallel stayed sheets, through which pass the two 21.4 in. water drums at the bottom and two 30.75 in. steam drums at the top. Ports through the drum shells in the header spaces, provide for circulation between the drums and headers. The front extensions of the steam drums pass through a saddle connection of parallel stayed sheets which is riveted to the boiler shell. Circulation between



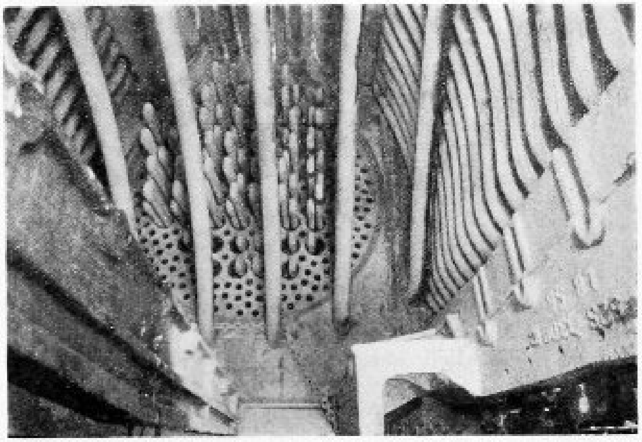
The Delaware & Hudson triple-expansion locomotive



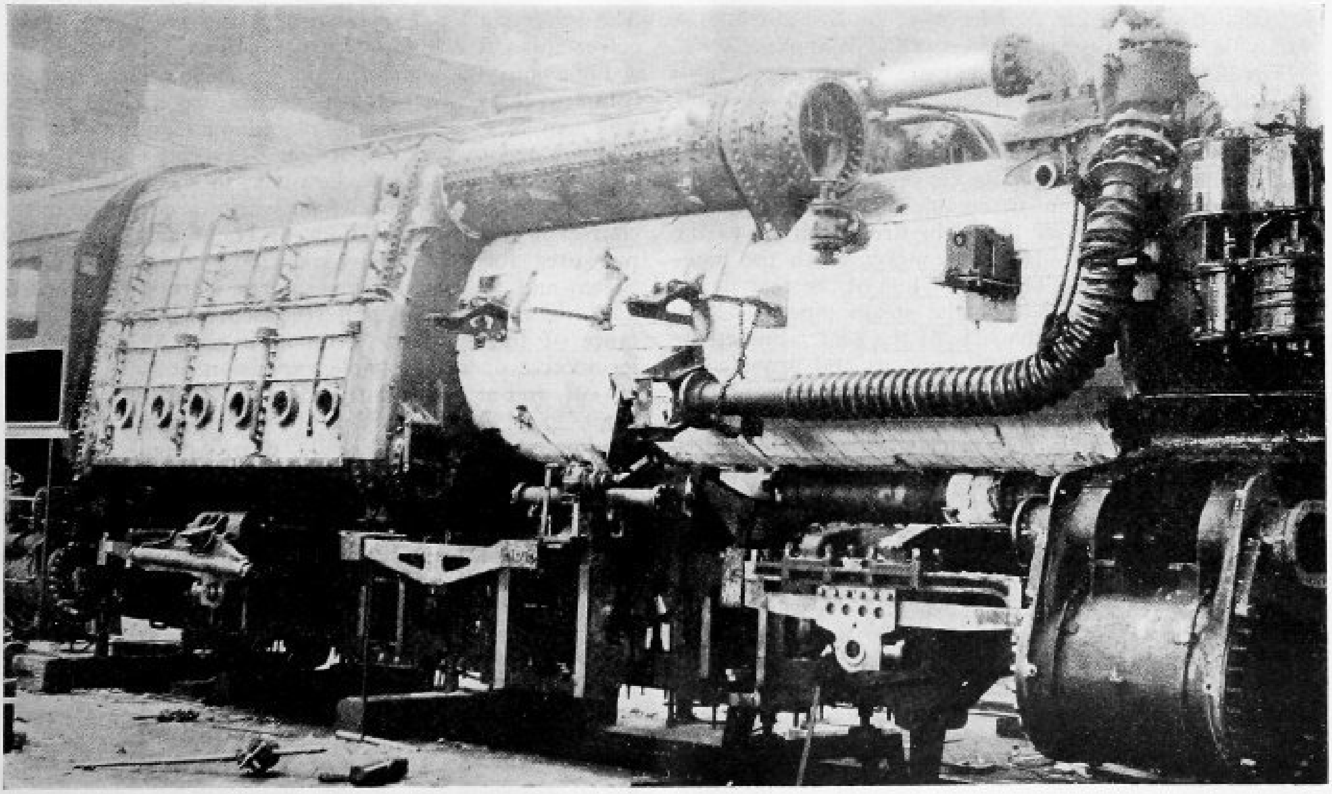
The boiler of the triple-expansion locomotive

the barrel and the steam drums, through the saddle, takes place through ports in the shell. The barrel shell is riveted into a flanged opening in the front wall of the front water leg and the rear fire-tube sheet is riveted into a similar opening in the back wall of this water leg.

One of the outstanding differences in the construction of the boiler of the "L. F. Loree" as compared with those on the preceding three locomotives is in the use of solid-forged nickel-steel steam and water drums in the firebox construction instead of drums of riveted plate construction. These drums are turned and bored eccentrically, thus providing a thickening of the walls at the sides where the water-tube holes are located. Thus the compensation is effected for the reduction of section through the water-tube holes without the necessity of using plate of this thickness all around. The sections of the steam drums ahead of the firebox are of riveted plate construction. Compared with the butt-seam riveted drums on the No. 1402 which carry the same



Interior of firebox



The locomotive in the erecting shop, showing the corrugated section of the high-pressure steam pipe

Comparison of Delaware & Hudson High-Pressure Locomotives with Watertube Fireboxes

Name	L. F. Loree	James Archbald	John B. Jervis	Horatio Allen
Road number..	1403	1402	1401	1400
Year built....	1933	1930	1927	1924
Type	4-8-0	2-8-0	2-8-0	2-8-0
Cylinders, dia. and stroke, in.				
High pressure	20 × 32	20¼ × 32	22¼ × 30	23½ × 30
Intermediate	27½ × 32			
Low-pressure	(2) 33 × 32	35½ × 32	38½ × 30	41 × 30
Diameter of driving wheels in.	63	63	57	57
Weight lb.				
On drivers .	313,000	300,000	295,000	298,500
Engine truck	69,000	56,000	41,500	49,500
Total	382,000	356,000	336,500	348,000
Boiler pressure, lb. per sq. in.	500	500	400	350
Heating surface, sq. ft.				
Firebox and firebrick tubes ...	1,026	1,114	1,217	1,187
Fire tubes and flues	2,325	2,325	1,904	2,013
Total evaporating..	3,351	3,439	3,121	3,200
Superheating	1,076	1,037	700	579
Grate area, sq. ft.	75.8	82.0	82.0	71.4
Tractive force, lb.				
Simple ...	90,000	84,300	84,300	84,300
Compound.	75,000†	70,300	70,300	70,300
Aux. loco..	18,000	18,000	16,200	18,000

† Triple expansion.

boiler pressure, this construction saved 5,274 lb. in the weight of the boiler.

The boiler shell and the two front steam drums, including liners, welt strips, etc., are of silico-manganese steel. Other parts are of suitable grades of carbon steel.

The side walls of the firebox are closed with $^{3}/_{16}$-in. Ascoloy plate, outside of which are applied successively one ½-in. layer of No. 319 Johns-Manville cement, a 1¼-in. layer of Superex, a 1-in. layer of 85 per cent sectional magnesia and a ½-in. layer of No. 302 Johns-Manville cement. Over this the jacket is applied.

The high-pressure superheated steam is conveyed from the superheater header to a Wagner throttle under the jacket on the right side of the smokebox. From the throttle flange a corrugated steel pipe leads downward and to the rear in a sweeping curve to a seamless cold-drawn steam pipe, 8 in. in outside diameter, which extends back alongside of the right firebox drum to the rear cylinder casting. Here it connects with the high-pressure steam chest. The center line of the rear flange of the corrugated section of the steam pipe is 51 in. below and 115⅛ in. to the rear of the center line at the top flange. These are cold dimensions and provide for expansion when hot. They are increased when the pipe is bolted in place to 51$^{5}/_{16}$ in. and 116½ in. by $^{5}/_{16}$ in. and 1⅜-in. cold draw, respectively, which is permitted by the flexibility of the corrugated pipe.

When bolted in place the steam pipe is attached at its ends to flanges which bear a fixed relation to each other, while the joint between the two sections of the pipe changes its position with relation to the ends with variations in the temperature of the pipe. The support for the front end of the rear section of the steam pipe must permit longitudinal movement without binding and still care for a variable tendency toward vertical displacement, because of the eccentricity of the expansion and contraction forces. The bracket, which is secured to the boiler, is fitted with bearing pads at the top and two sides. The latter are spaced to provide $^{1}/_{64}$-in. clearance on each side of the wearing ring, surrounding the pipe where it passes through the support. At the bottom the pipe rests on a spring-supported shoe, fitted to the circle of the pipe. With the pipe pressed against the top pad the compression of the spring is set to exert an upward pressure of about 600 lb. The further compression movement of the spring is limited by stops to $^{11}/_{32}$ in., at which point the spring exerts an upward pressure against the pipe of something more than 900 lb.

The steam pipe is heavily insulated with a 1½-in. inner layer of Johns-Manville Superex, a 1½-in. outer layer of 85 per cent magnesia block lagging, wired in place and covered with Johns-Manville No. 302 cement.

List of Special Parts, Appliances and Equipment Applied on the "L. F. Loree" Boiler

Owner	D. & H.
Builder	American Locomotive Co.
Boiler details:	
Blower connection	Barco
Blow-off valves	Okadee
Boiler steel	Lukens
Brick arch	Economy
Coal sprinkler	Nathan
Feedwater heater	Dabeg
Fire door	Franklin Butterfly
Steam injector	Type "W," Hancock
Wrought-iron pipe	Byers
Staybolts	Ulster special
Throttle valve	Wagner
Unions	Kewanee, extra heavy
Gage cocks	Hancock
Low water alarm	Cleveland
Steam gages	Ashcroft
Water columns	Nathan

The locomotive is equipped with the Dabeg feedwater heater, with which the D. & H. has already had considerable experience. This device is an open-type heater and is operated by a pump which takes its power from the left front crosshead.

The locomotive is provided with two duplex steam gages. One registers pressure in the high-pressure steam pipe and in the intermediate-pressure receiver. The other shows the pressure in the low-pressure receiver and at the low-pressure exhaust.

Following the delivery of the locomotive time for complete tests was not available before the locomotive was sent to Chicago to be placed on exhibition at the Century of Progress Exposition. A series of dynamometer-car runs were made, however, to check the tractive capacity of the locomotive at various cut-offs, in the course of which observations of boiler and steam-chest pressures for the three expansion stages were made. Steam and feedwater temperatures were also recorded. The highest drawbar pull recorded, without the assistance of the auxiliary locomotive, was 82,000 lb., the locomotive operating triple expansion at 87½ per cent cut-off, and at a speed of 4 m.p.h. Operating at a constant speed of 4 m.p.h. and 66 per cent cut-off, ascending a .24 per cent grade, drawbar pulls of 61,000 to 63,000 lb. were recorded. The trains on which these observations were made consisted of 4,763 actual tons in 71 cars, the dynamometer car and the caboose. With a train of 6,103 actual tons in 92 cars, the dynamometer car and the caboose, the locomotive operating at 66 per cent cut-off with the auxiliary locomotive cut in, developed a maximum drawbar pull of 74,000 lb. at the top of a .52 per cent grade, operating at about 4½ m.p.h.

On another run, with a train of 3,274 actual tons in 50 cars, the dynamometer car and a caboose, the locomotive developed a drawbar pull of 37,000 lb. working in 50 per cent cut-off at a practically constant speed of 20 m.p.h. on a .42 per cent grade.

Table of Dimensions, Weights and Proportions of the "L. F. Loree"

Railroad	D. & H.		
Type of locomotive	4-8-0		
Service	Freight		
Cylinders, diameter and stroke:			
High-pressure	20 in. by 32 in.		
Intermediate-pressure	27½ in. by 32 in.		
Low-pressure (2)	33 in. by 32 in.		
	H.P.	I.P.	L.P.
Cylinder clearance, per cent	13.5	9.4	8.8
Valve gear, type	Dabeg, Rotary cam		
Valves, double-beat poppet, size:			
High-pressure, both	9 in.		
Intermediate-pressure: Admission	9 in.		
Intermediate-pressure: Exhaust	9½ in.		
Low pressure: 1. Admission	9¼ in.		
Low pressure: 2. Exhaust	9 in.		
Maximum lift:			
High-pressure and intermediate admission	1 in.		
Low-pressure admission	1-1/16 in.		
High-pressure and low-pressure exhaust	1 in.		
Intermediate exhaust	1-1/16 in.		
	H.P.	I.P.	L.P.
Release in shortest cut-off:	8½ in.	5½ in.	4½ in.
Compression in shortest cut-off:	3 in.	3 in.	3⅜ in.
Weights in working order:			
On drivers	313,000 lb.		
On front truck	69,000		
Total engine	38,200		
Tender (full load)	274,500		
Wheel bases:			
Driving	18 ft. 10 in.		
Rigid	18 ft. 10 in.		
Total engine	33 ft. 9 in.		
Total engine and tender	83 ft. 8¾ in.		
Wheels, diameter outside tires:			
Driving	63 in.		
Engine truck	33 in.		
Journals, diameter and length:			
Driving, main	13 in. by 14 in.		
Driving, other	11 in. by 14 in.		
Engine truck	7½ in. by 13 in.		
Boiler:			
Type	Water tube—fire tube		
Steam pressure	500 lb.		
Fuel, kind	Bit. coal		
Diameter, first ring, inside	68-1/16 in.		
Firebox, length and width	139-15/16 in. by 77¾ in.		
Arch tubes, number and diameter	6—3½ in.		
Tubes, number and diameter	155—2 in.		
Flues, number and diameter	52—5½ in.		
Thickness, tubes	No. 12 min. B. W. G.		
Thickness, flues	No. 5, min. B. W. G.		
Length over tube sheets	15 ft.		
Grate area	75.8 sq. ft.		
Heating surfaces:			
Firebox	965 sq. ft.		
Firebrick tubes	61 sq. ft.		
Boiler tubes	1,209 sq. ft.		
Flues	1,116 sq. ft.		
Total evaporative	3,351 sq. ft.		
Superheating	1,076 sq. ft.		
Combined evaporating and superheating	4,427 sq. ft.		
Tender			
Water capacity	14,000 gal.		
Fuel capacity	17½ tons		
Rated tractive force:			
Simple	90,000 lb.		
Triple-expansion	75,000 lb.		
Auxiliary locomotive	18,000 lb.		
Weight proportions:			
Weight on drivers÷total engine weight, per cent	81.9		
Weight on drivers÷tractive force (simple)	3.48		
Weight on drivers÷tractive force (triple expansion)	4.17		
Total weight engine÷comb. heat. surface	86.2		
Boiler proportions:			
Tractive force (triple exp.)÷comb. heat. surface	16.9		
Tractive force (triple exp.)×dia. drivers÷comb. heat. surface	1,064.7		
Firebox heat. surface (incl. firebrick tubes)÷grate area	135.3		
Firebox heat. surface (incl. firebrick tubes), per cent evap. heat. surface	30.6		
Superheat. surface, per cent evap. heat. surface	32.2		

Operating in 66 per cent cut-off at speeds of from 4 to 16 m.p.h., a pressure drop of about 13 to 20 lb. is indicated between the boiler and the high-pressure steam chest. Boiler pressures varied from 485 to 500 lb. With full pressure in the boiler at speeds of 4 to 6 m.p.h., the intermediate receiver pressure varied from 270 to 285 lb. and the low-pressure receiver pressure from 88½ to 97½ lb. per sq. in. At higher speeds somewhat lower intermediate cylinder pressures are indicated. As the cut-off is reduced, the pressure in the intermediate receiver is also reduced to about 235 lb. per sq. in. at 58 per cent and 215 lb. per sq. in. at 50 per cent. The highest steam temperatures recorded were 710 deg. F., operating at 58 per cent cut-off, and consistent readings of about 665 deg. were obtained in a number of observations with the locomotive operating at 66 per cent cut-off. With final completion of adjustments in the drafting of the locomotive, however, it is anticipated that temperatures of 700 deg. and upward will be obtained regularly.

National Recovery Administration Personnel

General Hugh S. Johnson, Administrator for the National Recovery Administration, has appointed Malcolm Muir of New York as a Deputy Administrator, and Professor Alonzo E. Taylor of Stanford University, and Lucius R. Eastman of New York, president of the Hills Brothers Company, as members of the Consumers' Advisory Board.

Mr. Muir's appointment represents a "horizontal" cross-section of industry, due to his intimate acquaintance with the problems of the "capital goods" and machinery groups as chief executive of the McGraw-Hill magazines, and past president of the Associated Business Papers (the trade association of the business press). Mr. Muir was also a member of the National Committee for Industrial Rehabilitation and chairman of its New York Board, thus having been active in industrial recovery a year before the new law was enacted. Mr. Muir is also director of the National Publishers' Association, the American Arbitration Society, the Advisory Board of the Army Ordnance Association for the New York district, and a director of the Merchants Association of New York.

Professor Taylor, who is director of the Food Research Institute at Stanford University, was professor of pathology and physiological chemistry at the University of California for more than 10 years until 1910. From 1910 until 1921 when he became Director of the Food Research Institute, Professor Taylor was Rush professor of physiological chemistry at the University of Pennsylvania.

Mr. Eastman is president of the American Arbitration Association and American representative on the economics committee of the League of Nations.

Burner Men Adopt Recovery Code

With a substantial majority of the industry's responsible manufacturers represented, an oil burner manufacturers' conference on June 15 in Chicago unanimously approved an all-industry recovery code and empowered the directorate of the American Oil Burner Association to present the recommended code to President Roosevelt under the terms of the administration's National Industrial Recovery Act, according to a recent announcement made by Morgan J. Hammers, president of the A. O. B. A.

While the all-industry code is the official answer of the A. O. B. A. directorate to the government's mandate, Mr. Hammers explained, it represents the consensus of all the leading forces in the industry, for the code as approved by the association's board was first submitted to a round-table conference of manufacturers not as yet members of the association. The dealer division of the American Oil Burner Association, comprising a membership of 2000, also acted and approved the measure unanimously, it was announced by R. S. Bohn, chairman of that division. "This code," Mr. Hammers stated, "is set up for the purpose of increasing employment, establishing fair and adequate wages, effecting necessary reduction of hours, improving standards of labor and eliminating unfair trade practices, to the end of rehabilitating the oil burner industry and enabling it to do its part toward establishing that balance of industries which is necessary to the restoration and maintenance of the highest practical degree of public welfare."

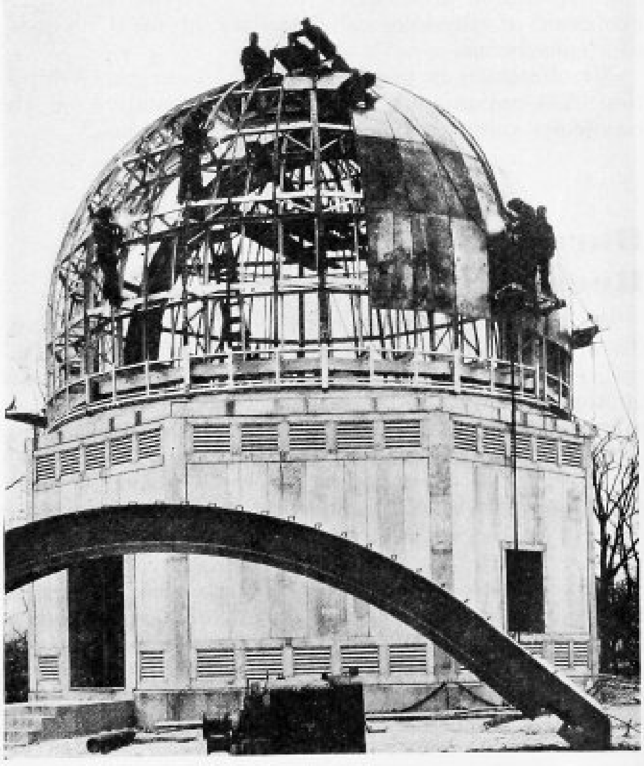
Arc Welding Keeps U. S. Time Accurate

While the delicately balanced $30,000 Naval Observatory clock clicks off the seconds at Washington, D. C., less than 90 yards away two unique buildings are being completed silently and without causing vibrations which might injure the mechanism of the famous timepiece These buildings, observatories for two new telescopes, are being constructed entirely of steel and arc welded throughout. They will house 15-inch and 40-inch telescopes—the larger instrument said to be the finest in the country.

Welded design was decided on for three reasons. It was believed, first, that expansion and contraction of the dome plates, if riveted, might permit the entrance of light and heat rays to an extent which would be harmful to the telescopes; second, that unnecessary vibration caused by rivet hammers might damage the observatory clock; and, third, that welding would provide more rigid and more economical structures.

The larger of the two buildings, shown in the illustration, is 35 feet high and 33 feet in diameter. The smaller structure, of similar construction, is 25 feet in height.

Frames of the buildings are arc welded with the base



Construction of observatory dome

of the columns held down by 4-inch anchor bolts embedded in concrete. A circular structural table built on top of the columns forms a base for the rollers of the dome turntable.

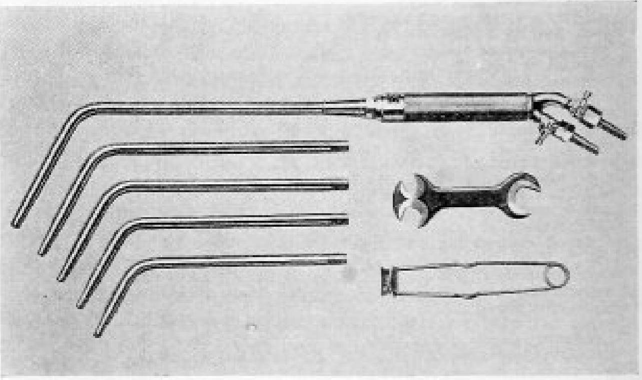
The exterior of the buildings is covered with steel sheets welded in place. Ventilating louvers are provided at the top and bottom of each section. Steel sheets are welded to the inside of the columns, leaving an air space between the outer and the inner vertical walls.

The dome, which revolves freely, is provided with an opening from top to bottom which allows the telescope to protrude. The shutter which fits over this opening is seen in the foreground.

All welding is being done by the J. K. Welding Company of New York City, using equipment manufactured by The Lincoln Electric Company of Cleveland, O. The general contractor is the McHarg Company. Structural shop welded fabrication was done by The Virginia Bridge and Iron Works.

Welding Torch for Wide Range Of Work

The Linde Air Products Company, 30 East Forty-second street, New York, has developed a welding torch known as the Purox No. 28. Ten one-piece, 60 deg.



Purox No. 28 welding torch

goose-neck tips, numbered from 6 to 15, are available for use with this torch. They are built of hard-drawn copper stock to withstand the intense reflected heat of the heavy welding jobs. By means of a union nut these tips may be adjusted so as to point in any direction. Thus, overhead or vertical welding can be accomplished without any change in the normal grip of the torch handle.

Tips Nos. 6, 8, 10, 12, and 14 are furnished with the torch, giving it a range from 16-gage sheet up to heavy castings. By using the Purox No. 21 cutting attachment with this torch, steel up to 2 in. in thickness can be cut.

The Purox No. 28B welding torch is the same as the Purox No. 28 welding torch except that it is supplied with tips Nos. 6, 8, and 10, mixer No. 6-10, friction lighter, and wrench.

By means of an adapter Purox No. 11 welding-torch tips can be used on both the Purox No. 28 and No. 28B torches. This provides a convenient means of increasing the range of usefulness of the Purox No. 28 welding torch in the lighter welding field. This feature is particularly useful in that it obviates investment in an additional small torch when there is only occasional need for light welding.

Derivation of Revised A. S. M. E. Boiler Code Rules for Reinforcement of Openings

Some comments have reached members of the Boiler Code Committee that the new rules for the reinforcement of openings in shells and heads, as given in Pars. P-268 and U-59, of the Code, are difficult to understand. In order to assist those who have had this difficulty, the following simplified explanation has been prepared.

Fig. 1*A* and *C* shows nozzles attached by riveting and by fusion welding to the shell of a drum, and *B* and *D* the same nozzles with parts of the cross-sections marked in different ways for use in the explanation.

Pars. P-268*b*(1) and U-59*b*(1) state in effect that the area of the hole to be reinforced is the diameter of the opening plus the diameter of the rivet holes, if any, measured at the weakest section, minus 2 inches, multiplied by the thickness of shell plate as calculated by Pars. P-180 and U-20, using $E=0.90$. Also, that the amount of reinforcement, deducting for rivet holes, if any, must be equal to that area, with the stipulation that no parts outside of the rectangle *ABCD* may be computed as reinforcement. The limits of this rectangle are (1) *AD* and *BC*, which are located each side of the center line of the opening a distance equal to the actual inside diameter *d* of the opening, (2) *AB* and *CD* which are located 3 times the actual plate thickness above and below the middle line of the actual shell plate thickness.

In the case of nozzles, that portion of the walls to a height of 2½ times the wall thickness *n* above the surface only may be used as reinforcement.

Within the limits of the rectangle *ABCD*, the excess thickness of the shell plate, deducting for rivet holes, if any, above that determined by Pars. P-180 and U-20 for $E = 0.90$, as above stated, may be included as reinforcement.

When two openings are close together so that the limiting rectangles normally would overlap, the limit lines between the openings must be adjusted so that no overlapping occurs, since reinforcement can be applied to no more than one opening.

These rules are substantially what was required by those now obsolete in the 1931 combined edition of the Boiler Code, but are more explicit as to details of calculation.

The reason that the efficiency *E* is taken as 0.90 is to make the revised rules conform with the old and well-established rules for reinforcement of steam domes and manholes. The reason for deducting 2 inches from the diameter of the opening in determining the area to be reinforced was to permit the use of many types of small openings which experience has shown to be safe, such as hydraulic couplings welded into thin shells, and welding necks without reinforcing pads.

Fig. 1 gives simple illustrations of riveted and welded nozzles lettered to show the application of these latest A.S.M.E. rules for openings of the reinforced type.

The several designations are defined as follows:

Lines *AB* and *CD* = extreme upper and lower limits of reinforcement
Lines *AD* and *BC* = extreme side limits of reinforcement
Line *XY* = extreme height of walls of nozzle that may be computed as reinforcement
m = actual thickness of shell plate
t = required thickness of shell plate as determined by Pars. P-180 and U-20 with $E = 0.90$
n = thickness of wall of nozzle
d = diameter of opening
Areas *N* and *O*, Fig. 1*B* and *D* (horizontally shaded parts) = attached reinforcement
Areas *P* and *Q*, Fig. 1*B* and *D* (oblique-line shaded parts) = excess shell thickness considered as reinforcement
Areas *R* and *S*, Fig. 1*B* and *D* (vertically shaded parts) = area to be reinforced.

When expressed as formulas, we have

$$N + O + P + Q \geqq R + S$$

By comparing the cross-sectioned areas in Fig. 1*B* and *D* with Fig. 1*A* and *C* it will be found that the amount of reinforcement required is the same as by the A.S.M.E. Rule, as illustrated in Fig. 1*A* and *C*, where the cross-sectioned areas within the rectangle *ABCD* which come below the line *XY* must be at least equal to or greater than the sum of the areas *EFGH* and *JKLM*.

It will be seen on examining the diagrams that the diameter *d* of the opening for a riveted nozzle is the

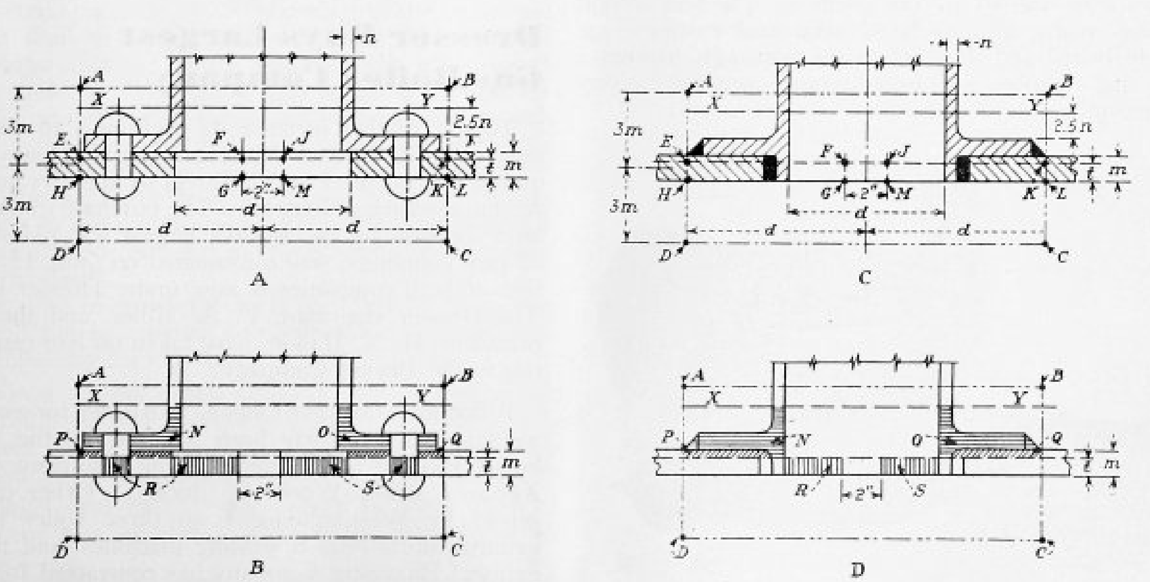


Fig. 1

diameter of the opening in the shell, whereas the diameter *d* for a fusion-welded nozzle is the diameter measured inside of the nozzle opening. The reason that the diameter is measured on the inside of the nozzle opening in the case of a fusion-welded nozzle is that the strength of the fusion welds makes it necessary to reinforce only the opening that is inside of the nozzle.

For riveted nozzles where the rivet holes straddle the center line of the opening, the section is taken through the rivet holes nearest the center line and the dimensions used in the calculation are those in this plane, except that the limit lines are defined by the diameter of the opening in the shell at the center line of the opening and the actual wall thickness of the shell or the nozzle.

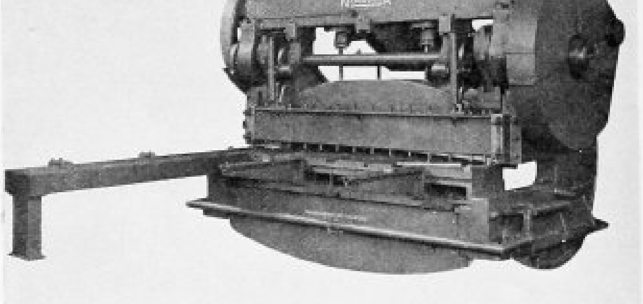
It is not required that the means of attachment shall lie within the limit lines. For instance, in many riveted nozzles, especially those of small diameter, it is manifestly impossible to locate the rivets within a distance of one diameter from the center line of the opening. In such cases, the rivets are credited with their full shearing strength, regardless of their location with respect to the limit lines, but only those rivet holes or parts of rivet holes lying within the limit lines are considered when determining the area of the hole to be reinforced and when computing the reinforcement either in the nozzle flange or in the excess shell thickness.

Another feature to be investigated in the case of riveted connections is the possibility of failure of the shell plate by tearing around through the rivet holes. This may be checked by the method given in Par. P.193*c*.

Any excess thickness provided for corrosion should be deducted before applying the rules for reinforcement of openings.

New Shears for Heavy Plate

To meet the exacting demands of the industry for shearing heavy plate, the Niagara Machine & Tool Works, Buffalo, N. Y., has developed a new M series shears. Semi-steel castings form the housings. The use of castings in these members permits proper distribution of weight giving the maximum strength at the points where stresses are the greatest. The box section bed and crown, also made of semi-steel castings, are securely bolted and doweled to the housings, making a frame that complies with every requirement for rigidity and strength.



Niagara plate shear, equipped with belted motor drive

A feature, worthy of more than passing mention, is the independent chuck carrying the lower knife. It is this construction that permits permanent location of the bed and facilitates adjustment for proper knife alinement. The box section crosshead carrying the upper knife is counterbalanced with air cylinders mounted in the crown. These cylinders, directly connected to the regular shop air-line, operate with practically no loss of air in that the down stroke forces the air back into the line. This type of counterbalance offers the particular advantage of balancing the crosshead in all positions. The large eccentrics operating the crosshead are forged integral with the main shaft and are supported on both sides with substantial bearings to give the maximum strength at the point of load application.

One of the outstanding features of Niagara shear construction, incorporated in this shear, is the patented holddown. Each foot of the holddown is arranged with an individual spring cushion. The feet are self-adjusting for different thicknesses of material, building up pressure as the thickness of material increases. Sheets of shorter length than the maximum cutting length of the shear are gripped with uniformity without tilting the holddown, regardless of whether the sheets are cut in the center of the shear or at either end. The shear may be used for cutting full capacity plate at one end and light gage plate at the other in the same stroke.

All the gears have generated teeth produced by the lobbing method to insure quiet smooth operating gears with maximum strength for shock loads.

A powerful jaw clutch, with hardened tool steel inserts on both striking and backlash surfaces, drives the main shaft. The operator trips the clutch mechanism by means of the foot bar conveniently located in front of the shear and unless the foot bar is held in a depressed position, the main shaft will make one revolution and stop at the top of the stroke.

The shear is furnished with a belted motor-drive arrangement. The illustration shows the short center flat belt drive with the tension maintained by a ball-bearing idler pulley actuated by a compression spring. This drive is extremely quiet in operation and has proven particularly efficient in the sense that it relieves the duty on the motor and the motor bearings and operates at full capacity with no perceptible slippage of the belt.

Dresser Buys Largest Gas Boiler Company

To still further increase its usefulness to the gas industry, S. R. Dresser Manufacturing Company has acquired the facilities and business of the Bryant Heater & Manufacturing Company. The purchase of this Cleveland concern, by the world's largest and oldest builder of pipe couplings, was consumated on June 15. Operation of both companies is now under Dresser direction. The Dresser chairman, F. A. Miller, and the Dresser president, H. N. Mallon, have taken on like responsibilities in the Bryant Company.

WELDING-MACHINE ORDER: An order for a carload of welding machines has been received by the Westinghouse Electric and Manufacturing Company from the Kewanee Boiler Works at Chicago. Other orders received by Westinghouse from three boiler and tank manufacturers total 8 welding machines, and the International Harvester Company has contracted for a three-operator 750-ampere welder.

Rules for the Inspection, Maintenance and Repair of Locomotive Boilers*

Superheater units and headers, exhaust, steam and dry pipes shall be subjected to a hydrostatic pressure test while all engines are receiving classified repairs.

A hydrostatic pressure test of not less than 50 nor more than 100 pounds per square inch shall be used, and while this pressure is maintained, careful inspection shall be made to locate all leaks.

For engines receiving classified repairs, this pressure test shall be made before front end draft appliances are in place in order properly to permit necessary inspection.

Two general methods of testing are allowable. By the first method the exhaust pipe shall be blanked and the water introduced through the cylinders after which the throttle valve shall be blocked in closed position in order to confine the test to the superheater equipment. By the second method, the exhaust pipe is to be blanked and the superheater equipment filled from the boiler through the throttle; this being done after the hydrostatic test on the boiler. Standard appliances for blanking exhaust pipes are shown on company drawings. The cover shall be applied to the top of the exhaust nozzle and made tight with a rubber gasket. The appliance includes a gage for indicating the pressure obtained.

Where locomotives are equipped with outside smokebox throttles, the throttle shall be opened wide and the shut-off valve in the dry pipe closed. On locomotives equipped with feed-water heaters, the exhaust steam line shall be blanked off.

Superheater units, headers and connections, exhaust, steam and dry pipes, steam chest and cylinders shall be carefully examined and all leaks effectively stopped before approving engine for service.

Warm water shall be used during these tests except at points where it is impossible to obtain anything but cold water supply.

Shop and mechanical superintendents shall institute proper records to permit effectively checking the observance of these instructions. Date of the last test of the superheater shall be inserted in the margin of the boiler-wash card.

All units removed at the back shop shall be tested to a hydrostatic pressure of 250 pounds. While under test, the unit shall be tapped with a hammer under the ball ends and around the return bends, which will assist in locating defects. They shall also be given a visual examination to insure that bands and supports are properly applied, spaced and secured. If any defects are found, the unit must be replaced with one in good condition.

All defective units shall be returned to the stores department. When a sufficient quantity has been assembled, the units shall be shipped to the Superheater Company for overhauling.

Units shall be protected with one coat of asphaltum paint and the ball joints covered with grease mixture of the following composition:

Refined mutton tallow	100 pounds
Paraffin wax	20 pounds
White lead	25 pounds
Cylinder oil	20 pounds

All units shall be properly tagged to show class of engines and unit numbers. Units must not be shipped without having ball joints protected by wooden blocks.

Unit bolts are of a special grade of steel to New Haven Material Specifications. The service to which these bolts are subjected makes it necessary that no other material be used. Finished bolts shall be carried in stock subject to requisition. Bolts made up in shops or enginehouses of other material must not be used.

Unit bolts shall be applied with special nuts. Before nuts are applied to bolts they shall have their threads coated with a mixture of common black engine oil and graphite in equal parts. The threads of the bolts shall also be covered with the mixture before applying nuts.

Welding of defects in superheater headers will not be permitted. If defects develop, which make headers unfit for service, they shall be replaced with new headers.

The following tools shall be kept in the tool room at all shops and at all engine points handling superheater engines and will be furnished on properly approved requisition:

1—45-degree reamer for header seats
1—Ball facing tool for units
1—Taper shank grinding lead holder
6—Concave grinding leads
6—Convex grinding leads
1—Ball joint and header seat contour
1—Pincher for applying bands and supports
1—Dolly bar for riveting bands and supports
1—Tong for applying bands and supports.

Testing of Boilers

All boiler work (including application of all studs, etc.), shall be completed and hydrostatic and fire tests made before the locomotive is wheeled.

A hydrostatic test is required after the completion of boiler work on all locomotives repaired. The boiler shall be filled with hot water and a hydrostatic pressure of 125 percent of the rated pressure applied. All leaks shall be marked and shall be repaired after removing the pressure. After repairing, the pressure shall again be applied and the process repeated until boiler is free from leaks.

A fire test shall be made on locomotives as follows:

All locomotives receiving Class No. 1, No. 2 or No. 3 repairs; also locomotives with class No. 4 and No. 5 repairs which have had heavy firebox work.

When locomotives have flexible staybolts to the extent of 25 percent of the total number of staybolts in the boiler, the fire test shall be made after each periodic removal of caps as required by the I. C. C. regulations.

Fire test will not be required on new boilers received from locomotive builders.

After completion of the hydrostatic test, 75 pounds of Oakite which has previously been thoroughly dissolved in warm water, shall be added to the water already in the boiler.

The fire test shall be made with an oil torch, raising the pressure to about 40 pounds at which point all leaks shall be repaired. The boiler shall then be raised to the rated pressure. Leaks shall be marked and when the pressure has been reduced they shall be repaired. The process shall be repeated until the boiler is free from leaks. When the fire test has been completed, the boiler will be drained and washed.

All hydrostatic and fire tests shall be made under the

* Continuation of standard rules of the New York, New Haven, & Hartford Railroad. This series began in the April issue.

supervision of the inspector, together with the boiler foreman as required by the I. C. C. Rules and no boiler shall be considered complete until accepted by the inspector.

Engine House Maintenance

All boilers shall be washed as often as the water conditions require, but not less frequently than once each month, in accordance with Federal rules.

In preparation for boiler wash, the boiler shall be blown down until all pressure is removed. All washout and arch tube plugs must be removed after blowing down the pressure and before beginning to wash boiler. At points not equipped with hot water washout system, boilers must be thoroughly cooled before washing out with cold water.

Begin washing through holes in the side of the boiler opposite the front end of the crown sheet. Wash the top of the crown sheet at the front end and between the rows of crown stays, directing the stream towards the back end of the crown sheet. After washing through holes near the front end of the crown sheet, use the holes in their respective order towards the back of the crown sheet. The object of this method is to work the mud and scale from the crown sheet towards the side and back legs of the boiler and prevent depositing it on the back ends of the flues. Next wash the crown sheet from the back head, inserting the nozzle as far as possible and revolving it so as thoroughly to wash the top of the boiler and all radial stays or bolts as well as the crown sheet.

Wash the back end of the flues through holes in the roof sheet, revolving the nozzle so as to get the water at all sides of the flues and boiler. Use all the holes in their respective order towards the front end of the boiler to clean the flues over their whole length.

Next wash the water space between the back head and firebox door sheet, through the holes in the back head, being careful to remove all scale and mud above and below the fire door hole.

Arch tubes must be washed and cleaned with pneumatic cleaners every time the boiler is washed. If scale is allowed to form in arch tubes, the metal becomes overheated and bulges are formed, and if allowed to remain, the tube warps out of line with holes, strains are set up and cracks develop. This makes the tube dangerous in that it is liable to pull out or burst.

The condition of an arch tube as to scale on the water side can readily be determined by the presence of clinker adhering to the fire side. If an arch tube is clean on the water side, it will be clean on the fire side. Any clinker adhering or sandpaper roughness on the fire side indicates scale formation opposite.

Using the holes on the side of the boiler opposite the crown sheet, wash down the side sheets and staybolts, making sure that all spaces on side of firebox are clear of mud and scale.

In washing the barrel of the boiler start at the front hole and wash towards the back, turning the nozzle and moving it about to reach all accessible parts. It is necessary to direct the stream of water between the flues as well as on the bottom of the barrel. Continue the process in all of the holes until the bottom of the barrel of the boiler is clean.

Use the side and corner holes of water legs, revolving the nozzle so as thoroughly to clean the side sheets, and finally clean off the scale and mud from the mud ring by using the corner holes. The water must run out of the holes clean before the boiler may be considered clean, and even this must not be taken as conclusive proof that it is clean.

No plugs shall be re-applied until the inspector has determined that the boiler has been properly washed and that all old staybolts have been removed.

All standard brass plugs must have a good thread and shall be coated with graphite grease before being applied. All washout plug holes for these plugs must have good threads and if any holes show indication of leakage, they must be retapped before plugs are re-applied. When graphite, through successive applications becomes baked, forming a shoulder, the threads must be cleaned. When a plug becomes shouldered by wear, it shall be scrapped, if it is not practical to rethread it to a smaller size.

Huron washout plugs have a copper gasket seat and graphite grease should not be applied to the threads of this type of plug.

Washing Syphons

Syphons applied to new and old fireboxes require careful attention to details of cleaning operations in order to prolong the life of the device. In bad water territory, more attention is required than when feed water is without scale-forming ingredients.

After locomotives go into service, the syphons shall be washed at the regular washout period. Washout holes are provided in the roof, back head and throat sheets of the boiler for insertion of nozzles and for inspection. Nozzles shall be used as shown on Locomotive Firebox Company's drawings. These drawings will be furnished on request by the assistant mechanical engineer and must be conspicuously posted, for the reference and information of all concerned in washing syphon-equipped locomotives.

When locomotives use water that deposits scale, the syphons shall be "bobbed" at suitable intervals to remove the deposit, special attention being given to the lower portion of the barrel of the firebox syphons on account of solids settling in this part of the syphon and the probable effect of its nearness to the hottest part of the fire. Bobbing shall be done only as often as necessary, the intervals to be determined by local conditions. The boiler shall be empty and hot when bobbing syphons as the scale will usually become detached from the sheets more readily under such conditions than when the boiler is cold and the scale wet. The bobbing tool shall be used in a short-stroke air hammer which has sufficient power to dislodge the scale without damaging the syphon. The working face of the tool shall be shaped to fit the contour of the syphon barrel.

Repair of Minor Defects

When possible, calk minor leaks in firebox sheets while the boiler is still warm.

When rivets leak, it is an indication that they are loose or broken. Therefore, a leaky rivet seam in a firebox must not be worked on to stop leaks while there is any pressure on the boiler.

Calking of leaks around staybolts is permissible only under the direct supervision of the boiler foreman. A combination fuller and riveting tool shall be used for this purpose.

The bolt shall be worked so as to maintain, as nearly as possible, a buttonhead appearance. If bolts continue to leak, leakage is probably due to a poor fit in the thread or to checked holes, and the staybolt shall be renewed, and the checked holes repaired by welding.

Maintenance of Flues

Unwelded flues which are slightly leaking at the firebox end shall be tightened with form C straight finger sectional expander, after which reset beads lightly with a standard beading tool.

(*To be continued*)

New Law Covering Marine Boilers

The United States Senate bill No. 1129, which was drafted by the Steamboat Inspection Department and had for its object the repeal of all laws governing steamboat inspections that were practically obsolete, and gave authority to the Bureau of Navigation and Steamboat Inspection to formulate rules and regulations, subject to the approval of the Secretary of Commerce, was passed by both the Senate and House and signed by the President on June 13.

This bill makes it possible for the Steamboat Inspection Department to formulate rules that are up to date and in keeping with present engineering standards, as they apply to boilers, unfired pressure vessels, appurtenances and steam piping. The provisions of this bill are as follows:

Be it enacted, etc., That sections 361, 392, 406, 407, 408, 409, 410, 411 and 412 of title 46 of the United States Code be, and the same are hereby, amended to read as follows:

SEC. 361. Every vessel subject to inspection propelled in whole or in part by steam or by any other form of mechanical or electrical power shall be considered a steam vessel within the meaning of and subject to all of the provisions of this act: *Provided, however,* That motor boats as defined in the act of June 9, 1910, are exempt from the provisions of this act.

SEC. 392. The local inspectors shall also inspect, before the same shall be used and once at least in every year thereafter, the boilers, unfired pressure vessels, and appurtenances thereof, also the propelling and auxiliary machinery, electrical apparatus and equipment, of all vessels subject to inspection; and the inspectors shall satisfy themselves by thorough examination that the same are in conformity with law and the rules and regulations of the board of supervising inspectors, and may be safely employed in the service proposed. No boiler, unfired pressure vessel, or appurtenances thereof shall be allowed to be used if constructed in whole or in part of defective material or which because of its form, design, workmanship, age, use, or for any other reason is unsafe. At each annual inspection all boilers, unfired pressure vessels, and main steam piping shall be subjected to hydrostatic tests or such other tests as may be prescribed by the board of supervising inspectors. The ratio of the hydrostatic test to the maximum working pressure shall be determined by action of the board of supervising inspectors.

SEC. 406. All boilers and unfired pressure vessels constructed of iron or steel plates or other approved metals for use on vessels subject to inspection shall be made of material that has been tested, inspected, and stamped in accordance with the requirements of this act.

SEC. 407. Any person, firm, or corporation who constructs a boiler, or steam pipe connecting the boilers, or an unfired pressure vessel for use on vessels subject to inspection, of iron or steel plates or other approved metals which have not been duly tested, inspected, and stamped according to the provisions of this act and the requirements of the board of supervising inspectors; or who knowingly uses any defective material in the construction of such boiler, steam pipe, or pressure vessel; or who drifts any rivet hole to make it come fair; or who delivers any such boiler, steam pipe, or pressure vessel for use, knowing it to be defective in design, material, or construction, shall be fined $1,000. Nothing in this act shall be so construed as to prevent from being used on such vessels any boiler, steam generator, steam pipe, or unfired pressure vessel which may not be constructed of riveted iron or steel plates: *Provided,* That scientific data and facts are submitted to enable the board of supervising inspectors to satisfy themselves that such boiler, steam generator, or pressure vessel is equal in strength and as safe from explosion as one of the best quality of iron or steel plates of riveted construction: *Provided, however,* That the Secretary of Commerce may grant permission to use any boiler, steam generator, or unfired pressure vessel not of iron or steel plate riveted construction upon the certificate of the supervising inspector for the district wherein such boiler, steam generator, or pressure vessel is to be used, and other satisfactory proof that the use of the same is safe and efficient, said permit to be valid until the next regular meeting of the board of supervising inspectors who shall act thereon: *Provided further,* That such boilers, steam generators, or pressure vessels may be constructed with seamless shells or by means of any approved method of welding governed by the rules and regulations prescribed by the board of supervising inspectors.

SEC. 408. All iron or steel plates, or other material used in the construction of boilers or unfired pressure vessels for use on vessels subject to inspection shall be tested and inspected in such manner as shall be prescribed by the board of supervising inspectors and approved by the Secretary of Commerce, so as to enable the inspectors to ascertain the tensile strength, homogeneity, toughness, and ability to withstand the effect of repeated heating and cooling; and no plate or other material shall be used in the construction of such boilers or pressure vessels which has not been tested, inspected, and approved under the rules and regulations of the board of supervising inspectors: *Provided, however,* That small unfired pressure vessels having diameters not exceeding 30 inches and subject to a maximum allowable working pressure not exceeding 100 pounds per square inch shall be exempt from this requirement.

The Director of the Bureau of Navigation and Steamship Inspection may, under the direction of the Secretary of Commerce, detail inspectors to inspect iron or steel plates or other material at the mills where the same are manufactured; and if such plates or material are found in accordance with the rules of the board of supervising inspectors, the inspector shall stamp the same with the initials of his name and the official stamp of the Bureau of Navigation and Steamboat Inspection, which stamp shall be authorized by the board of supervising inspectors; and material so stamped shall be accepted by the local inspectors of the various districts as being in full compliance with the requirements of this section regarding the test and inspection of such plates and material: *Provided,* That any person, firm, or corporation who affixes any false, forged, fraudulent, spurious, or counterfeit of the stamp herein authorized to be put on by an inspector shall be deemed guilty of a felony and shall be fined not less than $1,000 nor more than $5,000 and imprisoned not less than two years nor more than five years.

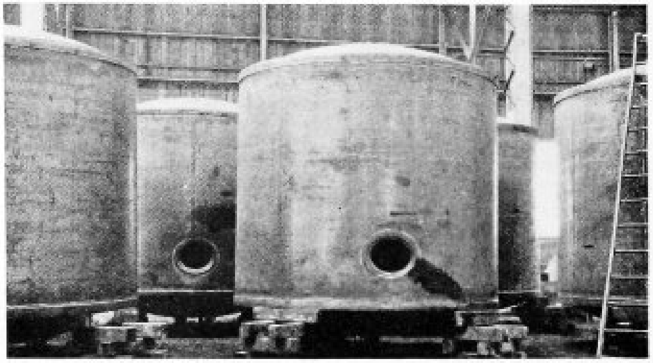
SEC. 409. Every plate of iron or steel, made for use in the construction of boilers, unfired pressure vessels, or riveted steam pipe shall be distinctly and permanently stamped by the manufacturer thereof, and, if practicable, in such places that the marks shall be left visible when such plates are assembled, with the name of the manufacturer, and the minimum tensile strength in pounds per square inch, and the inspectors shall keep a record in their office of the stamps upon all plates, material, and boilers which they inspect.

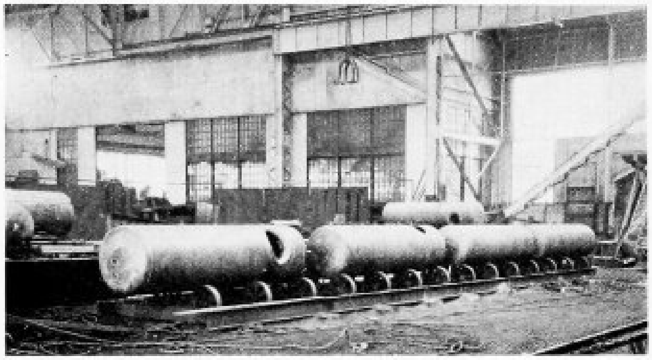
SEC. 410. Any person, firm, or corporation who counterfeits, or causes to be counterfeited, any of the marks or stamps prescribed for iron or steel plates or other material tested and inspected under this act, or who designedly stamps, or causes to be stamped falsely, any such plates or material; and every person who stamps or marks, or causes to be stamped or marked, any such plates or material with the name or trade mark of another, with the intent to mislead or deceive, shall be fined $2,000, and may in addition thereto, at the discretion of the court, be imprisoned not exceeding two years.

SEC. 411. The board of supervising inspectors is hereby empowered to prescribe formulas, rules, and regulations for the design, material, and construction of boilers, unfired pressure vessels, and appurtenances thereof, and steam piping for use on vessels subject to the provisions of this act. The maximum working pressure shall be determined by formulas prescribed by the board of supervising inspectors, and no such boiler, pressure vessel, or appurtenance thereof shall be designed or operated where the factor of safety is less than four: *Provided,* That the minimum thickness and maximum allowable working pressure of valves, fittings, and other appurtenances shall be determined by formulas prescribed by the board of supervising inspectors.

SEC. 412. The maximum allowable thickness of shell plates and the details of material, design, and construction of externally fired boilers shall be determined by action of the board of supervising inspectors.

All laws or parts of laws which may conflict with the provisions of this act are hereby repealed.





All-welded tanks for breweries

Breweries Place Large Orders For Welded Steel Tanks

Beer continues to provide additional business for manufacturers in various fields. Tank fabricators have enjoyed an especially large increase in volume. The tanks shown in the illustrations are part of a shipment of 68 brewing tanks built by the Chicago Bridge and Iron Works for the Lafayette Brewery, Inc., Lafayette, Ind. These tanks are butt welded by the shielded arc process using equipment manufactured by The Lincoln Electric Company, Cleveland, O.

The Chicago Bridge and Iron Works is also welding a number of carbon dioxide tanks for other breweries. These tanks are built in accordance with A.S.M.E. specifications and are designed for a working pressure of 250 pounds.

Welding is being used extensively in the brewery field inasmuch as butt-welded tanks are perfectly smooth on the inside, enabling them to be coated easily.

Stainless Clad Steel Government Measuring Tanks

As soon as the return of legalized beer was assured, the Prima Company of Chicago, like nearly all breweries throughout the country, was faced with the problem of purchasing and installing new equipment to meet the demand. Among the equipment necessary at the Prima brewery were three 150-barrel government measuring tanks. Stainless-clad steel was the material selected for these tanks, and represents one of the first major installations of this comparatively new material for breweries.

These tanks were field constructed and welded throughout. The walls are of ¼-inch Ingoclad, and the heads of 5⁄16-inch Ingoclad, both having a 20 percent thickness of 18-8 stainless steel on the inside. Stainless steel welding rod was used for all welded seams.

The Ingoclad material produced by the Ingersoll Steel & Disc Company, a division of the Borg-Warner Corporation, Chicago, under their patented ingot process showed a high tensile strength which gives a substantially greater factor of safety under pressure than would similar gages of ordinary steel and permits the use of approximately 40 percent lighter gage material.

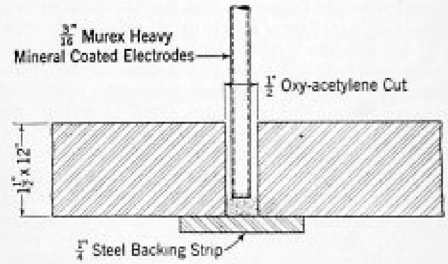
The tanks are used to meet the exacting requirements of government measuring service. Frequent tests during the two month period since they have been in service have proved the stainless clad steel vessels entirely non-toxic to beer.

On the other hand, the stainless interior shows no sign of discoloration nor corrosion, which demonstrates the absolute inertness of both the Ingoclad material, and the stainless steel welds to attack by beer.

Straight Gap Welding

The Metal & Thermit Corporation, New York, has, in a measure, gone into competition with itself by introducing an electric welding process known as Murex straight gap welding. It does away with the need for "veeing" or grooving of plate edges.

Heretofore it has been the practice to bevel the edges



Arrangement of plates and backing strip for straight gap welding of a 12-inch seam in a 1½-inch plate

of plates to be welded and the narrowest bevel considered possible was 12 deg. on each plate, making a total included angle of 24 deg. When the bevel angle is made smaller than this, the metal which is filled in undercuts the sides of the plates and causes pockets to be formed from which slag cannot be removed.

With the straight gap method, square-edged plates are lined up with the welding edges parallel and with a steel backed strip ⅛ in. thick or heavier to close the bottom of the gap. The space between the plates varies according to the size of the electrodes used.

The welding wire has a heavy mineral coating which effectively keeps oxygen and nitrogen out of the weld. The deposited metal passes through the arc in a fine spray without spattering and without abrupt momentary changes in the current flow. It is deposited in the gap with a fillet at either edge and without the formation of pockets in the plate edges. The slag is extremely brittle and is easy to remove.

With this process, a relatively small amount of metal is required to fill the joint. It is suitable for plates up to 4 in. in thickness. Smooth even deposits of unusual high tensile strength and ductility are obtained consistently.

The Boiler Maker

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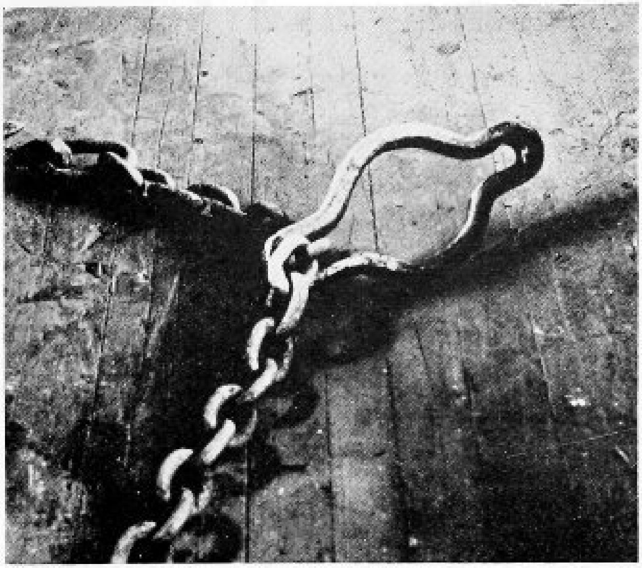
Communications

Hook Link for Connecting Chains

An indispensable piece of equipment for shop use is the "hook link" shown in the accompanying illustration. The hook link can be used any place that the chain hook is used, and while there is always a liability of the chain hook slipping due to straightening out, this is entirely eliminated by the hook link for the reason that the more strain placed on it the more rigid it becomes, as it will close instead of opening.

The links are very easily manufactured. A large welded link is placed in a forge and heated sufficiently to form around a piece of round iron of the thickness of the chain with which it is desired to use the hook link.

Another advantage is that chains on which hooks are attached cannot be forced through small openings whereas with the hook removed the chain can be entered into small openings and both ends fastened after it has been made taut.



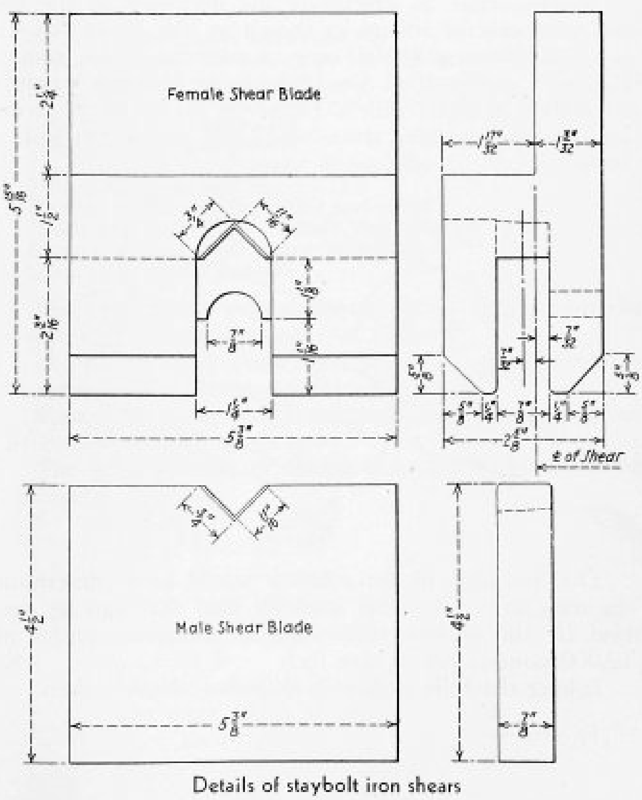
A link that closes under load instead of opening

These links are useful in chaining trucks to cars or tenders during derailments, for chaining up cars out on the line or for bundling up piles of rail or other scrap.

Shears for Heading Staybolt Iron

The illustration shows a set of shear blades for shearing staybolt iron to length and heading the bolts at the same operation. These blades are being used successfully in the boiler shop of the Lucey Manufacturing Corporation, Chattanooga, Tenn., and are attached to an ordinary double-column bolt cutter. The illustration is self-explanatory.

T. C. Ervin.



Details of staybolt iron shears

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

Why Does Water Leave the Water Glass Faster Under Pressure?

Q.—Why does the water leave the water glass faster when there is pressure on the boiler than when there is no pressure on the boiler, when the water glass drain valve is opened?

Why does it leave the glass faster as the pressure increases?—J. M. D.

A.—The velocity of water through a given orifice increases as the head or pressure increases.

The pressure per square inch due to one foot of head is equal to 0.434 pound.

Thus, when there is no pressure on the boiler, the pressure on the water in the water glass due to the head is very small as the height of the water in the glass is generally only between 3 and 5 inches.

Diameter of Top Roll

Q.—Will you please furnish me the formula for calculating the diameter for the top roll of a pair of rolls in relation to the diameter of the two bottom rolls, so that an equal amount of pressure will be placed on all three? I am interested in a set of rolls 38 inches long. The bottom rolls are 3 inches in diameter.—J. C. B.

A.—In order to determine the diameter of the top roll of a pair of rollers as shown in Fig. 1, so that the top and bottom rolls will carry a uniform stress, assume the rolls are made of steel having an ultimate strength of 60,000 pounds, with a factor of safety of 5, giving an allowable working stress of 12,000 pounds per square inch.

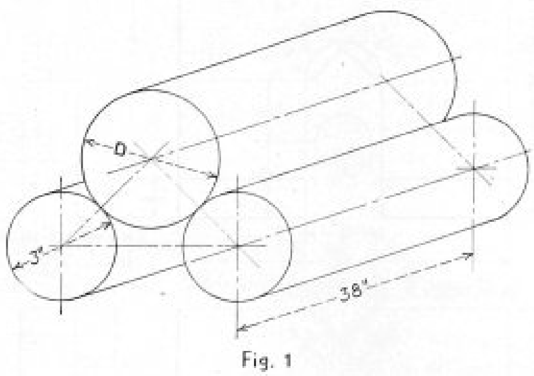


Fig. 1

The first step in the solution would be to determine the maximum allowable working load that can be carried by the bottom rolls with an allowable stress of 12,000 pounds per square inch.

Taking the rolls as beams uniformly loaded, then

$$(1) \quad S = \frac{M}{Z}$$

Where, S = Maximum allowable stress in pounds per square inch,
Z = Section modulus in inches.

For a beam uniformly loaded

$$(2) \quad M = \frac{Wl}{8}$$

Where, M = Total bending moment at middle.
W = Total load in pounds.

Substituting (2) in (1), we have

$$S = \frac{Wl}{8Z}$$

and substituting the values given in the question, we have

$$l = 38 \text{ inches} \qquad d = 3 \text{ inches}$$

$$S = \frac{W \times 38}{8Z} \qquad Z = 0.098d^3$$

$$Z = 2.646$$

$$S = \frac{38\,W}{21.168}$$

Assuming 12,000 pounds for S (allowable stress), we have

$$12{,}000 = \frac{38\,W}{21.168}$$

$$1.79\,W = 12{,}000$$

$W = 6700$ pounds, maximum allowable working load on each bottom roll.

Having determined the allowable working load on the two bottom rolls with a given allowable stress, the next step is to determine the load on the top roll that will be equivalent to the combined load on the bottom rolls. To do this it is necessary to assume some definite relation between the rolls in respect to each other. The distance between the bottom rolls was not given in the question.

Assume therefore that the rolls contact at an angle of 45 degrees, as shown in Fig. 2, and applying the principle of parallelogram of forces:

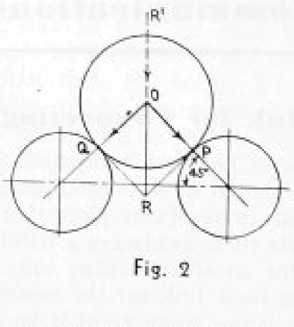


Fig. 2

When a body remains at rest while being acted on by two or more forces, it is said to be in a state of equilibrium, and so also are the forces. Thus, if the forces Pp, Qq, Rr (Fig. 3) acting on the body p, q, r keep it at rest, they are in equilibrium, and any two of them balance the third.

The lines of force, if produced, meet at one point O within the body, and, if a parallelogram be constructed having two adjacent sides proportional to and parallel to two of the forces respectively, to represent them in magnitude and direction, the diagonal of the parallelogram will represent the third force in magnitude and direction.

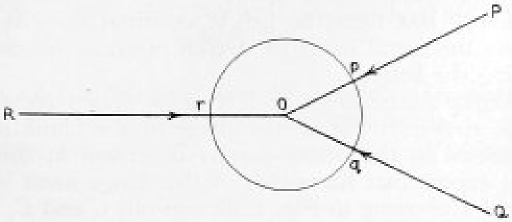


Fig. 3—Equilibrium of Forces

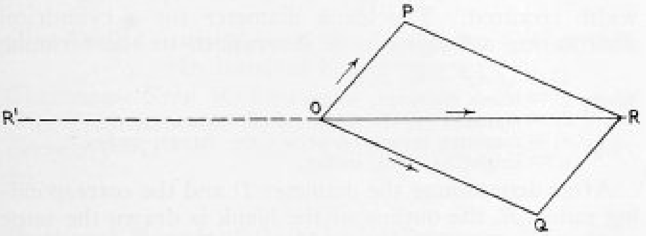


Fig. 4—Parallelogram of Forces

Set the lines *OP* and *OQ* Fig. 4, representing the forces *Pp* and *Qq* in magnitude and direction, and complete the parallelogram by drawing the parallels *PR,* and *QR*. Then draw *OR*. *OR* represents, in magnitude and direction, the resultant of the two forces. *RO,* taken in the opposite direction, represents the third force *Rr,* Fig. 3. If it be applied in this direction to the point *O,* as indicated by the dotted line OR^1, it would balance the other two. This construction is called the parallelogram of forces, and is applicable to any three forces in equilibrium.

Applying this principle to the problem, *OP* and *OQ* in Fig. 2 equal 6700 pounds in magnitude and direction and

$OR = 2(6700 \times \text{sine } 45 \text{ degrees})$

$OR = 2(6700 \times 0.70711)$

$OR = 9375$ pounds, equals load required on top roll to exert a load of 6700 pounds on each bottom roll.

Thus, in order to have a uniform stress of 12,000 pounds per square inch on the top and bottom rolls, the top roll will have to be of sufficient diameter to carry a load of 9375 pounds.

Substituting in formulae (2) and solving for *D,* we have

$$S = \frac{W1}{8Z} = \frac{W1}{8(0.098d^3)}$$

$$12{,}000 = \frac{9375 \times 38}{0.784d^3}$$

$$12{,}000 = \times\ 0.784d^3 = 356250$$

$$9408d^3 = 356250$$

$$d^3 = 37.8$$

$d = 3.356$, or $3\frac{3}{8}$ inches, required diameter of top roll.

With this diameter top roll and with the rolls contacting at an angle of 45 degrees, the distance between the bottom rolls would be $4\frac{3}{8}$ inches.

The answer obtained is for the conditions assumed as the load on the top roll will in all cases be determined by the angle of contact as shown in Fig. 2.

Evaporation in Locomotive Boiler

Q.—Would you study the following data and give your opinion as to the length of time in which the evaporation could have been sufficient with the gage indications mentioned to allow the fusible plug to let go?

The data are as follows:

When the engine arrived at its destination the water level showed a faint indication of water in the bottom gage cock on the rear boiler head. In a period of about 20 to 25 minutes the fusible plug started to drift. The fire was immediately drawn. The bottom gage cock is between 3 and 4 inches above the crown sheet. How near would the water level have to be to the cock in order to get a faint indication of water, and how long would it take for the water to evaporate from this point to a point which is approximately one inch above the crown sheet which is the top of the fusible plug? At this time the engine was standing on perfectly level track. There were no cars attached. An 11-inch compressor was running as well as the electric dynamo. The boiler pressure was about 195 pounds per square inch. The engine did not blow off. However, steam was being used in attempting to get the left injector working. The right injector was using steam but forcing water out on the ground, due to a defective overflow valve. The engine involved has about 75 square feet of grate area. E. H. C.

A.—It is difficult to say how much water was over the crown when the bottom water gage showed a faint indication of water, as it is a known fact that on engines where the gage cocks are screwed directly into the backhead a correct indication of the water level is not given.

When steam is being generated and escaping, there is an upward movement of water at the backhead of the locomotive boiler which carries it above that further ahead over the crown sheet and that the gage cocks, when applied directly into the boiler, register this rise of water and do not indicate the level further ahead, while the water glass registers the level of water further ahead and not the water at the backhead. On tests, the rising of the water around the firebox at the backhead and wrapper sheets reached a height above that over the remaining portion of the crown sheet of approximately 2 to 4 inches in proportion to the amount of steam being generated and simultaneously escaping from the boiler.

It is quite possible in this case that there was less than 3 to 4 inches of water over the crown.

The data given are not sufficient, in that the boiler dimensions necessary for computing the water over the crown are not included. I have therefore assumed a typical case, which can be followed for any given set of conditions.

Example:

Type—0-8-0
Boiler Type—Conical connection
Boiler Pressure—200 pounds per square inch
Boiler Outside Diameter front end, inches—78
Boiler Outside Diameter back end, inches—83⅞
Firebox length, inches—110
Firebox width, inches—100
Tubes, number and diameter, inches—401-2
Tube length, feet and inches—15-0
Heating surface, tubes, square feet—3128
Heating surface, firebox, square feet—220
Heating surface, total square feet—3348
Grate area, square feet—75

The total water evaporated per hour is based on the Coatesville evaporation tests as follows:

Pounds of water evaporated per hour, per square foot of outside tube heating surface—10

Pounds of water evaporated per hour, per square foot of firebox heating surface—55

The total pounds of water evaporated per hour by the boiler would be

$$3128 \times 10 = 31{,}280$$
$$220 \times 55 = 12{,}100$$

43,380 Total

The approximate weight of three inches of water over the crown would be

Approximate length of water = 306 inches
Approximate width of water
3 inches above crown = $72\frac{1}{2}$ inches
Depth of water = 3 inches

$$\frac{300 \times 72.5 \times 3}{231} \times 8.33 = 2400 \text{ pounds of water.}$$

The boiler evaporating 43,380 pounds of water per hour would evaporate 2400 pounds of water in

$$\frac{2400}{43{,}380} \times 60 = 3.31 \text{ minutes required to evaporate 3 inches of water over the crown.}$$

This would be under maximum working conditions; however, based on the above and under the conditions given in the data, the fact that the boiler pressure was 195 pounds would indicate that there was a good fire in the firebox, together with the fact that steam was being used by four auxiliaries, twenty-five minutes would be more than ample time to evaporate what was probably less than 2 inches of water over the fusible plug at the time the engine arrived at its destination.

Blank for Rectangular Box

Q.—Please give the method of developing a blank for a rectangular box, which is to be pressed into shape. E.R.

A.—To lay out a blank for a rectangular-shaped box first draw the plan view of the finished box, the corners being given the required radius. Next draw the sides and ends, making the length A and the width B equal to the length and width of the drawn part minus twice the radius r at the corners. We now have a blank which would produce a rectangular box without corners.

To provide the right amount of material for the corners, first find what blank diameter would be required to draw a cylindrical shell having a radius r. This diameter can be obtained by the formula,

$$D = \sqrt{d^2 + 4dC}$$

where D = blank diameter, inches
d = diameter of drawn shell, inches
C = height of shell, inches.

After determining the diameter D, scribe arcs at each corner having a radius R equal to one-half of diameter D.

The outline of the blank for the rectangular part is then obtained by drawing curved lines between the ends and sides as illustrated in Fig. 1. These curves should touch the arc R. The exact shape of the curve depends somewhat upon the proportions of the drawn part, but it can readily be determined by drawing a few trial blanks and making whatever changes may be necessary to secure a more even edge along the top of the drawn part.

If the drawn part is narrow in proportion to the length, the dimension C at the ends of the blank should be slightly less than the height required for the work, because the metal tends to stretch more at the ends, increasing the height.

When a flange is to be left on a drawn rectangular box as shown in Fig. 2, the shape of the blank may be determined in the same way as described in the foregoing, except that the width of the flange must be considered. Referring to Fig. 1, dimensions C and C_1 on the flat blank are made equal to the height of the drawn part plus the width M of the flange and the radius R at the corners should be established from the formula for a shell of radius r, having a flange corresponding to the width required. The blank diameter for a cylindrical shell having a flange can be determined by the formula,

$$D = \sqrt{d_2^2 + 4d_1 \times C}$$

where D = blank diameter, inches
d_1 = diameter of the drawn shell, inches
d_2 = diameter measured across the flange, inches
C = height of shell, inches.

After determining the diameter D and the corresponding radius R, the outline of the blank is drawn the same as for a rectangular shape without a flange.

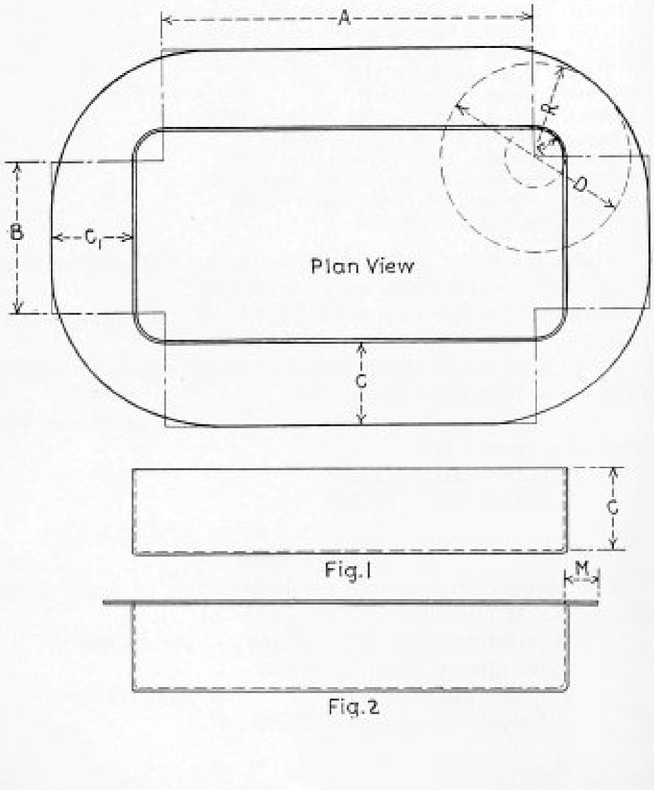


Fig. 1

Fig. 2

Government Specifies "Largest" X-Ray Weld Test

The giant sections of the Hoover Dam penstocks, which are to be welded both circumferentially and longitudinally, are to be tested throughout their length by the X-ray method, according to the specifications to the Babcock & Wilcox Company, Barberton, O., to whom the contract for this work has been awarded. The undertaking is mentioned as the largest industrial X-ray job to have been let to date. It is estimated a minimum of 159,000 separate exposures will be necessary, calling for the use of more than 24,000,000 square inches of X-ray film.

The size of the undertaking required the construction of a new type of X-ray apparatus, rated at 300,000 volts and 10 milliamperes, and capable of producing radiographs on a continuous operation basis of welded steel plate up to 4 inch thickness. The penstock sections range from 8½ feet to 30 feet in diameter and the steel is 3 inches thick in many places. The specifications require that every inch of steel (the total length is about 75 miles) be subjected to careful analysis.—*The Locomotive.*

OXWELDING FOR GENERAL MAINTENANCE.—This booklet describes the use of the oxy-acetylene process of welding and cutting in reclamation of broken and worn machine parts, alteration, fabrication and installation of equipment. Among the various plant equipment covered are piping, tanks and containers, machine elements, engine and pump parts, frames and conveying equipment. Repair of worn parts by bronze-surfacing and hard-facing is given special consideration. Among the many illustrations is a chart giving thirteen simple tests for identifying the more common metals.

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

Manager—James D. Andrew.

Secretary—H. E. Aldrich.

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
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

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.		Tampa, Fla.

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

States

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

Cities

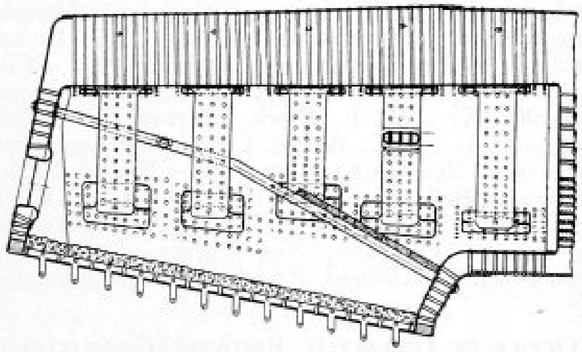
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

Selected Boiler 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.

1,819,907. CROWN SHEET SUPPORT FOR LOCOMOTIVE FIREBOXES. JESSE C. MARTIN, JR., OF LOS ANGELES, CALIFORNIA.

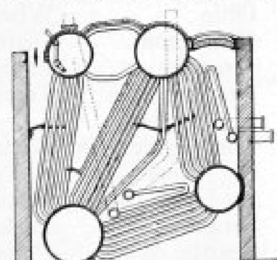
Claim.—In a crown sheet supporting structure for a locomotive firebox, a hollow water carrying column having a cross-section arranged symmetrically about a long and a short axis set at right angles to each



other, connecting ends on said column secured to the side sheet and crown sheet of the firebox and communicating with the water leg of the firebox and the water space over the crown sheet, said column having a single radius of curvature between its connecting ends concave toward the connected sheets, and cross-sections adjacent its connecting ends with long axes substantially parallel to the horizontal longitudinally extending center line of the firebox. Eight claims.

1,820,520. BOILER. ASHUR U. WETHERBEE, OF CHICAGO, ILLINOIS.

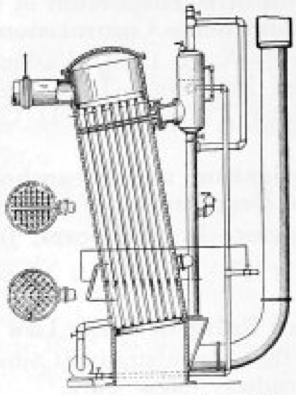
Claim.—In combination, a boiler casing having a front wall, a boiler in said casing comprising a mud drum at the back of the casing, a water drum slightly above the mud drum and disposed at the forward side of the casing and sealed with the front wall, a steam and water drum disposed at a higher level than the water drum and between the water drum and the mud drum, tubes connecting said three drums in a ring circuit,



a furnace in the lower part of the casing, the tubes joining the mud drum and water drum being inclined at a small angle to the horizontal to provide circulation, the length of said tubes being proportioned to the capacity of the furnace so that the fire gases flowing from the furnace strike across said tubes and fill the entire space through which said tubes are projected, and a baffle disposed above the lower tubes so as to provide a relatively large gas space above said tubes along their full length, and a bent tube type of superheater disposed in the aforesaid gas space substantially parallel to the lower-most bank of tubes. Nine claims.

1,819,470. STEAM GENERATOR. WALTER DOUGLASS LA MONT, OF LARCHMONT, NEW YORK, ASSIGNOR TO LA MONT CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

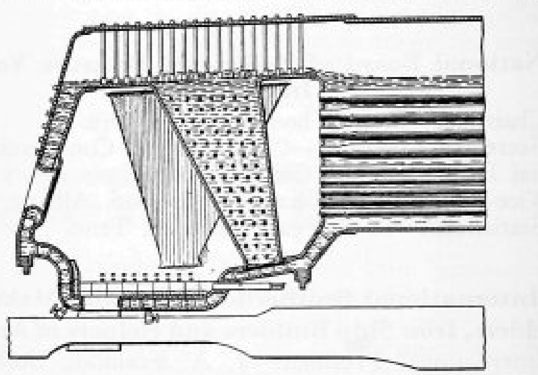
Claim.—Method of operating a boiler of the type having water tubes connected at their ends to a drum which normally contains a large part of the volume of water within the boiler and in which is normally maintained a water level adjacent the upper portions of the heat transferring surfaces of the boiler whereby said heat transferring surfaces are normally substantially completely covered with the water of said volume of water within the boiler and in which the generated steam is normally discharged above said water level, which consists in maintaining a volume of water within the boiler having a water level at such a point that the tubes are uncovered for substantially the entire extent of their heat transferring surfaces, supplying water to the interior surfaces of the tubes so that it flows thereover under the action of gravity in quantity



in excess of the steam generating capacity of the tubes but less than sufficient to fill the space between their surfaces, discharging said excess water after passage over the tubes to said volume of water, and causing the gases used to furnish the heat for steam generation to flow in a direction counter to the flow of water over the heat transferring surfaces. Five claims.

1,819,134. BOILER. HENRY V. STEVENS, OF TOPEKA, KANSAS.

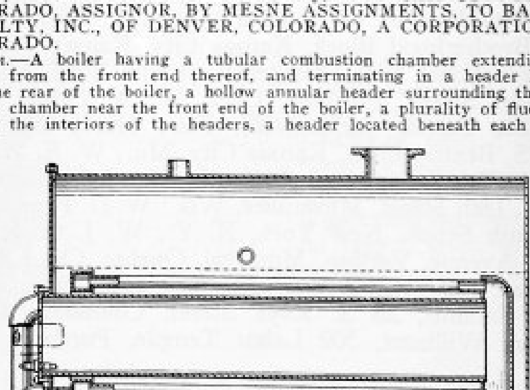
Claim.—In a boiler including a fire box, water legs at the sides of the fire box, a water table forming the bottom of the fire box and comprising



shelf portions on all sides of the fire box directly communicating with the water legs, and a floor portion positioned below the shelf portions and co-operating with the shelf portions to provide a fuel combustion chamber. Ten claims.

1,829,993. BOILER. WILLIAM A. J. KREAGER OF DENVER, COLORADO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO BARQUE ROYALTY, INC., OF DENVER, COLORADO, A CORPORATION OF COLORADO.

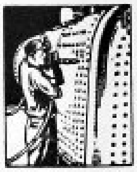
Claim.—A boiler having a tubular combustion chamber extending inwardly from the front end thereof, and terminating in a header located near the rear of the boiler, a hollow annular header surrounding the combustion chamber near the front end of the boiler, a plurality of flues connecting the interiors of the headers, a header located beneath each of the



other two, the one located beneath the annular header having a plurality of separate compartments and the one located beneath the rearmost upper header having one compartment less than the front lower header, flues interconnecting the compartments in the lower headers so that flue gases will pass successively through all of the compartments, means for connecting the interior of the annular header with the upper compartment of the lower front header, and means for connecting the lower compartment of the last named header with a flue gas outlet pipe located outside of the boiler. Three claims.

The Boiler Maker

Reg. U. S. Pat. Off.



"Master Boiler Makers Convention in Print"

In order to maintain interest in the work of the Master Boiler Makers' Association among the membership and above all to retain for the benefit of the railroads of the country the incalculable service this Association has rendered in the past, the officers have enlisted the co-operation of *The Boiler Maker* to conduct for them what will be known as the "Master Boiler Makers Convention in Print." This convention, equivalent in every respect but personal contact with an actual convention, will be published in the October issue. There will be addresses by a number of prominent railroad mechanical officials from each section of the country; addresses by officers of the Association; topic committee reports covering every phase of developments in boiler shop methods, tools, equipment and materials of the past three years, and an exhibit section in which supply companies may display their new and improved products. Discussions of all reports will subsequently be published.

At no time in the thirty-one years of existence of the Association has the need been greater for unity of thought and practice in the conduct of locomotive boiler department operation. Individually and collectively the members of this craft can perform an invaluable service to their roads in meeting the serious problems of rehabilitating the motive power of the country which inevitably will face them in the coming months.

It would be difficult to conceive a more opportune moment for co-ordinating effort within this important branch of the mechanical department. The value of conducting this convention has received the unqualified endorsement of chief mechanical officers all over the country.

Officers of the association have been untiring in developing the material to make this convention a success. It remains in the hands of all members and, in fact, of all readers throughout the industry to give this effort their complete support.

The Boiler Manufacturing Code

The code, which is to govern the boiler manufacturing industry under the National Recovery Act, is rapidly reaching its final stages of development. While nearly 90 percent of the production of the industry is concentrated in the plants of members of the American Boiler Manufacturers' Association, there is a great number of small companies in the boiler manufacturing and allied industries yet unorganized, but which will be obliged to conform with the provisions of the code.

In order to give the entire industry an opportunity to consider the code and to discuss how it will be administered, at the time of going to press it was understood a meeting would be held at the Hotel Cleveland, Ohio, on August 10 and 11. At this meeting it was also planned to consider supplementary codes covering the sale of products of the various subdivisions of the industry. There are many branches concerned with the fabrication of different types of boilers, such as water-tube, horizontal return tubular and oil field boilers, as well as stokers and pulverized fuel equipment, in the closely allied industries. The sales problems of each group are somewhat different in character so, while each will be governed by the basic provisions of the code on production hours, wages, and the like, there will inevitably be variations in the requirements for marketing products.

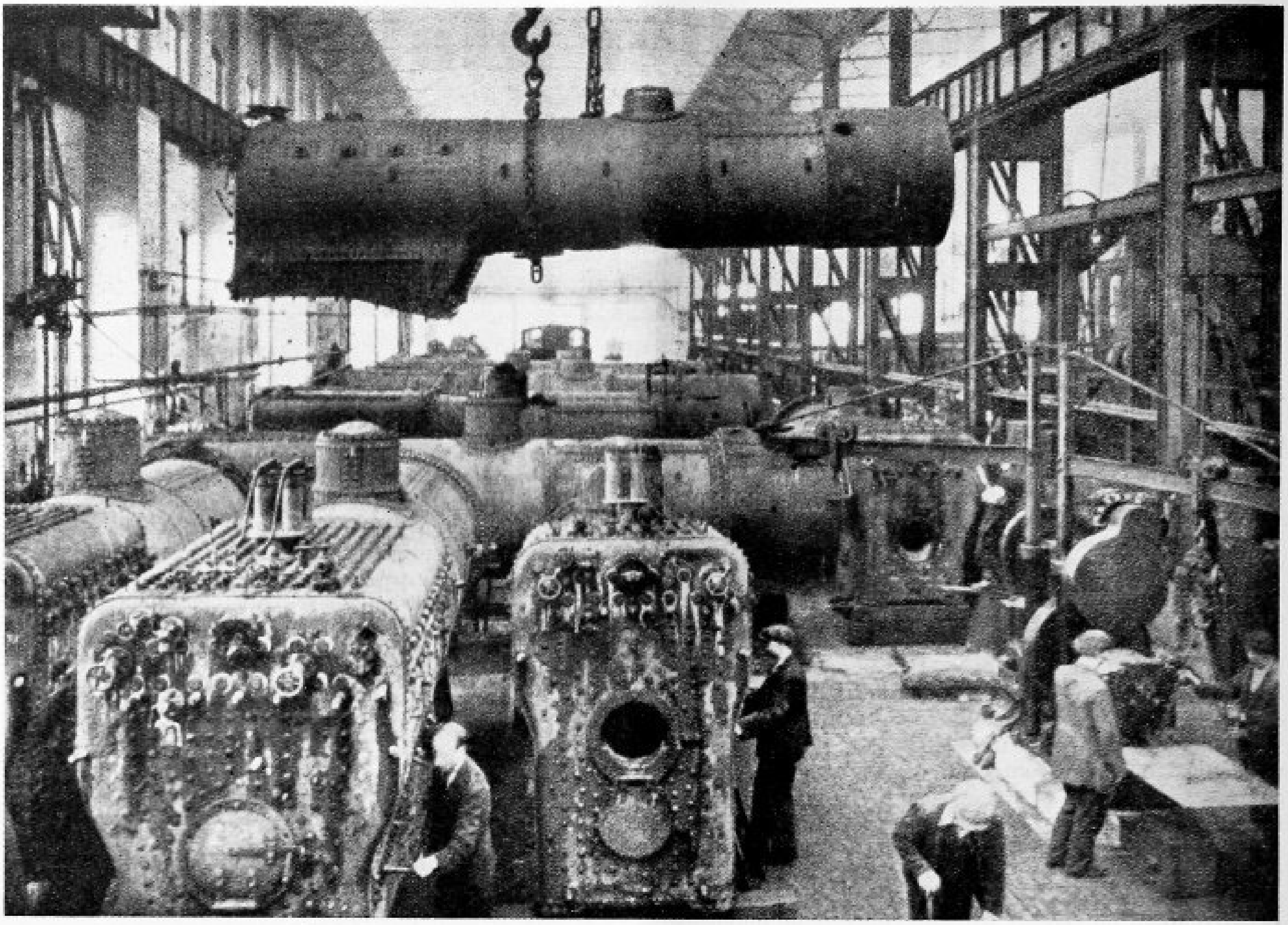
The date for official hearings on the code has not as yet been set by the National Recovery Administration, but should be fixed shortly. Anticipating the approval of the code, many members of the boiler manufacturing industry have already placed in effect its provisions, covering wage rates and hours, in conformance with the desire of the Administration to speed recovery.

There can be no question that in this, as in other industries under code operation, the possibilities of developing equitable and fair practices are greater than ever before.

Business Continues to Increase

The general improvement in the boiler manufacturing and plate fabricating fields that was evident in May, continued through June, as evidenced by reports of the Bureau of the Census, Department of Commerce. In June, 511 power boilers of 549,618 square feet of heating surface were ordered, as against 328 of 395,601 square feet in May. In spite of the extremely low production in this industry for the first three months of the year, the six months' total of 1640 boilers of 1,761,099 square feet exceeds the first six months' production for 1932 by 3.65 percent in number and by 4.2 in heating surface.

The steel plate fabricating industry showed more than a 50 percent gain in June over May production. The figures for new orders in June are 36,958 tons as against 16,243 tons in May. In this industry the 1933 six months' total is 99,322 tons, which is 7.2 percent greater than in the first six months of 1932. One extremely significant development in the type of production took place in June; namely, in the oil storage tank classification. In May, tanks aggregating 2858 tons were ordered, and in June, 20,894 tons. Tank cars increased from none in May to 333 tons in June. Miscellaneous fabrication increased from 8183 tons to 13,951 tons.



Erecting shop in the Stratford Works of the London & North Eastern Railway

Reorganization of British Locomotive Works Speeds up Production in Tube Shop*

During the past few years a considerable reorganization has been undertaken at the Stratford works of the London & North Eastern Railway. Prior to amalgamation, the locomotives, carriages and wagons of the former Great Eastern Railway were maintained and, to a large extent, constructed at Stratford. Following upon the amalgamation of the Great Eastern with the remainder of the companies forming the London & North Eastern system, the policy of building new stock at Stratford was discontinued and a scheme of reorganization planned to secure the best and quickest means of maintaining the rolling-stock on this section. Stratford works had originally to provide for the upkeep of 1380 locomotives, 5222 coaching-stock vehicles, and 21,478 cars.

In 1917 the Great Eastern Railway constructed a new shop intended for the repair of locomotives. This shop is situated on the western side of the works, some little distance from the main supply shops, such as the machine shop, the foundries and the boiler shop. When the reorganization work was undertaken it was, therefore, decided to follow a definite policy and to utilize this new shop for the maintenance of the largest of the locomotives which could not be conveniently dealt with in the original shop used for erecting and repairs, and to concentrate the repair of what might be termed the standard Great Eastern engines, including the somewhat large proportion of tank engines needed for suburban traffic, in the original shop, which is situated in close proximity to the main supply shops. The first object, therefore, was to make the new shop, to which reference has been made, as far as possible self-contained and to install adequate and up-to-date appliances in the original one.

The output of the new shop, which, as stated, deals exclusively with the largest types of engines, is kept down to the repair of approximately three engines a week. By doing this it has been possible to restrict the actual engine-repair work to one of the three bays, at one end of which the stripping work for these engines is also undertaken. The central bay has been equipped with wheel-repairing plant, and possesses its own facilities for doing a large proportion of machine work and

*Tube shop and boiler shop details in this article were released for publication through the courtesy of *The Railway Engineer*, London.

all the white-metal work. The third bay has been divided in two, in one-half of which all the tender repair work is carried out, while in the other half of this bay the boiler-repair work for the engines dealt with in the shop is undertaken. If a complete new firebox is required, it is manufactured in the main boiler shop and transferred to the boiler-repair bay, where the firebox is fitted. Except for heavy repairs to boiler shells, the shop is self-contained.

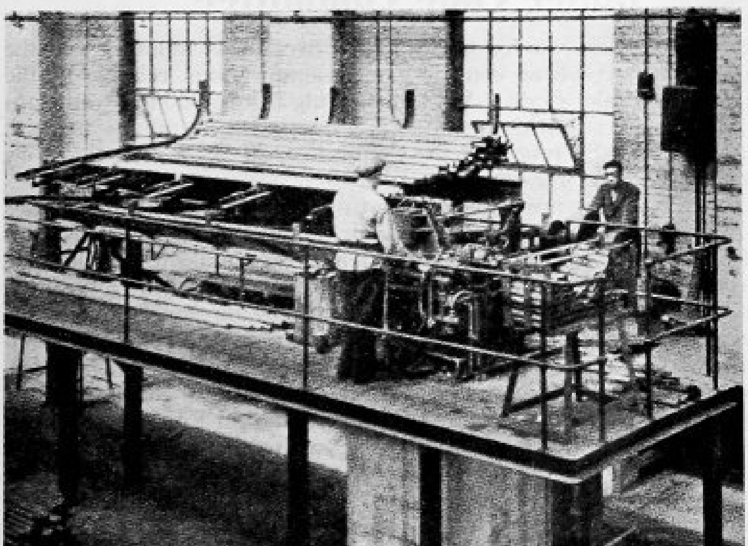
The concentration of the tender work in this shop has made it possible to relegate what was formerly the tender shop to the work of engine stripping. This shop is situated at the point at which engines sent to Stratford for repair are received. The shop has been provided with new crane-power and engine pits, and in it the engines are stripped and the boilers taken out and sent on boiler trollies to the tube-repair shop. The motion and other parts are cleared and sent by power truck to the inspection room, the frames being sent on their own wheels to the erecting shop, on the eastern side of the works. The boilers on arrival on their trollies at the tube-repair shop, which is close to the engine-stripping shop, are placed under an outside awning. At this point the tubes are taken out, after which the boiler itself is forwarded to the main boiler shop, which is also on the eastern side of the works.

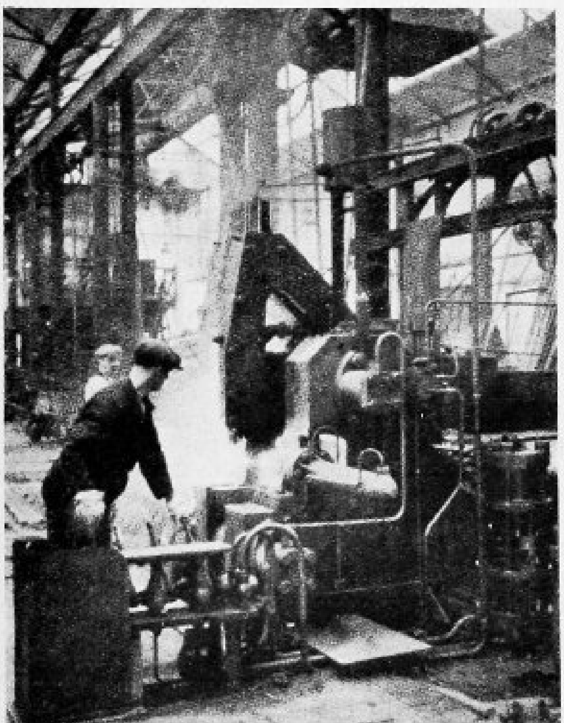
The component parts are delivered as stated, by power truck to the inspection room. At this point they are dealt with by inspectors, who pass or reject each article on maximum and minimum gages and mark by means of paint what repair has to be carried out. A part which is to be scrapped is, for instance, marked in red, a repairable one in yellow, and a part to which nothing need be done in green paint. The parts which do not require attention are laid out on the floor of this shop in the position allocated to the engine number, where they are ready to go back to the erectors, as required, and from this shop orders are issued for the manufacture of parts which have to be replaced on account of scrapping and for the exact repair which has to be done to the parts capable of renovation.

The tube shop, in which the whole of the tube repair work, including superheaters, is carried out, has been entirely redesigned and re-equipped. A plan denoting the processes involved is reproduced. The tubes removed from boilers are taken by trolley to one end of the shop; at this point one end is cut off and they are passed through Crow Hamilton reeling machines. They pass next to a sorting bench, where the scrap tubes fall through a trap into a pit and the good tubes are cut to length and passed to containers for the next operation. This consists of electric butt welding by a 35 kilovolt-ampere machine after which the fin formed by the welding is ground off, and the tube then passes down a skid by gravity to the swaging position. From this point the tube rolls down to the testing machine and subsequently gravitates to containers on trollies, where the finished tubes are collected. The plant is duplicated on each side of one bay of the shop. The total number of the tubes examined, cleaned and welded in this way amounts to 3600 to 4000 a week. In the far bay the smoke tubes are dealt with on similar lines, and are butt welded by means of a No. B.9.a. 250 kilovolt-ampere machine. This machine is capable of welding tubes up to 6 inches diameter and can deal with one large tube or two small ones simultaneously. All the butt-welding machines are hydraulically operated and automatically controlled.

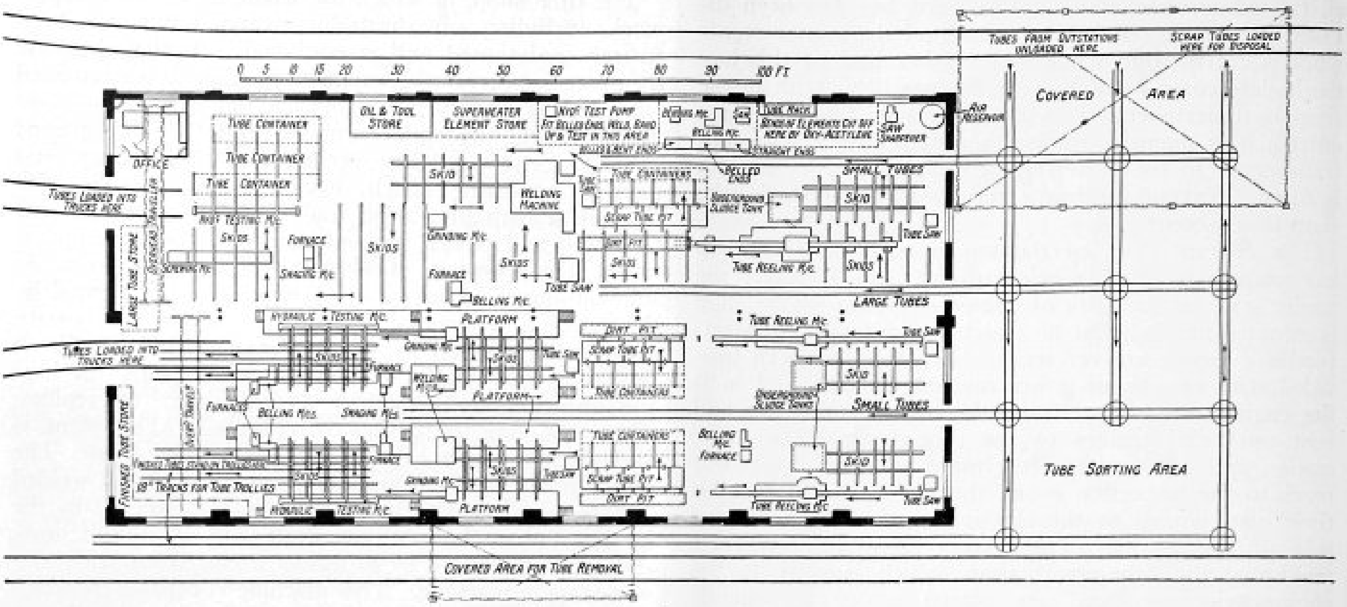
Tubes received from outstations requiring repair arrive in car loads at the same end of the shop on the opposite side and pass through exactly the same process. All tubes are delivered in bulk, after repair, to the main boiler shop, to the self-contained engine repair shop or to outstations, as called for by circumstances.

So far no extensive modifications have been undertaken in the boiler shop. The question of its reconstruction is at present under consideration, and it is hoped that this may be proceeded with shortly. Considerable attention, however, has been given to the equipment used in the shop itself. As the supply of compressed air was formerly inadequate, a new air compressor of 1000 cubic feet free air capacity a minute was installed





Above are tube skids serving welding and grinding machines for small tubes. At right is a superheater tube butt welding machine



Layout of the new flue shop at the Stratford Works

and a considerable number of tools have been provided, including pneumatic drills, riveting and chipping hammers and rivet guns. Other specialized tools provided include three portable automatic electric tube expanders, electric drills with pneumatic feed, and an automatic acetylene cutting plant. In addition to this the system of testing a boiler under steam has been modified. Previously, boilers were lit up by hand at a point which presented a certain amount of difficulty as regards access. This has been overcome by the provision of a crane outside the existing boiler shop. A parent boiler provides the necessary steam required for testing, after which the finished boiler passes directly through the boiler shop to the erecting shop for use on the engine to which it has been allocated.

As a result of the reorganization system, the number of days taken to repair a locomotive has been reduced from the region of 70 days, in 1927, to an average of 24 days in 1932. Consequent upon this, the percentage of engines under and awaiting repair has been reduced during the same period from an average of 11.9 in 1927 to an average of 5.25 in 1932. This means that the number of engines in stock has come down from 1378 in 1927 to 1293 in 1932, and the engines continuously out of traffic now number between 50 and 60 against a figure of approximately 100—120.

An engine progress system has been instituted. Each engine received for general repairs has a scheduled number of days allotted for it to be dealt with by the erectors, the number of days depending on the type of engine and nature of repairs required. A schedule has been prepared fixing the number of days allowed for the preparation of various details for each type of engine, and cards, A, B, C, D and E (the index letter standing for particular details) are issued to all subsidiary shops concerned on the day the repairs to the engine are taken in hand. These cards show the date on which the details should be ready for the erectors and are returnable to the locomotive progress office in advance, indicating on the card, in a space provided, whether the work is completed, or if not, when it will be, with reasons for non-completion if delay is involved. The progress of each engine through shops, from receipt to return to traffic, is indicated by a key card suspended on a board in conjunction with the engine cards mentioned above. The staff dealing with this progress work consists of one technical assistant and a clerk. Recently certain classes of engines have been re-boilered and have had modifications made to their steam distribution, by which improved results have been obtained. The standard Great Eastern express engine of the 4-6-0 type has been fitted with a boiler 5 feet 6 inches in diameter and provided with a modified valve travel-arrangement, giving a maximum of 6⅛ inches; also one boiler has been designed which is common to the Great Eastern standard 4-4-0 type of passenger engine and four classes of goods engine owned by the old Great Eastern Company.

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 given records of the interpretation of the Committee in Cases Nos. 749, 751 and 754, inclusive, as formulated at the meeting of May 26, 1933, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 749 (Reopened).—*Inquiry:* Do not the provisions of Par. U-77, which require hydrostatic testing of all welded pressure vessels, conflict with those of Par. U-64, which provide for testing by air pressure if the size is too great for the foundations to withstand the weight of the water used in testing?

Reply: It was the intent in the revision of Par. U-64 to make an exception of large riveted vessels for gas-storage purposes. To provide for this it is proposed to revise Par. U-64 as follows:

U-64. *Hydrostatic Test.* Each vessel constructed under these rules shall be tested under hydrostatic pressure of not less than 1½ times the maximum allowable working pressure except that for enameled vessels including those of welded construction, the test pressure shall be at least, but need not exceed the working pressure and excepting other fusion welded vessels which shall be tested in accordance with Par. U-77.

Gas storage vessels of riveted construction which are so constructed or installed as not to be capable of safely withstanding the weight of the large mass of water required to fill them for hydrostatic test, may be tested by compressed air to a pressure of at least, but which need not exceed, the maximum allowable working pressure of the vessel, provided the allowable working pressure does not exceed 80 per cent of that which would be permitted if the vessel were subjected to the regular hydrostatic test pressure.

Case No. 751.—*Inquiry:* The welding specifications for both power boilers and Class 1 unfired pressure vessels require two test plates to be made for each vessel. It is not specified by whom such test plates should be made, nor is there any reference made to the qualifications of welders if several are employed on the fabrication of any particular vessel. Please clarify the intent of the Boiler Code Committee as regards the qualifications of welders engaged in Class 1 and power boiler welded construction.

Reply: It is the intent of the Boiler Code Committee that in fusion welding for power boilers and Class 1 unfired pressure vessels, where several welders are employed on one vessel, the manufacturer shall satisfy the inspector that all of these welders have proved their ability to comply with the requirements for Class 1 construction by previously conducted tests. It is the duty of the inspector to satisfy himself that only welders who are proved competent by these tests are used to weld any pressure part of the vessel and that all welding complies with the Code requirements. To enable the inspector to perform this function, he shall be permitted to observe all the welding operations on said vessel. The inspector has the right at any time to call for and witness the making of test specimens by any welder and to observe the physical tests to satisfy himself that this welder has the necessary ability to comply with these requirements. When more than one welder is employed on a power boiler drum or a Class 1 unfired pressure vessel, the intent of the Boiler Code Committee will be fully met if the test plates are made by one of these welders, but it is the opinion of the Committee that the inspector may designate which welder shall make the test plates.

Case No. 754 (Reopened).—*Inquiry:* When there are a number of vessels of substantially identical dimensions and of the same grade of material being fabricated by welding, would it be permissible under Par. P-102*b* of the Code to furnish two test specimens for a given length of welded joint?

Reply: The Boiler Code Committee recommends that when there are several vessels being welded in succession on any one order whose plate thicknesses fall within a range of ¼ inch and whose diameters differ by not more than 6 inches, and of the same grade of material, the provisions of Par. P-102*b* be considered as being complied with, if two test plates are furnished for each 50 lineal feet of either or both longitudinal and girth joints, provided the joints are made by the same welders and by the same method of welding.

Dual-Control Arc Welder

A new four-bearing, self-excited, dual-control arc-welding machine, known as Model S. A., is now in production at the plant of Wilson Welder & Metals Co., Inc., North Bergen, N. J. This machine is built to meet the ever-increasing demand for the high amperages and arc voltage required in speed and shielded-arc welding. It offers the distinct advantage of a two-unit machine with a flexible coupling, which permits the changing of the motor or the generator in case of failure, without that loss of time which results when trouble occurs in a dynamotor set which has all of its units mounted on a single shaft.

This new machine combines ruggedness of construction with simplicity and compactness of design. Not a single electrical contact or connection is exposed. The only projecting parts are control handles, and these are placed so that they are safe from injury. Moreover, the voltmeter and ammeter (the only parts subject to breakage) are set at an angle which greatly reduces chances of damage.

Every part (except motor and generator) is visible, and can be easily adjusted or removed by simply loosening the wing nuts and lifting the side covers, which are hung on sturdy hinges.

By means of the Wilson dual-control system, the voltage and amperage may be set independently, and the instruments may be read with the greatest ease.

The machine will weld at rated current in amperes, with 40 volts across arc, i. e., a high-speed shielded arc.

It has at least 10 percent higher efficiency when using high-speed rods, due to higher arc voltage (40 volts).

It requires no exciter, with the result that idling loss is very low.

It has a very large overload capacity.

It provides sparkless commutation at all loads.

It is equipped with dead front controls (no live parts exposed).

The new Wilson S.A. arc welder is built to N. E. M. A. and U. S. Navy specifications.

New Wilson arc-welding machine

National Board of Boiler Inspectors' Report

Because of business conditions during the past two years, the National Board of Boiler and Pressure Vessel Inspectors has not been able to hold its customary annual meetings. The following is an excerpt from the report of the board prepared by the secretary, C. O. Myers, Columbus, O., for presentation at the 45th annual convention of the American Boiler Manufacturers' Association, held at Skytop, Pa., June 5 to 7. The report follows:

The executive committee of the National Board met June 27 and 28, 1932, at Columbus, O., and settled a number of questions of vital importance to the advancement of uniformity, particularly with reference to the interchange of inspectors commissions between states for field inspections and the adoption of a uniform field inspection report form. They provided for the annual renewal of the National Board Commission and the further advancement of the use of the National Board stamping for unfired pressure vessels.

When the National Board of Boiler and Pressure Vessel Inspectors was organized, the laws and regulations in some of the states and cities provided that qualified boiler inspectors pass a written examination given by a board in such states and cities. One of the objects of the National Board is to secure reciprocity of boiler inspectors' commissions. The most urgent need at that time was for one commission that would be accepted by all of the members of this board for shop inspection of new boilers, and therefore we all agreed to have our laws and regulations amended so that we could accept new boilers that were constructed in accordance with the A.S.M.E. Code and inspected during construction by a person holding a National Board commission. The activities of the board have been confined to commissioning of inspectors for shop inspections of new boilers for states and cities whose law did not interfere. It was recommended that the National Board commission be accepted for field inspection as well as shop inspection. The National Board commission has been in effect for more than ten years. Considerable care has been exercised in the issuing of commissions, and the members of the National Board have established confidence in one another in the qualification of inspectors, therefore, it was the unanimous opinion of the members of the executive committee that persons holding National Board commissions should be recognized for field inspections as well as shop inspections. To bring this about it was necessary that some minor details with reference to the qualifications and the number and type of questions for the examination of inspectors be adjusted by the various state boards. We are now working on this and I can report progress.

A general discussion of ways and means to bring in other revenues than from the stamping of boilers was conducted. It was suggested that the boiler insurance companies and the members of the National Board be urged to recommend that all unfired pressure vessels be stamped National Board. As a result of this activity, we have received from the registration of unfired pressure vessels a sum that while not great has helped in our work. Some of the manufacturers in the State of California have been resisting the acceptance of the A.S.M.E. Unfired Pressure Vessel Code and have insisted that they construct vessels in accordance with a code of their own. The State of Oregon recently used an effective weapon against such practice by refusing to accept in their state any vessels not constructed in accordance with the A.S.M.E. Code and stamped National Board. To retaliate this action, the State of California has recently issued similar orders, which in the end will result in the construction of unfired pressure vessels in accordance with the A.S.M.E. Code only. With this co-operation and the co-operation of other states in a similar manner, it is evident that from the number of requests we are receiving to qualify manufacturers, that the use of the National Board stamping will be universal within a short time.

The executive committee authorized the renewal of Inspectors National Board commissions annually and provided a small fee for such renewals. This was put into effect January 1, and to date we have renewed 532 Commissions. This additional revenue has aided us considerably, but even with this we did not have sufficient income to take care of our regular expenses and had to economize further by reducing actual expenses mainly in curtailment of salaries of our small staff.

The number of boilers registered in 1932 were 4262. This compared with 1929, which was 20,164, shows approximately an 80 percent drop in the registration of boilers between 1929 and 1932. With the improvement in business that is now occurring we hope to report more favorably at the next meeting.

Weld Test Bureau Established

A Welding Division has been organized by Pittsburgh Testing Laboratory, Pittsburgh, Pa., to render six distinct and separate types of service:

Reports on the welding processes of manufacturers, fabricators, contractors and firms or corporations, when such reports are necessary to comply with specifications, codes or rules or to obtain insurance on the product or structure.

Reports on weld specimens which are made prior to construction by employees of manufacturers, fabricators, contractors and firms or corporations, when such reports are necessary.

Reports on weld specimens which are made during construction by employees of manufacturers, fabricators, contractors and firms or corporations, when such reports are necessary.

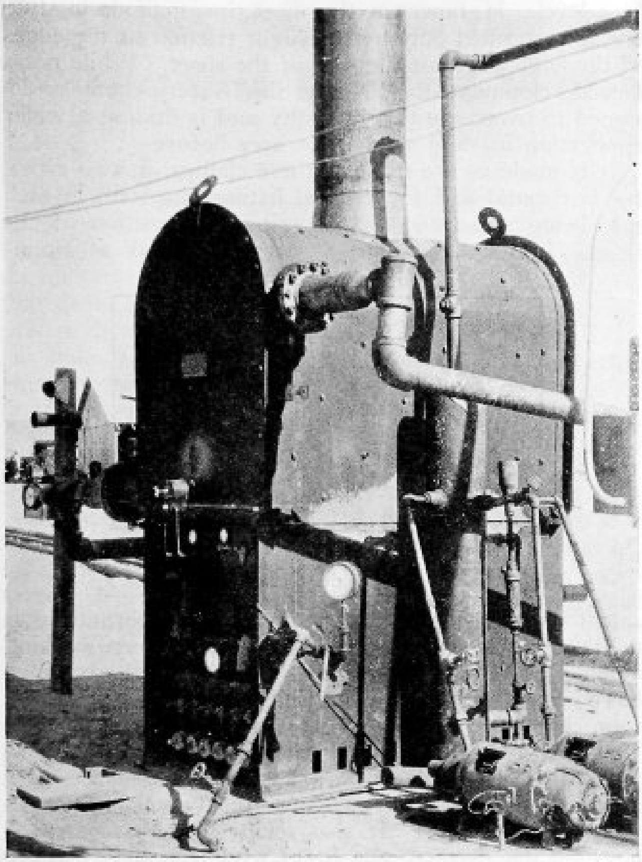
Laboratory tests of weld specimens which are submitted to the Bureau for test, and on which the Bureau's representatives have no knowledge of the process used, or the details involved in the welding of the specimens.

Inspection of welded products and structures, independently of or in conjunction with our weld testing services, depending on regulations governing the inspection of the product or structure, and on the requirements of clients.

Investigation of special welding problems, when this type of service does not conflict with the company's neutrality and impartiality.

The new Division, which is called the National Weld Testing Bureau, has no promotional interest in any particular welding process, or in any manufacturer's equipment, materials or supplies. It will have its headquarters in Pittsburgh and will be in charge of James W. Owens, as director.

The Wrought Washer Manufacturing Company, 2104 South Bay St., Milwaukee, Wis., has appointed H. M. Swain, 52 Maypole Road, Quincy, Mass., as distributor and direct representative in the New England States for its entire line of standard and special washers, corner braces, corner irons and stampings.

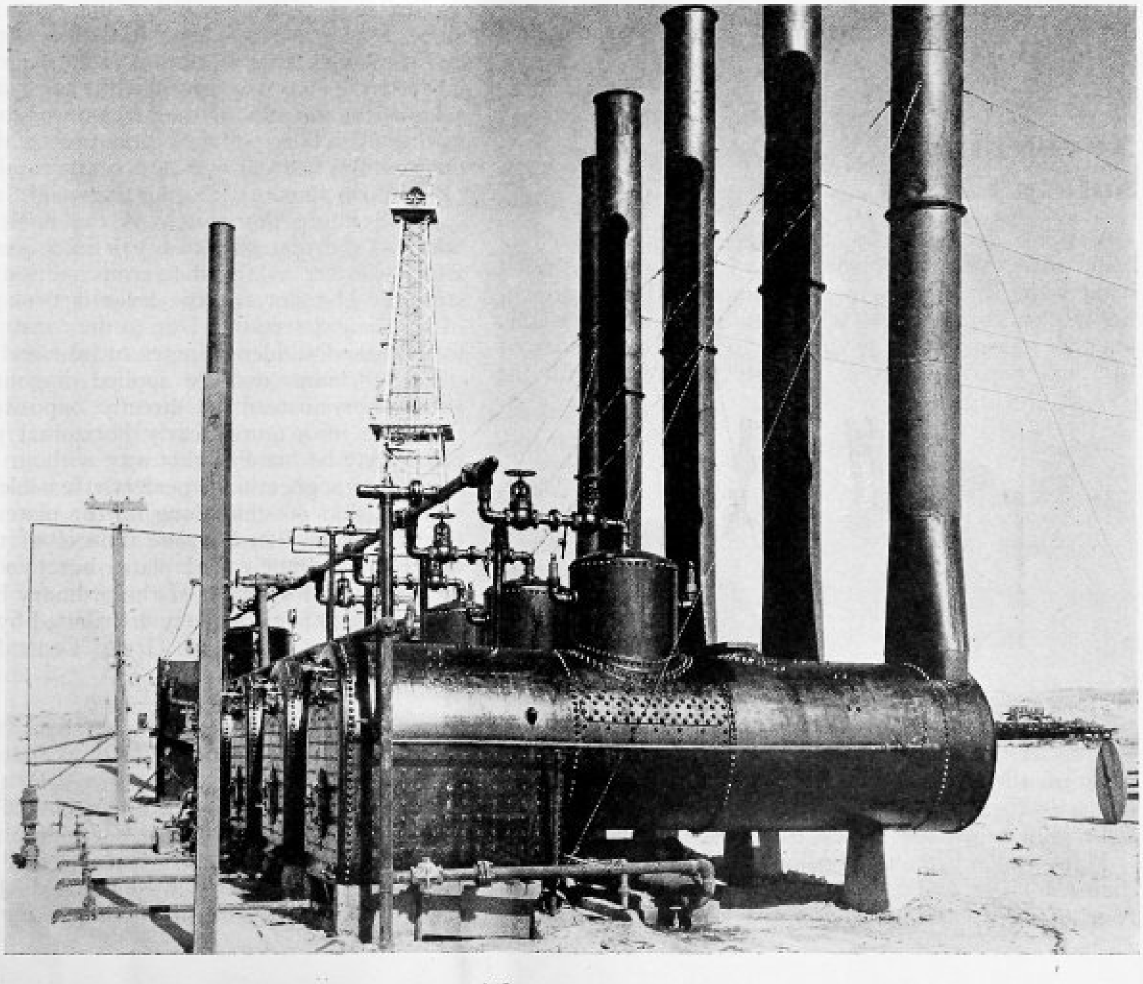


Oil Field Boilers

On April 22 of this year the record for the world's deepest well was broken by the Lillis-Welsh Well, No. 1 of the North Kettleman Hills Oil and Gas Company. This well reached a depth of 10,588 feet on that day and is still going down. The top of the well was drilled with a 25-inch bit and 24-inch reamer and is lined with 18⅝-inch casing for the first 1275 feet. The casing size then decreases until at the present level a 5⅝-inch reamer is used in the hole.

Drilling of this well has continued to a depth of 10,941 feet according to latest reports and may go to 12,000 feet. Forty gravity crude was found at 10,927 feet and other oil bearing sands were found at higher levels.

Separately fired superheater. Below is a battery of five oil-field boilers



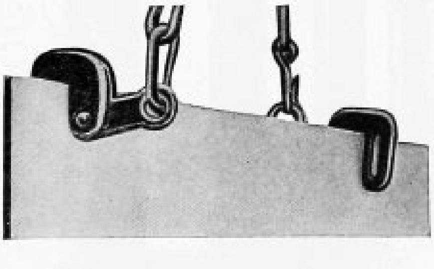
Considerable power is required to handle more than 10,000 feet of heavy casing and to turn the drill and reamer at the end of more than 10,000 feet of drill pipe. The power at this well is derived from steam produced by five 100-horsepower portable, oil-field type boilers. Steam is produced at a pressure of 220 pounds per square inch and is delivered through a Foster Wheeler oil-field type, separately fired superheater to drilling engines, hoists, pumps and lighting generators. The superheater raised the steam temperature to 550 degrees F. so that the steam is delivered to the drilling rig in a superheated condition.

In oil field work insulation is seldom used on either boilers or piping inasmuch as fuel generally has little or no value. Superheat, therefore, is not used to conserve fuel, but is used to increase the power output of steam-driven machines and reduce the amount of water required and the number of boilers necessary, also to protect the machinery from excessive wear and damage by slugs of water. When dry or superheated steam is delivered to the engine, initial condensation is reduced thereby enabling a given amount of steam to produce more power. At the same time the quantity of water in the cylinders is materially reduced. This conserves lubricating oil in the cylinders inasmuch as hot water tends to wash lubricating oil off the cylinder walls.

The Foster Wheeler oil-field type superheater consists of standard extended surface elements made up of steel tubes with cast-iron rings shrunk upon them. The superheater is built in a steel casing and is placed over a brick-lined furnace. The furnace is fired by either oil or gas. The advantage claimed for this type of superheater is that the amount of superheat may be controlled automatically inasmuch as all of the steam generated passes through the superheater where the rate of firing can be varied to meet requirements. When the boilers are moved from one site to another the superheater may be moved with them or delivered to any other desired site.

Never Slip Safety Clamp

Various devices have been developed for holding boiler plate, both in the vertical and horizontal positions, while being lifted. The most common method of attaching the load to the crane is by means of a sliding chain; but this scheme is far from safe under all conditions of lift, and the chain often seriously interferes with the

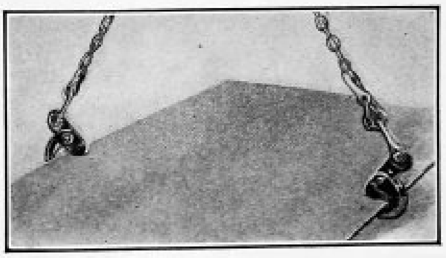


Safety clamp used in vertical position

placing of the load where desired. Then, too, the slipping of the chains while lifting scarfed work often damages the edges, and makes it difficult to obtain a tight joint when the pieces are riveted together.

Many shops use angle hooks at the end of their sling chains. These angles form a good lifting device when four of them are used, and the sheet being lifted is kept level. If, however, the sheet tips, it tends to slide, and is restrained only by the slight friction of the edges of the angles against the side of the sheet. While not a new development, the "Never Slip" safety clamp is designed to overcome this difficulty and is finding a wider application in shop work than ever before.

It is made as are most of these clamps, in two types, for horizontal and for vertical lifting, the term in each case being understood as covering the position of the sheet. Either clamp may be used for work at an in-



In use with plate horizontal

clination, and will hold it firmly without permitting it to slip and so jeopardize the safety of the men working under it. These clamps possess the additional advantage of requiring only one pair of sling chains, instead of the four chains required when the usual angle grip is used. This feature is of value when sheets, or partially completed boiler or tank work, are lowered into place, as it is easier to obtain clear way for the two holds than it would be for four. It also removes the necessity of blocking the sheet on the edges while the sling chain is pulled out.

The Never Slip safety clamp is designed so that the point of pressure of the lever against the plate, for all thickness of plate, is always the same horizontal distance from axis of the lever in the horizontal type clamp, and the same vertical distance from the axis of the lever in the vertical type clamp. Thus the ratio of the lever arms about the axis of the lever never exceeds a certain safe limit. This point of pressure of the lever on the plate is also always over the center of bearing surface of the hook thus distributing the weight evenly on it.

Furthermore the crotch of the hook of the clamp, which is the first part to break in a hook of this kind, and is known as the dangerous section, is made very strong. The slot for the lever is brought entirely out of the danger section. Due to the construction, it is able to withstand sudden changes in load and shocks.

These clamps may be applied diagonally opposed to each other, instead of directly opposite, thus holding the plate in a more nearly horizontal position. Long plates may be handled this way without buckling. This method of application is perfectly feasible, for the clamps will not skid or slide along on the plate. A number of plates may be lifted at one time if of the same width, and for handling round plates but two clamps are required instead of three of the ordinary hooks.

The clamp is exclusively distributed by the Never Slip Safety Clamp Company, Grand Central Annex, P. O. Box 448, New York.

Metallizing Process. — A booklet covering the metallizing process, its applications, advantages and accessory equipment, has been issued by the International Metallizing Association, Los Angeles, Cal. This is the first booklet ever published covering the process fully, and the applications include each field in which it is used, with a list of the objects coated, the type of metal used, and the purpose of coating.

Developments in the X-Ray Method of Testing Welds* ▲ ▲ ▲

By Ancel St. John†

In 1920 when the X-ray testing of welds was originated by the author, while associated with the Union Carbide & Carbon Corporation, the first tests were conducted on coupons welded with acetylene. It was found that defects such as improper fusion at the scarf, improper fusion between successive layers in the weld, gas holes and slag inclusions could be readily detected with the proper technique and the coupons were successfully classified for relative strength. Subsequently other investigators working on electric as well as gas welds confirmed these results.

In 1930 after trying other non-destructive tests with indifferent success the Babcock & Wilcox Company submitted two large test plates 2¼ inches thick with welds 48 inches long. The results were so thoroughly satisfactory that the author was promptly commissioned to design and install a plant for routine inspection of boiler drums at the Barberton plant. This installation began operation in July 1930 and has been in constant operation ever since, often running day and night. Before the end of the year overwhelming evidence for the competence of X-ray inspection to assure the quality of fusion welds led to the epoch-making revision of the Boiler Code of the American Society of Mechanical Engineers adopted in 1931.

X-ray inspection is really very simple. The X-rays originate when electrons traveling at high speed are suddenly stopped. The electrons are supplied by a heated filament in a vacuum tube, are driven off by a negative potential applied to the filament, acquire the speed while traversing the evacuated space to a block or plate of metal at a positive potential, and produce X-rays when they hit the plate or target. This is just what happens in any radio tube and actually a radio tube produces X-rays at the plate. But the penetrating power of these rays is so slight that they cannot get through the glass of the bulb. This is due to the comparatively low speed produced by the voltage applied to the radio tube. But when voltages of 100,000 to 300,000 such as are used for weld inspection are applied to a tube designed for them, the speed of the electrons is high and the penetrating power great.

Personnel must be protected against accidental contact with such high voltages and against exposure to the X-rays. Lead is the most economical absorbing material for cutting off undesired X-rays, and in the best practice the X-ray tube is entirely surrounded by lead except for a window through which the rays pass to the object to be tested. Auxiliary lead shields surround the X-ray beam between the safety box and the vessel to cut off scattered X-rays. A photographic film placed on the far side of the weld records the intensity of the rays from point to point and so gives a shadow picture of the intervening material. Another auxiliary shield cuts off rays which pass beyond the film. The high voltage power plant and the high voltage lines are placed in a sheet iron housing. In the best practice the housing is mounted on a movable truck and the safety drum can be moved with respect to the housing to accommodate different classes of work. In co-operation with the owner of the essential patents we are now bringing out a compact unit in which everything is immersed in oil and surrounded by lead except at the window. This unit for continuous operation at 300,000 volts will be only about six feet long and less than two feet wide by three feet high and can be operated in any position.

The interpretation of the radiographs is simple. The density of the shadow depends upon the thickness and composition of the material. Hence the bead of a weld casts a heavier shadow than the plate whereas a cavity in the weld casts less shadow than any neighboring portion of the weld. If the cavity contains slag the contrast will be reduced somewhat. It is usual to identify the regions examined by perforated lead markers placed beside the weld. The Boiler Code requires the use of the author's method of proving that the proper penetration has been used. A strip of metal 2 percent of the thickness of the plate is placed over the weld so that a hole drilled through this thickness gage falls on the weld. The gage and hole must be detected in the negative. If the negative otherwise shows a satisfactory density and they cannot be seen it is proof that the penetrating power of the X-rays was too great and the differentiating capacity too small. The masking of small cavities by the use of high penetrating power is thus prevented.

X-ray control of welding operations not only furnishes a means of determining the quality of the product but also assures a greater proportion of acceptable work. Welders are quickly convinced of the necessity of maintaining the proper flame, the proper angle, the proper speed and care in laying the bead. These factors for acetylene welding and the corresponding factors for arc welding vary with the weight of the plate and its composition, the size of the rod and its composition, and the coatings or other measures used for increasing the ductility of the weld metal. X-ray control offers a remarkably fast and sure means of evaluating these.

The Boiler Code permits a reasonable amount of porosity but is rather strict about faulty fusion or slag. When these occur in objectionable quantity the defective areas can be chipped out and rewelded. Unnecessary chipping can be avoided by a rapid technique introduced at Barberton for determining the exact location of the defect. The single shadow picture which disclosed the existence of the defect gives no information as to its depths below the surface, merely telling on what transverse line it lies. But two exposures on a single film with the tube in different positions enables us to get the information readily, just as an object which cannot be located exactly when seen with one eye or through a telescope is readily located when viewed with both eyes or through a range finder. Reference markers are placed on both the front and the back surface of the plate. In a particular case of a plate 1¼ inches thick the shadow of the front marker is displaced 14/32 inch, of the back marker 5/32 inch and of the defect 9/32 inch. Simple proportion then shows that the defect is 5/9 the distance from the front to the back surface or

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*Abstract of paper presented at the thirty-third annual meeting of the International Acetylene Association, Philadelphia.

†President, St. John X-Ray Service Corporation, New York.

11/16 inch below the front surface. These measurements can be made on the negative while it is still wet, in fact as soon as it has been cleared in the fixing bath. It is common practice to have the weld marked for the location and depth of the defect within ten minutes after the exposure is completed.

The importance of proper technique and intelligent interpretation of results cannot be over-emphasized. The wrong technique, whether wilful or careless, will mask the true conditions. We have some glaring examples of the damage that can be done by wrong technique. In a typical case of work done "at cost" by a government laboratory the voltage was too high and the exposure too short. Detail and contrast were lacking. The same piece was sent to us and we found objectionable conditions that had been missed. We mention this particularly because government laboratories maintained by taxes are constantly competing with commercial testing services which pay the taxes. If this is not illegal it is most unfair and should be stopped. When, as too often happens, this at cost work is done carelessly or incompetently it discredits the tests and tends to discourage their further use under any circumstances. One way to put a stop to such unfair and destructive competition is to recognize that cheap work is careless work and that the difference in charges between a government laboratory working at cost on taxpayers money and a commercial organization working at a fair price represents the brains and interest put into the job.

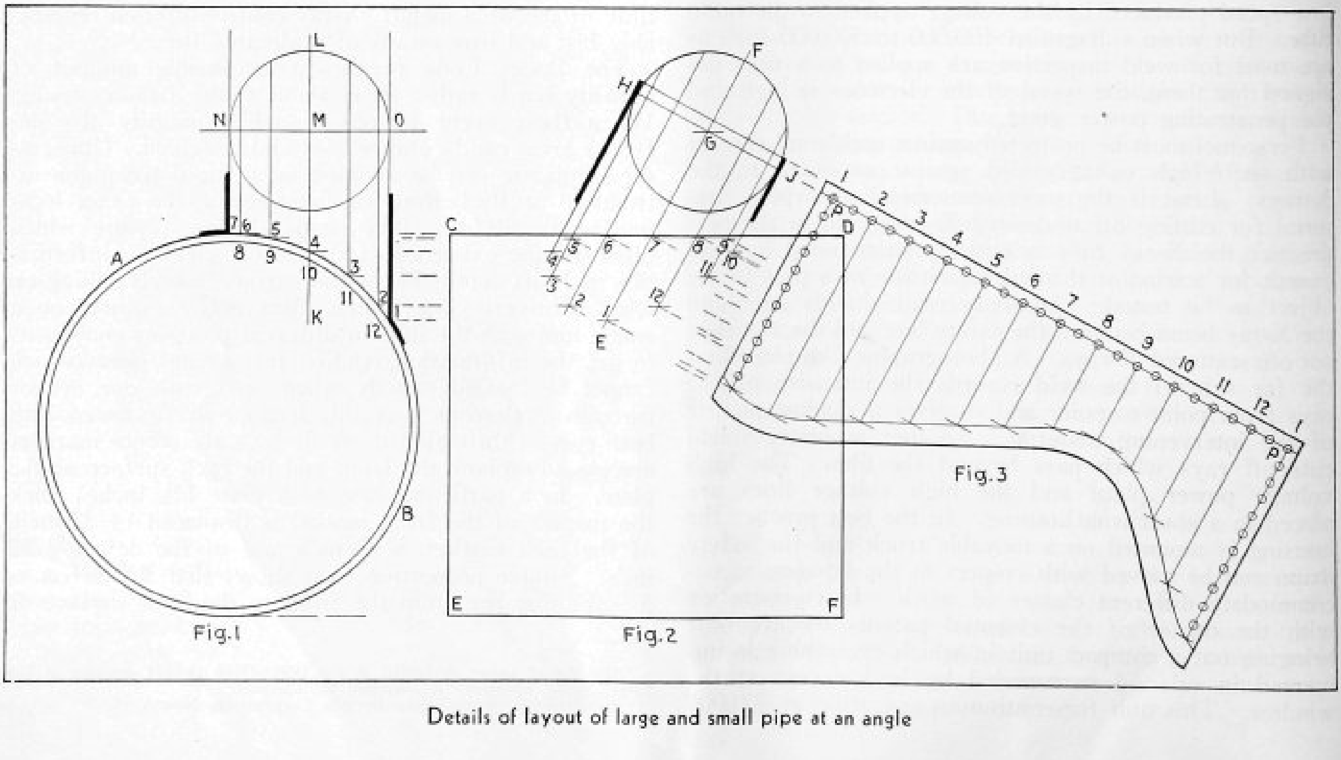
X-ray weld inspection is not restricted to the seams of pressure vessels. It has been used successfully on aircraft assemblies, metal boxes, tubing, repairs to castings, bridge structures, locomotives and the like. Thicknesses as great as 4¼ inches of steel are examined in routine. As more powerful X-ray tubes become available this thickness which can be examined under commercial conditions will be increased. The advent of the compact unit will increase the range of usefulness.

Developing a Pipe Fitting at an Angle to a Larger Pipe and Out of Center

By I. J. Haddon

Let the circle *AB*, Fig. 1 represent the large pipe, and *CDEF*, Fig. 2, a side view of the large pipe. Draw *E-F* at the angle required, and mark the point *G* at the height required, center of rivet holes as shown. Through *G* draw *H-J* at right angles to *E-F*. With *G* as a center, describe a circle representing the inside of the small pipe and divide it into 12 equal parts as shown. Through the points obtained draw lines parallel to *E-F* and well past the line *C-D*.

Draw *K-L*, Fig. 1, at right angles to *C-D*, and at any point as *M* describe a circle similar to the circle on *H-J*, and divide it into 12 equal parts, and through the points obtained draw lines parallel to *K-L* to meet the circle *AB* in *1, 2, 3, 4, 5, 6, 7*. These same points also represent



Details of layout of large and small pipe at an angle

8, 9, 10, 11 and *12* as shown on the foregoing layout.

Now draw lines from these points parallel to *C-D* to cut their respective lines on the pipe in Fig. 2, as shown. Then, from these new points up to the line *H-J* will be true lengths of the lines on the inside of the small pipe, up to the center of the rivet holes. It will readily be seen that only a portion of the circle *AB* may have been drawn, and the line *N-O* could have been divided similarly to the line *H-J*.

To develop: Produce *H-J* to *P-P*, Fig. 3, and make *P-P* (center of rivet holes) the required length according to the diameter and thickness of the small pipe, but calculating for its circumference from the center of its thickness; that is, supposing the pipe is say 24 inches diameter inside and to be of say ½-inch plate, then the distance from *P* to *P* would be $3.1416 \times 24.5 =$ to 76.9692 inches or nearly 77 inches. Now divide *P-P* into 12 equal parts and drop lines from these divisions perpendicular to *P-P* as shown, and cut them off the same length as those shown in Fig. 2. A curve drawn through these latter points will represent the bending line on the pipe. Rivet holes may be marked for the seam. Allow on material for the flange, allowing a little more material at lines *8, 9,* and *10* on account of the flange being so acute. Scarf the corners of the plate according to which seam is to be on the inside or outside after being rolled to shape. Fig. 3 represents the inside of the pipe.

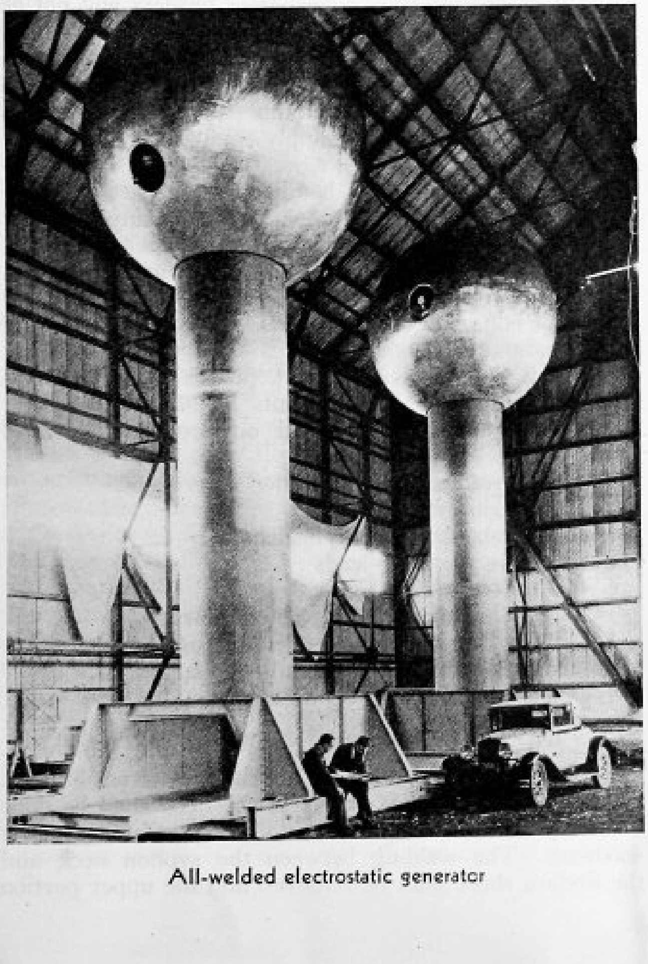
Pity the Poor Atom

The strange-looking apparatus shown in the illustration is designed to deliver 10,000,000 volts of electrical energy with the avowed intent of demolishing atoms.

The equipment consists of an electrostatic generator and 15-foot 6-inch arc welded aluminum spheres on truck-mounted textolite hollow columns. The potential is produced by carrying electrical charges on endless silk belts operating inside the columns from the base to the aluminum electrodes.

This latest venture in the exploration of atomic energy is being carried out at the Massachusetts Institute of Technology.

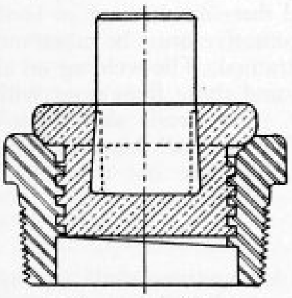
The aluminum spheres were carefully constructed and welded by the shielded arc process using equipment and aluminum electrodes manufactured by The Lincoln Electric Company, Cleveland, O. Fabrication was by the Chicago Bridge and Iron Works.



All-welded electrostatic generator

Square-Thread Washout Plug

Since it was brought out about two years ago, the Prime square-thread washout plug, made by the Prime Manufacturing Company, Milwaukee, has met with considerable success. In the construction of this plug the same composite type of assembly, namely, that of inserting and locking an iron core with a square head into



Prime washout plug

a brass cup, is used, which has made Prime plugs a generally accepted standard among the leading railroads of the world.

Because of this construction, this square-thread plug requires no gaskets. The plug proper is made of brass and on this brass plug a ball joint is turned which in turn seats into a bushing. Should the ball joint become bruised or damaged, it is a simple matter to repair it by placing the plug on a lathe on its original centers and redressing the ball joint. The plug therefore does not have to be scrapped as is generally the case with many square-thread plugs.

The plug consists of a steel bushing and a brass plug. This conjunction of metals will not rust, so that the Prime plug may always be easily inserted into or removed from the bushing. The iron core has a square head which affords a good grip for a wrench, thus eliminating the danger of the tool slipping off and causing injury to workmen.

It is claimed that, because of the ease with which the seat of the Prime plug can be redressed and because there is no danger of corrosion, the life of this square-thread plug is much longer than that of the ordinary plug. Easy maintenance, long life, low first cost and the fact that after the Prime plug has served its period of usefulness there remains the reclamation value of the brass joint in it make the Prime square-thread washout plug comparatively inexpensive (for example, a Prime square-thread plug with 2½-inch daylight opening contains approximately 3½ pounds of brass). For particulars on test applications of the Prime square-thread plug address the manufacturer.

Rules for the Inspection, Maintenance and Repair of Locomotive Boilers*

Flues which are slightly leaking at the smokebox end shall be tightened with a straight roller expander.

When unwelded flues are leaking so badly at the firebox end that the locomotive must be taken out of service, the boiler shall be drained, after which the firebox end of flues shall be reset with sectional expander, form C, and the beads then reset with a beading tool.

Heavy working of an electrically welded flue may cause trouble by starting the leaking of adjacent flues. Therefore, great care shall be taken in performing this work.

Leaking through pin holes in the weld shall be calked with fuller and hand hammer. The pein of a hammer or a beading tool shall not be used. If the leak is under the weld, cut off the defective portion of the weld, reset the flue with form C straight-finger sectional expander, bead down lightly, clean and reweld. If welding facilities are not available, reweld at first opportunity.

When welded flues are leaking so badly at the firebox end that the locomotive must be taken out of service, the boiler shall be drained. The welding on all defective flues shall be cut off and these flues reset with a form C sectional expander. The beads shall then be reset with a beading tool. The flue shall then be cleaned and rewelded. If welding facilities are not available, reweld at first opportunity.

Cleaning Flues

All flues of locomotives shall be inspected not less frequently than at each boiler wash period, also each time the fire is dumped or report is given that the engine does not steam freely and flues shall be blown out with air if found plugged.

Arch tubes shall be cleaned with a mechanical cleaner whenever it is found necessary, but not less frequently than at each boiler wash period. Watertubes on McClellon boilers shall be cleaned with a mechanical cleaner at each hydrostatic test period.

Air pressure at 90 pounds per square inch shall be used for blowing flues. The flue-blowing pipe shall be inserted in the flues not less than full length of the flue.

After cleaning, as described above, has been completed, a thorough inspection shall be made to determine that all flues are clean. A light, either a torch or other open flame shall be used for this purpose. In addition to inspection with a torch, superheater flues shall be inspected using a spotlight to detect foreign matter on the bottom of the flue or unit. Any clinker formation found on the return bend of superheater units shall be removed with a hook.

Maintenance of Superheater Units and Parts

Superheater units, headers, exhaust, steam and dry pipes shall be subjected to a hydrostatic pressure test at engine houses on any engine failing for steam where cause is not apparent, also when a locomotive is reported by an engineer at its home terminal as not steaming (although it has not yet failed) and cause is not apparent.

Procedure in testing and test pressures, etc., shall be as previously described.

New and repaired superheater units shall be requisitioned from Readville for points on Lines East and from New Haven for points on Lines West. Units shall be ordered to latest drawings.

In ordering, specify (a) Unit No. or Line No.; (b) Shape No.; (c) Class of locomotives.

Whenever units are removed at engine houses they shall be thoroughly and carefully inspected and any unit showing defects shall be replaced by one in good condition. Units must have bands and supports properly applied and spaced correctly, and have supports secured from shifting by depositing a small lump of welding material each side of the support on one pipe only.

Repairs to units at engine houses shall be confined to grinding in ball joints and necessary repairs to bands and supports. In all other cases the defective unit shall be shipped by points on Lines East to Readville Shops and by points on Lines West to New Haven Shops. Units so shipped shall have the ball joint properly protected by a wooden block. Units shall be removed from the flue by hand and if this cannot be done on account of flues being stopped up with cinders, the flue shall be first cleaned out. When sufficient quantities of defective units have been assembled at either of the above-mentioned points, they shall be shipped to the Superheater Company for overhauling. In this work, they will replace all threaded return bends with the latest design of welded return bend.

Unit bolts are of special material and when renewals are necessary, reference shall be made to instructions previously outlined, which must be strictly adhered to.

Welding of defects in superheater headers will not be permitted. If defects develop, which make headers unfit for service, they shall be replaced with new headers.

The following shall be stocked at engine houses to protect maintenance. A minimum stock of this material sufficient for one month's supply shall be maintained at all times.

1. Units for all classes handled at the particular engine house point. Approximately twice as many units for the two upper rows shall be carried as for the lower rows, as it has been found that they require more frequent renewal.
2. Unit bolts, nuts and washers.
3. Bands and supports.

The following tools shall be kept in the tool room at all shops and at all engine points handling superheater engines and will be furnished on properly approved requisitions:

1—45 degree reamer for header seats
1—Ball facing tool for units
1—Taper shank grinding lead holder
6—Concave grinding leads
6—Convex grinding leads
1—Ball joint and header seat contour
1—Pincher for applying bands and supports
1—Dolly bar for riveting bands and supports
1—Tong for applying bands and supports.

Relieving Strains in Syphon Necks

Syphon necks are not to be annealed after application. The work of relieving strains in the neck shall be done after one full month's service, not necessarily at the first washout. The welding between the syphon neck and the firebox sheet shall be removed and the upper portion

* Continuation of standard rules of the New York, New Haven & Hartford Railroad. This series began in the April issue.

of the diaphragm corrugation heated to allow the syphon neck to move upward until it fully relieves itself. The lower portion of the corrugation shall then be heated and laid up to the neck, after which new welding shall be applied.

Daily Inspection

Daily inspection of boiler shall be made after each trip or day's work, after arrival of engine at engine terminal. Inspection shall be made at the inspection pit at points so equipped.

The front end netting shall be inspected to see that there are no openings larger than the standard mesh of the netting. In case of doubt as to the size of a hole, it shall be checked with a gage which is $\frac{3}{16}$ inch minimum and $\frac{7}{32}$ inch maximum diameter.

Inspection shall be made of the outside of the smokebox for discoloration which indicates air leaks. In case of doubt, a torch shall be used to try for air leaks. Inspector shall note whether all studs, bolts and keys are in place and secure and make repairs if required. Upon completion of the inspection, a report shall be made on the required form.

An inspection shall be made of the exterior of the boiler for indication of leaks, cracks or defective staybolts. Special notice shall be taken to see whether or not there are any leaks around boiler fittings, studs, washout plugs and blowoff cocks. Steam leaks under the jacket may indicate a serious defect, and the source of the leak must be located and any defect corrected before engine is returned to service.

Inspectors shall look through the firebox door to note the condition of the side sheets, crown sheets and arches and whether or not any leaks are present. If low steam is reported by the engineman, a check shall be made of the flue sheet by holding a fire hook on top of the arch with oil-soaked waste attached to the end of the hook. When defects are found, the necessary repairs shall be made before the engine is returned to service.

See that the ash pan is properly secured in position and that proper clearances are provided. Inspect the ash pan for holes through which the fire may drop. The inspector shall note whether dampers and rod connections are in proper condition. Upon completion of the inspection, a report shall be made.

Inspection shall be made of the grates and grate rigging to see that they are properly connected up and in place.

All defects which cannot be corrected at inspection pit or ashpit shall be reported in the usual manner in the work report book.

In case fire is dumped between boiler washout periods, the interior of the firebox shall be inspected to see whether or not any defects are developing. Staybolts and rivets shall be inspected for leaks, and arch tubes or syphons must be carefully inspected for defects. Defective arch brick shall be renewed.

In case the dome cap is removed as much of the interior of the boiler shell and the flues as it is possible to see, shall be inspected.

Advantage shall be taken of every opportunity to become familiar with the condition of the interior of the firebox and of the interior of the boiler shell and of the tubes and braces, so that there will be a minimum of engine failures due to defective boiler parts.

Monthly Inspection

Inspection shall be made at least once each month at the time of the regular boiler washout according to Federal rules.

Examine carefully the interior of firebox and syphons for bulges, corrugations and deposits of honeycomb or clinker on any part of the firebox, crown sheet, syphons or other parts, as these are a fairly sure indication of scale forming on the water side. Special attention shall be given to those parts of the firebox where it is obvious that the interior of the boiler cannot readily be reached by the washout nozzle, and any indication of overheating shall be investigated at once.

Special attention shall also be given the arch tubes to see that they are free from leaks, ends properly rolled in the sheet and properly flared to an angle of 45 degrees, checking with a gage. Arch tubes that are split in the flaring shall be removed. Sprung arch tubes must be taken out and the new ones applied. Under no condition shall they be straightened. An arch tube which has been reworked on three different occasions on account of leaking shall be renewed if the leak again develops. A report shall be made to the supervisor of boiler inspection and maintenance on a special form to cover every case of reworking or renewing arch tubes. Defective arch brick shall be renewed, reference being made to the standard arch brick arrangement book for this purpose.

The heads of staybolts, rivets, crown bar bolts and radial stays shall be carefully inspected for defects or indications of leaks. Also examine all patches and mud ring corners for leaks and other defects. Leaks are suggestive of overheating from some cause, either of dirt accumulation or improper drafting, and when found the cause must be determined and remedy applied.

Staybolt testing shall be done after the boiler has been drained of all water by striking the firebox end of each bolt or stay with a light hand hammer. The sound will indicate whether or not the bolt or stay is broken or otherwise defective. All staybolts, flexible or otherwise, must be hammer tested at each boiler wash period. Firebox sheets shall also be sounded with a hammer, between staybolts, the sound indicating whether mud or other foreign substance has lodged around the staybolts. If such condition exists, corrective measures must be taken before the engine is returned to service.

Grates and bearers must be inspected to see that they are not burned, sagged or broken. See that connection rods have not become disconnected and that key bolts or cotter keys are not missing. Work the grate rigging in cab to see that grates move freely to full opening and close evenly without excessive lost motion. There must be no opening in grate area larger than the standard opening for the style of grate used, and it must also be known that none of the holes in the grates are plugged. Shaker levers and handles shall be checked with gage and must be the correct size.

Flues must be tested with a boiler maker's torch to see that they are open from end to end, by holding the torch to the flue, with house blower attached, at the smokebox, so as to create sufficient draft. If open, the flame will deflect into the flue because of the draft. All flues must be open before engine is allowed to return to service. Look for collapsed flues, and broken or defective beads or welds. Also look carefully for leaks on the inside of flues, due to pitting or leaking at welds. In order to avoid engine failures on the road, it is absolutely necessary that flues which show any leakage on the inside be removed as soon as discovered.

Inspect the ash pan to see that it is properly secured in place and provided with the proper clearance above rail. Examine hopper slides to see that they open fully and shut tightly. Inspect the ash pan and hopper slides for openings through which the fire may drop. Check ash pan damper rigging for slack and see that fulcrums, etc., are securely fastened.

Examine the netting for holes larger than the regular mesh, checking with a gage, which is $\frac{3}{16}$ inch minimum and $\frac{7}{32}$ inch maximum, in case of doubt as to the size of any hole. Any other holes observable around the front end netting shall also be checked with the gage. The inspectors shall check for leaks by holding a torch behind deflecting plates and angles, table plates and around steam pipes. The exhaust nozzle must be known to be the correct size, and it must also be alined properly. The condition of the basket bridge must be checked, and if in the opinion of the inspector, it is not suitable for another month's service, it must be renewed. The setting of the diaphragm and petticoat pipe must be known to be correct, checking against the drawings covering front end arrangement. Check petticoat pipe brackets and supports for worn bolts and holes. The blower pipe must also be checked for position and to see that it is securely fastened in place. The front flue sheet must be inspected for cracks, leaks, or other defects, and a similar inspection shall be made of the superheater headers, steam pipe joints, and superheater units. Inspection shall be made of the flues for thin spots, cracks and leaks.

An inspection shall be made of the exterior of the boiler for any indication of cracks, leaks or other defects, especially at studs and boiler fittings. Also the outside end of all staybolts not covered by the jacket, shall be inspected for indications of leaks at threads or telltale holes. All telltale holes found partially or fully plugged shall be opened up. Outside firebox sheets shall be painted in accordance with previous instructions.

In case the dome cap is removed, an inspection shall be made of as much of the interior of the boiler as is possible, to determine whether or not any defects are developing. The condition of the flues, braces, and interior of the shell must be noted and any indications of weakness must be investigated. The throttle and throttle rigging shall be thoroughly inspected for defects. Full advantage must be taken of every opportunity by the inspectors to become familiar with the condition of the interior of all boilers.

Interior of tank and oil skimmer, if used, must be thoroughly cleaned. It must be known that no oil remains in the tank water space. Minimum tank valve lift is 1¼ inches on all classes. When, through wear on the handle, handle stop or other parts, the lift has been reduced to 1¼ inches the parts must be built up to provide a full lift of 1¾ inches. Tank valves and strainers must be cleaned and inspection made to see that cotter keys, pins and bolts are properly fitted and securely fastened. Manhole covers shall fit properly and their hinges be securely fastened. Condition of splash plates, braces, etc., must be noted and all loose rivets renewed.

The inspector must know that all plugs have been removed and shall determine that the water spaces are clean by inserting the standard inspection light through all the holes, except those in the belly of the boiler. He must personally see that a stream of water flowing from one end of the belly of the boiler to the other flows out of the holes, clean and free.

The inspector shall check all defects to see that they have been properly repaired. He must note that the arch brick has been properly applied.

After the boiler has been fired up and before reports are signed the inspector shall make inspection of the boiler to see that all work has been done and that the boiler is in proper condition for service.

Report Form No. 1023 shall be properly filled in, signed and sworn to. One copy of this form, properly filled in and signed, shall be placed under glass in a conspicuous place in the cab of the locomotive before the boiler is allowed in service. The original and one other copy shall be sent to the office of the supervisor of boiler inspection and maintenance, at New Haven, one copy to the master mechanic and one copy filed at the point where inspection was made.

When inspection is made of a boiler equipped with arch tubes, Form No. 1100-1 covering the arch tube inspection shall be properly filled in, signed and sworn to by the boiler maker, boiler foreman and boiler inspector. The original shall be sent to the office of supervisor of boiler inspection and maintenance at New Haven and one copy shall be kept at the point where inspection was made.

All syphons shall be inspected at least once each month, at washout, for defects of any nature. Report on Form No. 1100-A must be made out and forwarded to the supervisor of boiler inspection and maintenance and one copy kept at the point where inspection was made. This report shall be signed and sworn to by the boiler foreman and boiler inspector. Intermediate inspections of syphons shall be made as often as conditions warrant and permit.

Annual Inspection

Annual inspection shall be made at the time of hydrostatic test which must be made at least once each year in accordance with Federal rules.

The boiler shall be filled with hot water and hydrostatic pressure applied up to 125 percent of the rated boiler pressure. All leaks shall be properly repaired.

The hydrostatic test shall be made under the supervision of the boiler inspector and the boiler foreman, as required by the I. C. C. rules and no test shall be considered complete until the boiler has been approved by the inspector.

The hammer test shall be applied to flexible and rigid staybolts while the boiler is under full hydrostatic test pressure.

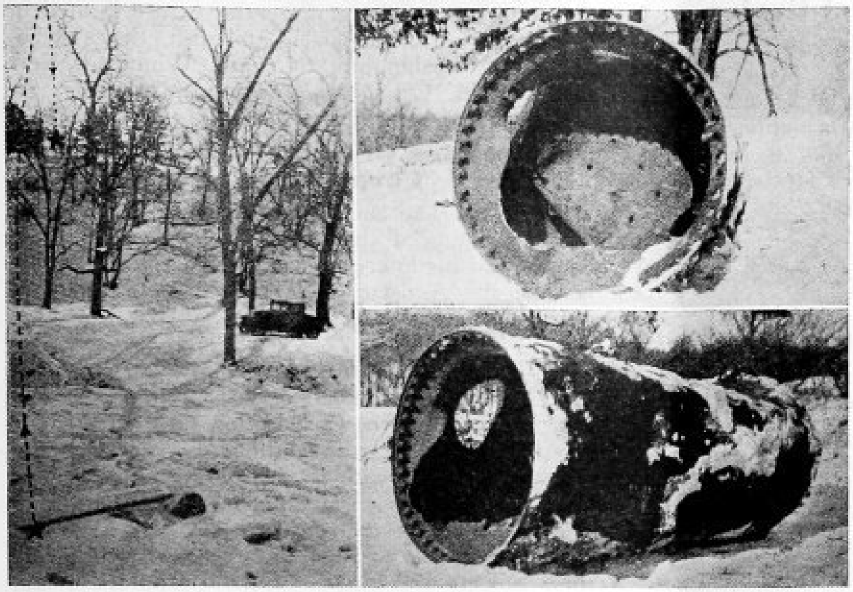
The dome cap and, if necessary, the throttle pipe shall be removed and an inspection made of the interior of the boiler. In cases where the boiler can be entered through the safety valve dome, this is permissible but notation to this effect must be made on the margin of the boiler card. All tubes and flues, braces and stays shall be carefully inspected and any indications of weakness investigated. All defects must be properly repaired.

Report Form No. 1024 shall be properly filled in, signed and sworn to, and one copy shall be placed under glass in a conspicuous place in the cab of the locomotive, before the boiler is allowed to return to service. The original and one other copy shall be sent to the office of the supervisor of boiler inspection and maintenance at New Haven, one copy to the master mechanic and one copy shall be filed at the point where inspection was made

Forms 1990-1 and 1990-A, B, C, D, E, and F must be filled in at the time of the annual inspection, or whenever any repairs are made to the boiler, firebox sheets or syphons and sent to the supervisor of boiler inspection and maintenance at New Haven. The purpose of these forms is to keep a permanent and up-to-date record of the condition of all boilers so it is important that the forms are properly filled in and great care must be exercised that no mistakes are made or that any details are omitted when they are filled in.

In case a boiler has been fired up without water in it, or in case water has been allowed to get low and crown sheet overheated, boiler must be given a hydrostatic test and thoroughly inspected, with the supervisor of boiler inspection and maintenance present before being allowed in service again.

(The End)



After the explosion—the boiler and where it went. The view at the left will give a good idea of the path of the Marseilles, Illinois mine boiler. It followed approximately the path indicated by the broken line, passing upward over the trees and hill to a resting place 700 feet distant. The pictures at the right show end and side views of the boiler, the former revealing how the firebox was forced up against the tubes, and the latter showing the firebox opening and the dent caused when the boiler landed.

Recent Power Boiler Explosions Involving Loss of Life*

Power boiler explosions resulting in serious loss of life and injury to persons have occurred with what appears to be unusual frequency during recent months. From among them we have selected the following as typical:

Back in the Russell county mountains of Virginia on a Saturday in February the hill men-folk had collected at a meal grinding mill as was their custom. It was a sort of social event to meet and "josh" each other and exchange views while their corn was being ground. Because of near-zero weather, men and boys were gathered close to the locomotive-type boiler, one youth being perched on a board on top of it. An explosion sent the youth out through the metal roof of the mill. He was found on a stack of lumber 50 feet from the mill, injured severely but not fatally.

Three men were killed instantly and eleven others were injured by flying parts or steam. Care of the injured was complicated by the extreme cold, their removal to a hospital some 20 miles distant involving precarious travel over icy roads.

The boiler failed in the crown sheet while an attendant was raising steam to operating pressure, preparatory to starting the mill engine.

Three men were killed and two injured in a similar accident in upper Colleton County, South Carolina, when a violent explosion of an uninsured boiler hurled the shell approximately 450 feet and parts as far as 850 feet. The men who were killed or injured were 40 to 50 feet from the boiler room.

A heavy piece of the boiler passed through the roof of a house 300 feet away and smashed through a dining table which had been set for the noon meal. The housewife had gone to another part of the house and was sewing when the accident occurred.

At a coal mine near Marseilles, Illinois, a 10-horsepower boiler used to operate mine machinery blew up and wrecked the engine room, killing one man and injuring another so that he died later in a hospital. The injured man's clothing, including his heavy boots, were entirely blown off by the explosion.

The boiler was of the vertical tubular type, 36 inches in diameter and 6 feet in length. The men were raising steam pressure in order to pump water out of the mine when the explosion rocketed the boiler 700 feet over a hill and out of sight. An idea of the boiler's "flight" and the damage done to it will be gained from the illustration. Because there was no path through the snow to the place where the shell landed, it was not found for two days.

Reports of two explosions resulting in death to persons came recently from the Texas oil fields. A boiler operated at an oil test near Nueces exploded and killed two men. At a well near Edom one man was injured and one was killed when boilers there exploded. The man who died was thrown more than 100 feet by the force of the explosion. The other was hit by a piece of derrick. One of the boilers crashed through the derrick, tearing it down, but a group of men working on the derrick floor escaped injury.

The boiler in a sawmill at Milton, Delaware, exploded with such violence as to demolish the mill and injure three men seriously. One of the setting bricks passed through the front and rear walls of a home 75 feet from the mill and another tore through the wall of a house about 300 feet away.

The vessel was a horizontal tubular boiler about 10 years old, 40 inches in diameter and 10 feet long. The thickness of shell was ¼ inch, the longitudinal joint of the double riveted lap type, the rivets ¾ inch in diameter and the pitch 3 inches. The shell was found badly pitted at the longitudinal seam on the water side. At a point 30 inches from the rear head the shell had deteriorated from the original thickness of ¼ inch to a thickness of 1/16 inch. It is believed that the rupture occurred at the weak point and extended along the entire length of the longitudinal seam, tearing the sheet from the front and rear heads by shearing the rivets for a distance of three-fourths of the circumference.

At Jasonville, Indiana, a boiler explosion and a subsequent fire in a cleaning plant wrecked the building and shattered windows in homes surrounding the plant. The boiler went through the roof of the building.

* Published through the courtesy of *The Locomotive*, of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

Locomotive Orders: The Durham & Southern has ordered one 2-10-0 type locomotive from the Baldwin Locomotive Works. The United Fruit Company has ordered two 2-8-2 type locomotives from the Baldwin Locomotive Works. The United States Navy Department has ordered 2 switching locomotives of 35-tons capacity from the Atlas Car and Manufacturing Co.

Car Loadings: In the week of July 29, car loadings totaled 638,396 cars, an increase of 127,293 cars over the corresponding week of 1932, or 24.9 percent.

Ryerson Publishes New Steel Book

Joseph T. Ryerson & Son, Inc., Chicago, has just published a larger and much more complete Stock List than any of its previous issues. The new book contains over 200 pages and includes complete information and data on practically every kind of steel that is made, including all special grades of cold finished steels, alloy steels, stainless steels, etc., also brass, copper and other non-ferrous metals.

A reference is given to Byers genuine wrought iron plates and sheets, products now being handled through the Ryerson service.

The book is extensively indexed and arranged in sections for ready reference.

Unusual Accident Prevention Record

Three years without a loss-of-time accident is the unusual record of the mechanical department of the Indiana Harbor works, at East Chicago, Ind., of The Youngstown Sheet & Tube Company. W. D. Cleavenger is superintendent of the department, where 312 men are employed. This means that 2,276,249 hours were worked without a loss-of-time accident.

In a letter of congratulation to the personnel of the department, Frank Purnell, president, said that such a record is a tribute of the employees toward safety and justifies the company's efforts to bring about the highest possible degree of safety in working conditions of the plants.

Stoker for Ashtabula Hide and Leather Company

A special stoker suitable for burning a mixture of coal and tan bark in the proportions of approximately 75 percent and 25 percent has been purchased by the Ashtabula Hide & Leather Company from the Westinghouse Electric and Manufacturing Company. This unit together with its boiler is part of a rehabilitation plan which the leather company is working on at the present time and is the second of its type purchased by that company. The original stoker was designed for this particular fuel requirement and functioned very effectively.

These two units are providing satisfactory operation under the extremely hard service required when burning a mixture of coal and tan bark. The boilers were supplied by the Union Iron Works who have furnished this company with their boiler requirements for the past twenty years.

Organization of Vulcan Soot Blower Corporation

The Vulcan Soot Blower Corporation, a Pennsylvania Corporation, Du Bois, Pa., manufacturers of Vulcan Soot Blowers, has been organized as successors to The Vulcan Soot Cleaner Company. Officers of the new corporation are: J. R. Osborn, president; Fred J. Brown, vice-president; J. E. Du Bois, M. H. Hartzfeld and J. Q. Groves, directors; W. N. McCreight, secretary and treasurer; D. E. Hibner, Jr., chief engineer and Fred C. Arey, consulting engineer.

The corporation succeeds to a pioneer business established in 1904, since which time it has manufactured a widely-known, highly successful soot blower with thousands of installations over the United States.

The high standards of the old company will be rigidly maintained and the trade is assured of the quality and mechanical excellence of this efficient equipment, with many improvements in the soot blower heads offered to the trade. Standardization and simplicity of design and economy of operation feature Vulcan soot blower equipment. Sales representatives are located in New York City, Philadelphia, Pittsburgh, Erie, Cleveland, Chicago, Washington, St. Paul, Winnipeg, New Orleans, Buffalo, Cincinnati, Dallas, Indianapolis, St. Louis, Milwaukee, Seattle and Toronto.

Payne Rejoins Greenfield Tap and Die Corporation

The Greenfield Tap and Die Corporation, Greenfield, Mass., has announced that Col. Frederick H. Payne, who disposed of his interests in the Corporation in 1929 and became the Assistant Secretary of War, has rejoined the Corporation as chairman of the board of directors.

Colonel Payne and associates recently purchased a large block of the common stock from interests who had been in control of the Corporation since 1929.

Charles N. Stoddard, who continues as president and general manager, will, with the board of directors, nine of whom are residents of Greenfield, direct the affairs of the Corporation in the future.

Colonel Payne, who will live in Greenfield, will devote his entire time to the affairs of the Corporation, and it is understood that the Corporation, which makes a large and diversified line of tools, consisting of taps, dies, drills, screw extractors, reamers, gages, screw plates, pipe tools, machine tools, etc. will continue the same aggressive merchandising policy it has maintained in the past.

Reading Iron Company Appoints William Craig Wolfe

The Reading Iron Company, Philadelphia, announces the appointment of William Craig Wolfe as vice-president in charge of sales.

Mr. Wolfe brings to his new position a wealth of experience in the marketing and merchandising of iron products. During 1907-08 he was with the Commercial Steel and Iron Company, Chicago, a brokerage company representing several mills. In 1908, he joined the Seneca Iron & Steel Company, Buffalo, N. Y. as a salesman, remaining with that company until 1919. He was then appointed Assistant to the President of the Standard Steel Tube Company, Toledo, O., and two years later became manager of sales for the Highland Iron & Steel Company. In 1928, he was made general manager, serving in that capacity until his recent appointment with Reading.

Mr. Wolfe was a moving factor in the organization of the Wrought Iron Manufacturers' Association. With the Highland Iron and Steel Company he started the rolling of iron sheets and sash. In addition, he was responsible for increasing the number of bar-iron shapes available.

New Electrode Welds Cromansil Steel

Two additions to the Murex line of heavy mineral coated arc welding electrodes are announced by the Metal & Thermit Corporation, 120 Broadway, New York.

One is a special electrode designed for welding Cromansil steel, a new development in high-strength steels having a tensile strength of 80,000 to 100,000 pounds per square inch along with high ductility. The new electrode gives a deposit of the same analysis as Cromansil. The weld metal has physical properties which are claimed to be equal to the parent metal.

The second addition to the Murex line is an electrode which deposits a metal containing 4 percent to 6 percent chrome and 0.5 percent molybdenum. It is specially suited to the welding of petroleum refinery equipment where metal of this type is used extensively.

The Boiler Maker

VOLUME XXXIII NUMBER 8

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Communications

Applying Shims in Tube Holes

To the Editor:

Shims as a rule, do not appeal to the writer very much in boiler construction, for they do not suggest good fits, and we were trained to get good fits, in other words to get the metal to metal contact and thus avoid trouble. This applied to tubes as well as all other parts of the boiler. In some shops it was usual practice in the old days to make the tube holes of such a size that no difficulty was to be experienced when the tubes were put in, and in this brief sketch I am not taking cognizance of locomotive practice, but rather to the general run of boilers built in what are known to the craft as contract shops. Why the tube holes should not be as near to the diameter of the tube as to be called a good fit I could not understand, but it was not uncommon practice to resort to shims to make up for the oversized holes.

It is almost always necessary to resort to the use of shims in retubing on old work, this may be occasioned by the tube holes having been drilled oversized when the boiler was built, or to re-rolling of the tubes to tighten them while the boiler was in service. Be this as it may, it is better to see that the tube is made quite tight in the hole before expanding it rather than taking a chance to expand the tube to fit a large hole and thus run the risk of splitting the tube.

In making the shim for tube purposes, it is good practice to have it extend around the outer periphery of the tube as far as possible and this will be governed by the thickness of the material used in making the shim. The shim should be scarfed to a very thin edge on the edge entering the tube hole first and on both ends of the shim, since by doing so it will facilitate entering the shim around the tube and prevent a "pin hole" where the shim stops at each end.

The shim should be driven in flush with the outer edge of the tube hole as this makes a neater looking job when the work is completed, especially if the tube is beaded. The width of the shim does not need to be much over the thickness of the tube sheet, but it is usually made wider to be sure that it is at least flush with the inside of the tube sheet when driven in. Sometimes it is not possible to drive it in as far as one would like. Scarfing can either be done by hammering or, if the facilities are at hand, grinding on the emery wheel is preferred, as it does a very neat job. After scarfing the shim should be bent to conform as nearly as possible to the shape of the tube.

Wollaston, Mass. Wm. K. Campbell

Cause of Boiler Explosions

To the Editor:

Rail Boiler Blast Kills Father of Eight

> ST. LOUIS, May 1.—Blown 125 feet when the boiler of a Frisco engine he was watching exploded, George Keener, 35, Pacific, Mo., father of eight children, is dead today. Railroad men believe the blast was caused when Keener turned cold water into the boiler.

The above again brings to our attention the popular fallacy, the beloved verdict of coroners' juries of another decade, that the deceased came to his death in a boiler explosion, caused by turning cold water into a hot boiler.

The writer, knowing fully the controversial nature of this subject and the credo of many that under no circumstances should the injectors be applied on a boiler with an overheated crown sheet, differs in many ways with those who hold this opinion. By what process of reasoning is it arrived at, that applying cold water to a hot crown sheet causes an explosion? In the first place, it is impossible with the modern locomotive to put cold water into a boiler. Even in the days before the injector, when cold water was applied directly into the boiler by the crosshead operated pumps, the cold water thus applied did not come in direct contact with the hot crown sheet. Even if it did, that would not cause an explosion. With no other means at hand for cooling the boiler, and lowering the temperature, applying water to the boiler at this time, instead of causing an explosion, would be the most effective means to prevent one.

By this it is not meant to convey an erroneous impression that applying the injectors in all cases will prevent an explosion, but that, in the event an explosion takes place, the fact that the injectors were put on at the time was not the cause of the explosion which would

(*Continued on page 156*)

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.

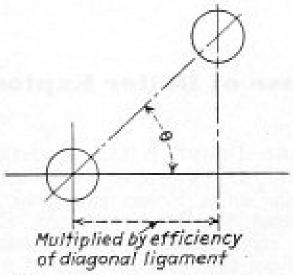
By George M. Davies

Efficiency of Diagonal Seams

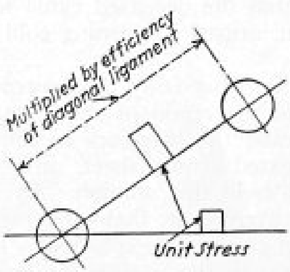
Q.—I have read your article in the August issue of THE BOILER MAKER regarding efficiencies of diagonal seams. These values, except for $\theta = 0$ and $\theta = 90$ degrees, do not agree with those found in Fig. P-7, the chart of diagonal ligament efficiencies given in the A. S. M. E. Code, for the analysis of which I refer you to the *Marine Engineer's Handbook*, by Sterling, pages 422 to 426.

A point on which I have not arrived at a satisfactory explanation, however, is in figuring equivalent longitudinal sections for diagonal ligaments. Paragraph P-193-C-30 of the Code states that the longitudinal distance between centers of holes forming the diagonal ligament multiplied by the efficiency taken from the chart is the equivalent longitudinal section. It seems to me that, since these efficiencies are based on unit stresses, the equivalent longitudinal section would be the diagonal pitch multiplied by the efficiency. This seems to be the method of your article in THE BOILER MAKER.

I am enclosing sketches illustrating this question, and will appreciate your comments regarding it. R.M.T.



As the angle θ increases, the strength of the diagonal ligament increases, but the equivalent longitudinal section decreases.



Unit stress in ligament = 10.
Unit stress in longitudinal section = 5.

$$\text{Efficiency} = \frac{5}{10} = 0.5.$$

∵ The diagonal ligament is 0.5 as strong as the same length section on the longitudinal.

The equivalent longitudinal section would be the diagonal pitch multiplied by the diagonal efficiency.

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) and also in the *Marine Engineer's Handbook* by Sterling, are determined by actual experiments, and are slightly under the efficiencies obtained by the formulae given in the August issue.

To obtain the equivalent longitudinal section of a diagonal ligament, the longitudinal pitch of the two holes having a diagonal ligament shall be multiplied by the efficiency of the diagonal ligament.

To multiply the diagonal pitch by its efficiency, as suggested in the question, would give the equivalent diagonal section, which would have to be multiplied by the cosine of the angle in order to obtain the equivalent longitudinal section.

This is the same as multiplying the longitudinal pitch of the two holes having a diagonal ligament by the efficiency of the diagonal ligament.

Gasoline Truck Tanks

Q.—Please inform me if you have any information or data relative to the design of thickness of metal for all-welded oval gasoline truck tanks, capacity from 2000 to 4000 gallons. I would like to obtain this formula for the calculation of same. B.M.S.

A.—The following data on the design of all-welded oval gasoline truck tanks, while not including formulas for the calculation of same, cover the present practices for this type of tank construction.

The material used is generally either open hearth steel or blue annealed steel. The thicknesses to be used for the various sizes of tanks are given in Table 1.

TABLE 1

Capacity	Minimum Thickness of Metal
Up to 500 gallons	No. 14 gage
500 to 1000 gallons	No. 12 gage
1000 to 2000 gallons	No. 10 gage
2000 to 3000 gallons	$\frac{3}{16}$ inch
3000 to 4000 gallons	$\frac{1}{4}$ inch

The thickness of the heads to be one gage heavier than the thickness of the shell to which they are connected.

All truck tanks can be divided into two general classifications, the single and the multi-compartment tanks, the general principles of both types of tanks being the same.

The following methods or types of construction are used:

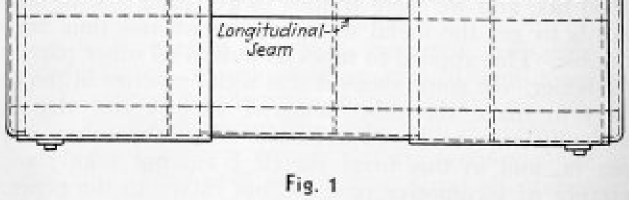


Fig. 1

Fig. 1 shows a tank built up from three oval rings welded together by means of circumferential and longitudinal seams.

Fig. 2 shows a tank with no circumferential seams

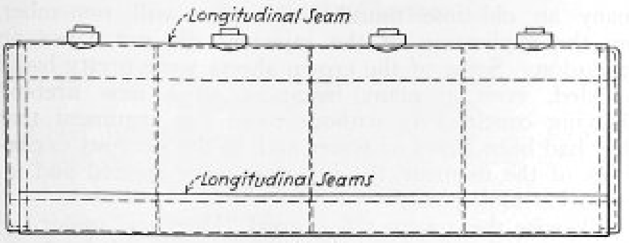


Fig. 2

with the exception of the heads, the tank being made with three or more sheets welded together on the longitudinal seams only.

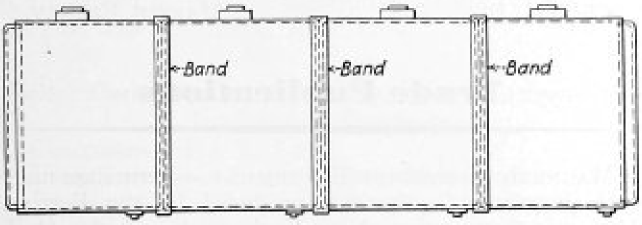


Fig. 3

Fig. 3 shows a tank composed of four independent oval compartments bolted together, the joints between the compartments being covered with bands.

Butt-welded seams are used for small and middle size tanks and lap-riveted-welded seams on large size tanks. The last method permits an easy fit to the body of the tank during the assembling and forms additional rigid bands which are important stiffeners to the larger size tanks.

All shell seams are welded inside and outside.

When butt-welded joints are used on the larger size tanks, the joints should be reinforced as shown in Fig.

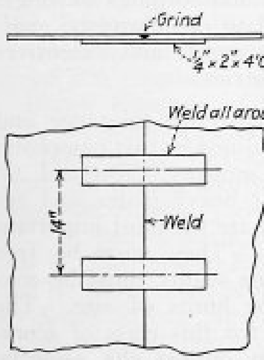


Fig. 4

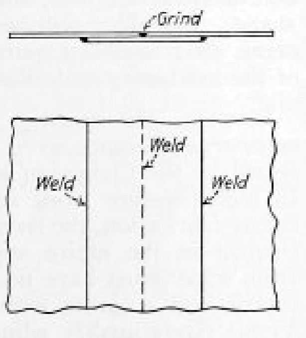


Fig. 5

4. The use of one continuous flat band for reinforcement as shown on Fig. 5 is not recommended. A gasoline "pocket" may appear under such reinforcement, and during repairs, even after steaming the tank, may cause an explosion under the torch.

Cross and longitudinal partitions (baffles) are spaced from 4 to 5 feet apart. All large compartments should be subdivided in order to prevent dangerous splashing about of the gasoline in the tank. The size and type of baffle depends upon the size of the tank.

For the small size tank, the baffles may be made the same thickness as the shell plate, flanged on the sides and welded to the shell of the tank. The longitudinal baffles are usually 6 inches to 9 inches lower than the cross baffles because of clearance for the manhole. They are also flanged on the ends and welded to the cross baffles.

For the middle size tanks, a light angle iron, continuously welded to the shell, and a baffle plate of the same thickness as the heads should be riveted or welded—not bolted—to the outstanding leg of the angle iron, the angle stiffening the shell and making a more rigid tank.

For the large size tanks it is important to build up a triangular system of baffle stiffeners, so that the baffle plates themselves will be more rigid. This type of construction is used in the tank illustrated in Fig. 6.

The heads and bulkheads of independent compartment tanks, as previously mentioned, are to be one gage heavier than the shell. Bulkheads may be single or double. When there is gasoline of a different kind in each compartment, double bulkheads must be used. Usually an air space of ¾ to 1 inch between compartments prevents an intermixing of gasoline in case of damage or a leak. A small hole at the bottom of such an air space helps to control leaking in the compartments. Each compartment of the tank should be tested after welding and proved tight with a minimum air pressure of 5 pounds per square inch.

There are two types of manholes for gasoline tanks, namely, the screwed and the bolted types. The screwed type of manhole is usually 14 inches in diameter, employing four threads to the inch.

When large manholes are required, the bolted type, with gas-proof gaskets, is used (see Fig. 6). Very often a large manhole is required, due to a proportioned relation between the body of the tank and the manhole itself.

The common rise of manhole is 3 inches above the highest point of the tank. Large tanks require for the expansion of gasoline a dome capacity equal to 3 percent of the total capacity of the tank. The gasoline expansion is small and on middle size tanks it will be taken care of by the raised manhole. According to the requirements of the National Fire Protection Association, no tank or tank compartment shall be filled in excess of 99 percent of the capacity.

Fillers and Vents.—Filler openings are usually located in the manhole and are not less than 4 inches in diameter, and are commonly 6 inches in diameter. These openings are standard pipe threaded and have screwed caps with

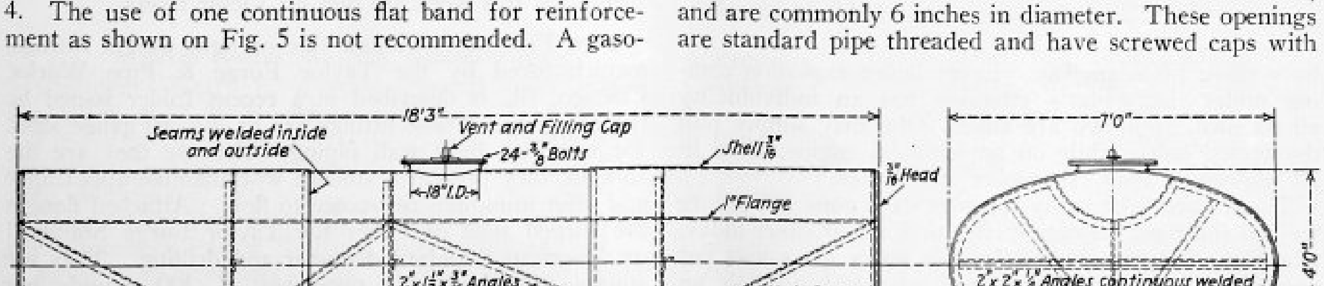


Fig. 6.—3000 gallon single compartment tank

a minimum ¾-inch vacuum and pressure operating vent. It is required by the National Fire Protection Association that "in addition thereto, venting facilities of such size and capacity as will safely relieve such internal pressure as may be created by exposure fires." There are many patented caps on the market which are built according to the above requirements.

Valves, Faucets, Emergency Valves.—Each compartment is equipped with a valve and faucet. All valves and faucets have threaded ends and permit a gas-tight connection with the piping and hose extending to the filling pipe.

To prevent the spilling of gasoline on the street in case of accident or fire, it is necessary to install an emergency valve inside the shell of each tank compartment, which is automatically kept closed, except during delivery operations.

Fig. 6 illustrates the design of a 3000-gallon all-welded single-compartment steel truck tank.

Aluminum tanks have come into use during the past few years. The metal being about half as heavy as steel allows the building of truck tanks which are lighter than the steel tanks and which permit the loading of from 15 to 25 percent more gasoline on the truck.

The specification of a recent aluminum tank is as follows: The tank was fabricated to hold 3000 gallons of gasoline. Specifications called for an ellipsoidal-shaped body 51 inches by 80 inches by 18 feet long, to be made of 3 S aluminum sheet ¼ inch thick. On the top side of the tank a dome 4 feet long by 2½ feet wide was constructed and partitioned off to hold a manhole in one half and fuel supply for the truck in the other half.

In order to retard the wash of liquid when the tank is only partially filled, four baffle plates, each having a manhole and four small openings, were placed inside and fastened by means of 2-inch by 2-inch aluminum clips welded to the tank.

The shell was formed of three plates which were welded together flat, making two longitudinal seams with butt-type welds. Then the shell was rolled to shape, and in this way any small amount of buckling, which might result from the heat of the welding operation, was eliminated. The dished heads were formed so as to have 2-inch flanges. These were then welded with a butt-type joint directly to the shell. The average welding time for seams was 5 feet per hour.

As all seam edges in the aluminum had been nicked back the thickness of the sheet at 2½-inch intervals on both sides before welding, excellent penetration was secured without applying too much heat from the blow pipe during welding.

Cause of Boiler Explosions

(Continued from page 153)

have taken place anyway. Every boiler explosion coming under the writer's attention has an individuality all its own. No two are alike. One may simply pull the crown bolts, while on an identical engine, alike in all respects, it may "skyrocket" the boiler.

There have been many times in days gone by, before we had the rigid inspection laws that are in effect today, where the bottom opening for the water glass was put any place convenient to a stud on which to bolt an "Old Man," where the crown sheet was heated and saved from disaster on the road by applying the injectors. The engine came in off the pit leaking, as many an old-time round house man will remember, but the application of the injectors did not cause an explosion. Some of the crown sheets were pretty badly buckled, even in many instances on a new firebox, showing conclusively without room for argument that they had been bared of water and, in the nervous excitement of the moment, the injectors were applied and no explosion took place.

Likewise there were a few good "Hoggers" under the sod when the enlightened jury convened and brought in the verdict mentioned above when in the light of what we know now, shown us by an extensive and thorough inspection of locomotive appliances, an explosion could have been and is caused by other means. This then is the kernel in the nut. Applying "cold" water to a hot boiler does not and will not cause an explosion.

Chicago, Ill. MARTIN FEENEY.

Trade Publications

MAGNETIC INSPECTION EQUIPMENT.—Fermango magnetic inspection equipment, produced by the Ferrous Magnetic Corporation, New York, is described and illustrated in a new catalogue issued by the company. This equipment is used for the examination of wire and wire rods, as well as strip steel. It also describes and illustrates a new type of portable Fermango magnetic weld inspection equipment for pipe or plate welds, construction welds and welds of boiler tubes.

NICKEL ALLOY STEEL COMPOSITIONS.—A circular chart, which shows at a glance the nickel alloy steel composition and treatments required to develop yield points up to 175,000 pounds per square inch in section sizes varying from 1 to 12 inches, has been issued by the International Nickel Company, Inc., New York. The figures given on this chart are based on numerous tests and may be used as a general guide to the selection of steels for bars, shaftings and forgings of single shape. The chart will be useful to metallurgists, engineers, steel salesmen, purchasing agents and executives of the machinery and allied industries.

RIVETS.—The qualities of Victor true-tolerance and super-true tolerance rivets are outlined in two pamphlets issued by the Champion Rivet Company, Cleveland, O. In high pressure work requiring heavy plates and accurate fabrication, the rivets used are the most important element in the entire structure. They must be free from scale, must have no fins nor seams, must be concentric and accurate within close limits of size. The Victor rivets qualify admirably for this class of work. The two pamphlets in question outline the essential characteristics for rivets in vessels operating with pressures up to 700 pounds per square inch. All requirements for this work are met by Victor rivets.

PIPE FITTINGS.—A new line of light weight fittings, manufactured by the Taylor Forge & Pipe Works, Chicago, Ill., is described in a recent folder issued by the company. These fittings are of No. 10 gauge steel, for use with light wall piping. Because they are die formed, they present a smooth workmanlike appearance and offer minimum resistance to flow. Attached flanges are forged steel of either the Taylor Forge Standard or American Standard diameter and drilling. They are suitable for hydraulic pressures of 200 pounds per square inch, or more on smaller sizes and are tested to 50 percent in excess of the working pressure for which they are ordered.

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.

Secretary—C. W. Obert, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—C. D. Thomas, Salem, Ore.

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

Vice-Chairman—William H. Furman, Albany, N. Y.

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.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.

Executive Board — Charles J. Longacre, chairman, division boiler inspector, Pennsylvania Railroad, Baltimore, Md.

American Boiler Manufacturers' Association

President—Charles E. Tudor, The Tudor Boiler Manufacturing Company, Cincinnati, O.

Vice-President—Owsley Brown, The Springfield Boiler Company, Springfield, O.

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

Executive Committee—(Three 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. (Two years)—J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.; M. E. Finck, Murray Iron Works, Burlington, Ia.; A. C. Weigel, Combustion Engineering Corporation, New York. (One year)—Homer Addams, Fitzgibbons Boiler Company, Inc., New York; George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn. (*Ex-Officio*)—H. H. Clemens, Erie City Iron Works, Erie, Pa.

OFFICE OF INDUSTRIAL RECOVERY COMMITTEE,
15 PARK ROW, NEW YORK

Manager—James D. Andrew.

Secretary—H. E. Aldrich.

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
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

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.		Tampa, Fla.

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

States

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

Cities

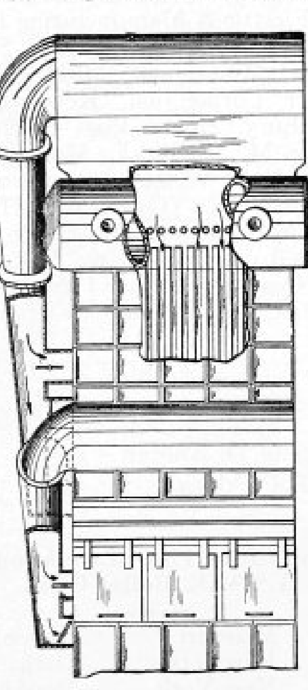
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

Selected Boiler 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.

1,834,261. STEAM BOILER AND METHOD OF OPERATING THE SAME. HOSEA WEBSTER, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

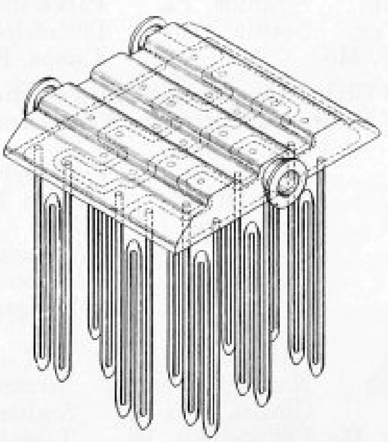
Claim.—In combination, a water tube boiler and a furnace, means for directing gases from said furnace across the tubes of said boiler in



a plurality of passes, an air heater located between two of the passes whereby gases pass in succession over boiler tube heating surface, then over said air heater, and then over other boiler tube heating surface, and means for utilizing the air from said air heater for combustion purposes. Ten claims.

1,833,314. SUPERHEATER. ALFRED W. BRUCE, OF NEW YORK, N. Y.

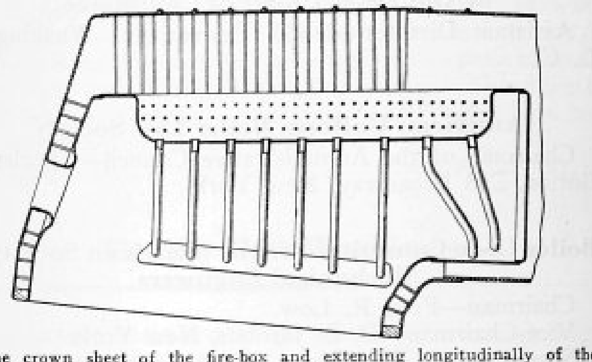
Claim.—A superheater comprising a substantially box-shaped header; a plurality of steam circulation tube units projecting from one side of said header and entering said header through said side, each unit comprising an



inlet end and an outlet end, communicating with said header, the units being arranged in spaced rows, the units of each row being spaced and the units of adjacent rows being staggered, the units of alternate rows being aligned, whereby the units of one row will be disposed abreast of the spaces between the units of the adjacent rows, the units of each row being arranged in parallel, one set of alternate tube ends of each row being inlets and the other set of alternate tube ends of said row being outlets; and winding partitions separating said header into compartments whereby all the inlet ends will be in communication and all the outlet ends will be in communication, through different compartments. Three claims.

1,818,544. SIPHON GENERATOR AND CIRCULATOR FOR LOCOMOTIVE BOILERS. GEORGE H. EMERSON AND WILLIAM B. WHITSITT, OF BALTIMORE, MARYLAND.

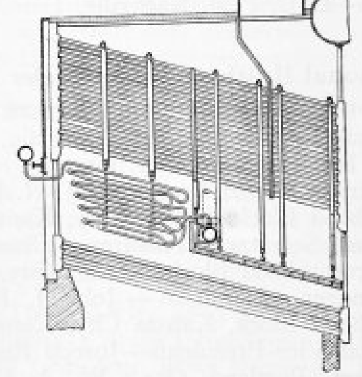
Claim.—The combination with a locomotive boiler having a fire box, a combustion chamber at the front thereof, a side water leg, and a barrel, of a water steaming and circulating device comprising a trough supported



by the crown sheet of the fire-box and extending longitudinally of the fire-box and into the combustion chamber, said trough communicating at its top through the crown sheet with the water space of the boiler above the level of the crown sheet, a set of water circulating tubes connecting the trough with the side water leg, and water tubes connecting the part of the trough in the combustion chamber with the water space of the barrel. Six claims.

1,818,390. BOILER. CHARLES W. GORDON, OF PLEASANTVILLE, NEW YORK, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

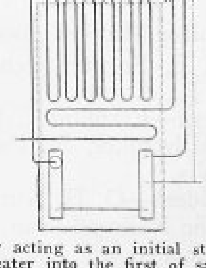
Claim.—In a boiler having two vertically spaced banks of horizontal



tubes, the combination with said banks, of a baffle between and parallel to them and spaced from both of them, and supports for said baffle hung from tubes in the upper bank. Six claims.

1,817,419. HIGH PRESSURE STEAM GENERATOR. WALTER GUSTAV NOACK, OF BADEN, SWITZERLAND, ASSIGNOR TO AKTIENGESELLSCHAFT BROWN, BOVERI & CIE., OF BADEN, SWITZERLAND.

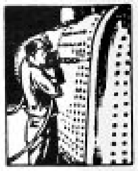
Claim.—In an apparatus of the class described, a steam and water drum, a series of alternately connected substantially dry evaporators and super-



heaters, an exciter boiler acting as an initial steam source and delivering steam through a superheater into the first of said evaporators, means for delivering water from said steam and water drum individually and in finely divided form into said evaporators, means for returning surplus water from said evaporators to said steam and water drum, and means for delivering steam from the last of said series of evaporators to a place of consumption. Three claims.

The Boiler Maker

Reg. U. S. Pat. Off.



Significance of the Master Boiler Makers' Convention in Print

Elsewhere in this issue appears the program of the "Master Boiler Makers' Convention in Print" which will be published in October. The importance of this event to railroad boiler shops throughout the country at a time when the pressure of rehabilitating power is beginning to be felt can hardly be overestimated.

Under conditions that have prevailed for the past three years in the railroad, as in all other industries, much ground unquestionably was lost through the closing of shops and the curtailment of operations in others. With the changes of the past few months, however, those qualities of shop practice embodied in organization, personnel and equipment which up to 1930 brought locomotive maintenance methods to a high level of efficiency, have assumed a new significance.

It is physically impossible over night to rebuild organizations of trained personnel and to carry on shop operations with the same degree of skill after months of inaction. Of all railroad mechanical departments the boiler shop represents one of the most difficult to reorganize since the staff must include trained men with long years of experience in a highly specialized line of work.

Recognizing this difficulty and wishing to aid the railroads towards recovery, the officers of the Master Boiler Makers' Association some months ago conceived the plan of conducting a complete convention in the pages of this publication insofar as possible to serve as a substitute for the customary conventions held up to 1930 and which since have been impossible because of financial conditions.

This Convention in Print will serve to stimulate interest in the association among members to whom it will be the first activity of their association since 1930. It will bring to them messages of encouragement from leading railroad mechanical officials. Practically it will inform not only the membership of the association but mechanical department heads, foremen and men going back to work in the boiler shops of developments in equipment, materials, tools and methods that have occurred in the past three years. Nothing could be of greater importance now than to bring out information on up-to-date boiler practice.

The subjects opened for discussion by the reports presented will be entered into wholeheartedly by the best minds of the trade. The convention should thus result in a wealth of practical information on all phases of boiler shop work that in no other manner could be made available for meeting the problems now confronting the mechanical department.

To the companies supplying equipment, tools and materials used in the boiler department, the Convention in Print offers the opportunity through the exhibit section and the advertising pages to present their products at a time when education in modern facilities and practices is of the utmost importance to the railroads.

An Opportunity for the Code of Fair Competition

In connection with the operation of the National Recovery Act, several branches of the boiler and pressure vessel industry have organized and are preparing their Codes of Fair Competition. These Codes undertake to lay down many rules for business conduct and sales procedure that should eliminate many of the evils of the former under-bidding and "chiseling" practices in trade. But, as generally outlined, they do not appear to go far enough—they do not make any attempt to set up standards of manufacture.

There is already established a code of minimum construction standards for safety of boilers and pressure vessels—the A.S.M.E. Boiler Construction Code—and, as ordinarily applied in the Code states and cities, the rules therein have the effect of establishing manufacturing standards. It would appear obvious that reference might be made in the new N.R.A. Codes to this well-known construction code as a minimum below which manufacturers are not allowed to construct boilers or pressure vessels. This would, as has been amply proven, place no burden on the industry, and at the same time do much to establish the uniformity of construction practices that is so much needed to insure fair competition in trade. If all manufacturers were required to bid on standards of construction that are at least equal to the Code minimums, the manufacturers would be placed on a fair comparable basis and the purchaser would certainly be assured of a fair deal.

Under the N.R.A. the industry is charged with the responsibility of adopting fair practices and reasonable procedures, so that business will be accelerated and a fair return insured on all products. What could be more fair to manufacturer and purchaser alike than to bid upon and construct boilers and pressure vessels that conform to the A.S.M.E. Code minimum requirements, with, of course, National Board inspection? Proper inspection by duly authorized inspectors is an essential part of the scheme of Code construction.

The American Boiler Manufacturers' code under the N. R. A. has reached its final form and is now only awaiting the President's approval officially to put its provisions into effect. The complete code will appear in a later issue.

Photographic Investigation of

Caustic Embrittlement

*By J. P. Morrison**

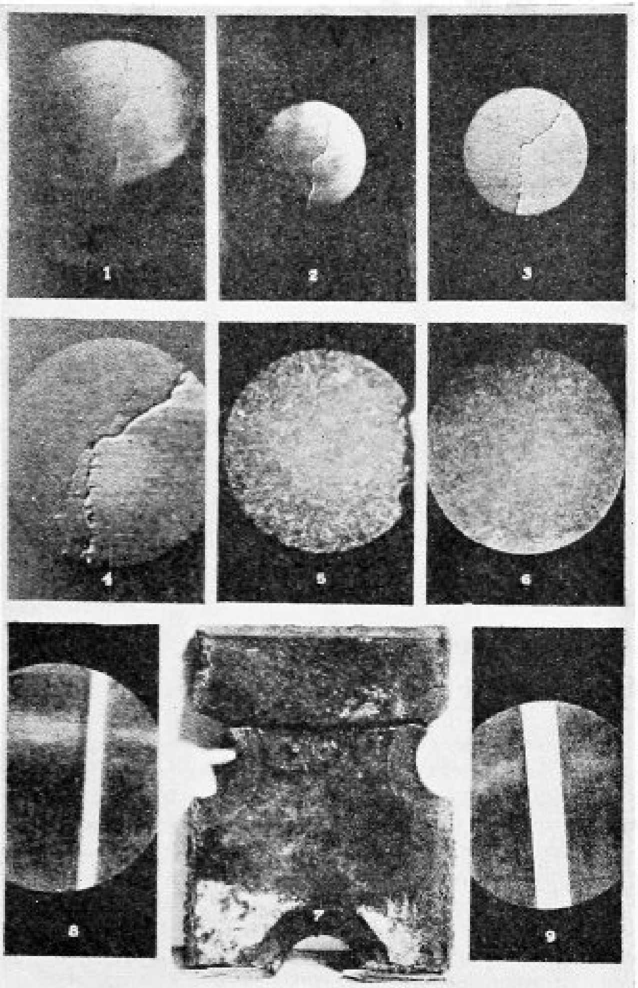


Fig. 1.—How caustic embrittlement cracks appear through the magniscope

Photographing the walls of rivet holes in a boiler drum through the Hartford magniscope, thereby combining the principles of the periscope, the microscope and the camera, was described in an article in *The Locomotive* for April dealing with developments in the detection of caustic embrittlement. The interest aroused in America and abroad by the reference to the Hartford Steam Boiler Inspection and Insurance Company's work on the subject appears to justify publication of further detail.

The difficulties of photographing evidences of caustic embrittlement are in themselves an interesting subject and form a logical supplementary article to that in the prior issue. The accompanying photographs, explained in detail later in the article, clearly illustrate the problems involved.

Prior to the development of the Hartford magniscope, our inspectors, by the use of small magnifying glasses, had become proficient in the discovery of cracks in boiler seams in spite of the difficulties encountered even in the comparatively small rivet holes in thin plate. Under the operating conditions of a few years ago, involving low rates of evaporation, the fissures were comparatively slow in development, requiring, in many cases, a number of years' operation with boiler water of high sodium carbonate alkalinity and low sulphate content, before the disease progressed through the plate a sufficient distance to impair the safety of the boiler. During that time, the defect in the wall of a rivet hole may have developed until visible to the eye. Not infrequently, one boiler became affected to a dangerous degree a considerable time before it appeared in other boilers operated under identical conditions. The seam of one boiler of which we have record was examined at intervals of two weeks for six years between the time the first evidences of caustic embrittlement were discovered and the time the development reached the danger stage.

However, with the higher rates of combustion and furnace temperatures now generally used, make-up water treatment is an absolute necessity, even where the boiler supply is principally condensate. The boilers of great capacity, designed for the higher ranges of pressure, have thick shell plates, and larger, longer rivets, and so have correspondingly greater areas to be affected by caustic embrittlement. If the distress is discovered in one boiler it is probable that all boilers in the plant are affected to a greater or lesser extent. The development instead of requiring a number of years may be the cause of an explosion within a year or less after the boiler is first placed in service.

Before the Hartford magniscope was developed, if no crack could be seen by the naked eye or under a small magnifying glass, the true condition of the seam could not be determined. The boiler was continued in service until greater development brought the defect into the range of visibility, but made the caustic embrittlement fissures visible at a stage too far advanced to permit salvaging the investment. The situation made it evident that some better method of investigating rivet holes would have to be devised, if the disease were to be

*Assistant chief engineer, boiler division, Hartford Steam Boiler Inspection and Insurance Company. Reproduced by courtesy of *The Locomotive*.

diagnosed in time to prevent the scrapping of expensive installations.

The Hartford magniscope with its periscope principle of inserting a mirror into the rivet hole, was devised to solve this problem. The original instrument, of 6 magnifications (little more than that obtainable with a reading glass) gave way to one of 12-power, which in turn was replaced by a magniscope of 20-power. We are now successfully using lenses giving approximately 100 magnifications of the surface being investigated. Etching the polished rivet hole enables us to bring out with this magnification, the grain boundaries of the steel showing the intercrystalline path of the fracture. This, we believe, has not been done previously except in a metallurgical laboratory.

The work of polishing and etching the rivet hole in the boiler violated many of the traditions and practices of such work. While the laboratory method of having a small specimen polished to a perfectly smooth, plane surface is recognized as the ideal working condition, we are not able to change the shape of the wall of a rivet hole, which is curved and frequently not over an inch in diameter. Furthermore, a caustic embrittlement fissure seldom develops in a straight line, so not only is the area to be polished, etched and photographed curved, but the problem of focusing is complicated by the fact that the defect in which we are interested usually crosses that curved surface at an angle. The difficulties in establishing a perfect focus with any sort of a magnifying instrument may be easily imagined.

Customary laboratory instructions for micro-photographing steel read about as follows: "After etching a sufficient length of time with acid, dip the specimen in ethyl alcohol to neutralize the acid, drying quickly in moving air to prevent rusting." This laboratory instruction is not so easily followed when the specimen is part of a boiler drum 54 inches in diameter by 30 feet in length and weighing 25 tons.

It was pointed out in *The Locomotive* article previously referred to that the surface to be magnified and photographed may be lighted either by means of a small electric lamp affixed to the end of the magniscope, or by a larger lamp so placed as to illuminate the rivet hole. Neither of these methods provides what might be termed a perfect light for as irregular a surface as the wall of a rivet hole which is being examined in detail for microscopic cracks. Because of the curvature of the surface to be photographed, the angles of the light rays upon the area within the range of the reflecting prism, as used in the magniscope of latest design, lead to diffusion in some zones and concentration in others. These particular difficulties of focusing are still a problem and we have not been able to overcome this trouble entirely. In taking the photographs accompanying this article it was sought to correct this condition as much as possible by getting the important part of the picture into the best focus and by throwing sufficient light on the part of the plate to be brought out in the photograph. In these cases, of course, the important part of the picture is the section of the rivet hole through which the embrittlement fissure passes. This explains why the center portion of some of the pictures is in sharper focus than is the outer portion.

Recently symptoms of caustic embrittlement were found in a plant containing five boilers. For the purpose of comparing the older methods with the newer, photographs made during the investigation are now reproduced as a matter of general interest.

Photograph No. 1 was taken through the original Hartford magniscope, using the camera attachment. The defect was faintly visible without the aid of magnification after the surface had been polished and the location of the defect had been determined.

Photograph No. 2 is of the same defect through an instrument similar to the original magniscope except that the reflecting mirror had been replaced with an optical prism.

Photograph No. 3, taken with the magniscope and camera attachment of the latest design, is of the same defect at about 20 magnifications. In this photograph the true nature of the embrittlement defect becomes clearer. What is seen in the photograph is not a large fissure with branches, but rather the junction of two large fissures, the one progressing upward in the photograph and the other downward. Thus the complete defect, which extends the full width of the boiler plate, was formed by the joining of two independent fissures, each progressing from the surface of the plate. Further investigation, after the plates forming the butt strapped seam had been separated, brought to light the fact that each of the two lines of cleavage, while appearing to unite at the wall of the rivet hole really extended independently of each other through the material of the plate in the direction of an adjacent rivet hole. These two fissures progressing from one rivet hole to another tended to make a section of the plate between them a sort of island cut off completely from the remainder of the plate.

Photograph No. 4 is of the same defect magnified about 40 diameters and gives a better illustration of the grapevine path of the smaller fissure shown in the lower part of the photograph.

Photograph No. 5 is a part of the fissure at the lower left of photograph No. 4 which was not visible in the pictures of smaller magnification. The larger defect which can be seen in photographs Nos. 1 and 2 appears as a large irregular gouge along the righthand side of this picture, which is of approximately 100 magnifications.

Photograph No. 6 is of the same defect as No. 5 except that the rivet hole wall had been etched. It is of approximately 100 magnifications and shows the path of the crack between the grains of the steel.

Photograph No. 8 shows the poles of a micrometer set at .005 inch and magnified about 40 times. If any part of the defect illustrated in photograph No. 4 were .005 inch in width it would be of the same width as the gap shown in photograph No. 8.

Photograph No. 9 shows the micrometer poles set at .005 inch and magnified 100 times. Thus if the hairline defect shown in photographs Nos. 5 and 6 were .005 inch in width, it would be as wide as the space shown in photograph No. 9. These two photographs (Nos. 8 and 9) are shown merely to give an idea of the minuteness of embrittlement cracks as they occur in their early stages.

The final stage of caustic embrittlement development is illustrated in photograph No. 7. This piece of metal came from the butt strap of a boiler which embrittlement had ruined. When the strap was removed, it fell apart under a very slight hammer blow.

Frequently, the fact that a caustic defect is not visible to the naked eye is used as the basis for an opinion that it is of minor importance and has not extended a distance sufficient to weaken the boiler materially. However, experience has taught us the impossibility of determining from its appearance across the wall of the rivet hole what distance the crack extends into the plate on a line parallel to the longitudinal axis of the drum.

This uncertainty has led to the perfection of an inspecting technique to ascertain with more accuracy the depth of a defect at a particular rivet hole or group of them. After the presence of the disease has been discovered in the wall of a rivet hole, it is known to a certainty only that the cracks are present in the surface of the hole. It is not known how far they extend into the plate, whether 1/8 inch, 1/4 inch or the entire distance to the next rivet hole. To determine whether the embrittlement has eaten only a short distance or whether it is more serious, a hole (see *A* Fig. 2) is routed into the side of the rivet hole where the crack was found by means of the magniscope. A dental drill or burr has been used with some success in excavating a cavity to a depth of 3/16 inch into the plate, but an especially designed combination of motor, flexible shaft and milling tool was used in exploring the particular defect shown in the photographs. With this tool a cavity 1/4' inch wide

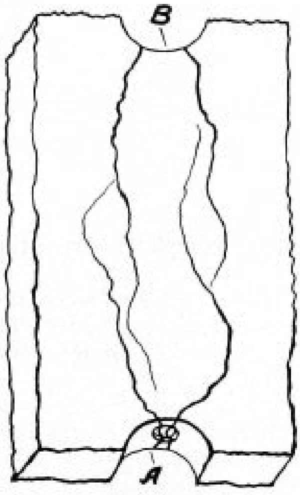


Fig. 2

was milled into the steel plate to a depth of 1/4 inch. This exploration revealed conclusively that the fissures extended more than 1/4 inch into the plate, and further investigation showed that they extended practically from rivet hole to rivet hole. Exploration in other rivet holes revealed a veritable network of cracks developing simultaneously through the plate. Had the cracks penetrated to a depth of only 1/8 inch the progress of the disease might have been checked by reaming the rivet holes oversize and reriveting the seam.

The case used in illustrating this article had progressed to a point where a dangerous weakening of the boiler plate and butt straps had taken place, so the drums were removed. One of the butt straps was cut, and the condition shown in photograph No. 7 was revealed. In another piece of the strap, with rivet holes into which cavities had been drilled in the sides, a condition similar to that illustrated in Fig. 10 was brought to light. It is shown here because it emphasizes the network of fissures which are often present in an advanced case of caustic embrittlement.

Fig. 2 is a drawing of a section of plate cut from a scrapped drum. In the case in point the development of fissures from two adjacent rivet holes was studied and charted. Two of the fissures passed through the cavity milled in the wall of the rivet hole *A* and then proceeded about halfway to the next rivet hole *B*. Two other fissures had started at the rivet hole *B* and had proceeded to a point where they merged with the two fissures developing at *A*. Thus in this case four separate fissures had contributed to the disintegration of the plate. These and other fissures had ruined the boiler drum beyond repair.

National Board of Inspectors' Convention

The National Board of Boiler and Pressure Vessel Inspectors will hold their ninth Annual Convention at the Hotel McAlpin, New York City, on October 17, 18, and 19.

This association is composed of the chief inspectors charged with the enforcement of Boiler and Pressure Vessel Codes, Rules and Regulations in the various states and cities of the United States, which have adopted the American Society of Mechanical Engineers' Boiler Code as the basis for their state or city rules and regulations in that respect. It has for its aim the adoption of uniform rules and regulations as applying to boiler and pressure vessels with respect to their construction, installation, and operation. It also has to do with the examining and qualifying of inspectors to carry on this duty thus promoting uniformity in construction, operation, and inspection of such boilers and pressure vessels. In this way the lives and property of the public at large are safeguarded.

It is a national organization. Members will be present from all parts of the Union and the Dominion of Canada.

An extensive program of technical and administrative subjects has been prepared on subjects of particular interest to the members.

The National Bureau of Casualty and Surety Underwriters is actively co-operating with the members of the National Board in an effort to make this convention interesting and instructive.

Among the speakers will be Dr. D. S. Jacobus, chairman of the A. S. M. E. Boiler Code Committee; Charles E. Tudor, president of the American Boiler Manufacturers' Association; and James A. Beha, general manager and counsel of the National Bureau of Casualty and Surety Underwriters.

Two sessions will be held daily at which various topics of the program will be handled by experts. There will be a luncheon each day at the hotel, with a dinner on Tuesday evening at which L. C. Peal will be toastmaster. On Thursday afternoon there will be the election of officers. The present officers of the Board are: C. D. Thomas, Oregon, chairman; William H. Furman, New York, vice-chairman; C. O. Myers, Ohio, secretary-treasurer; and L. C. Peal, Tennessee, statistician.

The executive committee consists of Messrs. Thomas, Furman, Myers, Peal, J. F. Scott of the National Board; G. W. Bach, representing the American Boiler Manufacturers' Association; C. W. Obert, representing American Welding Society, and J. P. H. deWindt, representing the National Bureau of Casualty and Surety Underwriters. Mr. Thomas is general chairman of the Ninth Annual Meeting, with Mr. Furman, Chairman for Tuesday morning, B. M. Book of Pennsylvania, Tuesday afternoon; F. A. Page of California, Wednesday morning, Mr. Scott, Chairman, Thursday morning, and Mr. Thomas, Chairman, Thursday afternoon.

LUKENWELD CONSTRUCTION.—"Lukenweld Construction—The Modern Method of Manufacturing Parts for Machinery and Equipment" is the title of Bulletin No. 2 issued by Lukenweld, Inc., Coatesville, Pa.

DURONZE.—Duronze high strength silicon bronzes are the subject of a 24-page booklet issued by the Bridgeport Brass Company, Bridgeport, Conn. These bronzes are used for making corrosion-resisting bolts, nuts, machine and cap screws, U and J bolts, washers, and other products for the railroad, marine, automotive and other industries.

NRA Holds Hearing in Washington on Code for Boiler Manufacturing Industry

Extended criticism by labor representatives featured the hearing on the code of fair competition for the boiler manufacturers, which was held in Washington on August 31 by Assistant Deputy Administrator George Brady.

Criticism of the code presented by the American Boiler Manufacturers' Association came from this direction because representatives of certain divisions of the industry said that the code did not concern them. The were R. A. Locke, R. B. Dickson and L. B. Weller, representatives of domestic boiler and stoker manufacturers, who declared that codes for their branches of the industry had already been filed with the Administration, and they preferred to await hearings on these codes.

At the conclusion of the hearing, Deputy Brady asked that they get together with representatives of the American Boiler Manufacturers' Association, who filed the code, and iron out differences of jurisdiction so that one code would apply to all sections of the industry. He also asked the latter association to appoint representatives to meet with labor delegates to iron out difficulties in the A. B. M. A. code.

The proposed code was presented by the American Boiler Manufacturers' Association, which claimed to represent 70 percent of the boiler manufacturing and affiliated industries. The interests represented included manufacturers of watertube boilers, horizontal return tubular boilers and self-contained firebox boilers, Scotch marine type and vertical firetube boilers, oil country boilers, miniature boilers and all other stationary and marine steel steam boilers except steel heating boilers, as defined in Section 4 of the Boiler Code of the American Society of Mechanical Engineers, stokers of 36 square feet of grate area and over, pulverized fuel equipment, superheaters, air preheaters and economizers and Class 1 welded pressure vessels, as defined in the Unfired Pressure Vessel Section of the Boiler Code of the American Society of Mechanical Engineers.

The section devoted to wages and hours of work provided that the minimum wage to be paid to any employee engaged in the processing of the products of the boiler manufacturing and affiliated industries and any labor directly incident thereto shall be paid 37 cents per hour unless the rate for the same class of labor on July 15, 1929, was less, in which case the minimum shall not be less than the rate on that date, and in no event less than 30 cents per hour. Casual and incidental labor and learners may be paid not less than 80 percent of the above minimum and the total amount paid to such labor shall not exceed in any calendar month 5 percent of the total wages paid to all process labor.

A minimum of $15 per week is provided for office and other employees with the usual exceptions.

A maximum work week of 40 hours is prescribed for employees engaged in the processing of products and for other employees except those engaged in executive, administrative and supervisory work, and traveling and commission salesmen. Provision is made for longer hours to meet emergencies and peak seasonal demands.

Employment of any person under 16 years of age is prohibited, provided, however, that where a state law provides a higher minimum age no person below the minimum provided by such state law shall be employed in that state.

Following presentation of the code by J. A. Andrews, manager of the American Boiler Manufacturers' Association, practically the entire morning was devoted to the statement presented by J. N. Davis, in behalf of the International Brotherhood of Boilermakers, Iron Ship Builders, Welders and Helpers of America.

Recognizing that three codes had been submitted to the Administration, namely, codes for the Boiler Manufacturing Industry, Steel Tubular and Firebox Industry, and Steel Plate Fabricating Industry, Mr. Davis addressed himself to the one filed by the A. B. M. A., stating that the code "violated the letter and spirit of the N.I.R.A.," in failing to include in its provisions sections of the Act calling for action to "induce and maintain united action of labor and management under adequate governmental sanctions and supervision."

Such a result would follow, Mr. Davis said, from the appointment of a joint standing committee, equally representative of the trade associations and labor organizations in the industry to aid in carrying out provisions of the code once in effect.

He particularly attacked the section of the labor provisions in the code modifying Section 7-A of the N.I.R.A., which reads that "nothing in this code is to prevent the selection, retention and advancement of employees on the basis of their individual merit."

Stating that industry's representatives had set up two wage minima in the code, Mr. Davis asked that, if this should be carried out, the minimum for unskilled employees engaged in processing and labor operations incidental thereto should be $25 per week, and the minimum for skilled workers $45 per week. For all other employees the minimum should be $15 per week.

Minimum wages in the proposed A. B. M. A. code are set at 37 cents an hour, and in no event lower than 30 cents an hour. Learners are to receive only 80 percent of the minimum, but they are not to total more than 5 percent of the aggregate number of workers.

Declaring that a penalty for overtime work must be assessed on employers in this time of "trying to get people back on the payrolls," Mr. Davis said that double time for overtime work should be laid down in the code, and that a flat 35-hour week for employees should be established.

In order to prevent employers from letting contracts to workers, a system of "sweating" workers and permitting their exclusion from provisions of the maximum hours and minimum wages provisions of the code, Mr. Davis would prohibit any system of contracting work which an employee undertakes to do at a specified rate and engages other employees to do the work for him.

In a statement defending the wages and hours provisions of the code, A. C. Weigel, of the Combustion Engineering Corporation, New York, pointed out that the industry is in the capital goods class, that it does not manufacture for stock or inventory and that quick-delivery orders "are occasionally" received, justifying the code's hours and wages.

The minimum wage of 37 cents per hour is in line with the approved rates in industries employing similar classes of labor in the same localities where the boiler shops are located, Mr. Weigel said. In those districts where the rates are higher, the boiler shops will have to meet the prevailing rates, he added.

A smaller number of hours than the 40 weekly stipulated in the code might result in the elimination of small shops, he stated.

Little objection was encountered in the trade practice section of the A. B. M. A. code, and at the conclusion of the hearing Deputy Brady said that he appreciated the efforts of all interested in reaching as much of an agreement as they had, but he asked that representatives of labor and industry meet, as well as differing representatives in industry itself, to work out conciliatory agreements.

"I readily admit that this is a complicated industry, with all its ramifications of labor and overlapping sections in regard to industry's trade practices," he said, "but I am sure that when you men sit down in committees you will work something out which will be satisfactory to all concerned."

Those assisting Deputy Brady were L. F. Boffey, of the Consumers' Advisory Board, Joseph Franklin, of the Labor Board, and W. C. Connelly, of the Industrial Board.

Washout Plug Location

By C. S. Handlee

The sketch shows a conventional Pacific-type locomotive on which the waist plates have been converted from rigid type (or connected onto the shell of boiler with studs or rivets) to the floating type.

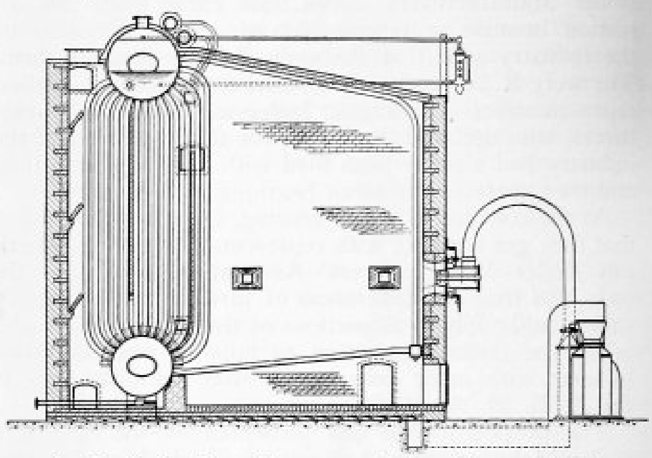
You will note the belly washout plug is close to the edge of the waist plate angle. With the rigid or attached plate this arrangement of washout plugs works out all right. However, with the floating waist plate, the angle will foul the plug. You will note the arrow indicating the line of expansion along the boiler due to heat, which is approximately ⅛ inch in 8¾ feet at 160 degrees temperature, while the base of the plate connection to frame of engine remains in rigid position—hence allowing the boiler to slip back in accordance to the ratio of expansion.

Line *A* is the center of the washout plug; line *B* indicates the edge of the washout plug; line *D* is the edge of the plate angle, and space between these lines is tolerance, which should not be less than 1 inch.

In making alterations of this kind on waist plates it would be well to check up on the location of belly plugs as the writer has observed several cases where waist plate angles have fouled washout plugs. Constant vibration or hammering cuts into the body of the plug causing it to become defective and leaky.

Steam Generating Unit for Small Plants

Combustion Engineering Corporation announces the C-E steam generator unit, a standard design built in a range of sizes for capacities of 8000 to 40,000 pounds of steam per hour. The principal features of this unit are its economy of first cost and operation, its compactness, and its suitability for firing by pulverized fuel, oil or gas. It comprises an assembly of standard equipment, and involves no radical departures from established practice. Its low head room and small floor space

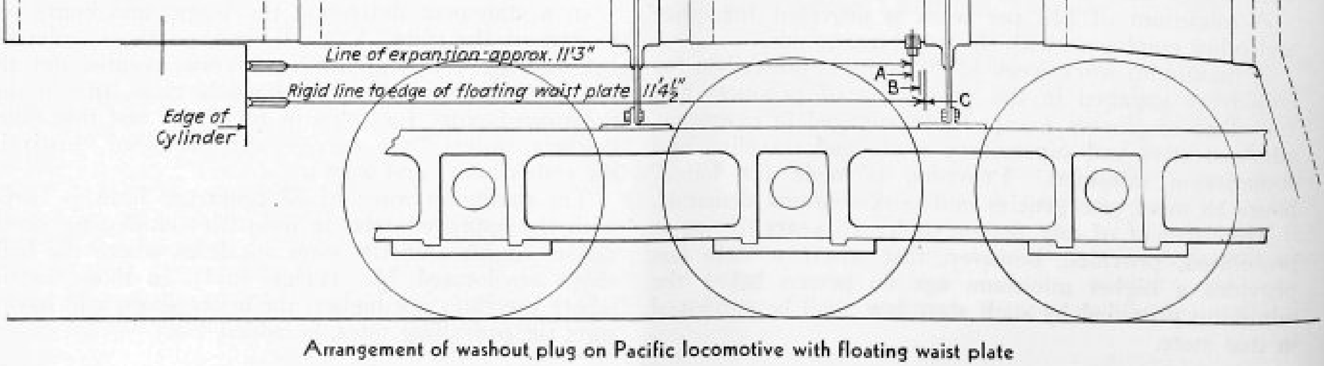


Sectional elevation of steam generating unit for small plants

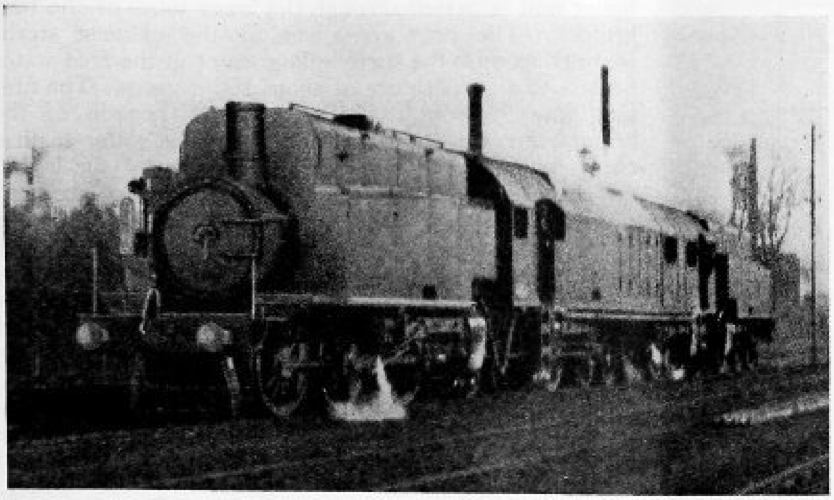
requirements make it particularly suitable for the limited space conditions found in many plants. The fact that it may be fired by pulverized fuel, oil or gas provides the advantages of wide choice of fuels, ability to pick up or drop load quickly, high average efficiency and no banking losses.

The general character of the design is shown by the illustration. The unit comprises a two-drum vertical boiler and a furnace of solid brick walls, the top and front of which are water-cooled by tubes connecting into the upper boiler drum and terminating in a header in the lower front wall. A water screen across the furnace bottom connects this header with the lower boiler drum. Pulverized fuel is fired horizontally by a natural draft burner to which fuel is supplied by a Raymond impact pulverizer mill, located either in front or to one side of the unit. The boiler can be arranged for either two or three gas passes and may be equipped with a superheater.

C-E Steam Generator Units are installed at a single price, under a single contract, and a single performance guarantee.



Arrangement of washout plug on Pacific locomotive with floating waist plate



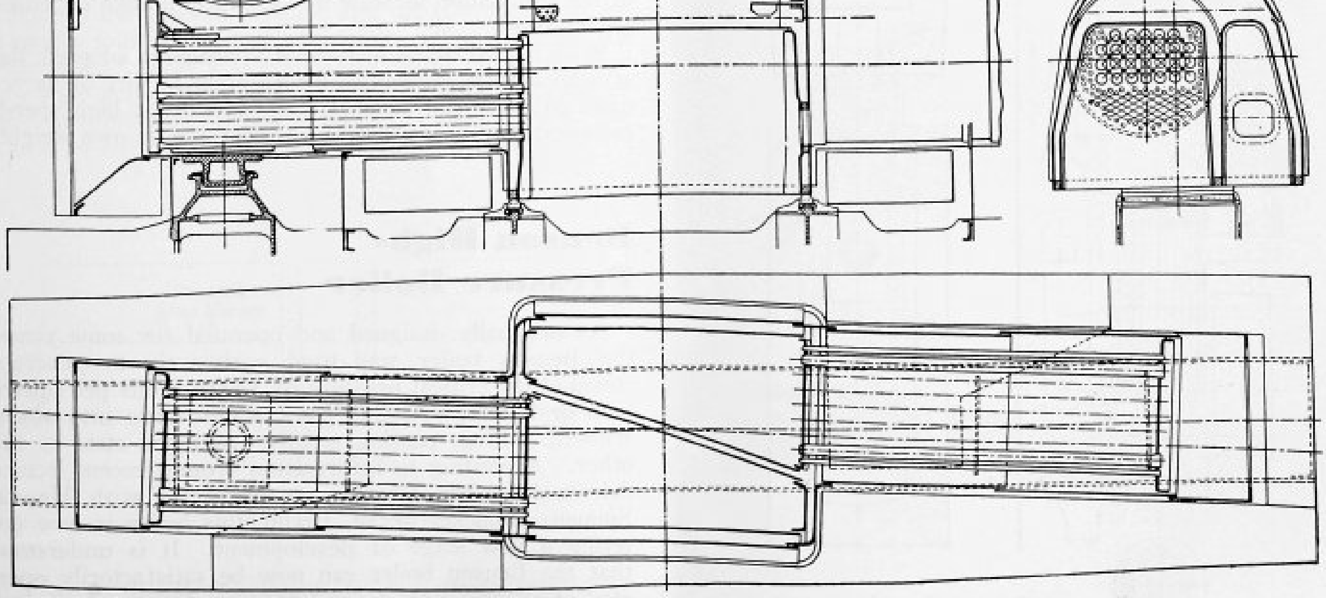
Belgian Works Builds Novel Locomotive

Recently in a paper "Modern Articulated Steel Locomotives," delivered before the Institution of Locomotive Engineers in England, W. C. Williams describes a new type of articulated locomotive known as the Franco, which had been built by the Syndicat Belge des Locomotives at the works of the Átéliers Métallurgique at Tubize, Belgium. This locomotive a short time ago completed trials on the Belgium National Railways. The fundamental idea back of the design was to provide a steam locomotive which would deliver greater power and work at higher thermal efficiency than the conventional form of locomotive and, at the same time, that would utilize in its construction only component parts of known reliability.

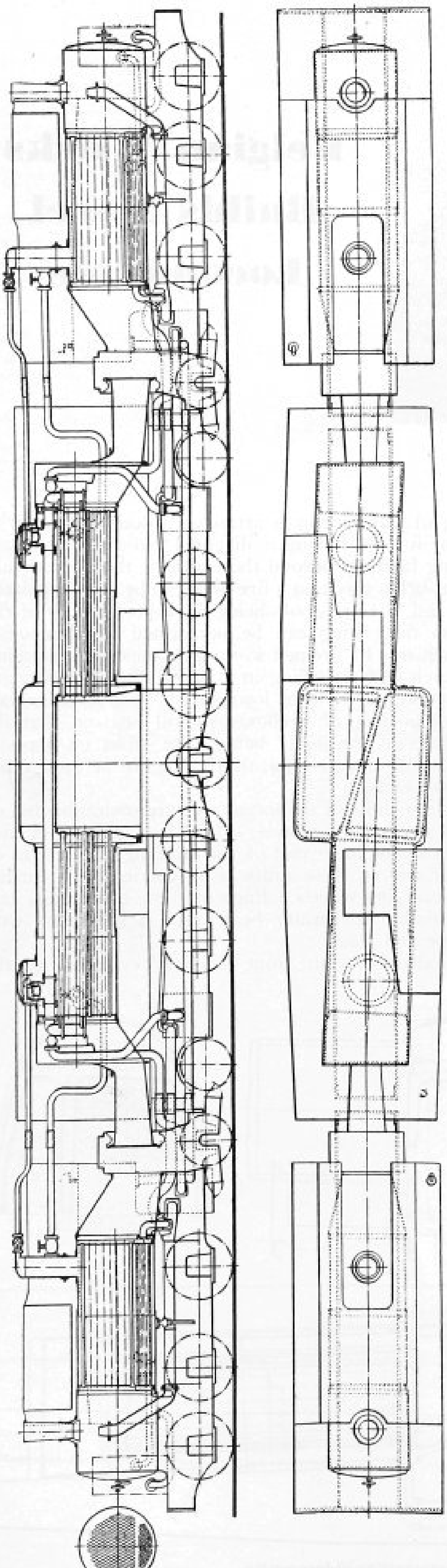
To this end the Franco locomotive consists of three sections each supported by groups of coupled and carrying wheels. The center section has two sets of four-coupled wheels each driven from pairs of cylinders placed outside and towards the extremities of the framing. The ends of the center section and its center are supported by pairs of carrying wheels, three pairs in all. On the framing of this section is arranged a double boiler with a central firebox having a diagonal cross partition and extending laterally beyond the width of the firebox tube plates in such a way that a fire door can be accommodated in each end, the fire doors being on opposite sides of the boiler so that firing can be performed simultaneously from each side by firemen working in opposite directions, but in each case shoveling in a longitudinal direction, as with the ordinary steam locomotive. To accommodate this arrangement of fireboxes it will be seen that the center lines of the boiler barrels are offset on opposite sides from the center line of the engine at their inner or firebox ends.

The outer units of the locomotive are each mounted on a set of six-coupled wheels, driven by a pair of outside cylinders at the inner end of the framing, the weight of the inner end of these units being carried by a further pair of carrying wheels. Each of these outer units carries a tubular feed-water heater and a smokebox with blast pipe and stack.

The exhaust steam from the four cylinders of the



Sections through double boiler and firebox of center section of locomotive



Belgian articulated locomotive

boiler unit is passed through the lower tubes of the feed heaters. The heat given out by the exhaust steam is stated to raise the surrounding water in the feed-water heaters to a temperature of about 100 degrees. The firebox gases passing through the upper portion of the heaters then raise the temperature of the water to that corresponding with the working pressure of the boiler, this being possible as both heaters and boiler are connected together by piping and consequently are working at the same pressure. It should be added that the water level of the boiler is higher than the top of the heaters, so that as the heaters are full of water the boiler is ensured of a supply of feed equal in quantity to that pumped into the heaters from the tanks mounted on the footplate at both sides of the heater.

The draft is obtained in the usual manner by the exhaust steam both of the boiler unit cylinders and of the heater unit cylinders. A portion of the exhaust steam from the cylinders of the boiler unit is passed back to the firebox ash pan where it warms the air entering the ash pan. As the pipes leading this steam into the ash pan slope downwards in that direction, the condensate is allowed to damp the ashes in the ash pan, so that in proportion to the work of the boiler the ash pan is kept wet.

It is argued for this arrangement of boiler that the whole of the heating surface of the boiler proper can be used for converting water into steam as no additional heat is required to raise the temperature of the feed-water up to boiler point. As the boiler water level is much higher than the tubes of the heaters there is no danger of the upper part of the heaters becoming dry when the locomotive is climbing a grade. The constant weight of the water in the heaters is an advantage as these units are used as traction units. The brick arch is kept small and it is possible to clean each fire separately.

It is claimed for the Franco locomotive that it has a heating surface and water circulation superior to that of an ordinary locomotive. Its feed water is always at a high temperature and scale is precipitated in the heaters and not in the boiler. Economy is realized from the use of two heaters and these features combined, the makers state, allow one square meter of the vaporizing boiler of the Franco locomotive to produce—the fuel and the pressure in the smokebox being equal—about 60 percent more steam than an ordinary locomotive and show also a saving in fuel equal to about 20 percent, and in view of the elimination of scale in the boiler, uptake expenses are reduced.

With regard to the method of articulation adopted, the arrangement is claimed to afford great facility of movement to allow the locomotive to operate at high speed, each unit being independent and carrying its own weight.

Benson High-Pressure Boiler

As originally designed and operated for some years, the Benson boiler was used exclusively to generate steam at the critical pressure of 3200 pounds per square inch or higher. At this point water turns into steam without boiling, passing quietly from one state to the other. According to information from a recent lecture delivered by Mr. Gleichmann, associated with Messrs. Siemens-Schuckertwerke, Berlin, this boiler is now entering a new stage of development. It is understood that the Benson boiler can now be satisfactorily operated at all pressures from 1000 pounds per square inch and up.

New Champion Master Rivet

The Champion master rivet recently perfected and patented by the Champion Rivet Company, Cleveland, is designed to permit cold driving in sizes that hitherto were considered impossible. This new rivet, coming within the category of pin riveting, consists of two parts, a pin or stem rivet and a sleeve through which the pin is inserted, each having a head of any desired shape.

The rivet was primarily designed to conform to governmental requirements in the fabrication of penstocks for the Boulder Dam project, but the qualities inherent in this type of rivet make it particularly adaptable for practically all types of work where speed of driving, accuracy of fit and great holding strength are essential and where cold pinning is particularly advantageous.

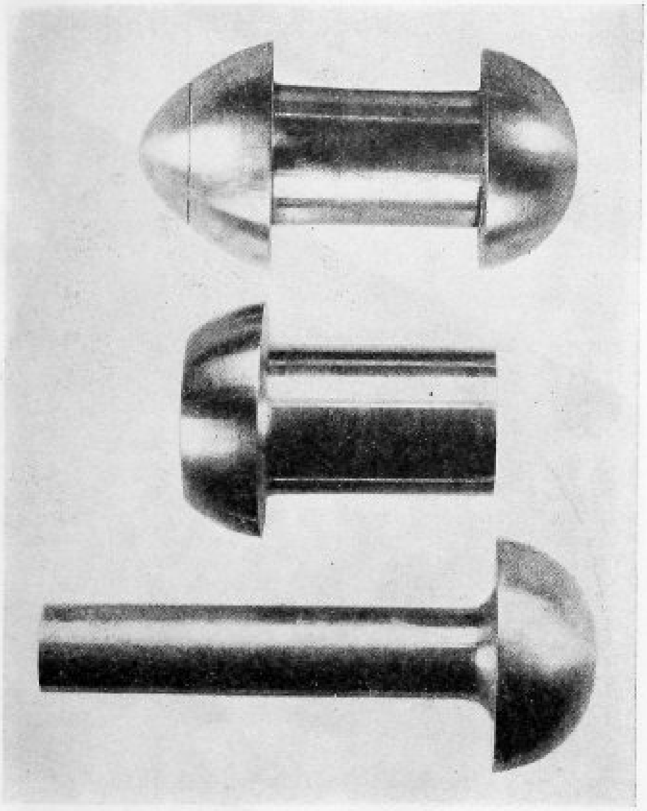
From an examination of the illustrations, the design may be readily understood. The rivet can be given practically any characteristics of strength required, that is, the sleeve may be mild steel and the pin high-tensile steel. Even with this combination it is possible to drive very large rivets cold. With ordinary rivet steel rivets up to 3 inches diameter can be driven cold. Accuracy of fit can be assured, since clearances may be reduced to plus or minus 0.003 inch, if desired. With drilled and reamed holes for extreme accuracy, the rivet, because of the accuracy of its construction and the absence of scale, can be made a sliding fit in the hole. When driven, the rivet is expanded to fit the hole more tightly than practically any other form of rivet.

Exhaustive tests have demonstrated comparable holding qualities with the conventional rivet and, as stated, the shearing strength can be made to meet any requirement by the adoption of a high-tensile steel pin with a mild steel sleeve.

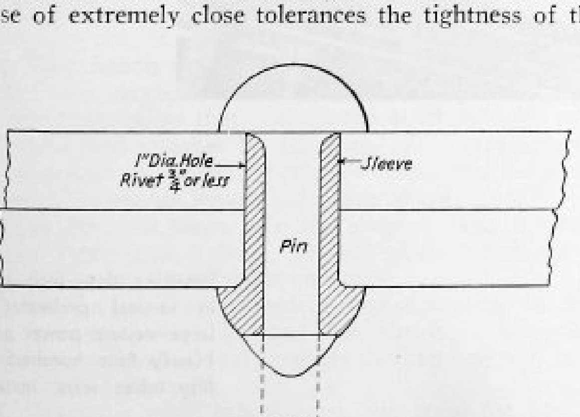
The advantages claimed for this rivet are many. With cold driving it is possible to obtain an accurate fit because of the absence of scale and the elimination of expansion and subsequent shrinkage. Heating costs are eliminated. This also results in higher efficiency from the shop staff, due to the absence of heat and the necessity with hot work of using tongs to handle rivets. Because of extremely close tolerances the tightness of the work is assured. There is less danger of inaccuracies in driving, such as off-center heads and the like.

A major quality claimed for Champion master rivets is the possibility of cold driving with equipment designed for correspondingly smaller hot rivets. For example, the average bull riveter intended to drive 1¼-inch rivets hot can be used successfully to drive 1¾-inch master rivets cold.

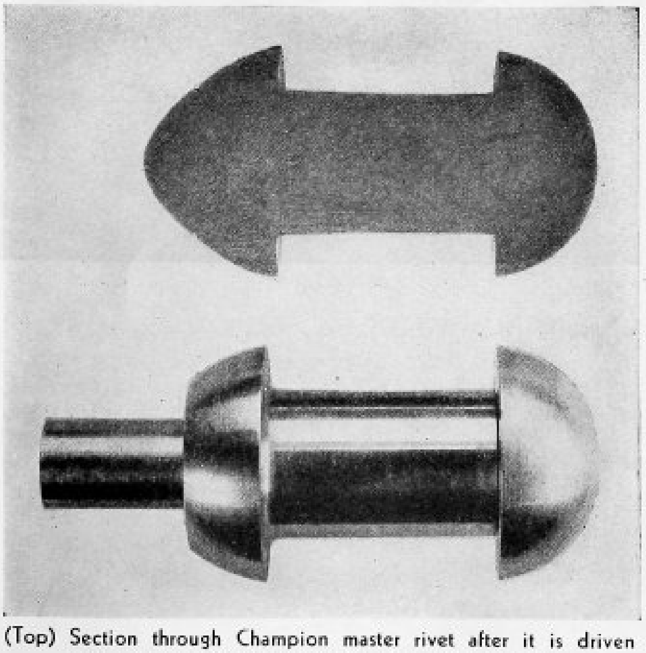
Further details and samples of this new rivet for test installations can be obtained from the Champion Rivet Company, Cleveland.



(Top) Champion master rivet after it is driven. (Center) Sleeve. (Bottom) Pin



Section through Champion master rivet, showing outline of pin before and after driving



(Top) Section through Champion master rivet after it is driven (Bottom) Pin and sleeve assembled ready for driving

Installing three-inch tubes in vertical preheater at large western power plant. Nearly four hundred and fifty tubes were installed

Welding Approved for Boiler Repairs

National Board of Boiler and Pressure Vessel Inspectors Adopts A. S. M. E. Code

The executive committee of the National Board of Boiler and Pressure Vessel Inspectors has adopted the 1931 edition of the A.S.M.E. Code for Construction of Boilers and Unfired Pressure Vessels. The use of fusion welding is allowed for the repair of boilers and pressure vessels where such controlled welding as permitted by the A.S.M.E. Code is used.

This, in fact, means that if a repair is to be effected by welding, say on a Class 2 pressure vessel, the welder doing the repair work must be qualified in accordance with the requirements for the qualification of welders engaged in the *construction* of Class 2 pressure vessels as laid down by the A.S.M.E. Pressure Vessel Code. Or, if the vessel is a Class 1 pressure vessel the welder must be qualified in accordance with the requirements for Class 1 *construction*.

In other words, where the Boiler Code permits welding in construction, welding may be used in repair provided the operators engaged in the work are qualified in the same way as if they were engaged in initial construction.

Apart from this, repairs by fusion welding to boilers and pressure vessels are limited in their application to those cases where the stress is carried by other construction which conforms to the A.S.M.E. Code and where the safety of the boiler or vessel is not dependent upon the strength of the weld. Firms having in their employ welders who have demonstrated their fitness to produce sound welds, the results of which would meet the requirements of approved welding codes, will be considered satisfactory for the execution of repairs by fusion welding in accordance with the foregoing restrictions.

It is provided in the new rules that an inspection shall be made by an authorized inspector and the method of repair sanctioned by him before any welded repairs are undertaken. If, in the opinion of the inspector, a hydrostatic test is necessary such test shall be applied when the work is completed.

The following examples of the possible application of fusion welding, not specifically covered by the Boiler Code, will serve to illustrate where in the opinion of the National Board such work should be accepted or rejected. Where specifically allowed by the Code or where specified in the following, welding is permitted on any part or parts of any boiler or its appurtenances operated at pressures in excess of 15 pounds per square inch.

1. Any fusion weld of reasonable 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. It is necessary for the inspector to use judgment in interpreting the meaning of "reasonable length" as given above, since it may vary in different cases. In the average case, it should be not more than 3 feet. Fusion welding will not be accepted in unsupported flat surfaces.

2. Fusion welding of cracks and fractures in cast-iron heating boilers or cast-iron members of power boilers or unfired pressure vessels shall be referred to an authorized inspector.

3. Cracks in girth seams extending from the edge of the plate to the rivet hole may be fusion welded provided the cracks are properly prepared to permit fusion through the entire thickness of the plate. Similar cracks in girth seams 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. 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 one-quarter 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. In all 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.

4. Cracks in the shells or drums of power boilers, except as otherwise specified herein, shall not be welded. Leakage at riveted joints or connections shall be carefully investigated to determine the cause. The building-up of a grooved or corroded area of unstayed internal surfaces, other than widely scattered pit holes, by means of deposited metal will not be permitted.

5. 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.

6. 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 shall come completely through the reinforcing metal so as to be plainly visible to the inspector. When necessary to replace stays, such stays shall comply with the requirements of the A.S.M.E. Code.

7. In firetube 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. The above mentioned 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.

8. 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. Such patches shall not be set in the shell flush with the surrounding plate.

9. On firetube boilers re-ending or piecing of tubes will be permitted as follows:

(a) Tubes which have been re-ended by the electric resistance butt welding method.

(b) Tubes which have been re-ended by the metallic-arc or oxy-acetylene process will be acceptable when said tubes have no more than two circumferential welds.

As this set of rules was worked up jointly by the insurance companies and the various state and municipal inspection departments, it is therefore authentic for all of the Code states and cities in the United States. It means that the boiler insurance companies have formally recognized the advantages of fusion welding for boiler and pressure vessel repairing as well as new construction, and except in those cases where it is not sanctioned, will underwrite for insurance repairs of this type when their inspections of the work have been completed.

This should open up a new field for the use of oxy-acetylene welding, as well as make it possible for owners and operators of boilers to obtain the advantages of speed, economy and strength which oxwelding gives.

USL "Protected-Arc" Welder

The USL "protected-arc" welder, manufactured by the USL Battery Corp., Niagara Falls, N. Y., is new in design and performance, giving high welding efficiency and economy. By the use of new USL stabilizing coils the new welder produces a constant flow of electrical energy, reducing current lag to an absolute minimum. It is claimed that even a beginner can hold a steady arc with this new welder, and experienced operators can weld faster and better than ever before. The use of heavy duty ball bearings in the generator results in a uniform gap between the fields and armature at all times, assuring efficient operation and dependable current output. It is claimed that it is now possible for moderately skilled workmen to produce a strong, homogeneous weld at greater speed, using heavily coated, high speed electrodes.

Operating this new welder is simplicity itself. Two convenient current and voltage controls permit any voltage and current combination desired. The convenient arrangement of the welding leads allows quick reversal of polarity. By simply making a dual adjustment, it is possible to weld the thinnest automobile body or the heaviest locomotive frame, for the new welder has the extremely wide welding range of 40 to 550 amperes. When it is considered that U. S. Navy specifications call for a range of only 50 to 400 amperes, and NEMA requirements are only 90 to 375 amperes, the extra welding range which this new welder provides can be appreciated.

New portable protected arc welder

A 60 percent increase in generator capacity—from 25 to 40 volts rating—enables the USL welding generator to handle all kinds of bare or coated electrodes without danger of overloading. The armatures of the motor, generator and exciter are all mounted on a single extra heavy duty shaft, eliminating any possible alinement trouble between the motor and generator, reducing friction and giving a more compact design. No resistors are used, thus eliminating another possible source of power waste. Contributing to the general high efficiency of this new equipment is a correctly designed fan and ventilating system, which keeps the welder unusually cool, even during long sustained operation.

With the complete mechanism, including motor, generator, exciter, controlling devices and all wiring enclosed in a heavy sheet steel cylinder, there is nothing about the machine that can possibly be damaged by falling objects, moisture or dust. No extra canopy is needed as it is entirely protected from the weather. The entire mechanism is easily accessible by a hinged steel cover on the commutator end of the machine. Wiring diagrams are mounted on the inside of this cover.

Business Trend

New orders booked for fabricated steel plate in July totaled 20,058 tons as compared with 37,020 in June. Although this represents a reduction of nearly 46 percent as compared with the preceding month, it represents an increase of 60 percent as compared with July, 1932. The new orders booked in the first 7 months of 1933, which totaled 119,442 tons, represent an increase of 14 percent as compared with the new orders booked during the first 7 months of 1932.

There were no July shipments of railroad locomotives from principal manufacturing plants, as reported to the Bureau of Census, as compared with two in June, 1933, nine in July, 1932, and 16 in July, 1931. Unfilled orders at the end of July, 1933, totaled 80 locomotives, five of which were steam and 75 electric, as compared with 71 at the end of June, 1933, five of which were steam and 66 electric, and 120 at the end of July, 1932, one of which was steam and 119 electric.

New orders for oil burners in July, 1933, totaled 6212 as compared with 4694 in June, 1933, and 4688 in July, 1932. Unfilled orders at the end of July totaled 1487 as compared with 1480 at the end of June, 1933, and 568 at the end of July, 1932.

During July, 1933, 1003 mechanical stokers were sold as compared with 742 in June, 1933, and 636 in July, 1932.

Production of range boilers in July, 1933, totaled 53,015 as compared with 71,502 in June, 1933, and 34,423 in July, 1932. New orders for range boilers in July totaled 48,886 as compared with 61,131 in June, 1933, and 28,857 in July, 1932. The production of range boilers for the first 7 months of 1933 totaled 347,661 as compared with 281,765 for the first 7 months in 1932. New orders for range boilers during the first 7 months of 1933 totaled 363,856 as compared with 286,764 for the first 7 months in 1932.

Program of the "Master Boiler Makers' Convention in Print"

With a complete cessation of convention activities in 1931, due to economic conditions, the officers of the Master Boiler Makers' Association have struggled against tremendous odds to keep up the morale and the high standards of the members against the time when a return of activity in the boiler shops would make heavy demands on their resources and require the best and most efficient service that they could give to the railroads. The recent upturn in railway traffic and general business indicates that that time is at hand, and so, through the direct sponsorship and co-operation of the officers of the Master Boiler Makers' Association, THE BOILER MAKER will conduct for them in its October issue what will be known as the "Master Boiler Makers' Convention in Print."

This convention, equivalent in every respect but personal contact with an actual convention, will include addresses by a number of prominent railroad mechanical officials from each section of the country, addresses by officers of the association, topic committee reports covering every phase of development in boiler shop methods, tools, equipment and materials of the past three years, and an exhibit section in which supply companies may display their new and improved products. Discussions of all committee reports will be published in later issues of THE BOILER MAKER, and finally the entire proceedings of the "Convention in Print" including addresses, committee reports, discussion of topics and descriptions of new and improved appliances, will be bound in a single cover and mailed not only to members of the Master Boiler Makers' Association but also to the mechanical officers of the leading railroads throughout the country.

The program for the "Convention in Print" is as follows:

ADDRESSES

Addresses will be presented by the following officers of the Master Boiler Makers' Association:

President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington and Quincy.

Secretary — Albert F. Stiglmeier, general foreman boiler maker, New York Central.

Addresses will also be presented by six railway officers representing different sections of the country. These messages will be inspirational and encouraging and will cover some phases of the railway situation or outlook as directly applied to the immediate problems to be met by the shops' staffs during the coming months. These officers include:

O. A. Garber, chief mechanical officer, Gulf Coast Lines.

C. L. Dickert, superintendent of motive power, Central of Georgia.

L. Richardson, assistant to vice-president, Boston and Maine.

G. McCormick, general superintendent of motive power, Southern Pacific.

E. B. Hall, general superintendent of motive power and machinery, Chicago & North Western.

H. M. Warden, chief mechanical officer, Missouri-Kansas-Texas Lines.

Leading members of the association have contributed their knowledge and skill to the preparation of the most comprehensive program of committee reports that have ever been presented for the information of this branch of the railway industry. These reports and the committee personnel follow:

COMMITTEE REPORTS

Topic 1.—Recommended Practices and Standards; Fusion Welding as Applied to Boilers and Tenders.

Committee: 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.

Topic 2.—Boiler and Tender Corrosion and Pitting and What Can Be Done in the Boiler Department to Relieve the Condition.

Committee: E. J. Reardon, service engineer, Locomotive Firebox Company, chairman; F. G. Jenkins, general locomotive inspector, Texas & Pacific; C. W. Buffington, general master boiler maker, Chesapeake & Ohio.

Topic 3.—Construction and Maintenance of High-Pressure Watertube Locomotive Boilers.

Committee: I. J. Pool, district boiler inspector, Baltimore & Ohio, chairman; J. A. Clas, general boiler foreman, Delaware & Hudson; R. A. Pearson, general boiler inspector, Canadian Pacific.

Topic 4.—Best Methods of Reclaiming and Safe-Ending of Flues and Tubes with Details, Layout and Equipment of the Flue Shop.

Committee: A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pittsburgh, chairman; S. F. Christopherson, supervisor of boilers, New York, New Haven & Hartford; J. M. Stoner, supervisor of boilers, New York Central.

Topic 5.—Methods Used in the Fabrication of Nickel, Chromium and other High-Tensile Steels of Special Alloys as Used in Fireboxes, Barrels and Tube Sheets, with the Maintenance of Same.

Committee: L. C. Ruber, superintendent of boiler department, Baldwin Locomotive Works, chairman; M. V. Milton, chief boiler inspector, Canadian National; J. A. Doarnberger, master boiler maker, Norfolk & Western.

Topic 6.—Better Methods Used in the Application and Threading of Staybolts, Iron, Nickel and Special Alloyed Steel, Flexible and Rigid, with Details and Tools Used.

Committee: G. B. Usherwood, supervisor of boilers, New York Central, chairman; E. S. Fitzsimmons, sales manager, Flannery Bolt Company; J. A. Graulty, general boiler shop foreman, American Locomotive Company.

Topic 7.—Will Multiple Application of Fusible Plugs Reduce Boiler Maintenance and Increase Safety of Operation?

Committee: O. H. Kurlfinke, boiler engineer, Southern Pacific, chairman; F. A. Longo, welding and boiler supervisor, Southern Pacific; E. H. Paepke, general boiler inspector, Union Pacific.

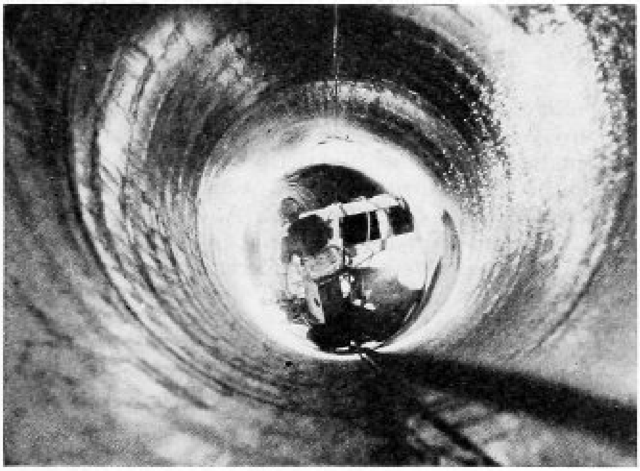
Exhibits

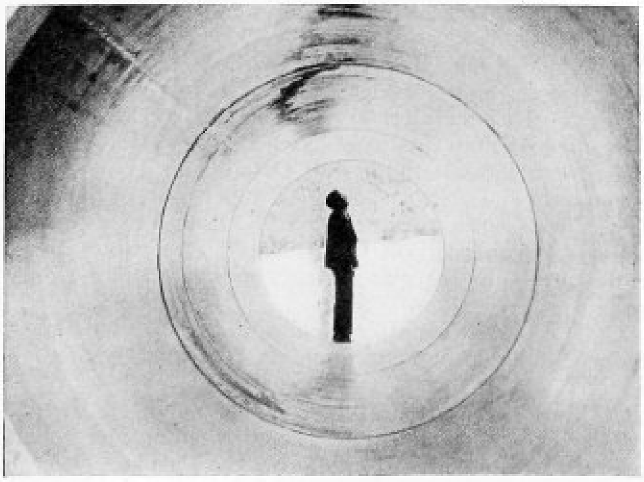
This section will be arranged in such an interesting and attractive manner as to enable the reader to become familiar with the new developments in tools, equipment and materials for the boiler shop. Products will be illustrated and will be described concisely so as to give the reader as broad and clear a picture as possible of the developments and improvements that have taken place within the last three years. Not only will new products that have been brought out by manufacturers in the past three years be described, but also important improvements in old established products.

Penstock Welded by Shielded-Arc Process

An interesting shielded-arc electric welding job was recently completed on the penstock of the San Francisquito Power Plant No. 2, a unit of the Los Angeles Bureau of Power and Light hydro-electric system.

The penstock, 1400 feet in length, of 7-foot steel pipe is on a grade of nearly 50 percent. This is the first all arc-welded penstock in the world. This type of construction was decided upon because of the increased efficiency of the pipe, made possible by the elimination of rivet heads and butt straps. The substitution of welded joints reduced friction losses and provided a permanently leak-proof line. Not a leak developed in the entire penstock under pressure tests.



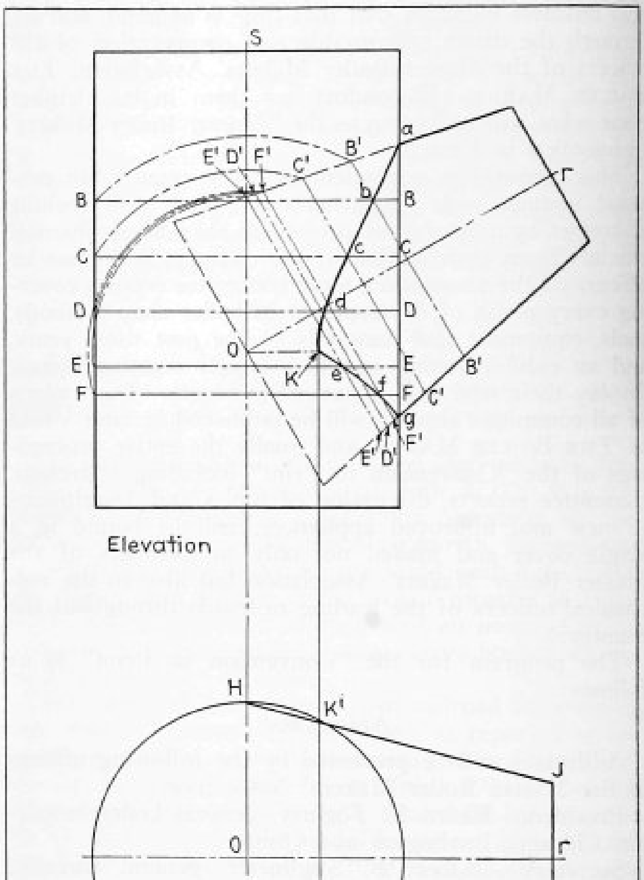


Views in welded penstock

Obtaining Miter Line

While reading the January issue, I noticed on page 14 an article describing a short cut method to obtain a miter line of various intersections.

In Fig. 4, showing a miter line for the intersection of a cylinder and cone, the miter line is shown as touching the center line of the cylinder. This, I consider, to be incorrect, and attach sketch giving as I consider, the correct miter line for this particular intersection.



Sketch showing correct miter line

In the plan of this sketch, it will be seen that the side of the cone *H-J* meets the cylinder at *K'*, this being the nearest point to the center line of the cylinder which the miter line attains. This point when projected to the elevation gives the point *K* of the miter line. The shape of the miter line is obtained by joining the points *a, b, c, d, K, e, f, g*.

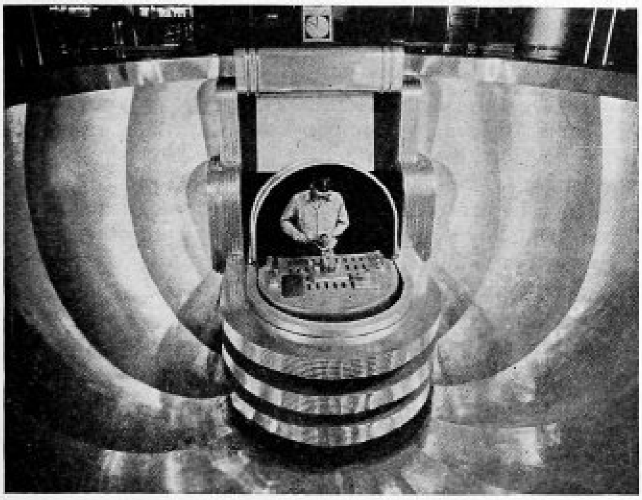
E. F. Brown

Redfern, Australia

Oxy-Acetylene Welding

A show worth seeing at A Century of Progress in Chicago will be found on the ground floor of the Hall of Science, where continuous demonstrations and motion pictures of oxy-acetylene welding and cutting are given in spectacular fashion in a sunken amphitheatre located in the exhibits of Union Carbide and Carbon Corporation.

You look down into a huge metal bowl flooded with light from concealed sources, and as you watch, an opening appears in the base of the bowl and a workman is



Oxy-acetylene welding demonstrated in sunken amphitheater at A Century of Progress

seen actually using the oxy-acetylene welding and cutting outfit. After each welding demonstration the lights fade out, the demonstrator disappears and a short motion picture is thrown on a screen to illustrate other uses of oxy-acetylene welding and cutting. Everyone is thus afforded a simple explanation and splendid example of the uses of the oxy-acetylene welding and cutting process. Those who now operate welding outfits will learn of new applications and those who have never used oxy-acetylene welding can absorb sound established information about the process and its uses.

Electrocoated Abrasives

A new product which saves time and money in the production shop and on repair work became available on September 1, when electrocoated abrasives were introduced by the Armour Sand Paper Works, the Behr-Manning Corporation, the Carborundum Company, and the Minnesota Mining & Manufacturing Company. These products, made by a recently developed electrostatic process, have been shown by test to give an improvement in working efficiency that lies between 30 and 40 percent.

The abrasive coating that results from the electrostatic process is the reason for this gain. Electrostatic force is employed for securely setting the abrasive granules in the glued surface of the backing in such a way that the sharpest cutting edges face outward toward the work and the spaces between them are all approximately equal. This gives a coating which has the most effective cutting surface and consequently does work faster, with less expenditure of labor.

Wrought Iron Tubes Installed in Vertical Preheater

An installation of 3-inch outside diameter No. 12 gage wrought iron tubes was sold recently by A. M. Byers Company, Pittsburgh, Pa., to the Chicago Commonwealth Edison Company for a vertical preheater erected at their Crawford Avenue Station. There were 443 tubes in the installation, and all of them were rolled in with an expander flare without a single crack or failure. Hitherto the drawback to wrought iron was its inability to stand expanding or flaring, but the Byers Company has perfected slag distribution to the point where this is no longer an obstacle.

Millhouse Elected President of Burden Iron Company

William E. Millhouse has been elected president of the Burden Iron Company, Troy, N. Y. Prior to his election, Mr. Millhouse had been executive vice-president, while the position of president remained vacant, since the death of James A. Burden on June 1, 1932.

Oil Burner Association to Hold 1934 Meeting in Philadelphia

The Board of Directors of the American Oil Burner Association, meeting in Washington on August 23, voted to hold the 11th national oil burner show and convention in Philadelphia, according to Harry F. Tapp, Executive Secretary of the American Oil Burner Association, who said that the exact dates for the 1934 show and convention would be announced later.

Westinghouse Operates Under NRA

F. A. Merrick, president of the Westinghouse Electric & Manufacturing Company, has issued the following statement regarding the company's participation in the National Recovery Act:

All works and offices of the Westinghouse Electric and Manufacturing Company and subsidiaries will, dating from August 15, operate under the provisions of the National Recovery Act which at that date becomes effective for the electrical manufacturing industry as set out in the Code of the National Electrical Manufacturers Association appoved by President Roosevelt.

General Electric Moves New York Offices

The General Electric Company and four of its associated companies have announced the removal of their offices in New York City to the new General Electric Building, 570 Lexington Avenue at 51st Street. Included are the executive offices, New York district office, air conditioning department, electric refrigeration department, Atlantic division of the Incandescent Lamp Department, Merchandise Department, and Plastics Department of the General Electric Company, and the General Electric Contracts Corporation, G. E. Employees Securities Corporation, General Electric Realty Corporation, and International General Electric Company, Inc.

New York City headquarters were formerly at 120 Broadway, where for 15 years three complete floors were occupied. Approximately 50 percent of the new building is occupied by the company.

At the service building of the company, at 414 West 13th Street, are located the field engineering division (except the New York district engineer and the application engineering division which are in the new General Electric Building), the construction division, order service division, New York service shop, and New York warehouse.

Chicago Pneumatic Tool Company Opens Branch Office in Seattle

The Chicago Pneumatic Tool Company announces the opening on September 1 of a new branch office at 1028 Sixth Avenue South, Seattle, Wash., Mr. A. M. Andresen, manager. The company is one of the world's largest manufacturers of pneumatic tools and is also a large manufacturer of rock drills; electric tools; air compressors; vacuum pumps and condensers; rock bits for oil well drilling; and Diesel, semi-Diesel and gas engines. A representative line of the company's products will be carried in stock, as well as parts for servicing same.

Chief Boiler Inspectors Appointed

John L. Scott, formerly inspector, adjuster and directing inspector for the Hartford Steam Boiler Inspection and Insurance Company in the Cleveland departmental office, has been advanced to the post of chief

John L. Scott

Frank G. Parker

inspector in the New Orleans Department, which includes Louisiana, Mississippi and Southern Texas. The promotion became effective May 16, 1933.

Mr. Scott entered the employ of the company as an inspector in the Cleveland Department on May 16, 1923. Two years later he became the adjuster for that department and in March, 1929, was made directing inspector under Chief Inspector J. F. Hunt. With this varied experience he is admirably fitted for the new responsibilities he is to assume at New Orleans.

The promotion was announced also of Frank G. Parker to the chief inspectorship of the Denver Department which includes Colorado, Wyoming, Montana, New Mexico, Utah and parts of Nebraska and South Dakota. Mr. Parker had been assistant chief inspector of this department for two years. He started with the company July 1, 1925, as a field inspector in the St. Louis Department. On February 1, 1928, he became assistant to the chief inspector at that office and continued in that capacity until he was appointed assistant chief inspector of the Denver Department on January 1, 1931. His experience in two of the company's middle western departments well equips Mr. Parker for the increased responsibilities in connection with his new position.

The new appointments made possible an enlarged scope of work at the New Orleans and Denver Departments where Managers R. T. Burwell and J. H. Chesnutt had handled the work usually assigned to chief inspectors in addition to the duties as managers.

Bigelow Company One Hundred Years Old

A veteran among the steam boiler manufacturers in New England is what is now known as the Bigelow Company of New Haven, Connecticut, which this year celebrates its one hundredth anniversary. In 1833 Mr. Cyprian Wilcox started a foundry and machine shop in New Haven, and with the development of the demand for power machinery went into the manufacture of water wheels, engines and boilers. In 1860 this plant became the Bigelow Company which gradually concentrated its work on the manufacture of boilers. Until 1905 the Bigelow horizontal return tubular and the Bigelow-Manning were the principal types of boilers manufactured, but the plant had also been making steam drums for several prominent watertube boiler manufacturers.

After it became evident that the watertube design was more suitable for larger units and higher pressures than the firetube, the Bigelow Company in 1905 obtained from the Richard-Hornsby Company of Grantham, England, the rights for the manufacture of the Hornsby watertube boiler. The original was redesigned and the Bigelow-Hornsby watertube boiler became one of the New Haven company's products. Since that time other types of watertube boilers and steam generating equipment have been added to the line.

Combustion Engineering Reorganized

As of August 1, 1933, Combustion Engineering Company, Inc., a newly organized company, took over the properties of International Combustion Engineering Corporation and affiliated companies recently sold by order of the Federal Court. The properties acquired include those of Combustion Engineering Corporation, Hedges-Walsh-Weidner Company, Coshocton Iron Company and Raymond Bros. Impact Pulverizer Company. In order to assure the best possible service to the company's customers, these properties will be operated under a single centralized management.

The new company will continue Combustion Engineering Corporation's complete line of fuel burning, steam generating and related equipment which includes all types of stokers, pulverized fuel systems and boilers, as well as water-cooled furnaces, economizers, air preheaters, ash conveyors and hoppers.

Combustion Engineering installations in recent years include such notable projects as the largest steam-generating units in the world (New York Edison Company), the highest-pressure steam-generating units in commercial operation in America (Philip Carey Company), the largest high-pressure steam-generating units in the central station field (The Milwaukee Electric Railway & Light Company), and the largest high-pressure boilers in the industrial field (Ford Motor Company).

The same engineering personnel and manufacturing facilities which have enabled the company to carry out these outstanding projects will be continued by the new organization. The company's principal lines of equipment will be available in a range of sizes adequate for plants ranging from about 50 boiler horsepower up to the largest built.

The officers of the new organization are: Frederic A. Schaff, president; Joseph V. Santry, executive vice-president; Robert M. Gates, vice-president in charge of sales; Martens H. Isenberg, vice-president in charge of production; John Van Brunt, vice-president in charge of Engineering; Harold H. Berry, treasurer; George W. Grove, secretary and assistant treasurer; George D. Ellis, comptroller.

The Boiler Maker

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Communications

Pipe Line Gangs Invade Birthplace of Civilization

To the Editor:

To the birthplace and the cradle of the Christian civilization comes one of the modern wonders of the world—an 1180-mile pipe line fabricated by the electric arc.

This pipe line taps the rich oil fields of Iraq (originally called Mesopotamia) and extends from Kirkuk to the Euphrates River, a distance of about 150 miles from which point a southern leg extends 467 miles to Haifa, a Mediterranean port in Palestine and a northern leg extends 381 miles across French territory to Tripoli, a port in Syria.

The line is being laid by the Mediterranean Pipe Line Company, Ltd., a subsidiary of Iraq Pipe Line Company, Ltd., an international company controlling rich oil deposits.

Four welding gangs working at widely separated points find welding complicated by strong winds, dust storms and rugged country. Despite this, reports from one gang show that two welders and a tacker are tying-in as high as four miles of pipe in an eight-hour day. Many American welding operators are being employed on the project. Welding is being done with welders and Fleetweld electrodes manufactured by The Lincoln Electric Company, Cleveland, Ohio.

The Line is scheduled for completion early in 1934. It will have a capacity of 30,000,000 barrels of oil annually.

A. F. Davis.

Handy Tools for the Layout Bench

To the Editor:

The sketches, Figs. 1 and 2, show two tools which have been found very handy at the layout bench. It is possible to make them larger or smaller than shown by

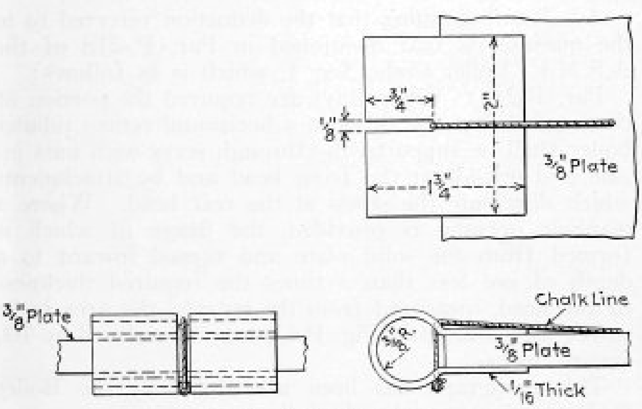


Fig. 1.—Chalk line holder

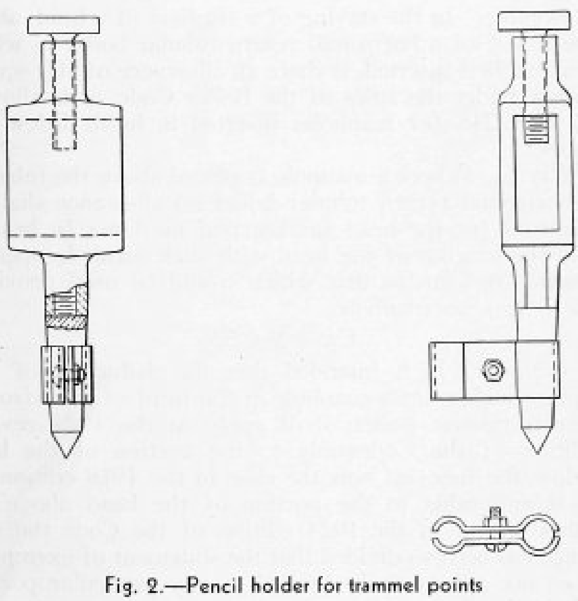


Fig. 2.—Pencil holder for trammel points

the dimensions on the sketches but it is believed that the dimensions shown will be the best.

The material required for making the pencil holder for trammel points shown in Fig. 2 is as follows: Two ½-inch by ¾-inch by No. 16 gage plate, and one 3/16-inch by ½-inch stove bolt.

Oswego, N. Y. J. A. Shannon.

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

Deduction for Manhole in Staying Flat Head

Q.—Why does the A. S. M. E. Code permit a deduction of 100 inches for manhole below tubes on flat head, but will not above tubes? The Massachusetts law will permit 94 inches above tubes. J. A. S.

A.—I am assuming that the deduction referred to in the question is that mentioned in Par. P.-218 of the A.S.M.E. Boiler Code, Sec. I, which is as follows:

Par. P-218: When stays are required the portion of the heads below the tubes in a horizontal return tubular boiler shall be supported by through stays with nuts inside and outside at the front head and by attachments which distribute the stress at the rear head. Where a manhole opening is provided, the flange of which is formed from the solid plate and turned inward to a depth of not less than 3 times the required thickness of the head, measured from the outside, the area to be stayed as indicated in Fig. P-11, may be reduced by 100 square inches.

This paragraph has been interpreted by the Boiler Code Committee under the following cases.

Case No. 154

Inquiry: In the staying of a segment of a head, above the tubes, of a horizontal return tubular boiler in which a manhole is inserted, is there an allowance of 100 square inches under the rules of the Boiler Code, as is allowed by Par. 218 for manholes inserted in heads below the tubes?

Reply: Where a manhole is placed above the tubes in a horizontal return tubular boiler no allowance shall be made as for the head surface that need not be braced, and the bracing of the head with such manhole opening should conform to that which would be used provided there was no manhole.

Case No. 526

Inquiry: Is it intended that the deduction of 100 square inches for a manhole in the head of a horizontal return tubular boiler, shall apply in the 1924 revised edition of the Code only to the portion of the head below the tubes as was the case in the 1918 edition, or is it applicable to the portion of the head above the tubes also? In the 1924 edition of the Code the sentence has been so divided that the statement of exemption does not appear to be limited to any particular portion of the head.

Reply: The reduction of staying allowed by the second sentence of Par. P.-218 was intended to apply only under the conditions specified in the first sentence, namely, to the portion of the head below the tubes.

Case No. 624

Inquiry: Is it the intent of Par. P.-218 of the Code, that permits of reduction by 100 square inches of the area of the front head below the tubes of a horizontal return tubular boiler that is required to be stayed, that a corresponding reduction of area is permissible in the portion of the rear head below the tubes?

Reply: The exemption of 100 square inches in the area of the front head of a horizontal return tubular boiler below the tubes was intended to permit of simplification of the staying requirements around the restricted area of the manhole. This exemption does not apply to a head without a manhole as provided in Par. P-218.

These being interpretations, no reasons are given why the deductions are not permitted to the area above the tubes.

Par. 264 of the Boiler Code is as follows:

P-264. All boilers must be provided with suitable manhole or handhole openings, except special types where they are manifestly not needed or used. A manhole shall be located in the front head, below the tubes, of a horizontal return tubular boiler 48 inches or over in diameter. Smaller boilers shall have either a manhole or a handhole below the tubes. There shall be a manhole in the upper part of the shell or head of a firetube boiler over 40 inches in diameter, except a vertical firetube boiler, or except on internally-fired boilers not over 48 inches in diameter. The manhole may be placed in the head of the dome. Smaller boilers shall have either a manhole or a handhole above the tubes.

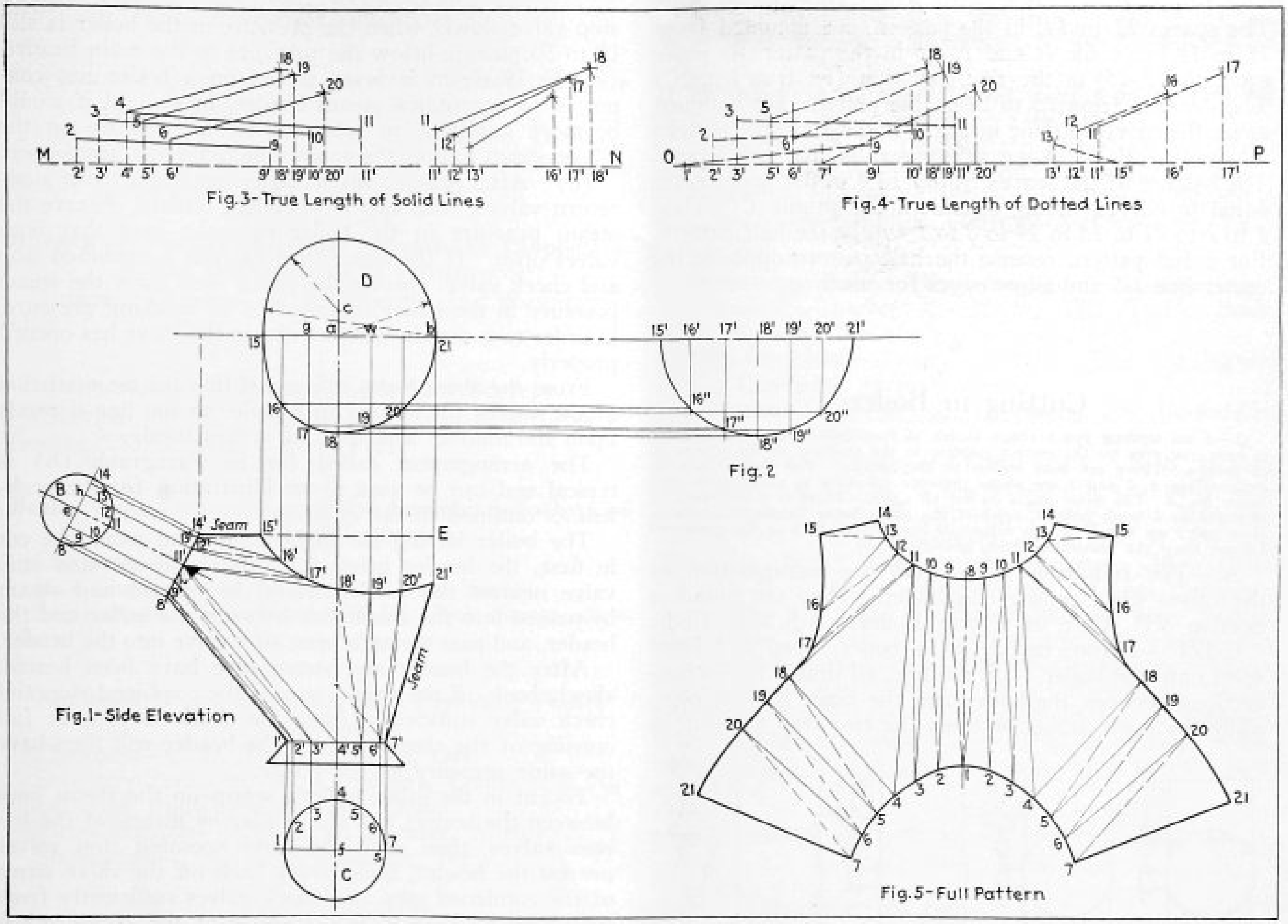
It is noted in this paragraph that the code requires that a manhole be located on the front head, below the tubes of a horizontal return tubular boiler and it has therefore, as noted in Case No. 624, provided for a reduction in the area to be stayed to permit of simplification of the staying requirements around the restricted area of the required manhole.

There being no requirements for a manhole above the tubes of a horizontal return tubular boiler, the Code does not make any provision for a reduction in the area to be stayed, as noted in Cases Nos. 154 and 526, when one is applied.

Developing a Funnel Sand Hod

Q.—Would you be so kind as to lay out in detail in The Boiler Maker a funnel sand hod. My desire is to have envelope sheet in one piece and by the most simple method that is available. J. J. M.

A.—To develop a funnel sand hod as illustrated in the question, lay out the elevation as shown in Fig. 1. In line with the funnel outlet *8′-14′* draw the profile *B*. In line with the base *1′-7′* draw the profile *C*, and in line with the horizontal plane *15′-E*, draw the profile *D* which is constructed with radii struck from centers *a*, *b* and *c* as shown. Through the center *e* in the profile *B* draw the line *8-14*, parallel to *8′-14′*. Through the center *f* in the profile *C*, draw the line *1-7* parallel to *1′-7′*. Divide the semi-profile *B* into any number of desired parts (in this case six are used), as shown from *8* to *14*. In like manner, divide the semi-profile *C* into a corresponding number of divisions as shown from *1* to *7*.



Layout of funnel sand hod

From the smaller figures *8* to *14* in *B* and *1* to *7* in *C*, draw lines at right angles to their respective base lines, cutting them from *8′* to *14′* and *1′* to *7′* in the side elevation.

Next, divide the upper curve in the side elevation into six spaces, as shown from *21′* to *15′* and from these small figures, erect vertical line crossing the curve in the semi-profile *D*, meeting the center line drawn through *a* and *b* as shown. Next, draw solid and dotted lines in the side elevation, as indicated. These lines then represent the basis of sections to be constructed, whose altitudes will equal the several heights, in the semi-profiles *B*, *C* and *D*.

Thus, the true lengths of the solid line *12′-17′* in the side elevation is found as follows: Take this distance *12′-17′* and place it on the horizontal line *M-N*, Fig. 3, as shown, by corresponding numbers. From *12′* and *17′* erect perpendicular the lines *12′-12* and *17′-17* equal respectively to *h-12* in the profile *B* and *g-17* in profile *D*. A line drawn from *12* to *17* in Fig. 3 will be the desired length. In this manner all the true lengths of the solid lines are obtained.

Proceeding to find the true length of the dotted line *6′-19′* in the side elevation, take this distance and place it on the line *O-P*, Fig. 4, as shown by corresponding numbers. From *6′* and *19′* erect perpendicular lines making *6′-6* and *19′-19* equal respectively to *s-6* in profile *C* and *w-19* in profile *D*. A line drawn from *6* to *19* in Fig. 4 will be the desired length. Obtain the true lengths of all dotted lines in elevation in this manner.

Preparatory to developing the pattern, the true edge line along *21′-15′* in the elevation must be found. This is accomplished in the following manner: Extend the center line *15-21* in profile *D*, as shown by *15′-21′* in Fig 2, on which step off the spaces *15′-16′*, *16′-17′*, *17′-18′* to *20′-21′* equal to the equal spaces *15′-16′*, *16′-17′*, *17′-18′* to *20′-21′* of the upper curve in the side elevation Fig. 1. At right angles to *21-21′* draw lines through the point *16, 17, 18, 19, 20* of profile *D* cutting the perpendiculars erected in Fig. 2 locating the points *16″, 17″, 18″, 19″* and *20″*, Fig. 2. Connect these points with a curved line, representing the half developed section on the curved line *21′-15′* in the side elevation.

The pattern is shown developed in one piece, with a seam along *14′-15′* and *7′-21′* in the side elevation. As *1′-8′* in the side elevation shows its true length, take this length and place it as shown by *1-8* in the pattern, Fig. 5. Take the distance from *8-9* in profile *B* and with *8* in the pattern, Fig. 5, as center, describe the arc *6*, which intersect by an arc, struck from *1* as center, and *1′-9* in the true length of dotted lines, Fig. 4, as radius. With *1-2* in profile *C* as a radius, and *1* in the pattern, Fig. 5, as center, describe a small arc near *2*, which intersect by an arc, struck from *9* as center, and *2-9* in the true length of solid lines, Fig. 3, as radius. Proceed in this manner, alternating first from the divisions in profile *B* to the true lengths of the solid lines Fig. 3, until the line *11-4* in the pattern Fig. 5 is drawn.

Now, with the true length of the solid line *11-18*, as radius, with *11* in the pattern as center, describe a short arc near *18*, which intersect by an arc struck from *4* as a center, and *4-18* in the true length of solid lines Fig. 3 as radius. Continue the operations in accordance with the foregoing procedure, until the pattern is completed.

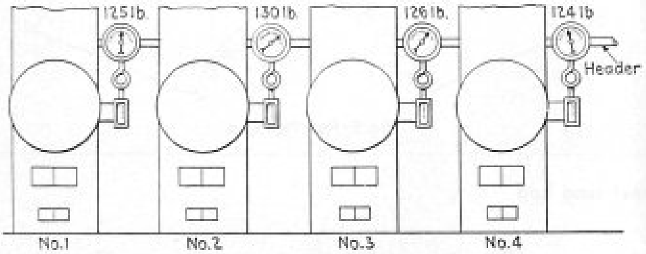
The spaces *11* to *14*, in the pattern, are obtained from *11* to *14* in profile *B* and *14-15* in the pattern is made equal to *14'-15'* in the side elevation (its true length.) The division from *15* to *21* in the pattern, are obtained along the curved outline in Fig. 2 and *7-21* in the pattern is equal to *7'-21'* in the side elevation, its true length. The balance of the spaces from *7* to *4* in the pattern, are equal to corresponding spaces in the profile *C*. Then *1* to *7* to *21* to *15* to *14* to *8* to *1* will be the half pattern. For a full pattern reverse the half pattern opposite the center line *1-8* and allow edges for seaming.

Cutting in Boilers

Q.—I am sending you a rough sketch of four boilers, and I would like to have you give me the correct solution to the problem, in the cutting in of boilers. There are four boilers in the battery. The header is cold. Boilers Nos. 1, 2 and 3 are under pressure. I want to cut into the line boiler No. 4. The steam gages do not all agree. There is a difference of as much as 4 to 10 pounds, some of the gages being lighter than others. How will I cut it in? Which valve will I open first, high or low pressure? Let me know the reason for doing so?—S. W. M.

A.—The following rules cover the manipulation of the valves when cutting in a boiler. They are found in Section VII, Care of Power Boilers, A.S.M.E. Code.

C-171:—Before cutting in a boiler, open and leave open until the boiler is on the line, all drains in the connections between the boiler and the main header, especially the open drains between the two stop valves. In



Sketch showing arrangement of boilers

cutting in a boiler to a steam header already in service, the steam line between the boiler and the header is usually warmed up by means of the by-pass valve, and the header valve then fully opened to allow the boiler to cut itself in automatically with the non-return valve. In case a non-return valve is not used, the boiler stop valve should, of course, be opened slowly when the pressure in the boiler and the steam line are approximately equal.

(a) With two hand-operated stop valves, open slowly (to avoid water hammer) to full opening, the stop valve nearer the main header. When the pressure in the boiler is nearly equal to the pressure in the main header, open slowly, to full opening, the stop valve nearer the boiler.

(b) With one hand-operated stop valve and one combined stop and check valve, when the hand-operated valve is nearer the main header, open it slowly and preferably only a small amount at first. When the pressure of the boiler is still 10 to 50 pounds below the pressure in the header, slowly back off the valve stem of the combined stop and check valve sufficiently from the check to provide full opening of the check valve. In order to insure that the check valve functions properly, always use it automatically for cutting in and cutting out boilers, provided that the main header is filled with steam at full pressure.

(c) With one hand-operated stop valve and one automatic non-return check valve, open the hand-operated stop valve slowly when the pressure in the boiler is still 10 to 50 pounds below the pressure in the main header.

(d) If steam is being raised on a boiler not connected to a common steam header, in general it would be more advisable to raise the steam pressure on the whole steam line at the same time, all drips being open.

(e) After cutting in a boiler equipped with non-return valves, with two independent outlets, observe the steam pressure in the boiler to make sure that both valves open. If the non-return valve is a combined stop and check valve, operate the rising stem after the steam pressure in the boiler has reached its working pressure, in order to ascertain whether or not the valve has opened properly.

From the above rules it is noted that the manipulation of the valves for cutting in a boiler to the line depends upon the number and type of valves used.

The arrangement called for in Paragraph (b) is typical and can be used as an illustration for the problem as outlined in the question.

The boiler having the highest pressure would be cut in first, the header being cold, the hand-operated stop valve nearest the header would be opened and steam by-passed into the steam line between the boiler and the header, and pass through open stop valve into the header.

After the header and steam pipe have been heated, slowly back off the valve stem of the combined stop and check valve sufficiently from the check to provide full opening of the check valve. The header will then have the same pressure as the boiler.

To cut in the other boilers, warm up the steam lines between the boilers and the header by means of the by-pass valves, then open the hand operated stop valves nearest the header, then slowly back off the valve stems of the combined stop and check valves sufficiently from the check to provide full opening of the check valves and the boilers will cut themselves in automatically, as their pressures raise to the pressure of the steam in the header.

The reason for cutting in the highest pressure boiler first is so that the remaining boilers will cut themselves in automatically.

Where automatic check valves are not used, the boiler pressures of boilers being cut into the line should not vary more than two pounds from the line pressure.

Trade Publications

Universal Arc-Welding Accessories. — Universal Power Corporation, Cleveland, O., has recently published Bulletin 1056 on their modern shunt inductor welder motor-generator sets and Bulletin 1057 on arc-welding accessories and clothing. Copies of the publications may be obtained from the manufacturers.

Data Book on Valves.—An excellent source of information on valves and valve layout is the new Catalogue No. 23 just published by Jenkins Bros., 80 White Street, New York. Not only does this book cover 400 Jenkins valves, in a wide range of types and patterns, but also it gives unusually complete details. All features of design and construction are clearly and fully described. Full information is given about the metals used in making the valves. Services, pressures, temperatures and fluids for which the valves are recommended are stated. In fact, this catalogue gives all of the facts that a valve buyer wants in selecting and specifying valves. The last section of the book contains many pages of engineering data that are constantly needed where valves are used.

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.
Secretary—C. W. Obert, 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—William H. Furman, Albany, N. Y.
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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Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland, O.
Executive Committee—(Three 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. (Two years)—J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.; M. E. Finck, Murray Iron Works, Burlington, Ia.; A. C. Weigel, Combustion Engineering Corporation, New York. (One year)—Homer Addams, Fitzgibbons Boiler Company, Inc., New York; George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn. (*Ex-Officio*)—H. H. Clemens, Erie City Iron Works, Erie, Pa.

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

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

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
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

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.		Tampa, Fla.

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

States

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

Cities

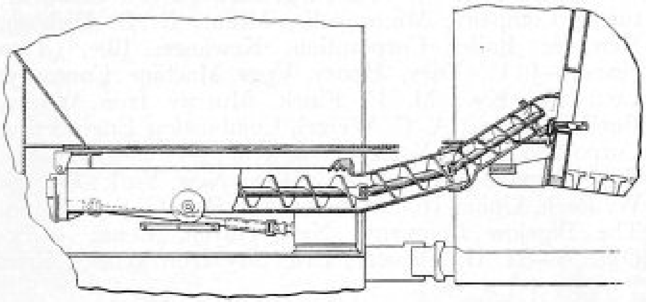
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

Selected Boiler 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.

1,814,645. STOKER CONVEYER. CHARLES J. SURDYKOWSKI, OF TUCKAHOE, NEW YORK, ASSIGNOR TO THE STANDARD STOKER COMPANY, INCORPORATED, A CORPORATION OF DELAWARE.

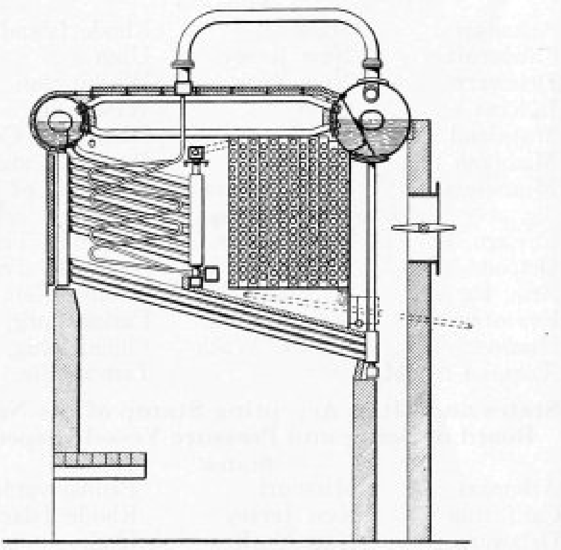
Claim.—In a locomotive, provided with a backhead having a firing opening therein, and a tender, a fuel conveying system comprising a conduit fixed rigidly to said backhead and communicating with said firing opening, a unitary transfer conduit movably mounted on the tender having an upwardly inclined forward portion and universally connected



at its forward end to the rearward end of said fixed conduit, a screw in the rearward portion of said transfer conduit, a screw in the inclined forward portion thereof, said screws being flexibly connected adjacent the bend in said transfer conduit, and a screw in said fixed conduit flexibly connected at its rearward end with the screw in said inclined forward transfer conduit portion.

1,814,447. WATER TUBE STEAM GENERATOR. EDWIN WALTER JONES, OF LINCOLN, ENGLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

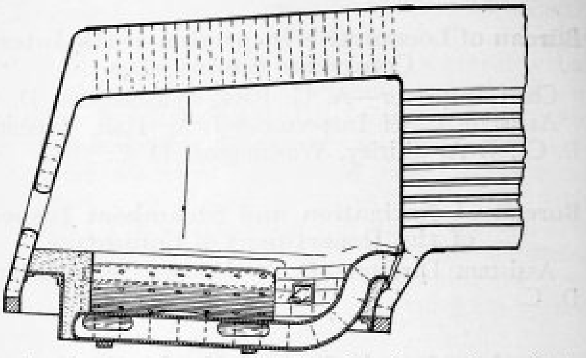
Claim.—In a watertube boiler, a lower bank of horizontally inclined water tubes, a second bank of tubes above said lower bank, said second bank being of less extent lengthwise of the tubes of said lower bank, a



chamber being formed above said lower bank and at the rear of said second bank of tubes, a steam and water drum, heat transferring means other than a superheater located in said chamber, supply means for said upper and lower banks of tubes, and a common delivery therefrom to said drum.

1,813,074. LOCOMOTIVE BOILER. ARTHUR WM. NELSON, OF PARK RIDGE, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

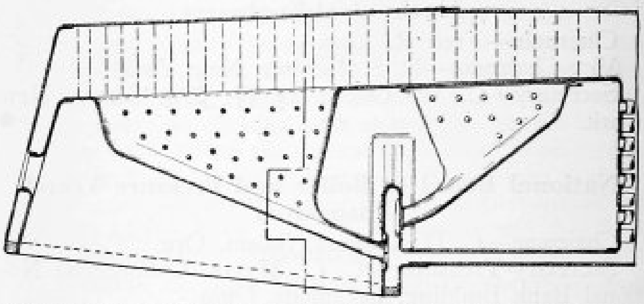
Claim.—A locomotive boiler construction embodying therein a firebox having side sheets and a throat sheet, a pair of relatively flat hollow water circulating and steaming elements, each being affixed at the top end to and opening through an associated side sheet and extending downwardly and inwardly therefrom and a header connected at one end to said throat sheet and positioned at its other end between said elements and connected to each element at longitudinally spaced points thereof and providing air



inlet openings for the firebox between said points of connection, said elements and header coacting to substantially close the bottom of the firebox.

1,814,257. LOCOMOTIVE BOILER. ERNEST I. NOEL, OF IRONTON, OHIO, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

Claim.—A locomotive boiler embodying therein, a firebox, a transverse water wall therein and communicating at its end with the side water



legs of the boiler, and including spaced sheets, a thermic siphon in said firebox opening at one end through the crown sheet of the firebox and having a tubular neck at the other end and a flexible diaphragm in one of said sheets in which said neck is secured, the other sheet having an outwardly dished portion in line with said diaphragm.

The Boiler Maker

Reg. U. S. Pat. Off

The Master Boiler Makers' Convention in Print

For three years the Master Boiler Makers' Association, because of business conditions, has been unable to hold its annual convention. Thus, in order to retain the continued loyalty and interest of its members, and to prevent a lapse in its contribution to the art of boiler construction, repair and maintenance, the officers of the association in co-operation with this publication have prepared a complete "Convention in Print," which appears in the following pages. Every element of the conventions of the past is present except personal contact. It is hoped that this effort will result in great benefit to all members of the association and to the railroads they serve. In one respect the convention in this form will have wider scope than any in the past, since it will reach not only the members of the association, but individual readers throughout the entire boiler industry and in the plate fabrication field. It also will be read by every important railroad mechanical officer in the country. The reports, presented by special topic committees, more comprehensively cover shop methods, equipment, tools and materials for boiler work than any in recent years. To be completely successful the convention must now await the response from members and readers throughout the country for their contributions in the form of discussions. The officers urge all members of the Master Boiler Makers' Association to submit discussions of these reports at the earliest possible moment after studying them carefully. Only in this way will it be possible to develop the best information on the subjects covered. Other readers who wish to contribute discussions are invited to do so. As received, these discussions will be published in subsequent issues of THE BOILER MAKER. After all who wish to take part have been heard from, the entire proceedings, including addresses, committee reports with their discussion, and exhibits of the supply companies will be published and sent to all members and to railroad mechanical officers throughout the country. Discussions should be sent either to Albert F. Stiglmeier, secretary of the association, or to the editor of THE BOILER MAKER. If the response from members is comparable with the efforts of the officers and committees which developed this convention, there can be little question of the interest and support of the mechanical officers of the railroads, who will be instrumental in making possible an actual convention, it is hoped, in the coming year. The association is also grateful for the support of the supply companies who by exhibiting in this convention issue have made it possible to present this information on the art of locomotive boiler maintenance and repair to the railroad industry

Lawrence Richardson, mechanical assistant to vice-president and general manager, Boston & Maine Railroad

George McCormick, general superintendent of motive power, Southern Pacific

E. B. Hall, general superintendent motive power and machinery, Chicago & North Western

MESSAGES TO THE M. B. M. A

Recognizing the importance of keeping alive the spirit of co-operation that has always existed among the membership of the Master Boiler Makers' Association, and which has been a source of real aid in meeting the locomotive maintenance problems of the railroads, mechanical officers of many important systems have heartily endorsed the "M. B. M. A. Convention in Print" which this year was developed to keep the work of the association active and virile until such time as it is possible again to hold an actual convention.

The following messages of advice and encouragement from officers in each section of the country will serve as an inspiration to all members and to the industry as a whole to advance the standards of boiler construction and repair and to enter whole-heartedly in developing by discussion the best shop practices for the guidance of the entire fraternity. By showing an active interest in the convention in the form conducted this year, members of the association will insure the continued support of their superiors and speed the time when the annual conventions will be resumed.

Master Boiler Makers Can Aid in Railroad Improvement

By Lawrence Richardson

The holding of a "Convention in Print" in THE BOILER MAKER is a commendable idea. It will preserve many of the advantages of an actual convention. It will in fact amplify the scope of the Master Boiler Makers' Association in that the papers themselves are read by a widened circle of readers. Increased interest by larger numbers leads to greater accomplishments.

The last ten years have been a real "Decade of Progress" in railroad boiler making. Better materials, more effective workmanship and improved designs have made it possible for us to maintain our boilers with but 43 percent of the forces of five years ago. But that is accomplished. The next decade will require more than doubled effort to accomplish even half that improvement. The real problem confronting the boiler-making personnel is "how it will be accomplished." Gleaning after a harvest requires intensive and individual effort. Progress must continue.

Practical knowledge brings results. Technical knowledge is equally effective. The combination of the two properly co-ordinated produces the best. In the past, the principal technical advances have been made by our commercial friends.

Today that situation is at the cross roads. The manufacturers have had lean business for more than three years and do not have the money nor resources to make the many experiments and researches necessary to advance the art. The railroad expenditures are also curtailed. With limited resources, results can only be accomplished by co-ordinated effort. This is done abroad. Research and development in Germany is principally done by a central engineering organization with adequate personnel and ample facilities. The results have well warranted their policy. Each problem is carefully analyzed. Then the full power of the organization is brought into play to produce results. They have been produced.

The side sheet and staybolt problems are but two among many that offer wide fields for betterment in boiler making. One degree of heat will produce 195 degrees of stress in confined steel. It takes but little over 200 degrees to reach the elastic limit of boiler steel. Temperatures beyond that can only be absorbed by movement of the sheet or ultimate failure of the material. Practical experience tells us that both take place,

H. M. Warden, chief mechanical officer, Missouri-Kansas-Texas Lines

C. L. Dickert, superintendent of motive power, Central of Georgia Railway Company

O. A. Garber, chief mechanical officer, Missouri Pacific Lines

ROM MECHANICAL OFFICERS

but the exact part played by each is not known. The larger areas in superpower fireboxes have intensified the trouble. There is no particular mystery about the fundamental causes, but the exact details, so necessary to solution, are lacking. Only intensive study and research guided by practical knowledge can bring the answer.

In judging the true values of companies, investors invariably place prime importance on research and development activities. If adequate, they signify capable management. The Master Boiler Makers' Association can promote progress by adopting these principles and press for adequate and co-ordinated research and development. The field is open, and your organization can demonstrate its value by accepting the challenge.

Continued Interest in Your Association Essential

By Geo. McCormick

The officers of the Master Boiler Makers' Association are to be commended in their endeavor to maintain the spirit of progress which your association has been noted for, by continuing to keep alive interest in the work being done, which has always been followed very closely by the mechanical officers of the railroads.

Your plan to convene at a stated period once a year for an exchange of personal views on topics of interest is a very efficient method to keep abreast of progress. It is only by such means that the best practices known to the art of boiler making can be fully developed. It would be very disappointing for you to allow the outstanding record made by your association in the past to be lost. And, mind you, I know that many of your oldest members and past officers have striven very diligently for years to place your association in the position it holds today as the medium through which much authentic practical information is released for the beneficial use of that branch of the industry dealing with the maintenance and repair of the locomotive boiler. Your work must continue.

Conditions are such that your association cannot hold a regular convention this year, but it is believed that helpful interest can be stimulated by publishing proceedings based upon the assembling of information by correspondence.

I have before me a copy listing the topics for this "Convention in Print" and the committee personnel that has been selected to prepare reports. It is my belief that some very interesting data will be presented, upon which much comment should be made by your membership. I, in the past, have always been keenly interested in your work and will look forward to the response made by you as requested by your officers to co-operate with them in continuing your endeavors by the means thus provided.

An active response by all is the instrument on which the continued success of your association will largely depend, for you cannot expect your officers to carry on unless they have the support of each and every individual member.

In the past few years the income of the railroads has fallen off considerably, not only from normal but from a high peak of prosperity. To adjust themselves to meet this abnormal decline, changes in railroad operation were necessary, forces had to be reduced, some shops were closed and many shop organizations were altered. It was a vast change from the usual order of things, but it had to be done if the railroads were to survive.

The part taken by the chief mechanical officers of the railroads in bringing about this adjustment was not altogether a pleasant one, and especially so where the employes were vitally concerned. Many in your membership have been directly affected by these conditions, including many others in the different branches of the railroad industry. However, notwithstanding this, I am encouraged very much with the responsive, diligent effort made by the supervisory forces and employes remaining. Production of classified repairs turned out of the shop was improved during this period and the condition of power maintained efficiently.

At this writing I am glad to announce that the revenues of the railroads in general are showing an increase and that in several quarters the shop forces have been increased.

We hope that the "New Deal" promised by President Roosevelt will continue to go ahead at full speed, and that the increase in business will be sustained to the extent that readjustments made in our routine will be permanent.

I hope the time is not far distant when I may have the opportunity of meeting you in convention and addressing you personally.

Boiler Makers Can Aid in Solving Operating Problems

By E. B. Hall

Owing to conditions which have existed for the past three years, it is regrettable that the Master Boiler Makers' Association has been unable to hold its regular annual conventions, and the idea of having a "Convention in Print" is a good one and should serve to keep alive the interest which has heretofore existed in the association.

It has been our pleasure to have attended a number of your meetings, and we have followed with keen interest the many topics and discussions which have taken place and the good results obtained.

Using the past twenty-five years as a guide and looking towards the future, we find many difficult problems confronting us. While we have been able practically to eliminate the causes of leaky flues and fireboxes, which gave so much trouble in the past, we are now confronted with designing and maintaining larger locomotive boilers in a limited cross-sectional area, carrying higher steam pressures, which result in greater contraction and expansion, thus setting up new problems.

The good results obtained from water treatment have enabled the railroads to cut down many costly boiler repairs to fireboxes and flues, caused by scale and mud, and have allowed an ideal operating condition insofar as leaky flues and fireboxes are concerned. Nevertheless, the man in charge of boiler maintenance should be ever on the alert to detect any change that might affect the water for locomotive use, causing leaks to develop or poor operating conditions by carrying water into the dry pipe and superheaters and destroying lubrication.

Like cancer to the human body, so also is corrosion and pitting to steam boilers, and the results from scientific research to determine the cause and cure are about equal. By the use of special materials and devices some good results have been obtained. Operating locomotives over long runs has been beneficial towards reducing corrosion and pitting in some districts. Formerly locomotives were assigned to divisions operating 150 to 200 miles. Some of these divisions supplied water which developed corrosion and pitting to the extent that flues had to be renewed in from 16 to 20 months. On several connecting divisions water was supplied that developed no pitting. Now operating locomotives through the entire district has resulted in neutralizing the corrosive water and has reduced the amount of pitting.

The railroads spend large sums of money for material and supplies, and it is your job to see that they get full value for the money spent. Regardless of the fact that rigid inspection is made at the manufacturing plants, defects sometimes creep in, and you should be on the alert to detect them and keep your superior officers informed so that they can insist on good materials.

Regardless of the progress that has been made by other means of motive power, the steam locomotive has not lost its place. However, it is necessary to keep improving its efficiency in order to keep pace with competition, and you men are in a position to assist greatly.

I hope these thoughts will be of some value to your association and that we will again meet in the near future.

A Time To Look Forward

By H. M. Warden

Someone has said that it is always darkest before the dawn, and from the evidences of returning prosperity all about us I think we may assume that our darkest days are behind us and that what we see is the first bright ray of the approaching dawn. During the long period of inactivity from which we are now happily emerging, there were many gloomy predictions of the approaching end of the railroad era. Prophets of despair were heard to forecast the decline of railroading, pretending to see the diversion of the great body of traffic to other transportation agencies. This should have occasioned no surprise, for such dire forebodings always mark periods of business depression.

As the cycle of depression nears its end, we hear a different story. Now, the railroads are not regarded as an obsolete or obsolescent agency of transportation. On the contrary, they are considered so vitally essential that railroad managements are being urged not only to put existing equipment into condition for use but to spend vast sums for additional equipment. So optimistic are some of the views entertained by those high in authority that fears of a car shortage are being expressed.

One need not subscribe to this extreme view to be able to recognize conditions that indicate an increasing need of railroad equipment, including locomotives, and whether this need be supplied through the purchase of new power or through the repair of existing equipment, or by both, it means a revival of activity in the industry in which we are all concerned. Some railroads, ours among others, have anticipated this need and already have placed in prime condition the bulk of its motive power, which indicates a pronounced trend in the direction of greater activity in our industry. There can be little doubt that before many months the machinery will be whirring in railroad equipment plants the country over and that when the returning tide of prosperity reaches its peak railroad shops throughout the country will be rushed as never before.

Although here, in the Southwest, we have never lost faith in the ultimate recovery of business, reflecting the studied sentiments of the Southwest, M. H. Cahill, the "Katy's" president, has throughout the entire depression maintained a spirit of optimism that has endeared him to the forward-looking people of the states served by our railroad. The manner in which he backed his faith and optimism by keeping the Katy in a high state of efficiency and in inaugurating various improvements has been typical of the Southwest and has been a source of continual encouragement and hopefulness to all classes of railroad workers. Suiting his words to action, he has seen to it that the Katy has not deteriorated during the lean years, but instead has steadily gone forward, with the result that now, with the skies beginning to brighten, our railroad is better prepared than ever to fulfill its obligation of efficient transportation service.

What we all should remember is that the commerce of this great continental nation simply cannot be carried on without our railroads and that the railroads cannot operate satisfactorily without an adequate supply of motive power. With the commerce of the country at last on the upward trend, the very logic of events presages a brighter day for our industry, and we should face the future full of courage and fired with hope for happier days to come.

Work of M. B. M. A. Must Be Continued

By O. A. Garber

I am glad to have the honor of addressing the Master Boiler Makers' Association, and I wish to congratulate you on the good work you have done up to the present time; but, as progress and economy are the main issues of today and of the future in all enterprises, it is vitally necessary that we keep in step with this phase of the problem.

The locomotive boiler is, so to speak, the sole producer of energy of a locomotive, and it must be the aim of every master boiler maker to build a better and more efficient boiler than that which we have at the present time. We still have to do better work to reduce the cost as much as possible.

In order to do better work the master boiler maker should instruct his supervisors and impress on them the necessity for a careful study and inspection of all work; to instill in the minds of his men the importance of a good boiler on a locomotive; to create an interest in his forces for the planning and execution of all the work, from the plain boiler sheets up to a complete boiler.

Our present practices should be carefully studied and a means found to build a better boiler at less cost, and supervisors should also be on the alert for better and cheaper means of maintaining them.

Competition at the present time is very keen, and in order to meet this problem it is of paramount importance that a locomotive be kept in efficient operating condition with a minimum expenditure for maintenance. Therefore it is essential that in maintenance work the best of workmanship be used at all times to keep the locomotive in service for longer periods of time than has been the case in the past.

In late years in order to increase boiler efficiency, the tendency is to increase boiler pressure, and in order to accomplish this, different types of boilers have been designed, built and tested in this country, as well as abroad. I am referring to watertube firebox boilers.

So far, very good results have been obtained from these boilers but not exactly what we really expected and what should be expected from this construction, as it will naturally increase the first cost of the boiler considerably. So far the efficiency and saving have not warranted the additional cost and increased maintenance.

The present trend in locomotive boilers is towards longer locomotive runs and longer operating periods between service attention at terminals. To make this possible we, in the Southwest, have found out that it is possible to extend our boiler wash-out periods and at the same time improve the interior of our boilers through proper terminal and road blowing through the blow-off cocks.

The thought that I wish to leave with the membership of the Master Boiler Makers' Association is that we are going to have to depend on the steam locomotive for years to come as the principal motive power unit, and that the work of your association is going to be of extreme importance and will require an ever-increasing knowledge and technical skill to keep abreast of the times.

Railroads in Southeast Show Substantial Gains

By C. L. Dickert

Business in the Southeast scraped the bottom of the depression trough in January, a slight improvement was manifested in February, and this continued during March in spite of the bank moratorium. Further progress was made in April, and a decided upswing took place in May which has continued with increasing force through June and July, with a slight recession in August. Carloadings on the Central of Georgia, the railroad with which I am most familiar, were in May 21 percent ahead of May, 1932, in June 35 percent, in July 51 percent and in August 15 percent ahead of like periods in the previous year.

The improvement in business is general and is not confined to any one class of traffic. There is marked activity in textiles. Many cotton mills are now operating both day and night. There is a decided increase in loadings of coal, some railroads showing as much as 33 percent gain over 1932.

One of the most encouraging features is the improved sentiment, optimism having replaced doubt. The territory served by the Central of Georgia is an agricultural one, and a large part of the prevailing optimism may, perhaps, be attributed to the betterment in agricultural conditions. Watermelons and peaches have been commanding better prices than for several years, and there are good crops of each, and the returns for tobacco were satisfactory.

I hesitate to hazard a conjecture as to whether this improvement in business is temporary or has promise of permanence. If the latter be true, the railroads of the Southeast will emerge from a long period of lean traffic and will naturally resume their normal functions as employers of labor and purchasers of materials and supplies. Even now a number of the railroads have increased their allotments for maintenance of equipment and maintenance of way in order to place their properties in position to handle the traffic offered. While not many new employes have been engaged, the present forces are enjoying the benefit of more hours.

On the whole, conditions are vastly more encouraging than they have been at any time since 1929.

I hope the "Convention in Print" will be highly successful. I am sure that some good messages will be sent out to the boiler makers in the absence of their regular convention meeting. I sincerely hope that in the next year or two we will be able to hold these conventions as we have in the past, as they are most helpful to those who attend them.

WORK FOR YOUR ASSOCIATION

Kearn E. Fogerty, general boiler inspector, C. B. & Q.

By Kearn E. Fogerty, President

For three years Kearn E. Fogerty, general boiler inspector of the Chicago, Burlington & Quincy Railroad, has guided the destiny of the Master Boiler Makers' Association through the most trying period in its history. This year's "Convention in Print" is intended by the Association to fill the gap made by the curtailment of actual conventions, which, Mr. Fogerty hopes, will be resumed in 1934

As president of the Master Boiler Makers' Association, it is necessary that I address you once again without anticipation of being privileged to meet with you in convention assembly. However, it has been the earnest effort of the officers of your association in co-operation with The Boiler Maker and with the support of the supply companies to make this "Master Boiler Makers' Convention in Print" as valuable a contribution to the industry we serve as any actual convention of the past. It will serve to strengthen the ties of common interest of the membership until such time as we meet again, and above all, it cannot fail to convince our superior officers that with imagination and concerted effort we are ready to face the problems of rehabilitating the motive power of the country that lie before us.

The situation, so far as the affairs of our organization are concerned, still remains about as it was last year and the year before; except that our expectations of recovery from business depression are more nearly realized at the present date; and the future looks far brighter.

I believe that I have the unanimous agreement of the personnel of our membership, in my conviction that the usefulness of our organization must not be impaired; but on the contrary, that the bonds which hold it together must be strengthened where there may be evidences of weakening and that we must all work together to the end that our association be maintained in its well earned position attained by the earnest efforts of the past. For example, if all of our members enter into the discussion of the committee reports here presented as they would at an actual convention, they will give evidence of their interest and support and no ground will have been lost.

Since our last report, there has, unfortunately, been little concrete evidence of improvement in our field of endeavor; but we must not be misled into believing, because few new locomotives have been constructed, that there have been no forward steps made. On the contrary, our designing engineers have not been idle and when new locomotives are constructed, in accordance with new programs now being formulated, we will be able to observe radical improvements in both design and construction, representing the effects of our unending thought, recommendations, and work of the past.

While admittedly difficult to continue our committee work, without the advantages of the discussions and personal intercourse accorded by our annual meeting, our membership must not be discouraged in meeting the requirements, despite these difficulties; in realization that the old incentives may be expected to be restored to us before another year has passed.

The interest of those who manufacture and furnish tools, materials, and equipment with which we work, has been continuous and unabated. The fact that they have been harassed and distressed by the business conditions of the past several years, has not discouraged them. When it again becomes possible for the railroads to patronize them, they will be found as actively interested as ever before and their support for our organization will be available. Evidence of this is not lacking in the display of new and improved products in the "exhibit" section of this "Convention in Print" nor in the advertising support accorded.

This year the City of Chicago has successfully conducted what is probably the greatest exposition of scientific and commercial advancement the world has ever seen. "A Century of Progress" World's Fair included exhibits of great interest to our membership. The transportation exhibit displayed examples of the improvements in locomotive design and construction mentioned in our last report. This exhibit has been well worth seeing and for the many members, who visited it, has been particularly useful in carrying us over through the period when we have not the opportunity for inspecting our own convention exhibits.

I wish again to express my appreciation to all of those individuals and organizations mentioned in my last report, as having continued to lend their unqualified support.

Master Boiler Makers' Association

PAST AND FUTURE

By Albert F. Stiglmeier, Secretary

Albert F. Stiglmeier, general foreman boiler maker, N. Y. C.

The majority of people judges ideals, values and their fellow beings by past performances. From these they decide what the future is likely to develop in their relations with each other. The same principle applies equally well to groups of individuals who have organized themselves in associations such as that of the master boiler makers. Going back to the beginning of this association, definite ideals were established which have been the guiding force throughout its thirty-odd years of existence. It would not be possible for any organization to produce a clearer record of helpfulness in the common work of its members nor one that offered a greater measure of service to the industry which it served.

It might be well at this time briefly to recall the inception of the association and the early members who established the ideals upon which our work has progressed. In July, 1902, there appeared in the *Railway Journal* an article by E. C. Cook suggesting the formation of an organization of railway boiler shop foremen and supervisors. His suggestion materialized on November 11, 1902, when a group of enterprising and far-visioned railway master boiler makers met in the assembly hall of the Lindell Hotel, St. Louis, and formed what was known as the International Railway Master Boiler Makers' Association for the purpose of promoting education among its members. It also proposed to develop all information that would be of general benefit to fellow master boiler makers of the railway companies and the great transportation systems in the United States and Canada. It was conceived solely as an organization of those in charge of railway boiler departments and to be officered by them with complete sanction of the railway management.

The association had these objects in view—to bring together for discussion among its members various topics of interest; to promote the exchange of ideas and methods used by various railroads, and, through frequent meeting, to provide a better acquaintanceship among members and thus increase the prestige and influence of this branch of the railway industry.

Other than the appointment of officers and the selection of topics for a 1903 meeting little else was accomplished during the November, 1902, session. The officers elected at this time were, president, F. J. Graves, master boiler maker, Chesapeake & Ohio Railroad, Huntington, W. Va.; first vice-president, J. A. Doarnberger, Norfolk & Western, Roanoke, Va.; second vice-president, Wm. H. Laughridge, Hocking Valley, Columbus, O.; secretary and treasurer, P. Sullivan, Big Four, Urbana, Ill.; assistant secretary, E. C. Cook, *Railway Journal,* 324 Wainwright Bldg., St. Louis, Mo. *Executive Committee:* Wm. P. Kelly, Pennsylvania Lines, Dennison, O., chairman; M. V. McCoy, Big Four Railway, Wabash, Ind.; John McDermott, Baltimore & Ohio, S. W. Chillicothe, O.; J. J. Meyer, Chicago, Burlington & Quincy, Burlington, O.

At this first meeting there were in attendance 68 representatives of their craft who constitute the charter membership of the association.

The names of these men, many of whom are no longer with us, explain the heritage of service on which our work has been based. They were: F. J. Graves and R. M. Casey of the Chesapeake & Ohio; J. A. Doarnberger, Norfolk & Western; N. Baker, Wm. P. Kelly, H. Denzler, Chas. Letteri, R. Pogue and J. L. Mayers, Pennsylvania Lines; P. Sullivan, M. W. McCoy, Chas. Kraus and H. W. Peterman of the Big Four; Wm. H. Laughridge, Hocking Valley; John McDermott, Illinois Central; J. J. Mayer, Chicago, Burlington & Quincy; John Corbett, N. O. & N. E.; John J. Brennan, Great Northern; D. G. Belford, El Paso & Rock Island; L. Borneman, C. I. & W.; J. W. Boland and Wm. Lindner, Central of Georgia; James Conroy, of the Rio Grande Western; C. S. Bomberg, Iron Mountain; Wm. Stewart, James Conley, J. Burns and W. S. Weir, Baltimore & Ohio; F. A. Batchman and John Harthill, Lake Shore; C. C. Shephard and E. J. English, Cotton Belt; W. H. Evans, G. S. & F.; W. M. Evans, L. & N.; E. J. Flavin, W. & L. E.; Wm. Gillies, M. K. & T.; Floyd Harris, Delaware & Hudson; Jas. T. Johnson, G. M. Wilson and Frank Shupert, Northern Pacific; L. J. Kent, Missouri Pacific; R. C. Young, Wm. Krum and Robt. F. McNickel, Chicago & North Western; George F. Lyon, Canada Atlantic; Wm. Lawler, Duluth Southshore & Atlantic; Joe McAllister, Cincinnati & Northern; John McKeown, of the Erie; Phillip Rentchler and W. J. Mahoney, C. P. & S. L.; J. E. Mulera, Delaware, Lackawanna & Western; Jas. Murry, Wabash; M. O'Connor, F. E. & M. V.; Chas. Patrick, John Quinlan and John Troy, Pere Marquette; W. H. Shaw, Buffalo, Rochester & Pittsburgh; S. J. Shaffer,

Franklin T. Litz, first vice-president, general boiler foreman, C. M. St. P. & P.

O. H. Kurlfinke, second vice-president, boiler engineer, So. Pacific

Ira J. Pool, third vice-president, district boiler inspector, B. & O.

L. E. Hart, fourth vice-president, boilerforeman, Atlantic Coast Line

William N. Moore, fifth vice-president, general boiler foreman, Pere Marquette

W. H. Laughridge, treasurer, general boiler foreman, Hocking Valley

New York Central; John B. Smith, Pittsburgh & Lake Erie; W. A. Timms, Philadelphia & Reading; R. W. Tiernan, of the Southern; C. E. Waite, Atlantic Coast Line; C. F. Wilde of the M. & O.; Harry Fisher and M. C. Conway, Lima Locomotive Works; Frank Rahrle, Baltimore & Ohio S. W.; and associate members; J. W. Williams and E. C. Cook of the *Railway Journal*.

The convention was next held May 19 to 21, 1903, at the Great Southern Hotel, Columbus, O. At this meeting committee reports were read and discussed with much interest and 37 new members were added to the roster of the association, including: T. F. Cleary, K. & C. So.; J. R. Cushing, John Wolmer, Big Four; R. H. Davis, L. & N.; Henry Enrett, K. & M.; Adolph G. Frey, Buffalo, Rochester & Pittsburgh; Rudolph Freye, Detroit Southern; John German, I. I. & E.; C. L. Hemple, Union Pacific; E. J. Hennessey, B. F. McGrath, New York Central; Wm. Jordan, Illinois Central; C. F. Lape, S. S. & I.; G. N. Nicholas, Missouri Pacific; J. H. O'Brien, Penn. R. R.; Wm. Keefe, P. & P.; Joseph Peters, T. & P.; J. A. Powell, Central of Georgia; F. J. Petzinger, S. A. Line; Fred J. Pepper, Boston & Maine; Joe Rusch, Sr. and Joe Rusch, Jr., T. & O. C.; W. J. Ritchie, C. W. Stable, of the C. O. & G.; Wm. A. Schultz, C. & P.; Robt. Spencer, of the S. S. T. Co.; W. M. Skidmore, Southern; W. S. Thomas, R. R. & G.; M. C. Vought, C. & A. C.; T. H. Williams, Southern; and associate members, J. W. Faessler and G. R. Maupin, of the Faessler Mfg. Co.; G. H. Williams, B. M. Jones & Co.; M. F. Fuller, Fuller & Co.; J. T. Goodwin, of the American Locomotive Co. and Wm. Thomas, Brooklyn Heights Ry.

The work of this association progressed rapidly until in May of the year 1905 at the Hollenden Hotel, Cleveland, O., through the untiring efforts of the officers of the International Railway Master Boiler Makers' Association and those of a similar organization, the Master Boiler Makers' Association, a merger was effected under the name of the International Master Boiler Makers' Association, having a total membership of 335. Until

1911 the association was continued under this name but at the convention that year at the Rome Hotel, Omaha, Neb., the name was charged to its present one, The Master Boiler Makers' Association. The total membership at that time was 440, which indicated the wide interest that its work had developed in the craft.

Master boiler makers from every railroad were quick to realize the benefits to be derived from the organization and throughout its history, through good years and lean, this spirit has never faltered. During the peak of activity in 1919, mainly through the efforts of Frank McManamy, then assistant director of operations of the United States Railroad Administration, the association boasted a membership of 631.

For thirty years since its organization the association flourished and through the development of the spirit of co-operation among its members performed an incalculable service to the railroads of the nation. Its work was recognized by mechanical officers as invaluable in the promotion of safety of the motive power of the country.

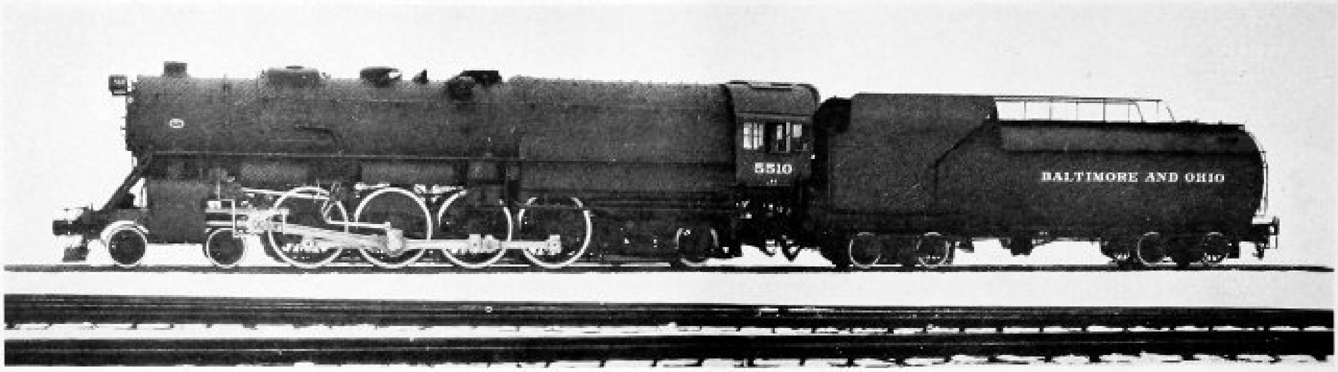
After these years of accomplishment the railroads have been obliged in these past three years of depression to curtail their support, which has made it impossible to conduct our conventions. With the reduction of shop forces, membership in the association has naturally fallen off, and, therefore, until we again can meet in convention it would never do to let interest in the association lapse since progress can never be developed by indifference. The adage, "Friction of mind upon mind broadens and sharpens the intellect," was never more exemplified than at the meetings of our association. Sound and progressive discussions aroused the interest of the younger as well as the older members. Many in this trade can trace their advancement from their active participation in the work of the association and through the fund of knowledge gained in their craft from their contacts at our conventions.

In spite of the difficulties which now confront us, it is the sincere ambition of the officers that the useful work of the Master Boiler Makers' Association be carried on. This "Convention in Print" issue of The Boiler Maker will make this possible. Great credit is due the officers and members of the various committees of our association who have served so faithfully through the years of 1931 and 1932, and to those who have prepared reports for presentation in the proceedings this year. We are indebted to the Simmons-Boardman Company, publisher of The Boiler Maker, for providing the medium through which the Master Boiler Makers' Association might present these committee reports to its members, and to all others interested in our work. Our sincere appreciation is accorded to those railway mechanical officials who have given of their valuable time in preparing messages of confidence that appear in this issue.

In order to carry on, the association must depend entirely on the loyalty and co-operation of the members, as well as upon the support of our friends in the supply companies, without whose help we could not have made this effort a success. It should be remembered that while the majority of the railway mechanical associations have ceased to function, or are inactive in their work, the Master Boiler Makers' Association has still carried on. With the renewal of railroad business, all the former activities of the association will be resumed. It has survived the worst of the storm and with co-operation in its ranks will continue to serve the industry. Let us look into the future with high hopes that we may soon again meet in convention. This will again become a reality if we all stick together and face the future with confidence.

The present officers of the Master Boiler Makers' Association, in addition to those whose personal photographs are published, are as follows: *Executive Board* (One year)—Charles J. Longacre, chairman, Division Boiler Inspector, Pacific Railroad; R. A. Pearson, general boiler inspector, Canadian Pacific Railway; M. V. Milton, chief boiler inspector, Canadian National Railways. (Two years)—John Harthill, secretary, general foreman boiler maker, New York Central Railroad; M. A. Foss, service engineer, Locomotive Firebox Company; George G. Fisher, general foreman boiler maker, Belt Railroad. (Three years)—George L. Young, foreman boiler maker, Reading Company; C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railroad; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad.

In 1908, the second year after the rival associations had amalgamated under the name International Master Boiler Makers' Association, the convention was held at the Hotel Pontchartrain, Detroit



Baltimore & Ohio locomotive equipped with Emerson watertube firebox

Construction and maintenance of high-pressure locomotive boilers equipped with

WATERTUBE FIREBOXES

Committee

I. J. Pool

J. A. Clas

R. A. Pearson

In constructing a boiler, regardless of whether the type be watertube or radial stay, every effort must be made toward perfection in workmanship. This effort is absolutely necessary in all construction of any design of boiler if the required results are to be obtained. Any faulty workmanship or neglect on the part of the worker helps to destroy the efficiency of the boiler.

One of the most important features in constructing boilers of the watertube design is to keep them in alinement to assist in their economical construction and keep their shape under control; otherwise, any deviation would affect the water levels.

There being many different designs of the watertube boiler, it would be impossible to write a definite procedure to be followed in actual construction of all such types of boilers. Therefore each particular design of boiler must be carefully studied and an outline of procedure must be made to meet the requirements of the particular design.

When a definite procedure has been agreed upon, those in charge of construction must see that the process outlined is carefully followed and the individual worker properly instructed, if the desired results in service are to be accomplished.

Maintenance of Locomotive Watertube Boilers

The maintenance expense on locomotive boilers is generally considered to include all expense incurred on a boiler to keep it in efficient operating condition. This will include such items as washing out, cleaning scale from tubes (which strictly should be considered an operating charge), as well as repairing or replacing defective parts in the boiler firebox.

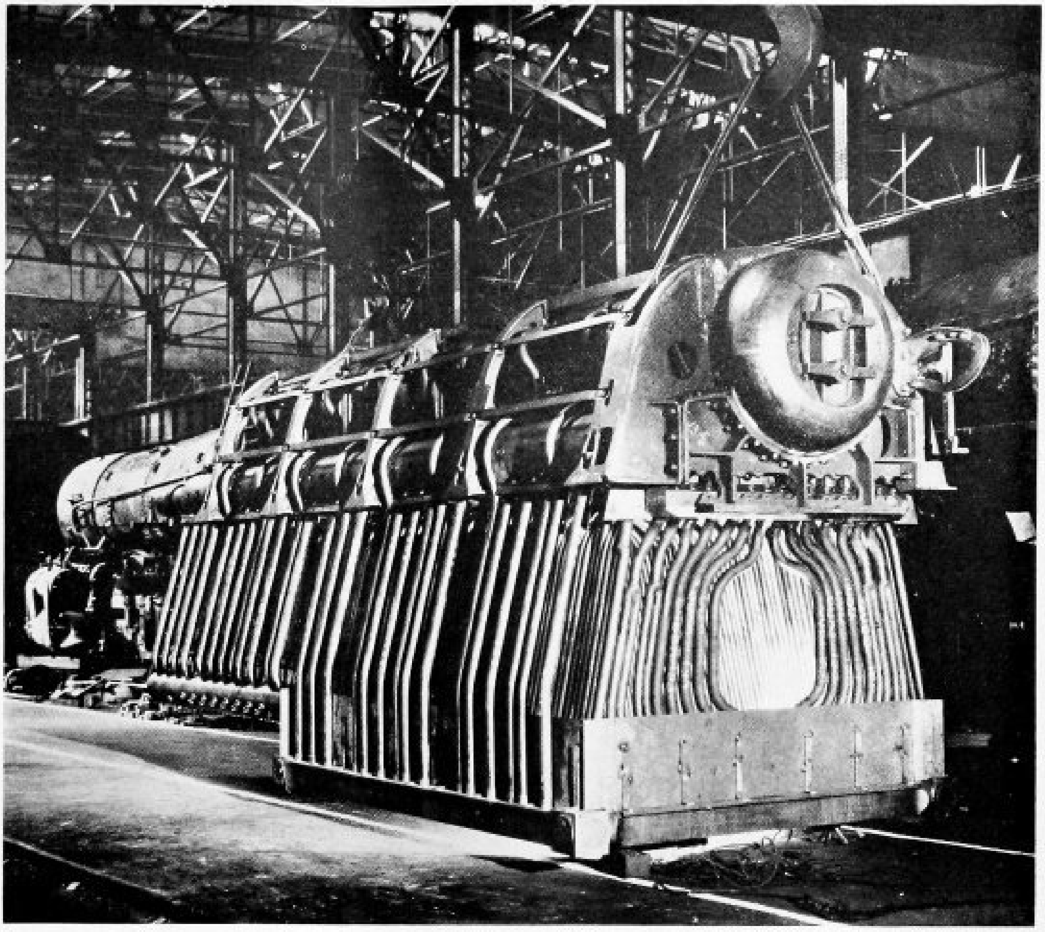
Watertube boiler maintenance is in no way different from that of the more generally used fire-tube boiler as regards its essentials. However, the fact that the water is inside the tubes instead of outside, requires a different cleaning procedure, and also owing to the fact that in the usual design of watertube boiler the tubes are located in the firebox zone and are directly exposed to the high temperatures there attained, there results a more rapid formation of scale in watertubes than on fire tubes. A large proportion of the heat transferred to the water in the firebox watertubes is agreed to be due to radiation, which type of transfer varies as the fourth power of the temperature, while in the case of fire tubes the greater part of the heat transfer is by direct conduction, which varies as the first power of the temperature. As scale formation may be considered a direct function of the rate of heat transmission, and also, as the temperature in the firebox will average twice as high as in the flues, it follows that scale will be formed on the inside of the firebox watertubes at a decidedly faster rate than on the outside of fire tubes or flues. For this reason the use of pure water for boiler feed is very desirable for locomotive watertube boilers.

However, as the only real difference between some designs of watertube boilers and fire-tube boilers is in the back end, any comparison of the two may be restricted to a consideration of differences in the firebox. Scale begins to form in the water space around the usual firebox as soon as a locomotive is put into service, and on account of the difficulty of thorough inspection and of cleaning, it is never entirely removed during the life of the boiler. Whereas in the watertube boiler, in which the firebox is formed almost entirely of tubes, which are so arranged as to be accessible to scaling tools, this serious disadvantage is eliminated.

Any evaluation of watertube boiler maintenance as

Note: The committee which submitted this report consisted of the following: I. J. Pool, district boiler inspector, Baltimore & Ohio, chairman; J. A. Clas, general boiler foreman, Delaware & Hudson; R. A. Pearson, general boiler inspector, Canadian Pacific.

Watertube firebox and boiler of the multi-pressure type as installed in Canadian Pacific locomotive No. 8000



compared with fire-tube design should take into account the greater loss in efficiency due to scale suffered by the fire-tube boiler, the firebox of which can never be completely cleaned without a major repair operation, while the efficiency loss due to scale on watertubes may be kept close to zero by frequent use of the turbine cleaner.

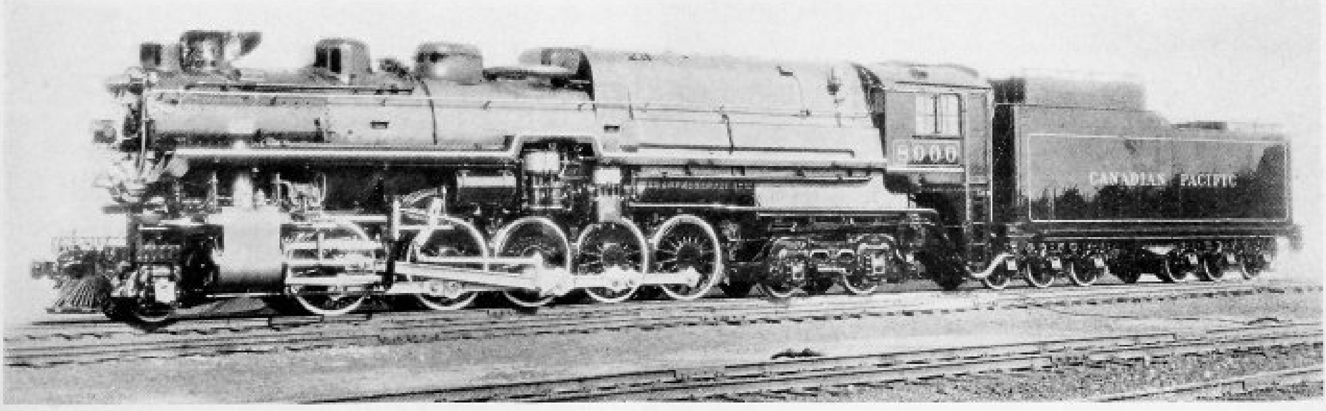
In this connection, it may be noted that the most serious objection to scale on boiler tubes or plates, is its effect on the maintenance bills. It is generally agreed, except perhaps by those interested in boiler compounds, that a film of scale up to $1/16$ inch thick has hardly a noticeable effect on the operating efficiency of a steam boiler. Its presence however, may be very harmful from the maintenance point of view, due to overheating of the metal.

For this reason, as far as maintenance is concerned, the watertube firebox, which can be kept practically free from scale, should be considered much superior to the usual conventional firebox design.

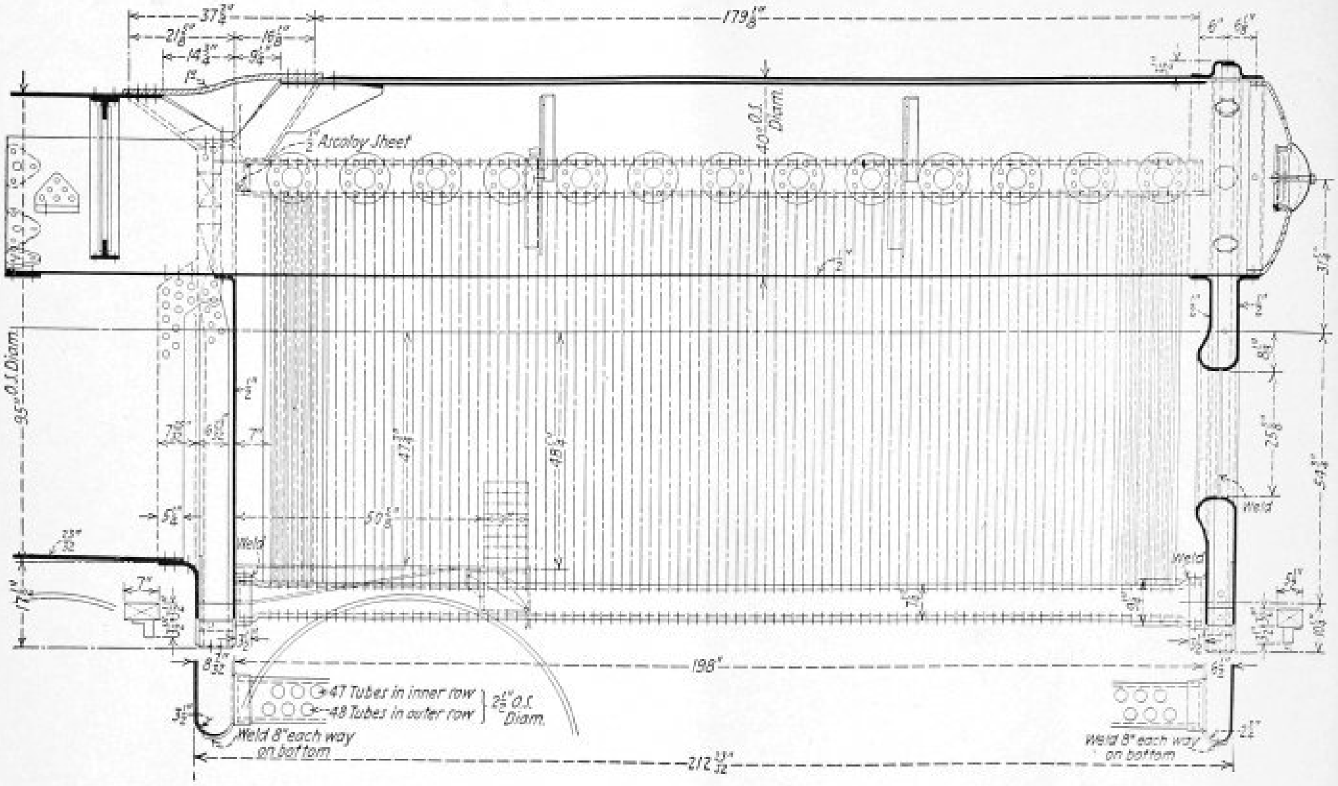
There has been placed in service to date, as recorded, locomotives with water tube firebox boilers on the following railroads:

8 on the Baltimore and Ohio Railroad
1 on the Canadian Pacific Railroad
4 on the Delaware and Hudson Railroad
1 on the New York Central Railroad
1 on the Pennsylvania Railroad

The New York, New Haven and Hartford Railroad has a few McClellon type boilers that have not as yet been retired. The principal of the McClellon type



Canadian Pacific locomotive equipped with multi-pressure boiler



Side elevation of the Emerson watertube firebox

watertube firebox boiler is shown in an article written in the 1928 official proceedings of the Master Boiler Makers' Association, on page 132.

Baltimore and Ohio Railroad

The Baltimore and Ohio Railroad to date has watertube fireboxes applied to eight locomotives, beginning early in 1927, with mileage from 40,000 to 350,000, consisting of—

3—Type 2-8-0, 215 pounds boiler pressure, 55,300 pounds T. P.

1—Type 2-8-2, 250 pounds boiler pressure, 74,614 pounds T. P.

1—Type 4-6-2, 230 pounds boiler pressure, 50,000 pounds T. P.

1—Type 4-8-2, 250 pounds boiler pressure, 65,000 pounds T. P.

1—Type 4-4-6-2, 250 pounds boiler pressure, 82,300 pounds T. P.

1—Type 4-6-4, 350 pounds boiler pressure, 66,750 pounds T. P.

One of the outstanding features of this design of watertube boiler firebox is that all tubes can be applied and rolled and the entire boiler cleaned without removing the dome cap for the workmen to go inside the drums. The entire cleaning operation can be performed from the running board in 4½ hours, the boiler being completely washed out and water tubes turbined, which is the average time taken for washing out and testing a staybolt boiler.

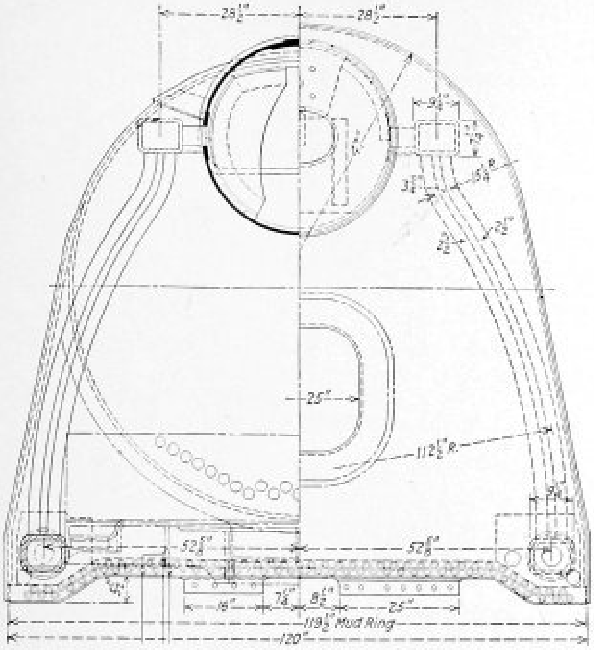
The excessive cost of radial stay firebox maintenance led up to the development and experimenting with a back end for locomotive boilers on the Baltimore and Ohio Railroad, designed with as many self-supporting shapes as possible to avoid the use of staybolts and radial stays, and extending from hollow mud ring in the bottom as a manifold, and connected at the top end to a header located alongside and connected by cross circulating tubes with the steam drums, which form the firebox crown, and with inspection plugs located in the mud ring and in the header opposite the ends of the side wall tubes.

In the early stages of the development of watertube fireboxes, several were built without a water leg at the front and back end, and staybolts were eliminated entirely, the drum being supported at the back end with a vertical sheet which acted as the back head of the firebox, and the usual throat sheet or water leg connected with the shell was eliminated. Firebrick was used against these sheets to prevent them from burning.

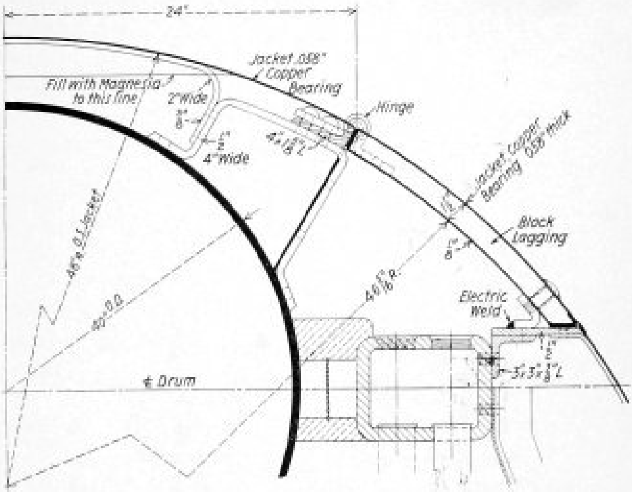
The firebrick gave considerable trouble due to the vibration of the locomotive, the average service being but 30 days. Since this trouble, all other watertube fireboxes were equipped with front and back water legs composed of parallel sheets having short rigid staybolts, which give no trouble.

On the first watertube fireboxes constructed, double drums were used and the flange at the flue sheet connection was turned toward the fire. This design gave some trouble due to the insulation or brick between the drums which was directly over the hottest part of the fire, breaking or falling out and giving short service. A single drum firebox was developed to overcome these difficulties and the flange of the back flue sheet was turned away from the fire toward the water space, eliminating cracks in the flange. In addition to this, the single drum has construction and assembling advantages.

Side wall air leaks have been overcome by grooving the firebrick to fit over the side wall tubes and inter-



Cross-section of the Emerson watertube firebox



Cover plate arrangement over header of Emerson firebox and installation between drum and bearer

locking with tongue and groove top and bottom edges and ship-lap ends. End bricks at the tube and door sheet are grooved and fitted over high heat resisting sealing strips and sealed with plastic asbestos. The outside of the brick is covered with plastic asbestos as an additional seal and acts as a cushion for ¼-inch reinforced supporting plates against the brick, which is followed by the usual asbestos lagging and jacketing course.

The staggered spacing of double row of side wall tubes protects the brick from receiving direct heat, giving life for several shoppings.

Comparison on Identical Locomotives on Number of Staybolts in Conventional Staybolt Type Firebox and Watertube Firebox with Total Boiler Evaporation

Type of Locomotive	Locomotive No.	Type of Firebox	Number of Staybolts	Evaporation
E-27	2504	Conventional	1419	36,625
E-27X	2504	Watertube	476	49,230
Q-1	4045	Conventional	2061	55,018
Q-1XA	4045	Watertube	600	59,891
P-7	5300	Conventional	2254	54,296
P-9A	5320	Watertube	578	60,933
KK-2	7450	Conventional	2968	71,358
KK-1	7400	Watertube	574	92,760
T-2	5550	Conventional	2784	73,457
T-1	5510	Watertube	574	89,576
P-1c	5047	Conventional	2030	47,074
V-1	5047	Watertube	519	75,305

A 4-6-4 type passenger locomotive is now being modernized at Mt. Clare from one of the light 4-6-2 Pacific types. A watertube boiler will be applied to this locomotive with a working pressure of 350 pounds per square inch.

The table below shows a comparison of tractive power, evaporation, heating surface, etc., of this locomotive, compared with the locomotive with the conventional firebox before conversion.

In the early part of 1931, the Baltimore and Ohio placed in service 4 test locomotives built by the Baldwin Locomotive Works; two were of the 4-8-2 type and two of the 2-6-6-2 type. One each of these locomotives was equipped with a conventional firebox and the other two with the Emerson watertube firebox. The boiler with the conventional firebox on the 4-8-2 type has a heating surface of 474 square feet, while the watertube firebox has 866 square feet and a capacity of 126 percent based on Cole's ratio. It was possible to obtain this increased heating surface and boiler capacity without increasing the weight on the trailer or the total weight of the locomotive.

Experiments made and reported to the Master Mechanics' Association give the firebox heating surface value eight times greater for heat transfer than for the fire tube heating surface in the shell of the boiler, due to the efficient heat transfer together with the very satisfactory water circulation. This is reflected in higher evaporation and fuel economy. A watertube firebox gives from 50 percent to 150 percent increase in heating surface, increasing evaporation.

Canadian Pacific Railroad

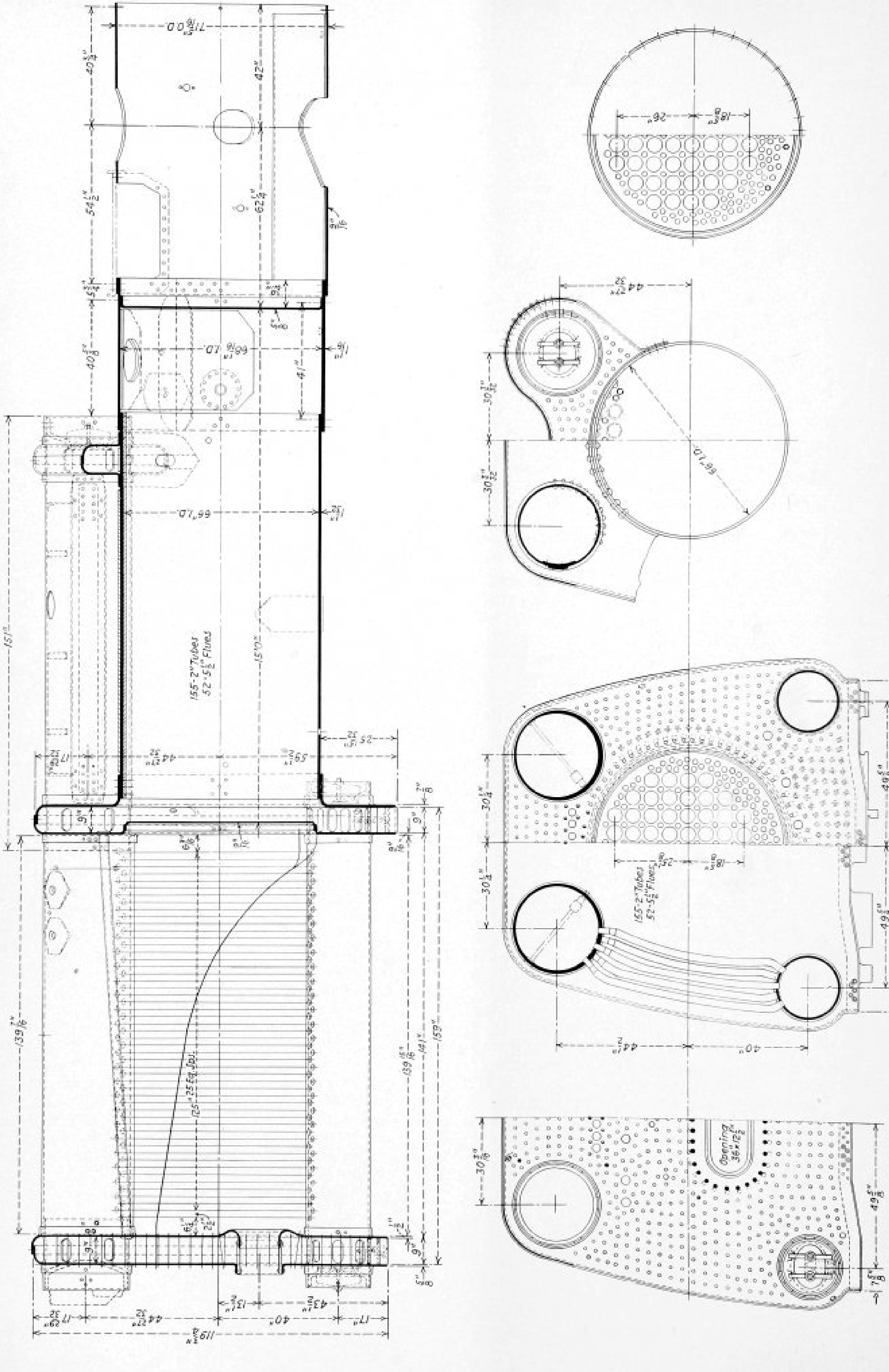
The only high-pressure watertube locomotive boiler in Canada is operating on the Canadian Pacific Railroad. The locomotive is of the multi-pressure type, engine No. 8000, T-4 Class, tractive effort 90,000 pounds. The boiler consists of three units and three working pressures, namely: 250 pounds, 850 pounds, and 1350 pounds in the three separate units.

The low-pressure boiler is the conventional locomotive design except that it has no firebox. It has 214 3½-inch tubes, length between tube sheets 19 feet ¼ inch, and is equipped with a type E superheater.

The closed circuit, 1350 pounds per square inch working pressure, forms the firebox and combustion chamber, and is constructed of watertubes which are rolled into a hollow foundation ring, better known as mud ring, also rolled into two upper drums, one on each side. These watertubes form the sides, back and combustion chamber, and cross over at the top at a suitable angle to allow for expansion and contraction.

The combustion chamber has a drum at the bottom

Type	Boiler Capacity	Tractive Power	Heating Surface			Evaporation		
			Firebox	Tubes and Flues	Total	Firebox	Tubes and Flues	Total
4-6-2 Original	90.7%	44,600	256	3,706	3,962	14,080	32,994	47,074
4-6-4 As Changed	124.3%	66,750	824	2,854	3,678	45,297	30,008	75,305



Longitudinal and cross sections through watertube firebox of the Delaware & Hudson locomotive L. F. Loree of each side as well as across the front. The floor of the combustion chamber is formed with watertubes rolled into the front of the hollow mud ring, also into the front bottom cross drum. The side tubes are rolled into the bottom side drums, also into the two longitudinal drums.

The closed circuit tube holes in the hollow mud ring and the drums, have serrations in them so that when the sheets are rolled into them there will be no possibility of their pulling out.

The closed circuit watertubes form the direct firebox heating surface, and the firetubes in the low-pressure boiler are the heating surface for this unit as well as for the type E superheater.

The high-pressure boiler is located in the center, longitudinally between the two upper closed circuit drums, and partly covers the top back end of the low-pressure boiler, all three units being connected together with a suitable frame.

The 850 pounds per square inch high-pressure boiler is not in direct contact with the fire, but is covered with a high-temperature protecting plate between it and the closed circuit cross-over tubes, as well as the top drums of the closed circuit. The high-pressure boiler has a system of heating coils, which are connected with proper ball joints to the closed circuit watertubes, and it is the heat from these internal coils that generates the 850 pounds steam pressure in this unit.

The locomotive is an oil burner and has two burners, one at the back and one at the front end of the firebox.

This locomotive was built at the Canadian Pacific Railway Angus Shops, Montreal, and was turned out for service in July, 1931.

The material used in the construction of the 250 pounds per square inch low-pressure boiler is nickel-steel plate, 75,000 pounds tensile strength. The 850 pounds working pressure and the 1350 pounds working pressure units were manufactured from low-carbon nickel steel, seamless drum construction.

In operation the low-pressure boiler receives its water direct from the tender, fed by pump through the feedwater heater. The high 850 pounds pressure boiler is fed by water pumped by a high-pressure pump from the low-pressure boiler, the object being that the impurities in the raw water would settle in the low-pressure boiler before being pumped into the high-pressure boiler, and thus eliminate the possibility of the heating coils in the high-pressure drum becoming incrusted with scale, such scale would prevent the heating coils from throwing off the necessary heat to generate steam in this unit, also from using high temperature feed water.

The closed circuit is filled with distilled water to within 1⅝ inches above the bottom of the upper drums, and when steam is raised it shows about 5 inches in the water indicator. It is not necessary to put any more water in this unit unless for some reason a leak develops. No such trouble has developed on the road so far.

For maintenance of the boilers, the low-pressure boiler in the territory in which this engine runs, requires washing out every 2500 miles. No trouble whatever has been had with the watertubes in the closed circuit overheating or bulging, because there is no scale forming matter in the distilled water used.

One of the advantages of boilers of this type is that there are no staybolts used. It is quite possible, if very high pressures are to be used in locomotive practice, the watertube boiler in some form will be developed. This of course means that good water will be a necessity, as the ordinary boiler water as used in some of the territory through which railroads operate could not be used safely in direct watertube boilers without heavy expense for washing out and turbining the tubes, as well as delaying power.

This engine, No. 8000, is operating over a mountain division which has grades of 2.2 percent and develops the power that it was designed for, with a saving of 14 percent to 15 percent in fuel, compared to the ordinary locomotives of the same capacity.

The Delaware and Hudson Railroad

The Delaware and Hudson Railroad has placed in service four locomotives having watertube boilers:

Locomotive No.	Name	Year	Boiler Pressure	Type of Locomotive
1400	Horatio Allen	1924	350	2-8-0 Cross Compound
1401	James B. Jervis	1927	400	2-8-0 Cross Compound
1402	James Archbald	1930	500	2-8-0 Cross Compound
1403	L. F. Loree	1933	500	4-8-0 Triple Expansion

The boilers are of the same general construction as illustrated. These illustrations cover the latest of the series which was completed in the spring of this year.

The boiler may be briefly described as follows. The back head and rear tube sheet connections of the firebox are both water leg headers of parallel stayed sheets, flanged and riveted together around the top and sides and secured to steel castings at bottom. Circular water drums pass through these headers near the lower corners and have ports cut through their shells in header water spaces. In a similar manner, the steam drums pass through headers at the top, the latter however, extending forward along the boiler shell, the front ends passing through a saddle which is secured to the top of the boiler barrel, communication with which is had through ports in steam drums at the saddle.

The firebox sides are formed of vertical watertubes expanded through the top and bottom drums. Longitudinal watertubes connecting the headers between the upper drums, and arch tubes provide additional firebox heating surface. The barrel of the boiler is secured to the front header by flanging.

Outside of the outer row of firebox tubes, 3⁄16-inch Ascoloy plate is applied, outside of which is placed ½-inch layer of No. 319 Johns-Manville cement, then a 1¼-inch layer of Superex on which a 1-inch layer of 85 percent sectional magnesia is applied and last a ½-inch layer of No. 302 Johns-Manville cement. The jacket is then applied.

Steam is taken from the top of the steam section of the steam drums, through collector pipes 6-inch diameter, suspended from the top of the drums and having several rows of ½-inch holes in the upper surface, thereby distributing the gathering of steam over a longer water surface and decreasing the tendency to lift moisture. The collection of dry steam is further improved by baffle or splash plates at the ends of the pipe, which prevent surging. The steam then passes through the superheater to the throttle valve at the front of the locomotive and thence through a steam pipe to the high-pressure cylinder.

The firebrick arch extends the entire length of the firebox and transversely between the inner rows of vertical watertubes, thus deflecting the gases upward and around the vertical tubes to the combustion chamber above the arch.

The superheaters on the first three boilers are confined within the flues at the back end, but on the last boiler the upper six rows project into the firebox 18 inches, while the lower two rows project 6 inches beyond tube sheet.

The firebrick arch extends the entire length of the conventional type, having butt seams and the sheets were of the thickness required to provide sufficient strength of bridge between the rows of vertical tubes where these entered the drums. These drums on the latest boiler are seamless forgings of nickel steel, machined eccentric, providing an increased thickness of wall where the tubes are applied, saving 5274 pounds.

The materials used in construction are shown in the accompanying table.

MATERIALS USED IN DELAWARE & HUDSON LOCOMOTIVE WATERTUBE BOILERS

	Locomotive 1400	Locomotive 1401	Locomotive 1402	Locomotive 1403
Shell sheets	Manganese steel	Manganese steel	Silico-Manganese steel	Silico-Manganese steel
Firebox sheets	Carbon steel	Manganese steel	Manganese steel	Silico-Manganese steel
Steam drums, front	Manganese steel	Manganese steel	Silico-Manganese steel	Silico-Manganese steel
Steam drums, rear	Manganese steel	Manganese steel	Nickel steel	Seamless Nickel steel
Water drums	Manganese steel	Manganese steel	Nickel steel	Seamless Nickel steel
Fire tubes	Solid cold drawn seamless steel	Solid cold drawn seamless steel	Seamless Nickel steel	Seamless Nickel steel
Fire flues	Solid cold drawn seamless steel	Solid cold drawn seamless steel	Seamless Nickel steel	Seamless Nickel steel
Vertical Watertubes	Solid cold drawn seamless steel	Solid cold drawn seamless steel	First inside row "Allegheny" metal, others solid	Solid cold drawn seamless steel
Horizontal Watertubes	Solid cold drawn seamless steel	Solid cold drawn seamless steel	Solid cold drawn seamless steel	Solid cold drawn seamless steel
Arch tubes	Solid cold drawn seamless steel	Solid cold drawn seamless steel	Solid cold drawn seamless steel	Solid cold drawn seamless steel
Staybolts	Complete installation hollow bolts	Flexible bolts below brick arch in throat sheet others hollow rigid	Flexible bolts below brick arch in throat and in circular row next to tube sheet others hollow rigid	Solid flexible water space bolts in throat and in 2 circular rows next to tube sheet, others hollow rigid

The service obtained with these watertube boilers has been so satisfactory that only a few minor changes have been made in their construction.

The bridges in water drums gave some trouble due to check cracks developing. In the first boilers these water ports had been burned out in the drum without finishing to a smooth surface. Inner sleeves with bridges milled were inserted and these have given satisfactory results, as have the bridges in the drums of the later boilers which were milled when built.

Some trouble was experienced in the first boilers with the row of staybolts around the back tube sheet and those in throat below the arch. These were originally rigid bolts but they have been replaced with flexible bolts, application of which was made on the later boilers with satisfactory service results.

The inner row of vertical watertubes gave some trouble at the lower ends just above entrance into the water drums. This was corrected by increasing the radius of the bend in the tube and improvement has resulted, although the length of service since the change has not been sufficient to determine if the trouble has been entirely eliminated.

GENERAL CHARACTERISTICS OF DELAWARE & HUDSON WATERTUBE LOCOMOTIVE BOILERS

	Locomotive 1400	Locomotive 1401	Locomotive 1402	Locomotive 1403
Pressure	350	400	500	500
Grate area, sq. ft.	71.4	82.0	82.0	75.8
Superheater, type	spiral single loop	spiral single loop	double loop	double loop
No. of tubes and diam.	145—2 in.	101—2 in.	155—2 in.	155—2 in.
No. of flues and diam.	42—$5\frac{3}{8}$ in.	52—$5\frac{1}{2}$ in.	52—$5\frac{1}{2}$ in.	52—$5\frac{1}{2}$ in.
Watertubes, vertical, No. and diam.	204—2 in. 102—$2\frac{1}{2}$ in.	286—$2\frac{1}{2}$ in.	286—$2\frac{1}{2}$ in.	260—$2\frac{1}{2}$ in.
Watertubes, horizontal No. and diam.	8—3 in.	8—3 in.	6—3 in.	6—3 in.
Fire tube spacing	$\frac{3}{4}$ in.	$\frac{3}{4}$ in.	$\frac{3}{4}$ in.	$\frac{3}{4}$ in.
Fire flue spacing	$\frac{3}{4}$ in.	$\frac{3}{4}$ in.	$\frac{3}{4}$ in.	$\frac{3}{4}$ in.
Length over tube sheets	15 ft.	15 ft.	15 ft.	15 ft.
Watertube, vertical spacing	5 in. by $2\frac{7}{8}$ in.	5 in. by 3 in.	5 in. by $3\frac{1}{2}$ in.	5 in. by $3\frac{1}{8}$ in.
Watertube vertical, average length	$69\frac{3}{8}$ in.	$67\frac{7}{8}$ in.	$65\frac{1}{8}$ in.	$65\frac{3}{4}$ in.
Watertube horizontal spacing	$4\frac{7}{16}$ in. by $4\frac{3}{16}$ in.	$4\frac{7}{16}$ in. by $4\frac{3}{16}$ in.	$4\frac{3}{16}$ in.	$4\frac{3}{16}$ in.
Watertube horizontal, length	11 ft. 6 in.	12 ft. 9 in.	12 ft. 9 in.	11 ft. 9 in.
Heat. surf. sq. ft.—tubes	1132	788	1209	1209
Heat. surf. sq. ft.—flues	881	1116	1116	1116
Heat. surf. sq. ft.—arch tubes	63	67	66	61
Heat. surf. sq. ft.—vert. tubes	832	865	809	742
Heat. surf. sq. ft.—hor. watertubes	79	70	51	47
Heat. surf. sq. ft.—f'box sheets	213	215	188	176
Heat. surf. sq. ft.—total f'box	1124	1150	1048	965
Heat. surf. sq. ft.—total boiler	3200	3121	3439	3351
Heat. surf. sq. ft.—superheater	579	700	1037	1076

NEW YORK CENTRAL RAILROAD

It is reported that the New York Central Railroad has one multiple-pressure locomotive. The boiler on this locomotive, we understand, is similar to the one operated by the Canadian Pacific Railroad, which is described in this report.

PENNSYLVANIA RAILROAD

The Emerson watertube firebox, similar in all respects to those used on the Baltimore and Ohio was applied to one of the Pennsylvania Railroad Mikado locomotives in 1932, and from all accounts has given good service.

What can the boiler department do with locomotive boilers and tenders to prevent

CORROSION AND PITTING

Committee

E. J. Reardon

F. J. Jenkins

C. W. Buffington

The failure of metals due to corrosion continues to be a very considerable factor in locomotive maintenance, although a more complete understanding of the causes of corrosion and pitting has suggested methods for preventing or minimizing this action, and, as a result, considerable savings have been effected together with extended service. Unfortunately, almost every problem concerning corrosion seems to be surrounded by local conditions or variations which make it very difficult to generalize as to any standard method of preventing the action, with the exception of a few definite rules which apparently apply in all cases.

Since the corrosion rate of iron and steel in locomotive tender tanks, and more especially in boilers, is dependent upon many variables, it is in some cases difficult to anticipate. A study of the nature of corrosion, its causes and

Note: The committee which submitted this report consisted of the following: E. J. Reardon, service engineer, Locomotive Firebox Company, chairman; F. J. Jenkins, general locomotive inspector, Texas & Pacific; C. W. Buffington, general master boiler maker, Chesapeake & Ohio.

effects, may therefore be of further assistance in bringing about its prevention or control. The uniform oxidation of metal surfaces gives rise to gradual weakening of the structure, but where localized action or pitting develops, rapid failure will often result and, therefore, the prevention of pitting is of the greatest importance. The tendency of corrosion to localize, with the formation of pits, is peculiar to underwater corrosion, with which we are most concerned. The principal causes of corrosion and the variables which influence the corrosion rate are:

(1) The presence of air (dissolved gases), and moisture, are necessary for corrosion to proceed. Corrosion is almost directly proportional to the oxygen concentration, where other factors are constant.

(2) Acidity or low alkalinity of the water in contact with metal increases corrosion. Waters containing acid-forming salts in solution are especially corrosive, and the presence of dissolved carbon dioxide gas also accelerates corrosion due to the slight acid effect.

(3) Dissimilar metals in contact with each other through the medium of water accelerates localized corrosion. Dissolved salts in the water influence this action by increasing the conductivity of the water, which acts as the electrolyte. The stresses and strains set up in a locomotive boiler may give rise to localized corrosion by the development of dissimilar areas in the metal.

(4) Circulation of water has an important bearing on the corrosion rate.

(5) The corrosion rate is increased at elevated temperatures.

(6) Overheating of the boiler metal due to the insulating action of scale deposits or other causes partially destroys the metal structure and makes it more susceptible to corrosion attack.

The many conditions which are favorable to underwater corrosion indicate that there is no simple remedy, and the most serious cases warrant special consideration and study in order to work out the proper preventive measures.

As indicated by the above, corrosion and pitting constitute essentially a problem of water treatment and are therefore usually handled by the water engineer, but in the final analysis this will always be a joint problem and therefore it calls for the co-operation of the mechanical department.

Chemical Treatment

Since the condition of the boiler water is the principal consideration in corrosion control, it follows that strict supervision of the water supply and the application of treatment is necessary. In stationary practice there is an opportunity for a much more positive and accurate control of the boiler water, and, therefore, much more can be accomplished in proper water conditioning. In the case of the locomotive boiler, where different water supplies are taken and where the boiler is operated under a more severe condition as far as stresses and strains are concerned, the problem of treatment is more complicated. This fact creates a special consideration in the case of locomotive work, although excellent results have been obtained in bad water territories where the corrosion problem had been of a most serious nature, and this has been accomplished by strict supervision of water treatment and tests.

Since dissolved oxygen is the principal corrosion accelerator, and low alkalinity or actual acidity is one of the principal offenders, it is logical to assume that in providing boiler water treatment it is necessary to establish and maintain the proper alkalinity of the boiler water, and at the same time either provide for the elimination of dissolved gases, before the water enters the boiler, or provide for the absorption of oxygen in the boiler water by the use of suitable chemicals. The reduction of dissolved gases in a boiler feed water can be handled conveniently in a stationary plant by means of an efficient feed water heater, but this cannot always be provided for in the case of locomotive work. The proper alkalinity must be rigidly maintained in order to effectively prevent corrosion.

Materials and Construction

The boiler department can be of definite assistance as far as chemical treatment is concerned by co-operating in every way with the water engineer and making sure, so far as possible, that treatment is introduced as required. The principal responsibility of a boiler department naturally has to do with construction materials and their application. Since the condition of the metal has a considerable bearing upon the corrosion rate, especially as regards stresses, strains, overheating, etc., it is apparent that the boiler department has a considerable responsibility in making sure of the uniformity and quality of material used in construction. It is generally considered that the working of metal in the construction of a boiler has a very important bearing on corrosion.

Some of the principal factors affecting corrosion and pitting can be attributed to lack of uniformity of the metal, unequal expansion and contraction, and excessive or incorrect rolling of flues in the sheets. In overheated firebox sheets due to coating of scale, crown stays, staybolts and firebox sheets are seriously affected, causing leaks to develop in the overheated area. In less severe cases where no immediate damage is evident, the crystalline structure of the metal may be affected to such an extent as to become subject to severe corrosion and pitting. The condition of the metal with reference to slag or oxide inclusions during the rolling or forming process has very much the same effect as overheating or improper working of the metal. These foreign particles give rise to dissimilar areas which seem to be largely responsible for localized corrosive action. It has been observed that grooving often takes place on the calking edges on the top or bottom of fore and aft seams. In many cases this trouble is caused on account of a flat spot in the joint when the joint is out of round with the other portion of the shell or ring. When the temperature of the metal is increased, expansion causes the flat joint to conform to the original radius of the shell. Subsequent cooling of the metal causes this flat joint to move back and forth, finally causing failure at this point.

In overcoming this condition, the ends of the shell sheet should be made the proper radius at the start. This operation can be done very easily when rolling the shell or ring plate. The flat spot occurs on the edges between the top and bottom rolls. To correct this condition, prepare two steel wedges 10 inches wide, 14 inches long, and 2½ inches thick, on the back end. Weld a small grab iron on the end of the thick part of the wedge for easy handling. Place the thin edge of the wedge on top of the bottom roll, underneath the edge of the sheet, roll in the end of the sheet which will curve up to any radius required. No sledging is needed in this operation.

Stresses and strains can also be induced by improper boiler washing. Rapid changes of temperature should be avoided in all cases.

Another important function of the boiler department is to call attention to any corrosion or pitting which has started to appear in the boiler and insist that it be taken care of by the proper measures such as may be indicated.

Visual inspection of corrosion with special reference to form and location often points clearly to the source of the trouble. A visual inspection of the pitted areas will usually give the most reliable information as to whether the trouble is due to the condition of the metal or whether it is more likely to have been caused by the condition of the water alone.

Corrosion of Engine Tanks

The corrosion of engine tanks is not as serious a problem as the internal corrosion of boilers, although considerable saving can be effected and failures prevented by providing the necessary protection in these tanks. An effort to treat the water in the tank for the control of corrosion is not practical and it is therefore necessary to depend upon protective coatings applied to the metal. The usual type of paint is not satisfactory, due to its tendency to become brittle, and failure caused by cracking and actual removal of large portions of the paint film often results because of poor contact with the surface of the metal which has been partially oxidized before the paint is applied. Rust preventives are available, which should be applied at the time the tank is assembled, and may be applied subsequently as required by spraying or brushing. The ideal rust preventive for use in this type of protection is one which does not dry completely or oxidize, but, on the other hand, maintains an elastic film on the metal and has the property of maintaining intimate contact with the metal surface. Expansion and contraction have no effect on these coatings as far as the penetration of the film is concerned, and long-time protection against rusting is obtained.

The coal bin section is also subject to serious corrosion and pitting, caused especially by the formation of acid sulphur compounds formed as a result of the action of water upon the sulphur content of the coal. Due to abrasion, the usual paints are not effective in protecting the metal, and the use of special non-drying rust preventive coatings is advisable.

The use of the proper rust preventive coating at the time the tender is built, or at time of repair, offers the most economical solution of this corrosion problem.

Recommendations for the application to locomotive boilers and tenders of

FUSION WELDING

Committee

H. H. Service

L. M. Stewart

M. A. Thompson

J. J. Davey

F. C. Hasse

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, and many of these changes have been reported previously and are included in your official proceedings.

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.

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,

Note: 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.

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 ⅛ 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.

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

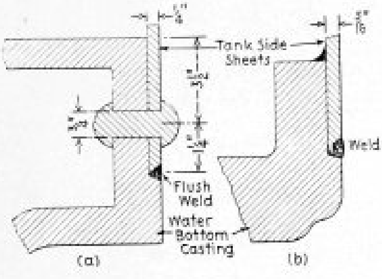


Fig. 1

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.

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

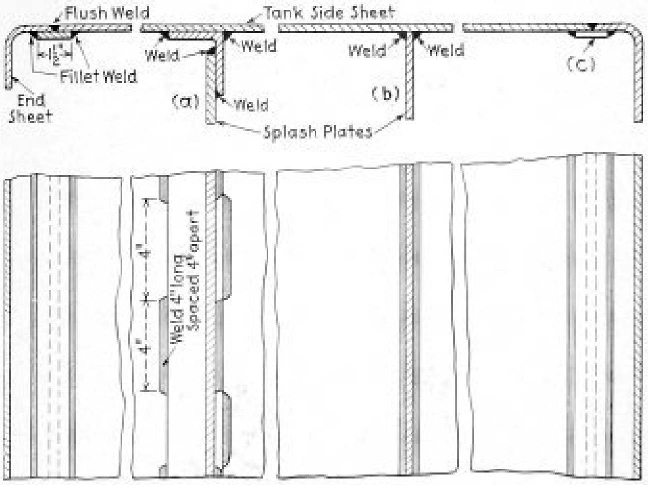


Fig. 2

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 beyond what your committee has found.

(Continued on page 213)

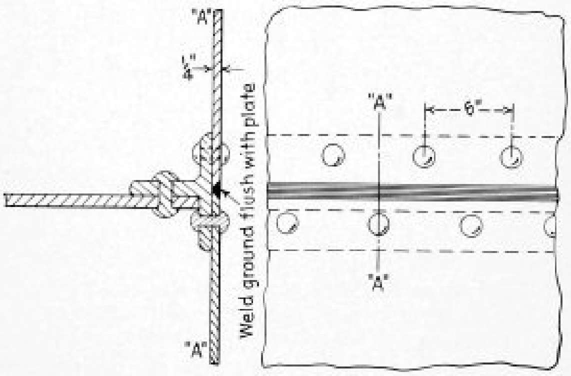


Fig. 3

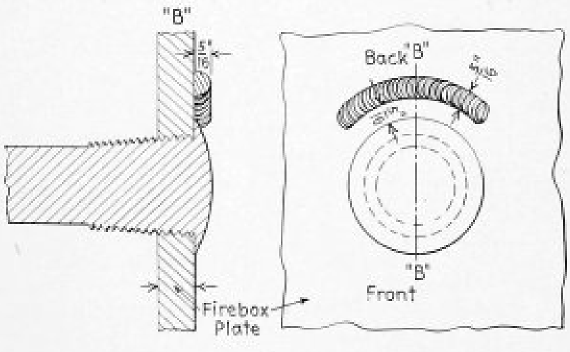


Fig. 4

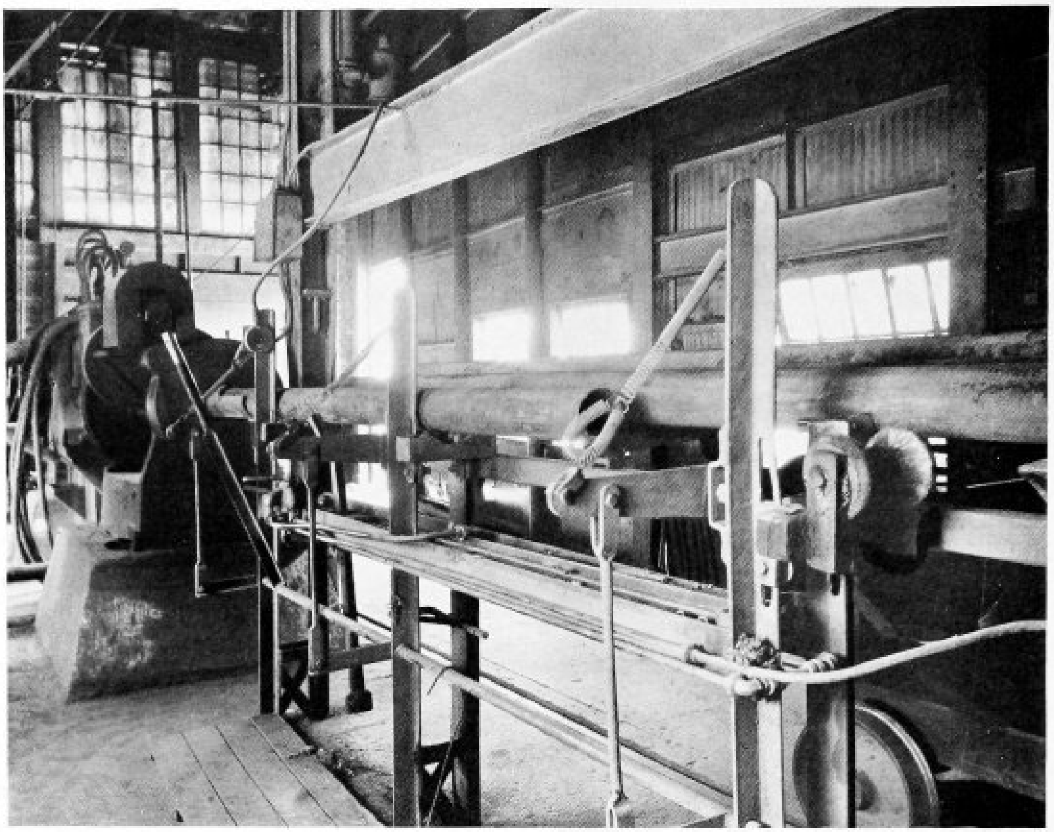


Fig. 1.—Cleaning flues in the universal scale cracking machine

Best methods, equipment and shop layout for

SAFE ENDING FLUES

Committee

A. W. Novak

S. F. Christopherson

J. M. Stoner

A century has passed since the steam locomotive came into existence. However, the last twenty-five and more, particularly the last ten years have marked the greatest development.

With the splendid locomotive of today naturally came the boiler of increased proportions and increased pressures. Therefore, the present-day boiler operations can be handled properly only with the aid of machinery designed for the purpose.

Of late the tendency on some of the larger railroad systems has been toward the centralization of repair facilities. The merging of facilities seems to be quite logical, particularly when applied to the tube and flue reclaiming operations, which require only one reclaiming shop, thereby eliminating the purchase or manufacture of necessary equipment for shops located at various points over the system.

Many articles have been written and there has been much discussion on the method of reclaiming and safe-end welding of flues and tubes.

Your committee is of the opinion that a practical flue shop is one arranged so as to have a continuous movement through the various repair operations without retracking, and with a minimum expenditure of manual labor. A flue reclaiming shop of the progressive layout is best illustrated by the methods employed on the New York, New Haven and Hartford Railroad and by flue shop layouts on the Canadian Pacific, New York Central and Chicago, Milwaukee, St. Paul and Pacific roads.

Replies received from representatives from a number of roads indicate that a difference of opinion exists regarding the type of flue cleaner, some preferring the dry chain rumbler, while others prefer the submerged wet rattler and washer, while several others advocate the roll scale cracker and sand-blast method. It is optional as to the type of flue cleaner used providing, of course, that the cleaner is so located that it will not interfere with the progressive movement of flues or tubes.

The time element required in the cleaning of flues with the sand-blast method is about equal, while the

Note: The committee which submitted this report consisted of the following: A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad, chairman; S. F. Christopherson, supervisor of boilers, New York, New Haven & Hartford; J. M. Stoner, supervisor of boilers, New York Central.

other types have a time element which varies due to the different scale formations, some of which require additional time properly to remove the scale deposit.

For the benefit of those who have supervision over the reclaiming of flues, your committee will endeavor herewith to give you an outline of the practices employed by several of the major roads which have centralized flue reclaiming shops, and their methods can be considered the best present practice.

Cleaning of Flues or Tubes

At this point it is optional whether the flue or tube ends are cut off prior to cleaning, depending on the methods employed in removing the tubes or flues, and how badly the ends are damaged. If badly damaged then the rough end will jam in the machine thereby causing a delay in the operation.

Flues or tubes received at the reclaiming shop are placed by crane on an inclined rack located to the left of the scale cracker and sand-blaster. This rack is constructed so that flues roll by gravity towards the operator. By means of a hand lever, each flue or tube is tripped onto the runway and immediately delivered by motor-driven rollers to the universal scale cracker which is equipped with three power-driven knurled cracking rolls, each of a different pitch and actuated by a cam which maintains a uniform periphery. The three rollers are adjusted by an eccentric, the opening of which can be made to take any size flue or tube from 2 inches to 5½ inches inclusive by turning a wheel attached to the machine. These three rollers also act as a feed to propel the flue or tube into the sand-blasting machine. They are set to feed a 2-inch flue at the rate of 18 feet, 2¼-inch at 17 feet, 3½-inch at 14 feet and 5½-inch at 8 feet per minute. When 5½-inch tubes contain a heavy scale deposit, it may be necessary to put this size through the machine twice, see Fig. 1.

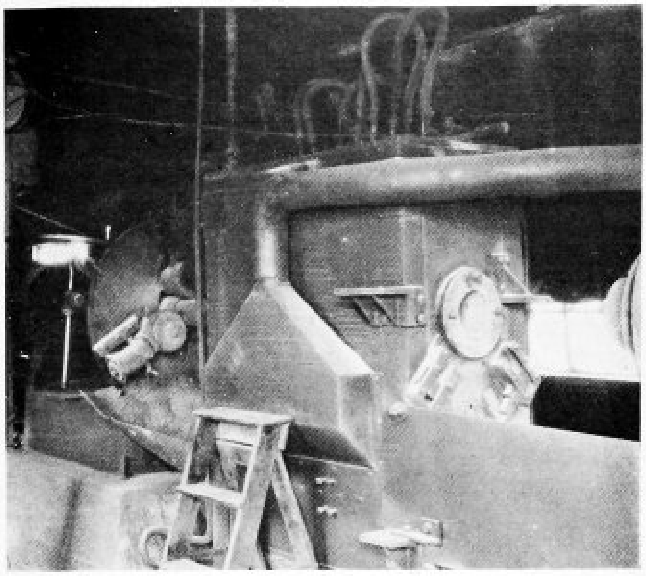


Fig. 2.—Sand blast machine, fitted with dust arrester

The sand-blast machine and dust arrester are shown

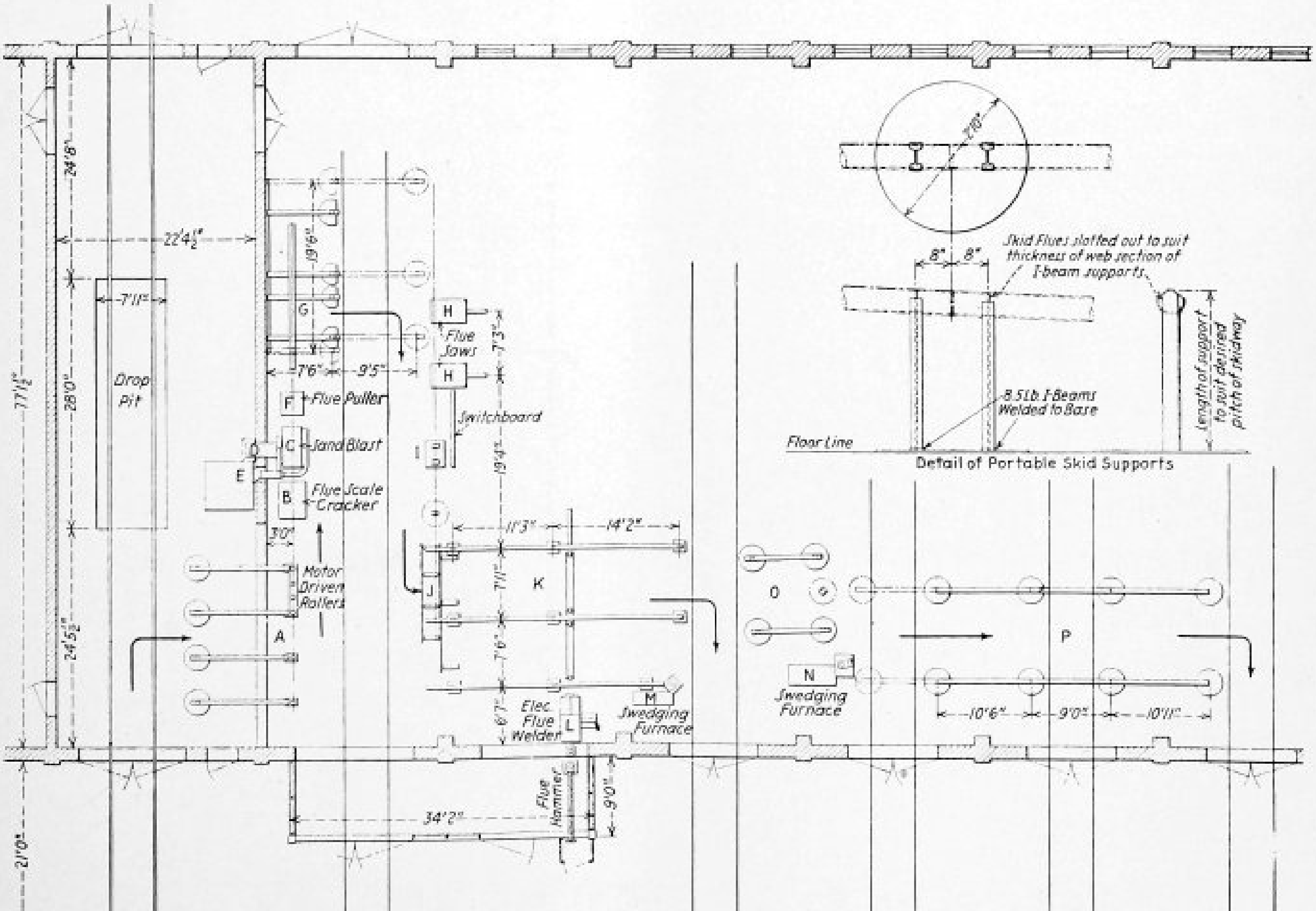


Fig. 3.—Arrangement of Chicago, Milwaukee, St. Paul & Pacific flue shop at Milwaukee

in Fig. 2, as made at New Haven, Conn. The dust arrester consists of an iron box with separate chambers and a fine wire mesh netting which serves to catch the heavy scale and let sand go through to be used over again. The machine is equipped with six adjustable nozzles with jet openings of ⅛ inch for air and ½ inch for sand. A 90-pound air pressure is used on the nozzles for blasting, and the whole nozzle frame is adjustable as a unit, for the various sizes of flues or tubes.

A moisture separator is attached ahead of the air line passing into the machine in order to insure that no water in the air will be mixed with dry sand and cause trouble. In order to function properly and do its work sand has to be dry. The dust arrester is operated by a 6-inch positive vacuum blower, separating the dust from the sand in the middle chamber of the sand-blast machine, letting the good sand go down to the bottom to be reclaimed and drawing the dust into the arrester which in turn is automatically discharging dust out of doors and into the waste container. Ordinary engine sand is used and is used over and over again until it becomes so light in weight that the dust arrester will pick it up and carry it away. All sand is dried before using. This is done in a shop-made steam dryer and is blown into the dryer by air.

The dry sand runs by gravity into a drum 36 inches by 8 feet submerged under the ground. If sand is needed in the sand reservoir, the dryer is closed by a slide and a cap is screwed on top of the drum, after which the sand is blown from the drum by air into the sand reservoir. This sand reservoir is set conveniently near the sand-blasting machine to facilitate feeding when needed.

As the flue or tube passes through the sand-blast machine, it is engaged by a flue puller equipped with three

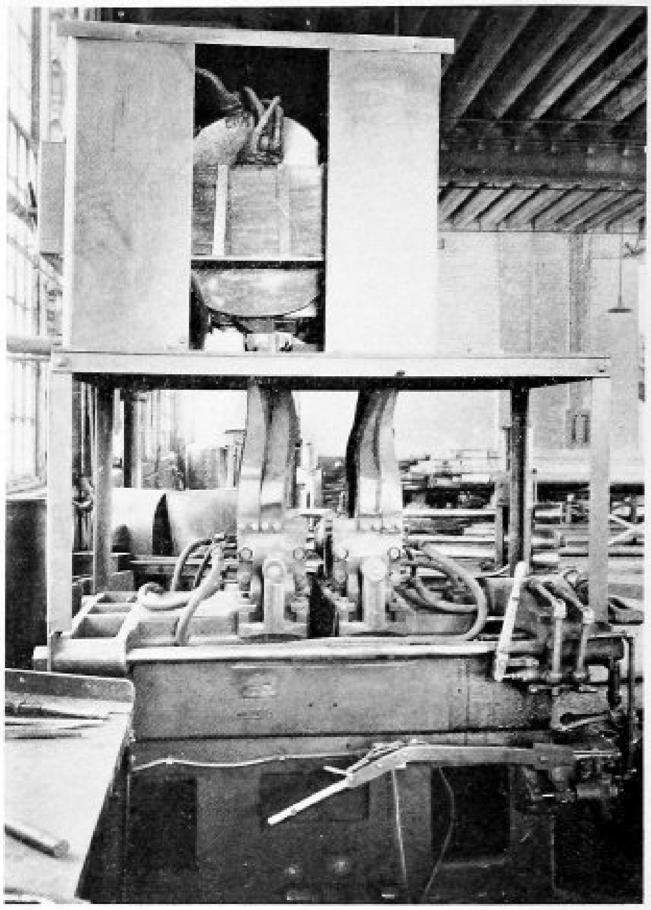


Fig. 5.—Modified electric flue safe-ending machine in the New Haven shops

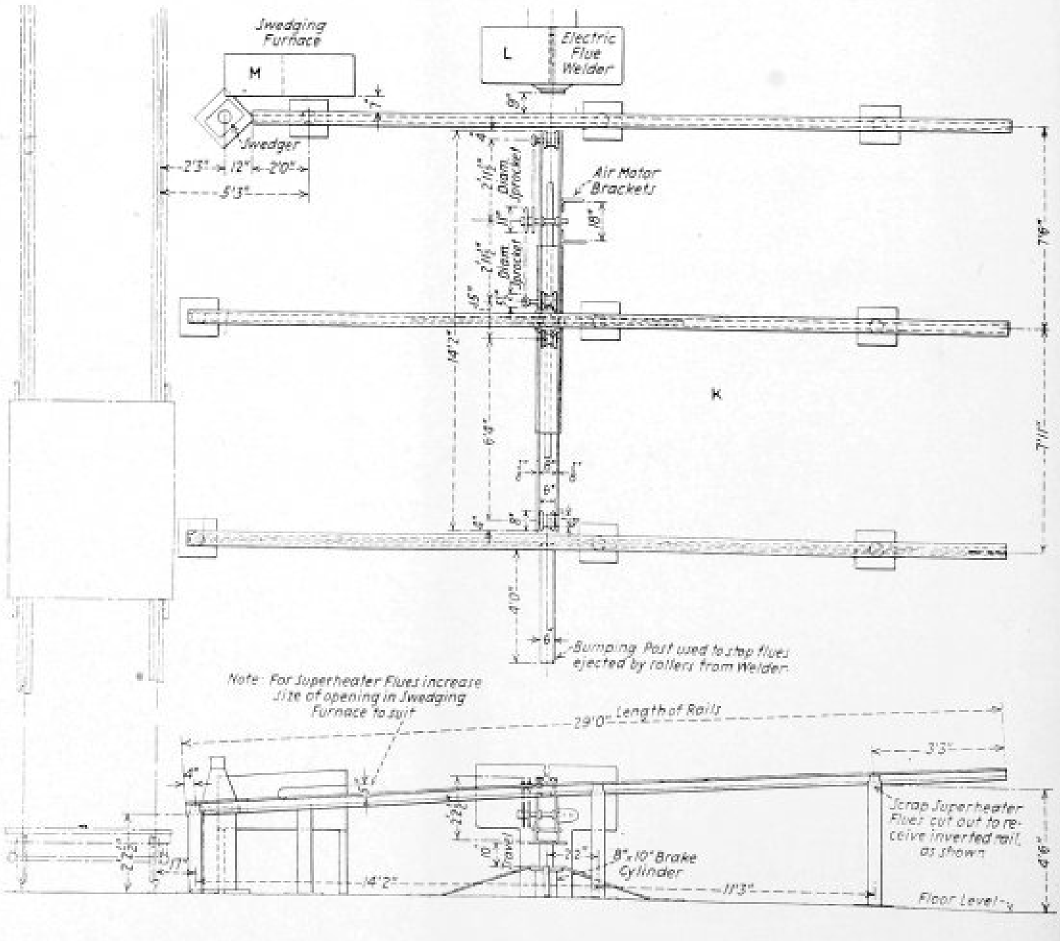


Fig. 4.—General arrangement of device for handling tubes and flues to the electric welder in the Milwaukee flue shop

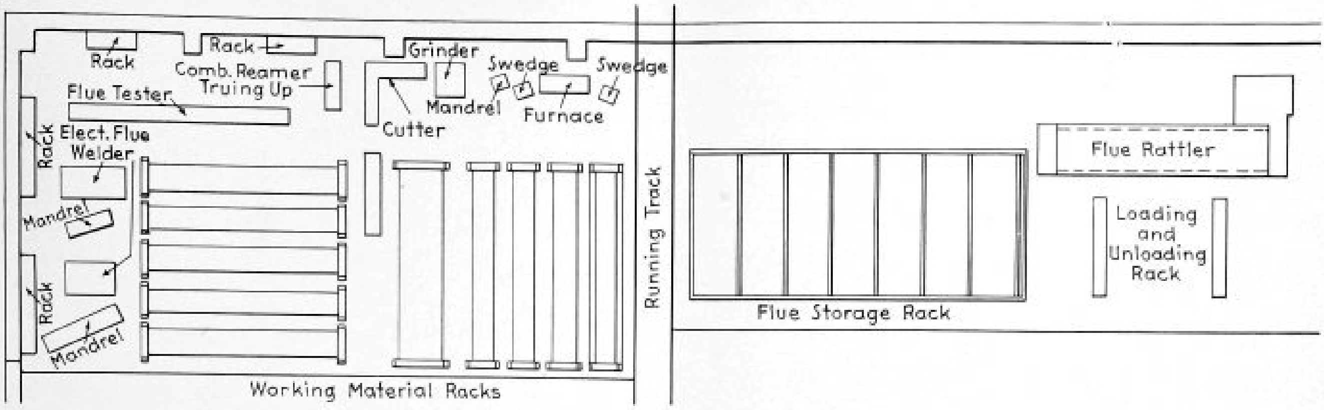


Fig. 6.—Flue department at the Collinwood shops of the New York Central

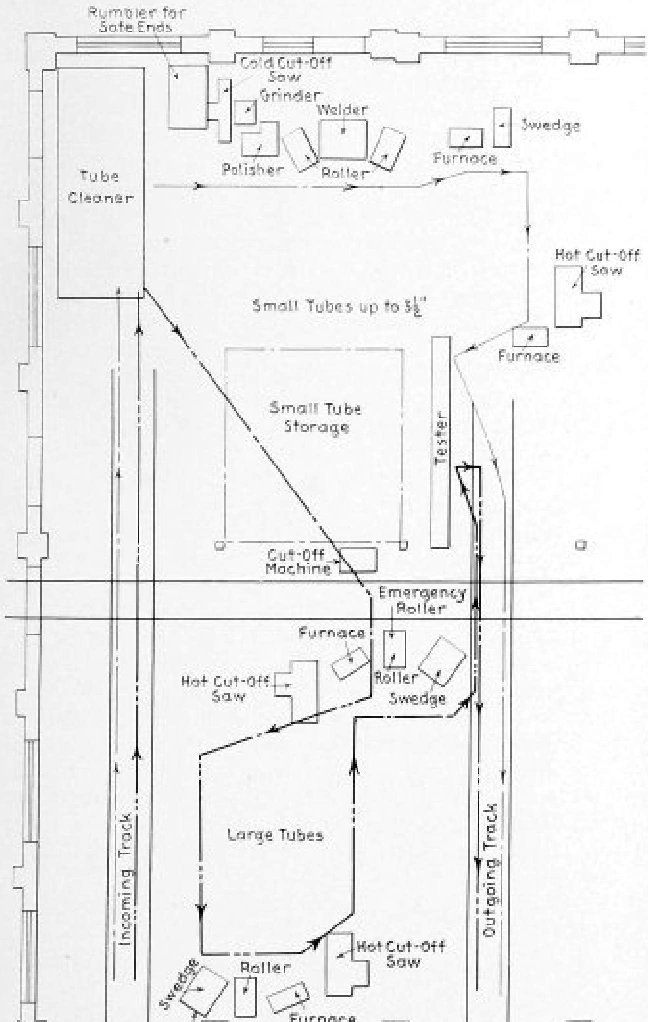


Fig. 7.—Layout of flue shop of the Canadian Pacific at Winnipeg

rolls, one of which is propelled by a 3-horsepower motor and set to move the flue or tube at the same speed as that of the scale cracker, Fig. 3.

Passing through the flue puller the forward end of the tube or flue engages a carrier of local design, which moves along an inclined I beam supported from the shop brick wall. When this carrier reaches the end of its travel, a trip is operated permitting the flue or tube to drop onto a skidway constructed from straight lengths of 5½-inch flues slotted at one end to engage a Z bar bolted to the wall, while the other end rests on short upright sections of 5½-inch flues welded to movable floor plates.

From this skidway, flues or tubes roll by gravity onto a rack where inspections are made for defects such as pitting, grooving, flats, and wear. If any pitting is found which is not severe, such flues or tubes are set aside and later reclaimed by the oxy-acetylene process. When tubes or flues show indications of wear they are set aside for further inspection and, if possible, to be reclaimed to a suitable length for another class of power.

Cutting Off Operation

Flues and tubes found suitable for reclamation are passed onto rolls placed in front of two friction saws,

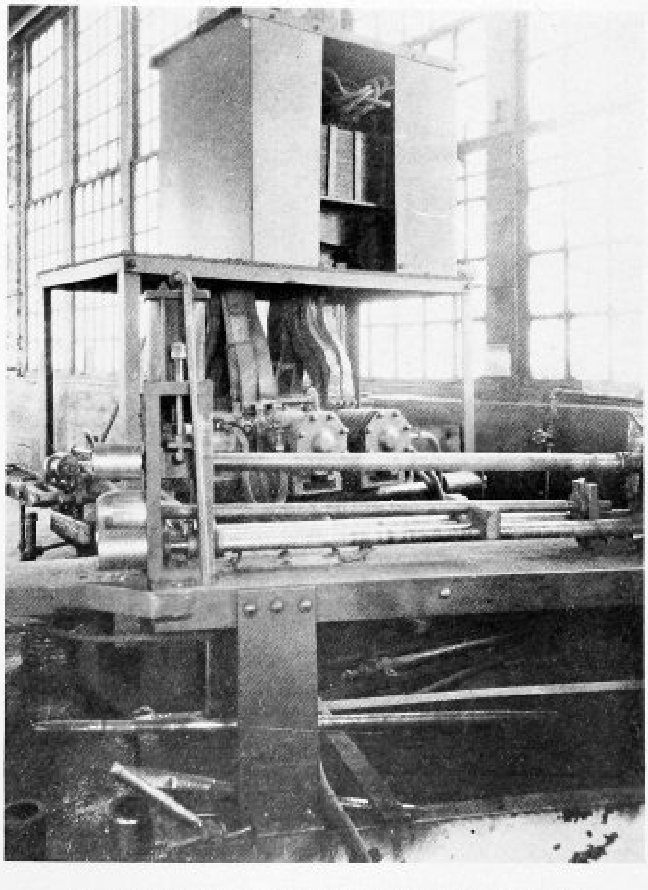


Fig. 8.—Pneumatic flue roller or smoothing machine

one of which is stationary while the other is adjustable to enable the cutting off to desired lengths, both ends being cut simultaneously. These saws are of the hobbed tooth friction type, water cooled, operated at 3600 revolutions per minute, each saw being propelled with a 10-horsepower motor.

Welding Safe Ends

Flues or tubes pass along revolving rolls giving them an impulse over rolls slightly sloped and dropping them into a rack at end and immediately below the highest point of the skidway. When the rack is filled, tubes and flues are elevated onto the skidway with the aid of a crane truck. This skidway is made from scrap 5½-inch flues, cut out to receive the inverted rail, Fig. 4.

These inverted inclined rails are welded to vertical supports of required height allowing flues and tubes to roll by gravity to a carrier equipped with spools arranged with 5½-inch diameter sprocket wheels keyed to the roller shafts, being driven by a reversible air motor and provided with an 8-inch by 10-inch air cylinder arrangement to elevate tubes or flues and propel them to the electric welding machine stopping them by the safe-end previously gripped in the die blocks. After the welding operation, the die blocks are released and the flue is moved forward through the dies into proper position over the mandrel and under the flue hammer to be smoothed and the weld reduced to proper radius and diameter. After the welding and smoothing operation the flue or tube is returned by reversing the air motor and rolls. Then it travels to the end of the skidway where a bumping post is provided to stop the flue or tube ejected by rollers from the welding machine, after which the flues are propelled by gravity to a swedging furnace of the open-side type 18 inches wide by 4 feet 6 inches long, providing for gradual heating. Flues or tubes taken from the hottest end of the furnace are swedged to size under the air hammer.

After swedging, flues are loaded on a push car ready to be blown out and delivered either to the erecting shop or stores department through the nearest shop door and over the transfer table. No flues are tested subsequent to reclamation, as experience has shown that less than 2 percent are failures after the application of flues in the boilers.

The following is a list of men performing the above operations:

1—Flue welder rated as boiler maker
1—Boiler maker helper,—cleaning
1—Boiler maker helper,—cutting to length
1—Boiler maker helper,—swedging to size
1—Boiler maker helper—assisting on superheaters
1—Boiler maker welder—oxy-acetylene operator, reclaiming slightly pitted flues.

The above organization reclaimed the following flues on several store orders taken at random.

QUANTITY COMPLETED

Store order	No. of flues	Size inches	Total No. of feet	Average Length feet	Total Man Hours
15292	3081	2	52,377	17	529½
15293	1416	2¼	24,063	17	282
15294	269	5½	4,580	17	212½

Note: The above man hours are figured to include shop expense and material.

The heavy direction lines as shown in Fig. 3 indicate the progressive movement of flues or tubes during the entire course of reclamation. A similar operation is employed by the New Haven in its centralized reclaiming shop, which can be considered best present practice. The following routine is observed in this shop:

On the first skidway after leaving the sand-blasting machine flues or tubes are inspected; those found sound are allowed to roll down to the welding machine. The flues found pitted or corroded or too light in weight are scrapped.

The safe ending and reclaiming is done on a modified electric welding machine, as shown in Fig. 5. The modification consisted in removing the transformer from the base of the machine to an elevated platform above the machine. By this change the transformer is air-cooled in the primary and secondary windings. The leads are of 2½-inch copper wiring of sufficient capacity to carry 150 kilowatts, 550 volts, 400 amperes, 25 cycle. The grip jaws, which are adjustable to take any size flue or tube, are water-cooled and operated by foot levers, and the cylinder pressure is 125 pounds per square inch. A hand jack operating a pump provides approximately 1200 pounds pressure for the upsetting of flues or tubes.

The handling of the flue or tube from the skidway is made very simple by lifting each flue or tube onto a swing jack placed in the corner of the skidway. It is swung in one move onto a roller which in turn is placed at an equal height and in direct line with the die blocks of the welding machine, Fig. 5.

No flux is used in welding owing to the thorough job sand-blasting has done in wearing the flue or tube down to bare metal. The problem of shooting holes through the flue or tube is solved by the thorough job the scaler and sand-blasting machine has done, eliminating the use of emery wheel and polishing machine. All tubes or flues are butt welded. However, they come out lap welded due to being upset while under welding heat in the die blocks. A boiler maker operates the welding machine while a helper feeds tubes from the skidway.

This helper also operates the flue rolling and smoothing machine. This machine is so placed and lined up that it is only necessary to slide the flue or tube backwards from the welding machine onto a runway, or tail piece of the rolling machine, and two steps forward and the flue or tube is in the machine ready for rolling. This pneumatic flue roller or smoothing machine as shown in Fig. 8 is shop made and consists of a 5-horsepower motor. Through reduction gearing the speed of this 5-horsepower motor has been reduced from 500 revolutions per minute to 70 revolutions per minute in order to make it a safe job when the flue or tube is turning in the machine. This machine has three shafts, each shaft having one roller, all three rollers being power driven, there being an interchangeable mandrel in the center. The upper shaft is equipped with a universal joint actuated by a 5-inch air cylinder for the purpose of supplying compression on the upper shaft and roller. It furnishes approximately 1200 pounds pressure between the three rollers and central mandrel. This air cylinder is operated by a foot lever, leaving both hands free to handle flue or tube. Rollers and mandrel are interchangeable for various sizes of flues and tubes. A 10-inch channel is placed at the tail piece to act as a support for the flue while revolving in the machine. Small rollers are placed at intervals on the tail piece to keep the flue or tube in line and steady it while revolving in the machine.

After the flue has been safe-ended and smoothed down to proper size it is again pushed back, one of the rolls in the tail piece being used as a whip placing the flue on the second skidway. Three flues are taken at random from the set furnished, cut off so that approximately 18 inches of the old flue will remain, whatever the length of the safe end. These pieces are shipped to the laboratory for test. This process is carried through in every set. The average for the test is about 98 percent.

TIME REQUIRED FOR WELDING AND SMOOTHING

2-inch or 2¼-inch flues	3¼ man hours per 100
3½-inch flues	7 man hours per 100
5½-inch flues	13 man hours per 100

All new and reclaimed flues or tubes are swedged from the second skidway. The flue or tube is handled as before, being whipped from the skidway onto a cross roller set at an equal height with the air hammer. The heating of the flue or tube is done in an oil furnace, and is swedged hot. Air-operated swedging hammers are shop made consisting of 5-inch cylinders operating with approximately 125 pounds air pressure.

TIME OF SWEDGING

2-inch or 2¼-inch flues	1⅕ man hours per 100
3½-inch flues	6½ man hours per 100
5½-inch flues	12 man hours per 100

The flue or tube is again handled as before, being whipped over onto the third skidway to the cutting-off machine. This machine is shop made, being driven by a 5-horsepower motor. It consists of a motor, three shafts and a 5-inch air cylinder for compression to the upper shaft. The two bottom shafts have a roller and reamer attachment and are power driven. The upper shaft with a disk cutter rotates the flue or tubes immediately when contact is made. The 5-inch air cylinder is set on the upper shaft and its compression is controlled by a foot lever placed in such position as to enable the operator to have both hands free to handle the flue or tube, in order to mark it for proper boiler length setting against a measuring plate.

All flues or tubes reclaimed are tested by air. The tester is located close to the operator so that no effort is necessary on his part, except in lifting flues or tubes from the cutting-off machine onto the tester. A boiler maker helper operates the air end of the tester at which end safe ends are located, where the operator can conveniently reach them with soapy water and brush.

If found sound, flues or tubes are placed on a truck set on the track which parallels the side of the testing machine. They are then pushed out into the shop, being picked up by the overhead crane and hauled directly to the locomotive in the erecting shop. All flues or tubes are measured by the flue shop operator.

Flues project through back flue sheet 3/16-inch and through front flue sheet not less than ⅛ inch nor more than ¼ inch for the 2-inch and 2¼-inch sizes. The 3½-inch and 5½-inch flues project through both front and back flue sheets ¼ inch.

TIME FOR CUTTING AND TESTING FLUES OR TUBES

2-inch or 2¼-inch flues	1⅕ man hours per 100
3½-inch flues	3 7/10 man hours per 100
5½-inch flues	4 man hours per 100

Similar operations are employed by the Canadian Pacific and New York Central, with similar machinery layout for the progressive movement and they too can be considered the best present methods. The shop layouts on these roads are shown in Figs. 6 and 7 respectively. In their operation the chain rumbler and the submerged combination rattler and washer are used and the ends of the flues are polished either with abrasive belt or emery wheel before welding of safe end. The balance of the operation is practically the same excepting that the testing is done by hydraulic pressure.

Replies received from several roads which weld the heads to the back flue sheet advise they cut tips for safe ends from accumulated second-hand flues for the 2-inch and 2¼-inch sizes and are obtaining satisfactory service due to the fact that the electric welded flues to the back flue sheet require practically no re-expanding or beading. In this connection consideration should be given to the practice of employing one safe end only on each flue. The increased pressures, long runs, and fast service, increase the liabilities for engine failures due to burst flues. It is recommended that the first time a flue is safe-ended, a tip 5½ inches in length be applied; on second removal the old weld should be cut off and a tip 7 inches in length should be applied; for the third removal 8½ inches, the fourth 10 inches, and so on for the duration of the life of the flue, each time the old weld is to be cut off.

The present service demands expected of locomotives requires the best of care and proper maintenance. Therefore, due consideration should be given to quality of workmanship, because quality rather than quantity is the measure in attempting to meet service demands.

Fabrication for fireboxes, barrels and tube sheets of nickel, chromium and other

HIGH-TENSILE STEEL

Committee

L. C. Ruber

M. V. Milton

J. A. Doarnberger

We do not consider this report as complete nor comprehensive since most of the members whose roads have some boilers in which alloy steel is used are reluctant to express a definite and final opinion on alloy metal in boilers. Most of the members feel that the steel has been in use too short a time to make an adequate comparison with carbon steel as used in most locomotive boilers and therefore very little information can be given about actual service results in the use of alloy steels at this time.

Following is a specification recommended for nickel steel for boilers which has been used successfully on boilers now in service:

Scope
1. These specifications cover two classes of high-tensile steel for boilers for locomotives, namely, flange and firebox.

MANUFACTURE

Process
2. The steel shall be made by the open hearth process.

ANNEALING

Annealing
3. After rolling, the plates shall be slowly cooled by packing them in dry sand or by pack annealing or other approved methods.

CHEMICAL PROPERTIES AND TESTS

Chemical Composition
4. The steel shall conform to the following requirements as to chemical composition:

Note: The committee which submitted this report consisted of the following: L. C. Ruber, superintendent of boiler department, Baldwin Locomotive Works, chairman; M. V. Milton, chief boiler inspector, Canadian National; J. A. Doarnberger, master boiler maker, Norfolk & Western.

TABLE I.—PERMISSIBLE OVERWEIGHTS OF PLATES ORDERED TO THICKNESS

Ordered Thickness, in.	Permissible Excess in Average Weights per Square Foot of Plates for Widths Given, Expressed in Percentages of Nominal Weights.									Ordered Thickness, in.
	48 in.,	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.	132 in. or over	
Under 1/8	9	10	12	14	..	..	..	..	..	Under 1/8
1/8 to 3/16 excl.	8	9	10	12	..	..	..	..	..	1/8 to 3/16 excl.
3/16 to 1/4 excl.	7	8	9	10	12	..	..	..	..	3/16 to 1/4 excl.
1/4 to 5/16 excl.	6	7	8	9	10	12	14	16	19	1/4 to 5/16 excl.
5/16 to 3/8 excl.	5	6	7	8	9	10	12	14	17	5/16 to 3/8 excl.
3/8 to 7/16 excl.	4.5	5	6	7	8	9	10	12	15	3/8 to 7/16 excl.
7/16 to 1/2 excl.	4	4.5	5	6	7	8	9	10	13	7/16 to 1/2 excl.
1/2 to 5/8 excl.	3.5	4	4.5	5	6	7	8	9	11	1/2 to 5/8 excl.
5/8 to 3/4 excl.	3	3.5	4	4.5	5	6	7	8	9	5/8 to 3/4 excl.
3/4 to 1 excl.	2.5	3	3.5	4	4.5	5	6	7	8	3/4 to 1 excl.
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

* The term "lot" applied to Table I means all of the plates of each group width and group thickness.

		Flange Percent	Firebox Percent
Carbon	Not Over	0.22	0.18
Manganese	Not Over	0.80	0.50
Carbon + Manganese	Not Over	1.00	
Phosphorous (Acid)	Not Over	0.04	0.04
Phosphorous (Basic)	Not Over	0.04	0.035
Sulphur	Not Over	0.04	0.04
Nickel	Not Over	2.25	2.25
*Molybdenum	Not Over	0.05	0.05
*Aluminum or Al_2O_3	Not Over	0.05	0.05
*Chromium	Not Over	0.05	0.05
Copper	Not Over	0.15	0.15
Silicon	Not Over	0.25	0.25

* These elements shall not be added to the charge, nor shall any other alloying elements be added.

Ladle Analyses

5. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of the elements specified in Section 4. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 4.

Check Analyses

6. An analysis may be made by the purchaser from a broken tension test specimen taken from the bottom of the plate representing each plate as rolled. The chemical composition thus determined shall conform to the requirements specified in Section 4.

Physical Properties and Tests

Tension Tests

7. (a) The material shall conform to the following requirements as to tensile properties:

	Flange	Firebox
Tensile strength lbs. per sq. in.	70,000 to 80,000	60,000 to 70,000
Yield Point Min. lbs. per sq. in.	0.55 Tens. Str.	0.55 Tens. Str.
Elongation in 8 in. Min. percent	1,890,000 / Tens. Str.	28
Reduction of area Min. percent	3,600,000 / Tens. Str.	45

(b) The yield point shall be determined by the drop of the beam of the testing machine.

Modification in Elongations

8. (a) For material over 3/4 in. in thickness, a deduction from the percentages of elongation specified in Section 6 (a) of 0.125 percent shall be made for each increase of 1/32 in. of the specified thickness above 3/4 in.

(b) For material 1/4 in. or under in thickness, the elongation shall be measured on a gage length of 24 times the thickness of the specimen.

Bend Test

9. (a) The test specimen shall stand being bent cold through 180 degrees without cracking on the outside of the bent portion as follows:

Thickness	Longitudinal	Transverse
1 inch and under	Flat on itself.	Around a pin, diameter equal to thickness of specimen.
Over 1 to 1½ inches, inc.	Around a pin, diameter equal to thickness of specimen.	Around a pin, diameter equal to twice thickness of specimen.
Over 1½ inches	Around a pin, diameter equal to twice thickness of specimen.	

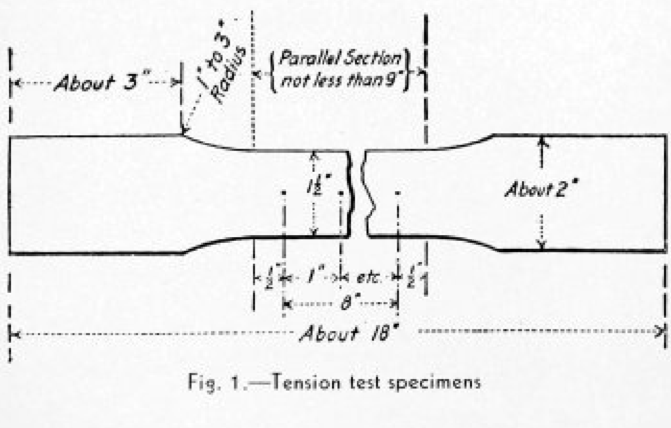


Fig. 1.—Tension test specimens

(b) Bend test pieces when heated throughout to 1200 degrees F. and quenched in water whose temperature is not over 150 degrees F. shall conform to the requirements shown in Paragraph 9 (a).

Drift Test

10. For all plates over 3/4 in. in thickness a piece of plate at least 6 in. square, the full thickness as rolled taken adjacent to the three bend test pieces at the top of the plate as shown by the sketch when machined on two adjacent edges and a 1¼ in. diameter hole drilled through the plate 1⅞ in. from both machined edges; shall withstand having the hole enlarged to 2¼ in. in diameter by forcing a hard steel tapered pin (with taper about 1 in. in 16 in.) into the hole without showing cracks in the hole or at the edges of the plate.

This operation shall be performed in the testing machine at a speed not to exceed 3 in. per minute and the test piece shall be supported on a hollow sleeve or collar or similar device to prevent buckling or dishing the plate.

Homogeneity Test

11. For firebox steel, a sample taken from a broken tension test specimen, taken from the bottom of the plate, shall not show any single seam or cavity more than 1/4 in. long, in either of the three fractures obtained in the test for homogeneity, which shall be made as follows:

The specimen shall be either nicked with a chisel or grooved on a machine, transversely, about 1/16 in. deep, in three places about 2 in. apart. The first groove shall be made 2 in. from the square end; each succeeding groove shall be made on the opposite side from the preceding one. The specimen shall then be firmly held in a vise, with the first groove about 1/4 in. above the jaws, and the projecting end broken off by light blows of a hammer, the bending being away from the groove. The specimen shall be broken at the other two grooves in the same manner. The object of this test is to open and render visible to the eye any seams due to failure to weld up or to interposed foreign matter, on any cavities due to gas bubbles in the ingot. One side of each fracture shall be examined and the lengths of the seams and cavities determined, a pocket lens being used, if necessary, with a magnification not over 4 diameters.

Test Specimens

12. (a) Tension and bend test specimens shall be of the full thickness of material as rolled, and shall be machined to the form and dimensions shown in Fig. 1; except that bend test specimens may be machined with both edges parallel.

(b) Tension test specimens shall be taken longitudinally from the top and bottom of the finished rolled material.

Bend test specimens shall be taken longitudinally from the top and bottom of the finished rolled material and shall also be taken transversely from the middle of the top of the finished rolled material.

Drift test specimens, see Section 10.

The longitudinal test specimens shall be taken in the direction of the longitudinal axis of the ingot and the transverse test specimens at right angles to that axis.

The location, etc., of all test pieces is shown by Fig. 2.

Number of Tests

13. (a) Six tension and bend tests are to be taken from each plate as rolled, as follows:

One tension test (longitudinal) from bottom of plate.
One tension test (longitudinal) from top of plate.
One cold bend test (longitudinal) from top of plate.
One quench bend test (longitudinal) from top of plate.
One cold bend test (transverse) from top of plate.
One quench bend test (transverse) from top of plate.

One drift test is to be taken from the top of each plate, 3/4 in. in thickness, as rolled.

(b) If any test specimen shows defective machining, it may be discarded and another specimen substituted.

(c) If the first specimen develops flaws, a second test specimen may be substituted.

(d) If the percentage of elongation of any tension test specimen is less than that specified in Paragraph 7 (a) and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

Permissible Variations in Thickness and Weight

Permissible Variations

14. The thickness of each plate shall not vary more than 0.01 in. under that ordered.

The overweight of each lot in each shipment shall not exceed the amount given in Table I. One cubic inch of rolled steel is assumed to weigh 0.2833 lb.

Permissible overweights of plates ordered to thickness shall conform to the limits shown in Table I.

Finish

Finish

15. (a) The finished material shall be free from injurious defects and shall have a workmanlike finish.

(b) Both sides of each plate shall be carefully examined and no plate shall show depressions or scale marks which extend more than 5 percent below the thickness ordered. In no plate shall the depth of any depression be in excess of 5 percent of the ordered thickness of plate and no plate shall contain more than 10 depressions to the square foot.

(c) Seams or small defects may be ground out only by permission of the inspector and provided the depth after grinding does not exceed 5 percent of the ordered thickness of the plate and provided also no evidence of the seam can be found after etching.

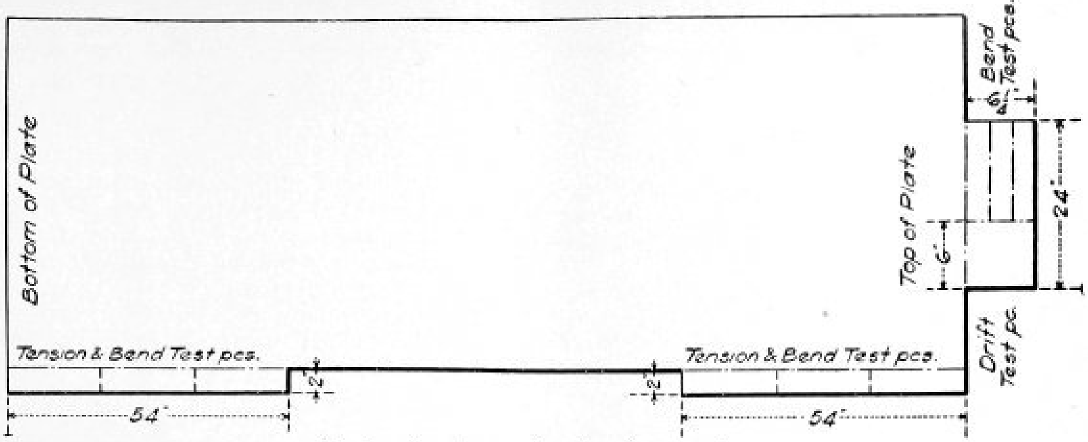


Fig. 2.—Location on the plate of test specimens

(d) Plates over ½ in. in thickness shall be cut with a torch, not sheared.

(e) Any piece of any plate shall not show a well defined hardening effect, brittleness, nor temper brittleness when subjected to the normal operations that are required in the manufacture of a locomotive boiler, such as cold bending or flanging, heating to a red heat, 1200 degrees F., and cooling in air or in contact with other plates at or above room temperature.

(f) Any test piece so treated when tested shall not show more than 110 percent of the elastic limit or tensile strength originally reported, nor less than 90 percent of the percentage of elongation or reduction of area originally reported. In no case shall the tensile strength be greater than 85,000 lbs. per sq. in., nor the elongation less than 22 percent in 8 in.

MARKING

Marking

16. (a) The name or brand of the manufacturer, the manufacturer's test identification number, class and lowest tensile strength specified shall be legibly stamped on each finished plate in two places not less than 12 in. from the edges and on each butt strap near the center line not less than 12 in. from each end. The manufacturer's test identification number shall be stamped on each test specimen.

The stamping should be as follows:

Manufacturer's name or trade mark.
Nickel steel.
Quality, viz., flange or firebox.
Minimum tensile strength allowed by the specification.
00000 (Serial Number).
00000 (Heat Number).
00000 (Slab Number).

And this marking shall be encircled with a ring of white lead paint.

In addition to this, each plate shall be marked with white lead paint showing the ordered size of the plate in inches, viz., length, breadth and thickness, and the purchaser's order number.

(b) When specified on the order, plates shall be match-marked as defined in Paragraph 16 (c) so that the test specimens representing them may be identified. When the plate rolled from a slab or ingot is cut into two or more smaller plates, each shall be match-marked so that they may all be identified with the test specimens representing them.

(c) Each match mark shall consist of two overlapping circles each not less than 1½ in. in diameter, placed upon the shear lines, and made by separate impressions of single-circle steel die.

(d) Match-marked coupons shall match with the sheets represented and only those which match properly shall be accepted.

INSPECTION AND REJECTION

Inspection

17. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture before shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection

18. (a) Unless otherwise specified, any rejection based on tests made in accordance with Section 6 shall be reported within five working days from the receipt of samples.

(b) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing

19. Samples tested in accordance with Section 6 which represent rejected material shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

TENSION TESTING

Tension Tests

Tension test specimens shall be machined on the edges and shall conform to the requirements of Section 12 and shall be placed in the testing machine in such a way that the axis of the specimen shall coincide with the direction of the pull of the machine.

For the determination of the yield point or elastic limit, the speed of the moving head of the test machine shall not exceed ⅛ in. per minute for an 8 in. gage length. The yield point shall be determined by the use of the beam of the testing machine or by the use of an extensometer or by the use of dividers.

After the yield point or elastic limit has been determined, the speed of the moving head of the machine shall not exceed 1½ in. per minute for determining the breaking strength.

BEND TESTING

Scope

1. This method to be followed consists essentially of bending the specimen by means of forces at the ends without introducing additional forces at the point of maximum bending.

Preparation of Test Specimens

2. The bend test specimens shall be machined on the edges in accordance with the requirements of Section 12.

For results in which the performance is independent of the thickness of the specimen, rectangular specimens with widths at least three times the thickness shall be used. The edges shall be smoothed so that the fracture will not take place at the edge. A radius up to one-eighth the thickness of the specimen may be used on the edges. The outside surfaces of the specimen shall be smooth and free from local defects and transverse scratches. The length may vary with the thickness of the piece and is unimportant provided it is long enough to perform the bending operation.

Method of Starting the Bend

3. When starting the bend, any local stress or strain at the section which eventually will have the greatest bending should be avoided. This may be accomplished by holding the specimen in a vise about one-third from the end, producing an initial bend at this point by hammer blows, or the specimen may be set up on cross supports and the initial bend started by compression at the third points. The initial bend shall be far enough from the final points of maximum bending so as not to affect it. This shall be performed on both ends of the specimen. The initial bend may vary from 5 to 30 degrees, depending on the ductility of the material. The magnitude of this initial bend does not affect the results.

4. (a) The specimen with initial bends on each end shall be placed in a vise or press as a strut and compression applied at the ends. The vise or press shall be closed until failure of the outside fibers occurs. The speed is not a factor provided actual shock is avoided. The continuity of closing and the speed may be varied at will without affecting the results.

(b) Bending may be carried out in special machines by any other suitable means provided that local stresses at the point of maximum bending are avoided.

Microscopic Examination, etc.

5. Any test specimen when polished and etched and examined in a microphotographic apparatus or microscope with a magnification of 100 diameters should show a fine grained pearlitic structure and should be free from non-metallic inclusions and should not show any sorbitic or martensitic structure; likewise, microphotographs made from such pieces should conform to these requirements.

BOILER CONSTRUCTION USING NICKEL STEEL

It has been the experience of all who have had an opportunity to work on nickel steel that it is far more tough and does not respond as quickly to the general procedure used in construction as does carbon steel. Therefore, considerable more time must be spent and special studies must be made to get the best results in working this metal.

In nickel steel the critical range is somewhat different from carbon steel and for this reason the greatest care must be exercised to have the steel heated to the proper temperatures prescribed by the steel mills for working. This steel should never be worked at a temperature lower than 1400 degrees F., and should never be heated to a temperature exceeding 1700 degrees F., as these are the limits for the critical temperatures as advised by authorities on this steel. Nickel steel should be left to soak in a furnace so that the temperature will be uniform throughout when it is being worked. The heating time therefore increases approximately 50 percent over the time for heating carbon steel. In hand flanging, on account of the close limitations in heat temperature, the operator requires considerably more time, as more heats must be taken and therefore the section of plate flanged from each heat is much smaller as the range of working temperatures is very definite and metal can only be worked for a very short period. This naturally increases the labor time of flanging whether the plates are flanged by machine or hand.

On account of the toughness of alloy boiler steel the number of inches drilled is less than the inches drilled in carbon steel of the same size in a given time.

The toughness of alloy boiler steel slows up the planing operation and the greatest care must be exercised to get the edges of the plates planed as smooth as possible so there will be no ragged edges after planing.

It is imperative that the rolling be carefully performed so that the circular courses will be rolled as near as possible to a perfect circle and all other plates to contours that will meet connecting plates with the minimum amount of fitting. In rolling plates it will require more passes in forming the plates to proper contours and less pressure exerted at each pass than is customary when rolling carbon steel. This also increases the necessary time in rolling nickel steel over the time required to roll carbon steel.

In fitting, the connecting parts must be a very close fit as the toughness of the steel makes it almost impossible to use the usual methods of setting up sheets with mauls and flatters. It being important that as little local heating be done as practical, therefore the setting-up time increases, as there must be considerably more time used in getting a metal to metal condition of connecting parts. When heating is required to set up the plates, it is advisable to heat a very short space at a time; otherwise it becomes almost an endless operation as the metal moves away from connecting parts.

The tools used for reaming and staybolting must be of the best high-speed tool steel, as the ordinary tool steels will not do the required work. Extreme care must be exercised in all reaming and staybolt tapping, otherwise the operator will find himself in a lot of trouble with holes badly chattered where reamed and in tapping he will have torn threads.

Editor's Note: A second specification for high-tensile steel, as used successfully by one railroad, was included in the report. In most respects it was similar to the specification in the foregoing pages. Space did not permit including it in the report. It will be published subsequently with discussion of the report, and also will appear in the final proceedings.

Operating Experience with Alloy Steels

Following is the experience of one of the members whose railroad has a considerable number of engines in service for which the above specification was used in making the boiler steel:

"I may say that during the past six years, we have built some seventy-five engines, seventy of which are carrying 250 pounds per square inch pressure and five, 275 pounds per square inch pressure. It is natural that before using the material, some tests were made other than the physical tests, by which I mean practical tests in construction. We took a piece of this material at the maximum required thickness, which was $^{27}/_{32}$ inch and rolled a 36-inch round section after same had been drilled to represent the requirements of the third course in the combustion chamber area, that is, $1\frac{3}{8}$-inch flexible staybolt holes drilled and pitched between $3\frac{1}{2}$-inch and 4-inch centers. When this course was rolled up, the action of the rolling and the surface of the material was checked over closely, both for radius, internal and external and also for checks from the drilled holes.

"There were no defects whatever found but the following methods were found more or less necessary: We should be careful in the rolling of high-tensile alloy steel because of its toughness. It does require more time to roll, that is, the application of pressure on the rolls should be placed in minimum sections at more frequent intervals. Care should also be taken with this operation so that the fitting requires the minimum amount of laying-up. Of course you are aware it is necessary to set a taper course to suit the straight course by opening up the taper section.

"I am also of the opinion that in the construction of this type of boiler, care should be taken in the local heating once sheets are placed together, by which I mean when local heating is necessary, it should be done over the largest area possible. Of course, the use of drift pins should be brought to a minimum, and in all laying-up a large area flatter should be used so that no markings whatever are made in the sheet. To be more clear in this matter, the sheet surface should not be fiber stressed or cut in sections by the marking of a hammer.

"Careful inspection was made of the first of these boilers that was placed in the hydraulic riveter. I personally followed the job along and, for your information, may say that the seams were set up as perfectly as possible, that is, no clearance in sections which would work around the joint by riveting. While the jaws of the riveter were cooled in the usual manner, I insisted that the least possible amount of water be used and kept as much as possible off the course sheets, this, of course, as a matter of prevention. However, after this boiler was constructed and tested, I again made close examination for any defects and can say with security that none were found.

"Now, in coming to maintenance, I may say that all motion angles and waste sheets were applied to the boiler by the application of a $\frac{7}{8}$-inch common carbon steel sheet, riveted to the barrel course and the angles riveted to this plate by the use of countersunk rivets. This, I think, is more or less a common practice in your country at the present time and a practice we have used here for many years. I am calling your attention to this fact, as you know the many years we have had cracking on boiler sheets of the old carbon type around these areas, caused by the stresses set up from the motion and the expansion of the boiler in the frame.

"At the first external examination of these boilers, after four years of service, in which period they had made some 200,000 to 250,000 miles, I made close inspection. No defects whatever were found and we have not, up to the present time, done any work to any of these barrels in the way of tightening of joints, calking of rivets or any such defects that may have been caused by the use of the alloy steel."

We follow with the experience of another member whose railroad also has some engines with boilers made of nickel steel:

"We have had some limited experience with nickel steel boiler and firebox sheets, and some alloy staybolt material. The locomotives equipped with nickel steel sheets have been in service from two to three years, and the service results have not advanced far enough for us to come to any conclusions regarding its general application and comparative value with carbon steel now used in locomotive construction.

"The experience we have had with alloy staybolt material is somewhat more comprehensive and covers a longer period than sheet material, and our results at the present time indicate that such materials may be expected to give good service under present increasing boiler pressures, although we have not made any radical departure from the use of staybolt iron."

Will boiler maintenance and safety of operation be aided by the multiple application of

FUSIBLE PLUGS

Committee

O. H. Kurlfinke

F. A. Longo

E. H. Paepke

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, we believe it incumbent upon this committee to review briefly 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 the activity toward their use is not very pronounced.

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 of alloy metal. The common design is shown in Fig. 1.

Another design, shown in Fig. 2, was used for a period between 1903 and 1914. 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.

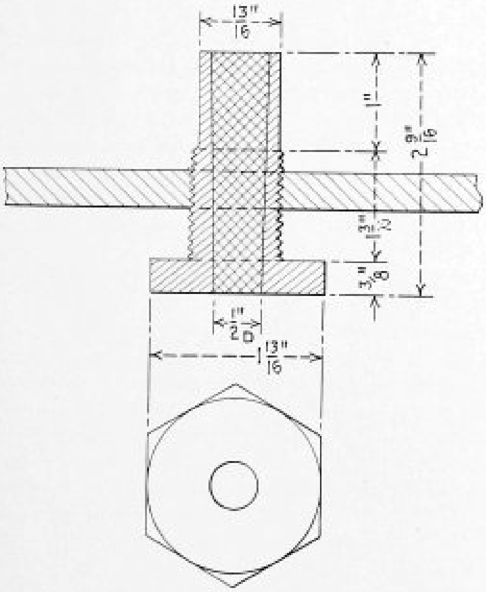


Fig. 1

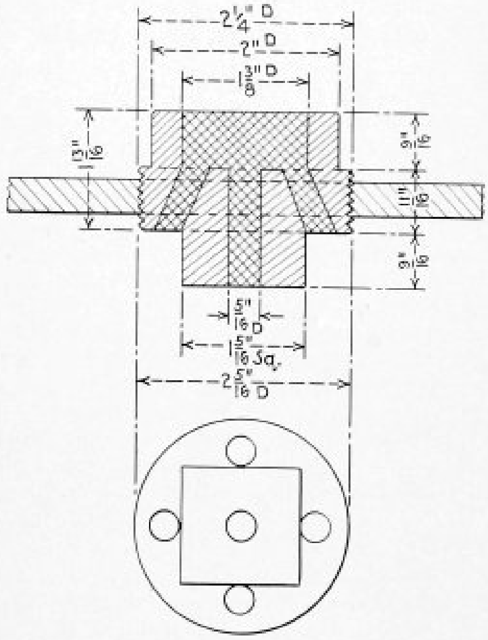


Fig. 2

In many cases where the plugs were still in good condition it was found that in cases of low water, although the plug was duly heated, the alloy metal would start to melt but 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, and the result would be that the plug was practically useless and therefore unreliable.

Adhering to the theory that fire-actuated fusible plugs are sound in principle and provide an economical means by which to forestall damage to firebox crown sheets on account of low water, further research developed the design of plug shown in 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 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 1914 has conclusively demonstrated that the design of this drop plug is fundamentally sound.

This deficiency, to a large extent, was caused by the 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

Note: The committee which submitted this report consisted of the following: O. H. Kurlfinke, boiler engineer, Southern Pacific, chairman; F. A. Longo, welding and boiler supervisor, Southern Pacific; E. H. Paepke, general boiler inspector, Union Pacific.

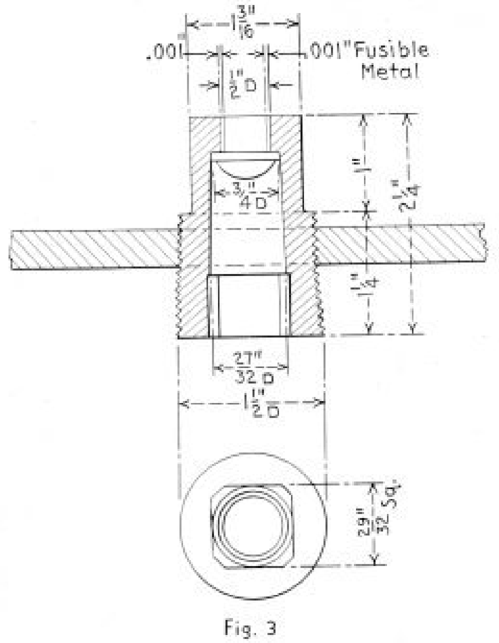


Fig. 3

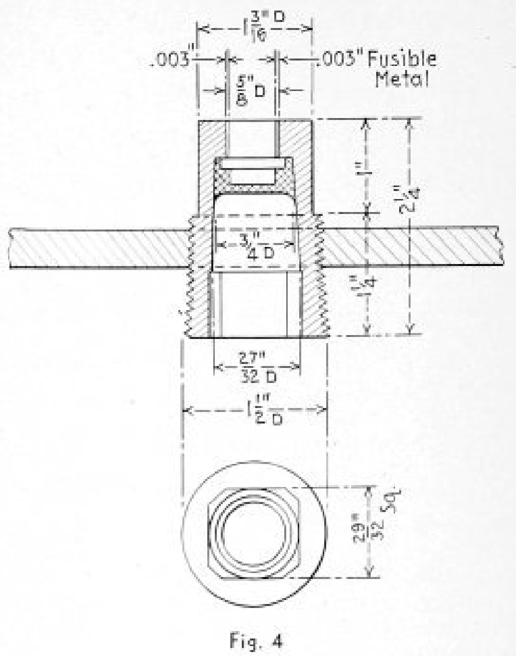


Fig. 4

the plugs after the button had been sweated in place impaired their consistent operation.

The railroad in question submits the following interesting record covering the application of drop plugs since the year 1914 and up to and including 1932, which gives the number fused on account of low water, and the number fused on account of being defective.

Record of Drop Plugs

The combustion chamber engines were equipped with two plugs, and the others with one. In both cases a plug was located at the highest point of the crown sheet, approximately 8 inches back of the tube sheet. The second plug, when applied, was located further back over the forward end of the firebox mud ring.

The locomotives referred to, excepting the 4402, were equipped with one plug. The 4402 had two plugs. In all these cases excepting the 2436, the engines were working hard at the time, and, while in each case there were undetermined circumstances regarding the cause of low water, the effect of the steam blowing into the firebox through the plug orifice was apparently not noticeable, since the draft was apparently severe enough to carry the escaping steam along with it through the tubes. On the 2436, the button did not drop, but was moved slightly as the engine did not have full pressure.

Whatever conclusions were reached at the time investigations were held to determine the exact contributary cause of these accidents, the final analysis was that the plugs should be made and so applied as to number and location that they would function in an absolute manner.

In the latter part of 1931 further improvements in the design and manufacture of this drop plug were 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 we invite your particular attention 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.

It was also considered necessary to increase the thickness of the fusible metal between the button and the plug body. The plug in Fig. 3 had 0.001 inch thickness of fusible metal around the button. The plug 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 quicker fusible metal is heated and cooled down the quicker oxidation.

As these drop plugs fuse due to the 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 the 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

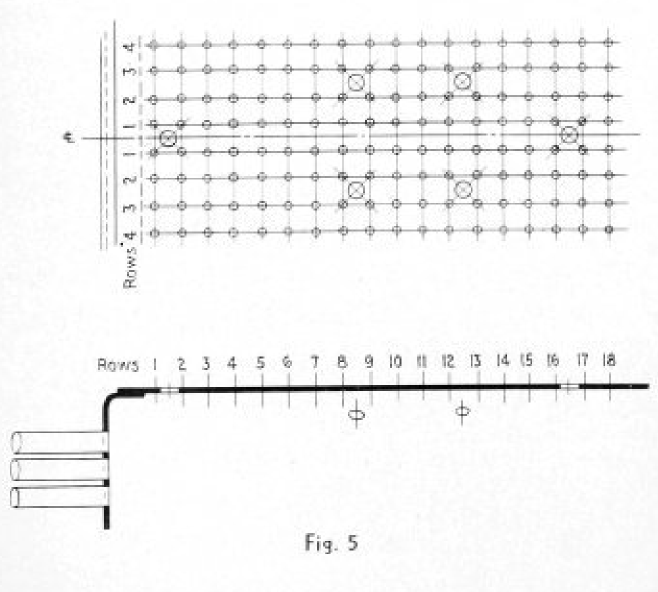


Fig. 5

RECORD OF DROP PLUGS APPLIED TO LOCOMOTIVE BOILERS

Year	Locomotives Equipped	Equipped with Drop Plugs						Plugs Fused Account Low Water: Responsibility: Crew	Yard or Roundhouse	Total	Total Plugs in Use	Plugs Fused Acct. Defective: No.	Percent of Total Plugs in Use	Explosions: No.	Remarks
1914		All						This data not available prior to 1927.				This data not available prior to 1927.		1	Eng.4037-Edison-Low water.
1915		"												1	Eng.2763-Ogilby-Low water.
1916	1361	"												1	Eng.2602-Ordway-Low water.
1917	1375	"												0	
1918	1403	"												0	
1919	1441	"												0	
1920	1458	"												0	
1921	1483	"												0	
1922	1506	One			Two									0	
1923	1492	1329			163						1655			0	
1924	1760	1520			240						2000			0	
1925	1742	1479			263						2005			0	
1926	1749	1446			303						2052			0	
1927	1723	1401			321			7	* 5	12	2044	5	0.245	0	
1928	1704	1364			340			8	14	22	2044	1	0.049	0	
1929	1691	1310			381			14	∮ 16	30	2072	3	0.145	1	Eng.4017-Wall Creek-Low water.
1930	1682	1256			426			5	7	12	2108	0	0.000	0	
1931	1667	1217			450			5	8	13	2117	40	1.889	2	Eng.2436-Sacto.R.H.-Low water-May 22. Eng.4402-Richvale-Low water-Dec.23.
		1⑥	2	3	4	5	6								
1932	1603	257	103	491	455	246	51	4	6	10	5292	2	0.00037	0	
1933	∮ 1597	234	103	498	462	249	51	3	4	7	5340	0	0.000	0	

* - Two cases fire started without water in boiler.
∮ - One case " " " " " "
∮ - To include 6-22-33.
⑥ - These locomotives out of service.

plugs fuse in multiple, the hazard of accident is less prevalent.

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 be continued 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 the effect similar to that of a sprinkler system such as is successfully used in large buildings and which releases 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 a 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 of gas area of the flues.

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.

Again referring to the record covering the application of drop plugs, it will be noted that during the year 1932, and especially during the first three months thereof, a total of 5292 drop plugs of the type shown in Fig. 4 were in service on 1603 locomotives. Since reliable drop plugs can be manufactured, no inconvenience is being experienced with faulty or defective plugs, as the record shows that, of the 5292 in service, only two fused with ample water over the crown sheet.

This committee feels that the report on this important topic would not be complete if we did not quote herein official reports made covering the circumstances involved in a portion of the 10 cases where plugs fused on account of low water. Lack of space is the only reason why we have not included the entire 10 instances, but you have our assurance that those we 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 boiler and found that water was allowed to get low enough to fuse the plugs but

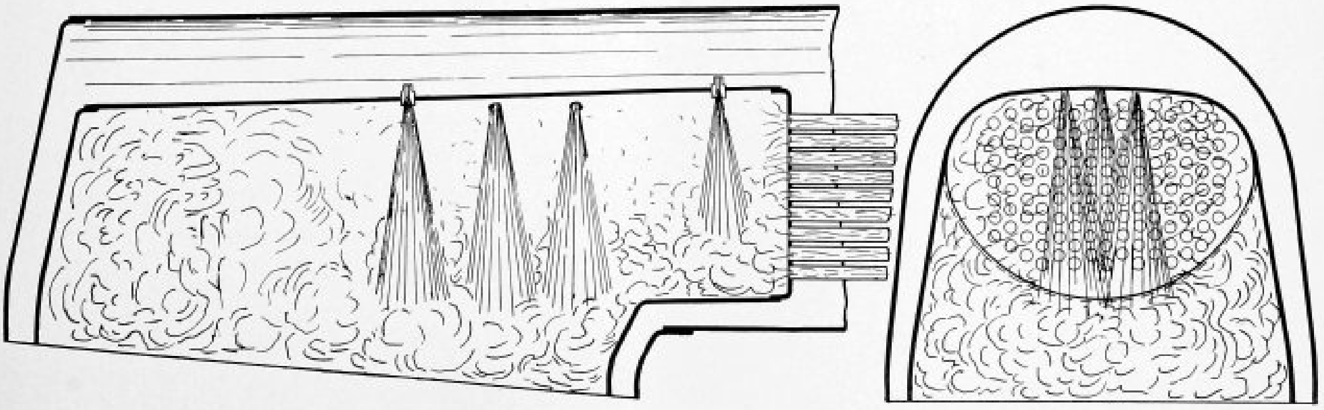


Fig. 6

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 the master mechanic reports that the 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 the 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 previous to the engine losing water, the fireman thinking he had the injector on when it was not delivering water.

Engine 1621, being used temporarily as a stationary boiler at Calexico, dropped button of fusible plug and was taken out of service. Could find no indication of 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 the engine watchman permitted the 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. The engine watchman accepts responsibility for failure to follow instructions in connection with firing up locomotives and maintaining proper water level in the boiler while under fire.

Engine 2819, while being watched by an engine watchman at Bowie, failed on account of drop plug fusing on account of low water for which the watchman was responsible. Back plug dropped bore heat serial No. 51. Water glasses, gage cocks, water hose, strainers, connections, injectors were found to be in good condition. No damage to the boiler.

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 persons.

When these drop plugs are manufactured, heat tests are conducted on one plug in each 100. 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. 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, 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 the 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.

We, therefore, believe that the foregoing remarks incident to the multiple application of fusible plugs will impress those concerned with the fact that such an application increases the safety of operation.

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 the water becoming low, much damage can be incurred.

Knowing that boiler explosions caused by crown sheet failures were 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 pressure carried therein. We have been told that the most prolific source of casualties due to failure of fusion welded seams has been in firebox crown sheets, and that experience has shown that these failures depend very largely upon whether or not the sheets or seams tear. Further, it is claimed that riveted seams are superior in strength to welded seams under these conditions, since the latter in some cases may be of unknown quality.

We 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, we 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.

Our conclusion is that, when the crown sheet is equipped with a multiple application of reliable drop plugs, so located and spaced that in 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 portion thereof is desirable economy and should not be discriminated against.

Better methods used in threading and applying

STAYBOLTS

Committee

G. B. Usherwood

E. S. Fitzsimmons

J. A. Graulty

The committee on "Better Methods used in the Application and Threading of Staybolts, Iron, Nickel and Special Alloyed Steel, Flexible and Rigid, with Details and Tools Used" has endeavored to collect data on the subject, particularly of threading and tapping.

A wide variation in practice was found on a number of roads checked, which would indicate the need for a thorough investigation of the subject. The committee believes that the subject should be continued and the committee enlarged, or sub-committees appointed, each to investigate and report on one of the subdivisions

Note: The committee which submitted this report consisted of the following: G. B. Usherwood, supervisor of boilers, New York Central, chairman; E. S. Fitzsimmons, sales manager, Flannery Bolt Company; J. A. Graulty, general boiler shop foreman, American Locomotive Company.

of the subject, and that each subdivision be handled and discussed separately at the next regular convention.

Thread Form. The first question taken up was the form of thread most desirable from the point of view of economy and satisfactory service.

The committee finds that there has been a gradual and quite general change from the V form to the U. S. form of thread over a period of years, and that at the present time much thought and consideration are being given to the Whitworth, or British Standard, and that many advantages are expected from those roads that use this form.

The advantages claimed are greater output per 0.001 wear on either taps or dies. At least two of the important trunk line roads have standardized this form, and we are informed several other roads are giving the matter serious consideration. The committee has not been able to secure sufficient replies to enable it to make definite recommendations, but believes there is sufficient merit to warrant further investigation.

Diameter Tolerances. The committee finds there is also a wide variation in practice as regards threading tolerances. Some roads use outside diameter measurements, others use pitch diameter, still others have no definite rule and depend on cut and dry methods.

Those having definite tolerance rules vary considerably. Some use the nominal diameter for maximum and permit variations down to 0.006 minus. Others use a maximum of nominal plus 0.002 and a minimum of 0.002 to 0.004 minus, from which it will be seen that there is lack of uniformity, and that there is obviously an opportunity for improvement.

Lead Error Tolerances. The committee likewise finds similar variations in tolerances on lead error. Some roads use plus 0.915 or minus 0.0015, others use plus 0.003 or minus 0.003, which is just double the former, while on some other roads no particular attention is given the subject, or any definite tolerance used.

Type of Tap. The committee also finds that many railroads prefer the straight-fluted type of staybolt tap, while others insist on the spiral-fluted type staybolt tap. It further finds that where there is no special tool to gage, much difficulty is experienced in getting the correct size of the tap, whether the same be the pitch or outside diameter, if the tap is of the five-fluted type.

Your committee recommends the following for the approval of the association, pending further investigation and report:

(1) That all thread dimensions and tolerances be measured on the pitch diameter.

(2) That nominal be used for maximum and a tolerance of minus 0.005 for minimum bolt size.

(3) That lead error be limited to plus 0.003 or minus 0.003.

(4) That bolt ends be chamfered or pointed 1/8 inch at an angle of 45 degrees to permit of readily entering the bolt.

(5) It further recommends that consideration be given to having the staybolt tap made of a standard six-fluted type, in order to simplify the gaging of the tap for its correct size.

As a result of checking actual applications and gaging and measuring many bolts over a period of several months, your committee believes that observance of the above recommended practice will result in work of satisfactory quality so far as the bolts are involved.

Tapping. A check of practice on a number of roads again indicates a variation in the use and checking of staybolt taps.

Much of the difficulty encountered in the application of bolts is found to be due to worn and undersize taps. Your committee believes that this condition is probably due to the depression of the past three years, and that with the revival of purchasing this condition will improve.

It is obvious that little can be accomplished in regulating bolt sizes, when tap wear is permitted below the maximum bolt sizes.

Pending further investigation, as above suggested, we recommend for consideration and trial the following practice, which has been suggested to the committee, and which we believe to be worthy of further study and trial, as affording economical use of taps and securing high quality of work in bolt application:

After the firebox has been tapped and made ready for staybolts, in the usual manner, we recommend an additional operation.

This additional operation is: To re-tap, or second tap, every hole in the firebox, using for the work a new full-sized tap, and a light motor of just sufficient weight and capacity to perform the small amount of work to be done. This will clean up the threads and size the holes on which small or worn taps have been used.

The amount of work to be done in this re-tapping will not be sufficient to heat up or perceptibly wear a new tap, therefore only one will be needed. Likewise, since only a small light-weight motor will be required, no dragging or sagging on the tap need be expected, and the result will be holes of uniform diameter with full clean threads to which the bolts may readily be fitted.

Fusion Welding

(Continued from page 199)

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.

EXHIBIT SECTION

Supply Companies Exhibiting in the Master Boiler Makers' Convention in Print

Air Reduction Sales Company

American Arch Company

The Baldwin Locomotive Works

Bethlehem Steel Company

Buckeye Portable Tool Company

Burden Iron Company

Champion Rivet Company

Dearborn Chemical Company

Falls Hollow Staybolt Company

Flannery Bolt Company

General Electric Company

General Refractories Company

Globe Steel Tubes Company

Huron Manufacturing Company

Lincoln Electric Company

Locomotive Firebox Company

Otis Steel Company

Page Steel & Wire Company

Penn Iron & Steel Company

Pittsburgh Steel Company

Republic Steel Corporation

Joseph T. Ryerson & Son

Steel & Tubes, Inc.

The Superheater Company

Gustav Wiedeke Company

Electrunite Resistance Welded Boiler Tubes

After many years devoted to the manufacture of tubing by the electrical resistance welding method, during which more than a billion feet of tubing was produced for countless purposes, Steel and Tubes, Inc., Cleveland, decided to apply the experience so gained to the production of a better boiler tube made by electrical resistance welding.

This modern type of boiler tube is now made of open-hearth steel, copper bearing steel, nickel steel or rust-resisting Toncan copper molybdenum iron.

Electrunite boiler tubes are made from clean, flat strip, cold formed to a perfect round and electric resistance welded. This method of manufacture insures a concentric inner and outer wall, gives even pressure of the expanding tool at all points around the tube and saves time in making a tight fit. It also insures uniform diameter and wall thickness, which with perfect concentricity, permits tubes to slide freely into the tube hole, eliminates re-drilling of the tube sheet to accommodate oversize tubes, and lets the expander work easier, faster and more evenly.

Because Electrunite boiler tubes are free from scale, it is never necessary to polish the tube ends for high-pressure work to obtain a tight fit. Because the tube surface is better, corrosion is retarded.

Due to the mechanically controlled electrical resistance method employed in welding, the weld is as strong as the wall. Every tube is tested at pressures far in excess of code requirements. Electrunite boiler tubes can be used in either fire-tube or watertube boilers requiring either straight or bent tubes. They are made in a full range of sizes to meet A.S.M.E. specifications. They also meet the requirements of the United States Department of Commerce, Steamboat Inspection Service and of the American Bureau of Shipping.

Champion Welding Electrodes and Rivets

It is of interest to the members of the Master Boiler Makers' Association that The Champion Rivet Company is now manufacturing a complete line of welding electrodes. This item of information is particularly significant in view of the fact that The Champion Rivet Company pioneered in the introduction of steel rivets in fabricating locomotive boilers.

Some forty years ago David J. Champion conceived the thought that steel rivets would serve the locomotive boilermakers better than iron rivets. The same vision and facilities which pioneered the steel rivet have guided the development of a complete line of welding electrodes.

The Champion heavy flux-coated rod has been given the trade name of "Red Devil"; this name ties in with the Champion trade mark of the Devil and Elephant.

The Champion Rivet Company has served and will continue to serve a very definite place in the plate-fabricating industry. Several of the types of rivet head designs in general use today had their inception in the engineering department of this company. About twenty-five years ago one of our larger railroads was searching for a type of rivet head that would produce better riveted construction with a minimum amount of calking. It was only natural to assume that the foreman boiler maker of that railroad should come to Champion with his troubles. There was developed from this conference a raised type double-radius head rivet known to the trade today as a bull head. This incident is cited as being typical of Champion's ability to serve the master foreman boiler maker in solving his riveting problems. That same type of service is now offered in the field of welding—thereby completing Champion's metal joining service to industry.

Agathon Nickel Staybolt Service Record

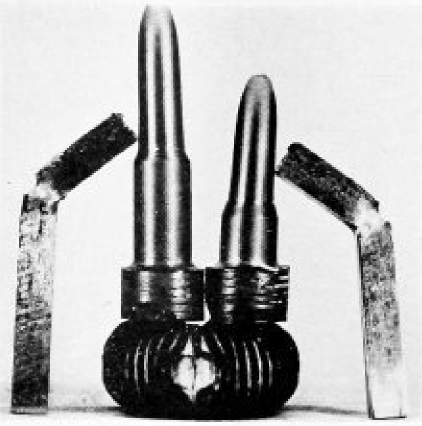
After eight years of successful service in a U. S. R. A. heavy Mikado locomotive, operating in the North Central states, a set of Agathon nickel staybolts was recently removed and tested.

In July, 1925, the locomotive was equipped with side sheets and door sheet with Agathon nickel staybolts. After eight years in service and over 300,000 miles, the plates were removed at the third shopping in September, 1933. The following table shows the comparison between physical properties of new bar stock and the tests on these bolts after eight years in service:

New stock, yield point 36,000 pounds per square inch; tensile strength 53,000 pounds per square inch; elongation in 8 inches, 32 percent; reduction in area 68 percent; Izod test, 85.

After eight years in service, yield point 34,000 pounds per square inch; tensile

Door sheet staybolts as removed



Bend, tensile and Izod tests on side sheet stays

strength 51,000 pounds per square inch; elongation in 2 inches, 38 percent; reduction in area 79 percent; Izod test, 76.

The question has often been raised as to the possible crystallization of staybolts after a period of service.

This test conclusively shows that eight years in service have not reduced the toughness and strength of Agathon nickel staybolts to any appreciable extent.

Agathon nickel staybolts are made tough and they will remain tough for a longer period than the life of the firebox plates.

Progress in Arc Welding

Millions of dollars have been saved to industry through the application of arc welding for both new construction and maintenance of boilers, tanks, pressure vessels, locomotives and similar equipment.

Lincoln portable welder

Within the last year, this process has reached new heights of efficiency through the use of shielded-arc welding with the "Shield-Arc" welder and "Fleetweld" electrodes manufactured by The Lincoln Electric Company, Cleveland. The shielded-arc process is accepted for the welding of Class 1 and Class 2 pressure vessels under the A.S.M.E. Code.

A uniform welding current is one of the outstanding features of the new "Shield-Arc" welder. By leveling the hills and valleys of the usual welding current the "Shield-Arc" has a higher average current which permits a great increase in speed of welding and amount of weld metal deposited. The capacity of the new welder is 60 percent greater than its predecessor, the new machines being rated at 40 volts.

Though of much greater capacity, the "Shield-Arc" welder has a 10 percent higher efficiency at full loads and even more on overloads. The stabilizer, said to be the cause of high losses, is eliminated by the advanced design of the new machine.

"Fleetweld" electrodes weld 2 to 3 times faster than bare or washed electrodes. The resulting weld has a tensile strength of 65,000 to 80,000 pounds per square inch and elongation of 20 to 30 percent in two inches. Resistance to corrosion, shock and fatigue are equal to or greater than that of mild rolled steel.

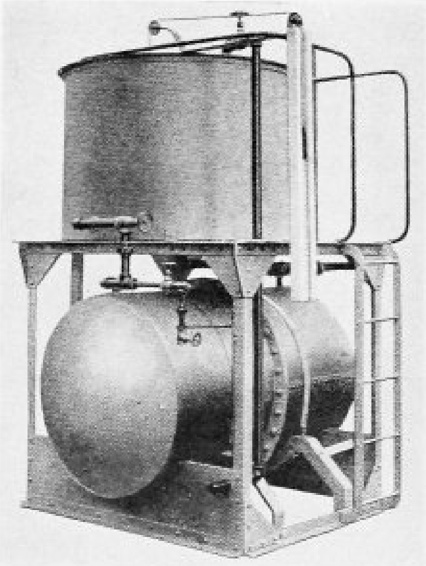
The Lincoln Electric Company also manufactures a complete line of electrodes for welding cast iron, alloy steels and nonferrous metals; welding accessories; alternating-current induction motors and starters.

Feed-Water Treating Equipment

To meet the rigid demands of modern boiler feed-water treatment, the Dearborn Chemical Company, Chicago, has developed methods and equipment that are recognized and accepted as standard throughout the world. Complete treating plants for locomotive or stationary boiler feed water and all accessories and equipment for proper treatment and control are supplied by the company.

The illustration shows a Type A-B treater as used where it is desirable to feed Dearborn water-treating preparations into locomotive water supplies rather than to introduce them directly into tender. The features of the plant are its simplicity and compactness and its ability to proportion the flow of solution to the flow of water and to operate only at such a time when there is an actual flow of untreated water.

Treaters of a variety of styles and capacities, covering the entire range of boiler feed-water requirements, are available.



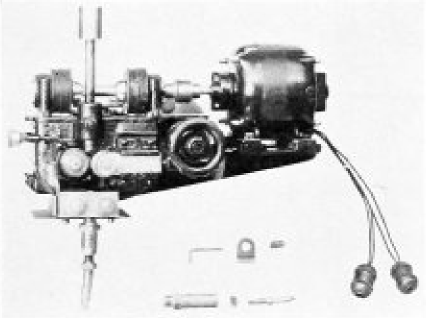
Type A-B Dearborn treater

Three types of Tret-O-Unit for installation upon any pump, water meter, rotor or other flow responsive equipment to proportion chemical treatment to feed water are featured by Dearborn. Feed or treatment by means of the Tret-O-Unit is strictly proportionate to the rate of flow. Pressure from an outside source, such as water, air or steam, drives the chemical pump and no load is placed upon the meter, rotor or pump to which the unit is attached.

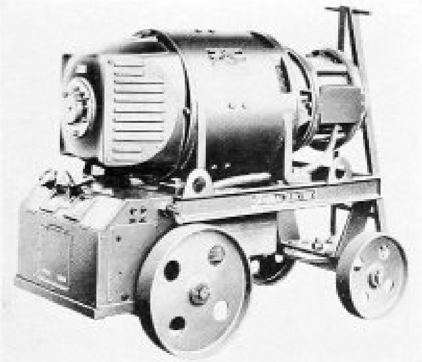
Electric Welding Equipment

The General Electric Company, Schenectady, has made a complete study of railroad welding applications and is in position to supply suitable equipment to meet any and the most rigid specifications.

The company has a complete range of electric-welding equipment, including stationary and portable welding sets for manual or automatic operation with motor or gas-engine drive; a complete assortment of welding electrodes, including bare, washed, or lightly coated, heavy-coated and special electrodes to meet particular requirements (Type F for general-purpose welds on boiler construction; Type M for welding flue beads to back flue sheets; Type L for frame and motion work; Type W-20 for high-speed welding; Type W-85 for manganese welding; and Type W-90 for battered rail ends).



Automatic arc-welding head



G. E. portable arc-welder

The General Electric also has a complete line of welders' accessories, including helmets, hand shields, protective glass, electrode holders, gloves, aprons, sleeve protectors, ultra-violet-ray paint, etc.

The company also maintains a complete application service directed by a G. E. railroad-welding specialist.

Refractory Products for Locomotive Boilers

The General Refractories Company was formed in 1911, acquiring at that time the Olive Hill Fire Brick Company with plant at Olive Hill, Kentucky and the W. H. Wynn and Company with plants at West Decatur (Blue Ball) and Sandy Ridge, Pa. Since that time, in addition to extensions to the original plants and the building of many new units, the following well established companies have been acquired: American Refractories Company, Hayes Run Fire Brick Company, Pennsylvania Fire Brick Company, Standard Refractories Company, Mount Union Silica Brick Company, Karthaus Fire Brick Company, Evens & Howard Fire Brick Company, Stevens, Inc., and Kier Fire Brick Company.

At the present time, twenty-one plants are owned and operated, with a combined capacity of more than a million brick per day.

It has always been the aim of the General Refractories Company to supply the highest grade brick and refractory materials. The brands manufactured have proved their quality by long and unexcelled records which cover locomotive arches, blast furnace and stove work, the open hearth, soaking pit, heating and puddling furnaces, bee hive and by-product coke ovens, cupolas, malleable furnaces, glass works, lime and cement kilns, boiler settings, copper refining and smelting furnaces, gas works, oil refining stills, paint and chemical industries, etc.

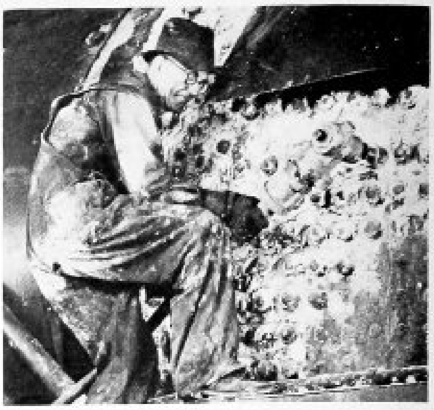
The management of the General Refractories Company has been engaged in the manufacture of high-grade refractories for many years, and each department, from the mines to the finished product, is under the supervision of men of long experience and known ability. With the very best of raw materials available in vast deposits, carefully selected at the mines, and with the painstaking care and attention given to the details of manufacturing, the General Refractories Company is in position to take care of all railroad arch and fire-brick requirements.

Pneumatic and Electric Portable Tools

The Buckeye Portable Tool Company, Dayton, O., manufacturer of Hercules pneumatic and high-frequency electric tools, placed the first successful pneumatic tool of the rotary type on the market in 1921.

In the intervening years they have developed a number of entirely new tools not previously on the market, particularly the disk sander, the frame jaw and rod grinder and now the power wrench with hand ratchet attachment.

The new Hercules pneumatic wrenches with hand ratcheting attachment are all of the close-quarter right-angle type and were designed and built especially to meet the needs of locomotive and boiler shops for a tool which would eliminate entirely the use of a hand ratchet wrench for cracking loose extremely tight nuts which can then be run off by the air motor, and for setting up nuts to maximum tightness, such as on cylinder heads, locomotive front ends, driving staybolts, staybolt caps, etc.



Hercules pneumatic wrench in service

Another Hercules Tool which has proven very popular in boiler shop use is the No. 16-3 drill for tell-tale hole drilling. While very light in weight, it has ample power for this operation and is absolutely vibrationless.

In addition to those previously mentioned, the Hercules line includes drills and reamers, screw drivers, nut runners, grinders, sanders, polishers, etc., in a wide range of sizes and types, all of which have been built with this one aim: "Designed to fit the job—Built to stand the gaff."

The Modern Locomotive

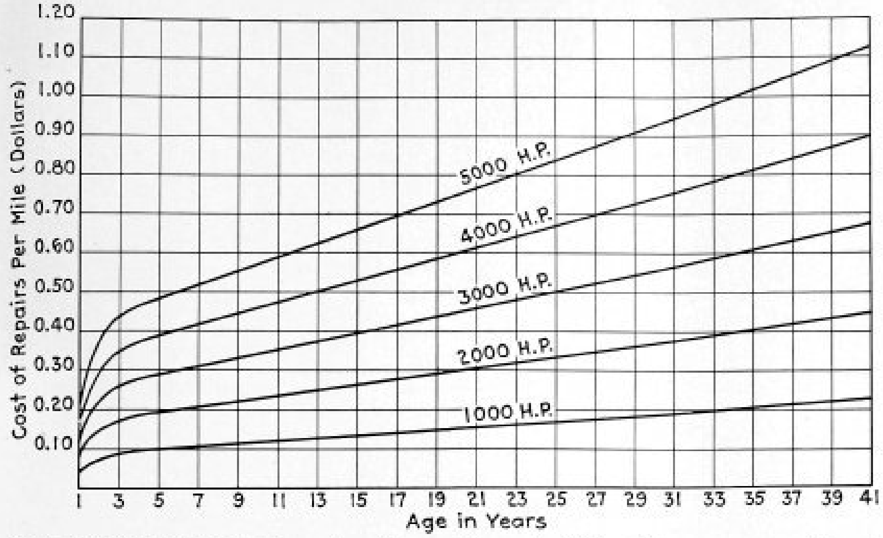
The Baldwin Locomotive Works, Philadelphia, has devoted more than a century to the development of the steam locomotive. However, the advancement in the art of locomotive building was never greater than during the past twelve years. The result is the modern locomotive with great potential boiler horsepower, high steam pressure, high steam temperature, high superheat and big driving wheels.

At thirty miles per hour, these locomotives will do twice as much work as their predecessors of only ten or twelve years ago.

This means that modern locomotives, replacing those twelve or more years old, will handle the same traffic with fewer locomotives and trains, permit higher scheduled speeds and show savings in the fuel and water consumed.

Take the example of one railroad on which twenty-two modern 4-8-4 type locomotives have replaced twice as many locomotives of the 4-6-2 and 2-8-2 types. The savings shown by the new locomotives amount to 38 percent on the investment. They have eliminated 650,000 train miles per year. Schedules have been accelerated 10 to 15 percent. Saving in fuel amounts to 10 percent on the basis of gross ton-miles per pound of coal.

Studies of actual repair costs of 10,983 locomotives covering 26,401 locomotive years, have shown that repair cost rises steadily during the first four years of life of the locomotive. After that the cost rises less rapidly but steadily for the remaining years of life. The average repair



Cost of repairs per locomotive mile of locomotives with different horsepower capacities at various years of age, showing how cost steadily increases

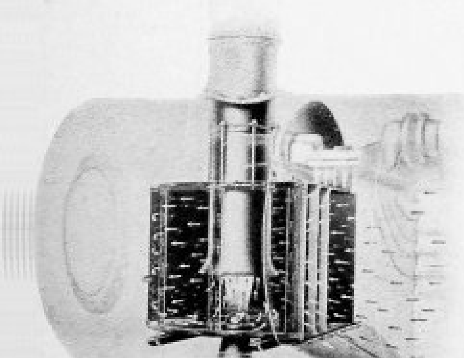
cost of a fleet of locomotives will increase 35 percent between the ages of 10 and 20 years.

This two-fold saving—lower operating costs and lower maintenance costs—makes the modern locomotive a good investment. About one-third of a railroad's total operating cost is chargeable to the locomotive. Therefore, any saving in this group of accounts is quickly translated into lower total operating cost and better net operating income.

The Cyclone Front End

The Locomotive Firebox Company, Chicago, manufactures the Nicholson Thermic Syphon, which was designed to provide added heating surface in the firebox and to create rapid boiler water circulation. As a result of these functions, fuel economy and increased boiler capacity are promoted, flue and firebox life materially increased, and general boiler maintenance reduced. Protection also is afforded against boiler explosion in case of low water.

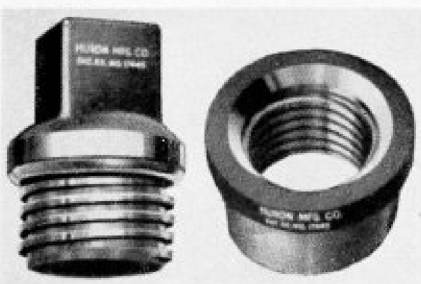
This company also manufactures the Cyclone Front End as shown in the accompanying illustrations. It is composed of a circular drum surrounding the extension stack and exhaust nozzle, with deflector vanes so placed as to create centrifugal travel of the gases before entering the stack. By this centrifugal action and delayed entrance of the gases into the stack, the live cinders are broken up and cooled sufficiently so that sparkless operation is assured. With this front end no netting is required. Draft conditions are improved, making it possible to increase the size of the nozzle tip, with a resultant decrease in back pressure. Reduced fuel consumption, increased hauling capacity or speed of the locomotive, together with other advantages, are claimed for the device.



Phantom view of cyclone front end

Washout Plugs for Locomotives

The Huron Manufacturing Company, Detroit, is the originator of square thread washout plugs for locomotives.



Huron square thread washout plug

For the past eleven years the Huron plug has set the standard on railroads for safety, economy and performance.

Huron plugs are solid steel forgings with sturdy square threads which will not wear or shear, eliminating blow-outs and overcoming the personal injury hazard. The special built-in leak-proof copper gasket, which forms an integral part of the plug, insures a steam-tight joint that stays tight.

Huron plug applications eliminate constant replacement, as they last the life of that part of the boiler in which they are installed.

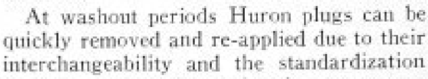
At washout periods Huron plugs can be quickly removed and re-applied due to their interchangeability and the standardization of sizes, which also makes it unnecessary for large stocks to be carried in storehouses.

The superiority of Huron plugs has been proven for the past eleven years, and while they have been imitated they have never been equaled.

Ideal Flue Tools

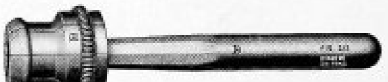
This opportunity is taken to advise users of Ideal flue tools that the firm of Gustav Wiedeke Company, Dayton, O., has issued a most instructive Ideal Catalogue No. 57, which illustrates and describes Ideal flue tools which have been a specialty of the company for over forty years.

Most of the tools supplied by the company are self-feeding for power use but can also be used by hand. In the catalogue, in addition to a description, the range of each tool is clearly indicated to enable the selection of the largest size expander that will enter the inside diameter of the tubes. The usual methods of setting copper ferrules, expanding, beading and flaring tubes are listed for the benefit of the practical boiler maker.



Ideal power roller type expander

Railroad safety power tube cutter



Sectional power tube expander

Most of the Ideal self-feeding power expanders have long reversible rolls which double the life of the expander as well as make rolling easier and avoid cutting into the mandrel. A large assortment of sectional expanders for use in the firebox tube sheet is listed for selection.

A special section of the catalogue is devoted to descriptions of the railroad safety power tube cutter which cuts off tubes in one revolution uniformly 1½ inches from the outside of the flue sheet.

Tube cutters for boiler manufacturers and repair men, as well as expanders for power plant use, are featured. A portion of the catalogue is of special interest to the refinery still foreman, showing a group of heavy duty expanders to roll and flare heavy wall tubes in return bends and flanges.

It is suggested for full details of these and other Ideal flue tools supplied by Gustav Wiedeke Company, that readers write directly for copies of this interesting and instructive catalogue.

A New Development in Flue Cleaning

During the many years that have elapsed since locomotives were first used there has been little change in the method of removing the scale, which forms on the outside of the boiler flues.

About five years ago Joseph T. Ryerson & Son, Inc., Chicago, developed an entirely different method of removing scale from boiler flues. For many years they had manufactured a machine called the Universal flue cleaning machine. This machine would crack the scale, but the flues were not sufficiently clean to allow the safe end to be electric welded, without polishing.

To the former Universal flue cleaner, Ryerson added a sand blast cabinet, through which the flue is propelled, and a pulling machine which pulls the flue through this cabinet, after it leaves the scale-cracking machine.

In the sand blast cabinet, a series of nozzles are arranged in a manner which allows them to be adjusted for various sizes of flues. To prevent dust in the shop, a powerful blower is used, connected to a dust arrester. Noise, which was always an objection with the use of the barrel type rattler, has been reduced to a minimum.

The action of the sand blast exposes all pit holes, making inspection comparatively easy.

The speed at which the flues revolve in the cracking and pulling machine loosens all soot on the inside of the flue, and this accumulation can readily be blown out.

Several installations of this cleaning unit have been made, the latest being at the Sayre, Pa. shops of the Lehigh Valley Railroad.

Personal

Joseph Franklin has been appointed labor advisor for the metal tank industry by the Labor Advisory Board of the National Recovery Administration.

William A. Nevin, of Joliet, Ill., has been appointed by the National Recovery Administration industrial advisor for the steel tubular and firebox boiler industry.

C. H. Rose, assistant treasurer of the Youngstown Sheet & Tube Company, Youngstown, O., has been elected by the board of directors to serve also as assistant secretary.

W. B. Gillies, vice-president in charge of operations of the Youngstown Sheet & Tube Company, Youngstown, O., has announced the appointment of W. T. Filmer as supervisor of safety for the company's plants in the Youngstown district. Mr. Filmer has had long association with the Youngstown Sheet & Tube Company, and formerly was fire prevention director.

Gilbert L. Yetter, formerly materials engineer in the Bureau of Construction and Repair, Navy Department, has been appointed welding engineer for the Bureau of Reclamation, Department of the Interior, assigned to the Boulder Canyon Project. Mr. Yetter is supervising the inspection of the fabrication of the welded steel penstocks being manufactured for the project.

At the recent stockholders' meeting of the Newhall Chain Forge & Iron Company, Harry C. Brown, the former vice-president, was elected president to fill the vacancy caused by the recent death of the late Henry B. Newhall. Mr. Brown has been associated with the company for about thirty-four years in various capacities and has served as vice-president in charge of manufacture and sales since 1909. The company will again, as it did up to about seven years ago, operate as an entirely independent organization and will no longer be connected with any other corporation. The New York offices and warehouse will remain at 48 West Broadway and the company will continue to operate its chain and forging works at Rensselaer, N. Y.

Emmett K. Conneely has been appointed manager of railroad sales by the Republic Steel Corporation, according to an announcement made by N. J. Clarke, vice-president in charge of sales. Mr. Conneely served in various capacities with the Pittsburgh and Lake Erie Railroad during his early business life, joining the Standard Steel Car Company during the war. He was later connected with the New York Air Brake Company as vice-president and became vice-president of the Pullman Company at New York upon that company's acquisition of the Standard Steel Car Company. He was subsequently made vice-president of the Standard Steel Car Company at Chicago. Mr. Conneely will make his headquarters at the Republic general offices in Youngstown, O.

The Boiler Maker

VOLUME XXXIII NUMBER 10

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The Boiler Maker

Reg. U. S. Pat. Off.

Send Your Discussions on M.B.M.A. Committee Reports

The October issue of THE BOILER MAKER was devoted almost exclusively to the Master Boiler Makers' Association Convention in Print. Letters from individuals throughout the entire field of boiler construction and maintenance, and particularly superintendents of motive power, indicate the widespread interest created by this effort of the association.

The full value of this convention cannot be realized until discussions of the committee reports presented have been received from members of the association. It is the purpose of the officers to have such discussions published in these pages, and later to combine the full convention, including committee reports and their discussions, in the form of Proceedings.

Unlike other conventions of the Master Boiler Makers' Association, readers in general who are informed on the practices covered by the reports are invited to submit discussions, in order that the most complete information possible may be compiled on each topic for the information of the entire industry.

It is the hope of those who have given unsparingly of their time and energy in preparing the convention, and making it successful, that members and others who intend to discuss the committee reports do so without delay in order that publication of the Proceedings may be speeded.

Write a communication at once, outlining your views on any of the subjects covered in the October issue, and send it either to Albert F. Stiglmeier, secretary of the Master Boiler Makers' Association, at 29 Parkwood Street, Albany, N. Y., or directly to the editor of THE BOILER MAKER. Do not delay, because when sufficient time has been allowed to prepare discussions, those received will be published and the Proceedings will be closed.

Administering the Boiler Manufacturing Code

Since October 16, the boiler manufacturing industry has been governed by a code of fair competition, which was approved by President Roosevelt, on October 3 under provisions of the National Industrial Recovery Act. Machinery was set up some months ago by the American Boiler Manufacturers' Association Industrial Recovery Committee to provide for the administration of the code. It is now essential that this central agency, provided by more than seventy percent of the boiler manufacturing and affiliated industries, be supported by all companies governed by the code. If this code is to function successfully, and if its provisions are to be administered uniformly and fairly throughout the industry, it is absolutely essential that every concern, large or small, become affiliated with and support the organization performing the duties of applying it.

The warning has been expressed by the President of the United States himself, not once but many times, that the entire program of recovery within any industry can be frustrated by the few companies who remain without the pale and persist in unfair competition. These the penalties of the Recovery Act will eventually reach. In this industry, however, which does not involve a tremendous membership, there should be every reason for companies not now enrolled in the American Boiler Manufacturers' Association to affiliate themselves without delay. Seventy percent of the industry is not sufficient representation in this old-established organization, recognized because of its prestige as the proper body for governing the industry.

The advantages of uniformity of procedure in administration, combined with the moral force within its ranks for controlling competition on a fair and equitable basis under the code, should make membership extremely attractive to every concern manufacturing boilers, Class One welded pressure vessels, stokers, pulverizers or products of other affiliated industries.

The National Board Meeting

The National Board of Boiler and Pressure Vessel Inspectors may be justly proud of the impressive program which it so successfully covered at its ninth annual meeting, held in New York in October.

The National Board of Boiler and Pressure Vessel Inspectors was organized for the purpose of promoting 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, and to secure interchangeability between political subdivisions of the United States.

How extremely successful it has been in fufilling its functions was demonstrated in the addresses presented by authorities from the various fields affected by its work and by the papers and comments which cover every phase of activity of the board.

The proceedings of this meeting are of such importance to the boiler manufacturing and pressure vessel industries that they will be published in complete form in these pages. The papers and comments of the first session appear in this issue. Later issues will carry the addresses and reports of remaining sessions until the entire proceedings have been made available for the information of all our readers.

Code of Fair Competition for the Boiler Manufacturing Industry . . .

On October 3, President Roosevelt approved the code of fair competition which is to govern the boiler manufacturing industry. The code provisions are as follows:

Article I—Purpose

To effectuate the policy of Title I of the National Industrial Recovery Act, the following provisions are submitted as a code of fair competition for the boiler manufacturing industry, and upon approval by the President shall be the standard of fair competition for this industry.

Article II—Definitions

The term "boiler manufacturing industry" shall be held to comprise all persons engaged in the manufacturing of all types of steel steam boilers for stationary and marine use (except boilers for locomotives and such boilers as may be specifically covered by codes approved hereafter by the President), stokers of 36 square feet of grate area and over, pulverized fuel equipment, superheaters, air preheaters, and economizers, and Class One welded pressure vessels, as defined in the unfired pressure vessel section of the Boiler Code of the American Society of Mechanical Engineers, and, with the approval of the Administrator, such other affiliated groups as may request inclusion.

The term "employer" as used herein shall mean any member of the industry.

The term "employee" as used herein shall mean any person employed in any phase of the industry, however compensated.

The provisions of this Code shall become effective on the second Monday after the approval by the President.

Article III—Application

The American Boiler Manufacturers' Association representing the industry hereby accepts and agrees to be bound by the following and/or other regulations established by the A. B. M. A. Committee of Industrial Recovery (duly constituted by the American Boiler Manufacturers' Association in convention assembled June 5, 1933, as the agency for the preparation and administration of this Code), and approved by the President of the United States, and enforced impartially on all manufacturers in the industry whether members of this association or not.

Article IV—Child Labor

No member of this industry shall employ any person under 16 years of age, provided, however, that where a State law provides a higher minimum age no person below the minimum provided by such State law shall be employed in that State.

Article V—Hours

Section 1. (a) No employer shall employ, in any labor operations, any person more than 40 hours per week, five consecutive days and eight consecutive hours per day, except as provided under paragraph (b), provided, however, that where it is necessary to work less than 40 hours per week, the hours may be divided by agreement between the employer and the employees to a lesser number of days per week, but in no case shall the hours exceed nine per day.

(b) In cases of emergency production, repair, or erection work that cannot be met by the employment of additional men and it becomes necessary, in order to protect life or property, to exceed the hours scheduled in (a), all such excess time shall be paid for at the rate of not less than one and one-half times the hourly rate for shop work and not less than double time for all repair, renewal, and construction and/or erection work.

(c) No new apprentices shall be employed in the industry except that the Administrator may grant the employment of such new apprentices if in his judgment the existing surplus of unemployed labor is absorbed in reasonably steady employment.

(d) For all other employees except executive, administrative and supervisory employees, and traveling and commission salespeople, the time worked shall not be in excess of 40 hours per week.

Sec. 2. No employee shall be employed or permitted to work for one or more employers in the industry in the aggregate in excess of the prescribed number of hours in a single week; provided, however, that if any employee works for more than one employer for an aggregate period in excess of such maximum without the connivance of any one of such employers, said employer shall not be held to have violated this paragraph.

Article VI—Wages

Section 1. (a) The minimum wage that shall be paid by any employer to any employee of the boiler manufacturing industry in labor operations directly incident thereto shall be 34 cents per hour for the Southern territory and 40 cents per hour for all other portions of the United States. The Southern territory is located south of the States of Maryland, West Virginia and Kentucky, and east of the Mississippi River.

(b) Old or partially disabled employees, and watchmen, are not included in the above labor provisions, except that they shall in no case be paid less than 80 percent of the above minimum, and provided that the total number of such employees shall not exceed 2 percent of the total number employed by any one employer, or where less than one hundred persons are employed such employer shall be entitled to two (2) employees of this class.

(c) The minimum wage that shall be paid by any employer to all employees, other than those covered in Section (a) except commission salespeople, shall be at the rate of $15.00 per week, provided, however, that office boys and girls may be paid not less than 80 percent of such minimum wage; but the total number of such office boys or girls shall not exceed in any calendar month 5 percent of the total number of all employees covered by the provisions of this paragraph (c), and provided, further, that where a State law provides a higher minimum wage, no person shall be paid a lower wage than that required by such law within that State.

Sec. 2. Any system of contracting shop work by which an employee undertakes to do a piece of work at a specific price and engages other employees to work for him is prohibited by this Code.

Sec. 3. The wage differentials for all operations shall be equitably readjusted, and in no case shall they be decreased. No unfair advantage shall be taken of any employee in making this Code effective. Each member of the industry shall report all such readjustments to the Code Authority within 30 days of the effective date.

Sec. 4. No employer shall contract for the fabrication and/or erection of any product of this industry with any employer or employee except when such employer or employee agrees to comply with the labor provisions of this Code during the performance of the contract.

Sec. 5. Each employer shall post in each workshop and central notice board in his factory Articles V and VI of this Code.

Article VII—Statutory Provisions

All employers in the industry shall comply with the following provisions of the National Industrial Recovery Act:

1. That employees shall have the right to organize and bargain collectively through representatives of their own choosing, and shall be free from the interference, restraint or coercion of employers of labor, or their agents, in the designation of such representatives or in self-organization or in other concerted activities for the purpose of collective bargaining or other mutual aid or protection.

2. That no employee and no one seeking employment shall be required as a condition of employment to join any company union or to refrain from joining, organizing, or assisting a labor organization of his own choosing; and

3. That employers shall comply with the maximum hours of labor, minimum rates of pay, and other conditions of employment, approved or prescribed by the President.

(a) Nothing in this Code is to prevent the selection, retention, and advancement of employees on the basis of their individual merit.

Article VIII—Participation

1. Any member of the industry may participate in the endeavors of the A.B.M.A. Committee of Industrial Recovery in the preparation of any revisions of, or additions or supplements to, this Code by accepting the proper pro rata share (in the proportion of dollar billings by each in the industry to the total dollar billings of this industry or in such other manner as the A.B.M.A. Committee of Industrial Recovery may deem advisable, subject to the approval of the Administrator) of the cost and responsibility of administering this Code; provided, however, that no inequitable restriction upon membership in the association shall at any time be imposed.

2. The association and its members bind themselves in every way to carry out the spirit as well as the letter of this Code.

3. This Code is adopted in a spirit of fairness to all concerned, and it is the intention of the members of the industry to accord to those from whom they purchase the same treatment that they expect to receive from those to whom they sell.

Article IX—Administration

1. To facilitate the effective administration of this Code, and to provide the Administrator with requisite data as to the observance or non-observance thereof, the A.B.M.A. Committee of Industrial Recovery is hereby designated as a Planning and Fair Practice Agency to co-operate with the Administrator in the enforcement of this Code. The Administrator may also appoint one or more representatives to serve with the committee in an advisory capacity. Such appointees to have no vote. Such committee shall have the following powers and duties, all of which shall at all times be subject to the approval of the Administrator:

(a) To collect from the members of the industry the reports and data provided for in this Code, or in any supplement thereof, which may hereafter be adopted. These reports and data shall be submitted to a full-time manager (or his deputy) who shall be appointed by the committee. All such reports and data shall be kept confidential by such manager (or his deputy) excepting insofar as may be necessary for the effective enforcement of this Code, but shall be available to the Administrator and his representatives.

(b) In addition to information required to be submitted to the committee, there shall be furnished to government agencies such statistical information as the Administrator may deem necessary for the purpose recited in Section 3 (a) of the National Industrial Recovery Act.

(c) To authorize the manager (or his deputy) to make such investigations as in its opinion may be necessary to effectuate the proper administration of this Code.

(d) To make reasonable rules and regulations designed to help effectuate the purposes of the Code.

(e) To hear complaints and, if possible, adjust the same.

Article X—Fair Practice

1. In the conduct of its business, each member of the industry shall use a method of cost accounting which recognizes and includes all items entering into costs, as set forth in the Standard Accounting and Cost System adopted by The Machinery Builders Society, 4th Edition, revised September, 1933, such system of accounting to be subject to the approval of the Administrator.

2. No member of this industry shall sell any combination of products, except repair and replacement parts, manufactured by him, or by any owned or controlled subsidiary, at a price less than the sum of his established selling prices for all items included in such combination.

3. No member of the industry shall make payment or allowance of rebates, refunds, credits, or unearned discounts, whether in the form of money or otherwise, or extend to certain purchasers services or privileges not extended to other purchasers under like terms and conditions.

4. The settlement of old accounts for less than the full amount as a consideration for accepting a proposal is prohibited under the meaning of clause 3.

5. No member of the industry shall make a deposit for the privilege of receiving plans and specifications and the opportunity to bid on a contract without an agreement by the issuer that such deposit will be returned to said member of the industry when the contract has been awarded or when said plans and specifications have been returned by said member to the issuer.

6. The committee will recommend to the Administrator forms of contract which, when approved, will be standard in all respects, except that they will not attempt to describe the equipment quoted upon. They will standardize the wording of all general conditions, warranties, terms, and deferred payments, guarantees of performance (if any) bonus and penalty clauses (if any), etc. These forms of contract and no others shall be used

by the industry except in cases where Federal, State, or Municipal laws necessitate otherwise.

7. No member of the industry shall make a guarantee of maintenance because of the impossibility of defining and maintaining the conditions under which such a guarantee can honestly be made. Guarantees of performance are permissible when conditions, under which such guarantees are to be met, are definitely stated. Guarantees of workmanship and material are quite proper. No member of the industry shall promise a better performance or make a higher guarantee than his previous experience leads him to believe he can obtain.

8. No member of the industry shall accept a contract containing a penalty clause either for performance of the apparatus sold or for time of delivery, unless the contract shall also contain a clause providing a bonus to the contractor at the same rate as the rate of penalty, except in cases where Federal, State, or Municipal laws necessitate otherwise.

9. No member of the industry shall accept a contract containing a clause providing for liquidated damages, except in cases where Federal, State, or Muncipal laws necessitate otherwise.

10. Where purchaser's specifications include a bonus clause for performance, efficiency, etc., in excess of that guaranteed, no member of the industry shall deduct from the price any bonus or portion thereof which he anticipates will be earned by reason of his obtaining a better performance or efficiency than that guaranteed.

11. Where purchaser's specifications include a penalty clause for performance, efficiency, etc., less than that guaranteed, no member of the industry shall make a guarantee in excess of that which he expects to obtain anticipating the acceptance of a penalty as a basis for reducing the cost to the purchaser.

12. No member of the industry shall circulate threats of suit for infringement of patents or trade marks among customers of a competitor not in good faith but for the purpose of harassing and intimidating customers.

13. No member of the industry shall disseminate false or misleading information relative to competitor's products, selling prices, credit standing, ability to perform work, or labor conditions among competitor's employees.

14. No member of the industry shall make false or misleading statements as to time of delivery, performance, facilities, equipment, or ability to perform work.

15. No member of the industry shall attempt to induce the breach or abandonment of any contract between a manufacturer and his customer.

16. No member of the industry shall be a party to commercial bribery in any form or under any condition.

17. No member of the industry shall enter into a written or oral agreement with any person that one or more clauses of the contract or the specification will not be enforced, thereby receiving an unfair advantage over competitors.

18. No member of the industry shall purchase patents from customers, their officers, engineers, or employees, for the purpose of influencing sales to such customers.

19. No member of this industry shall cause or permit any conduct by any one of his employees or agents which would constitute a violation of this Code.

Article XI—Monopolies

No provision in this Code shall be interpreted or applied in such a manner as to:

1. Promote or permit monopolies or monopolistic practices;

2. Permit or encourage unfair competition;

3. Eliminate, discriminate against, or oppress small enterprises

Article XII—Rights of President

This Code is hereby made expressly subject to the right of the President, pursuant to Section 10(b) of the National Industrial Recovery Act, from time to time to cancel or modify any order, approval license, rule, or regulation issued under Title I of said Act, and specifically, but without limitation, to the right of the President to cancel or modify his approval of this Code or any conditions imposed by him upon such approval.

Article XIII—Amendments

Such of the provisions of this Code as are not required to be included therein by the National Industrial Recovery Act may, with the approval of the President, be modified or eliminated upon the application of the A.B.M.A. Committee of Industrial Recovery as changes in circumstances or experience may indicate. It is contemplated that from time to time supplementary provisions to this Code or additional Codes will be submitted by the A.B.M.A. Committee of Industrial Recovery for the approval of the President to further effectuate the purposes and policies of Title I of the National Industrial Recovery Act consistent with the provisions hereof.

Welding Torch

The Linde Air Products Company, 30 East 42nd Street, New York, has announced the addition of a new welding torch to its Purox line of oxy-acetylene apparatus. Designated as the Purox No. 28, this welding torch has the same wide range of usefulness, and the same high efficiency and economical gas consumption as the Purox No. 20 torch, but is somewhat different in design. Its utility is such that it will handle heavy-duty work as easily as the average job.

Ten one-piece, 60-degree, goose-neck tips, numbered from 6 to 15, are available for use with this torch. They are usually well built, with plenty of hard-drawn copper stock to withstand the intense reflected heat of the heaviest welding job. By means of a union nut these tips may be adjusted so as to point in any direction. Thus, overhead or vertical welding can be accomplished without any change in the normal grip of the torch handle.

Tips Nos. 6, 8, 10, 12, and 14 are furnished with the torch, giving it a range from 16 gage sheet up to heavy castings. By using the Purox No. 21 cutting attachment with this torch, steel up to 2 inches in thickness can be cut.

Enduro Chromium Steels

Republic Steel Corporation, Central Alloy Division, Massillon, O., has recently issued a booklet on the new "Enduro 4-6 Percent Chromium Steels."

This booklet gives a fund of valuable information on the qualities and properties of this new material. Enduro 4 to 6 percent chromium steels possess resistance to corrosion, acid attack and scaling at elevated temperatures sufficient to render them well adapted for a number of applications, particularly in the oil refining industry. In addition, they can be rolled, formed, drawn, forged, welded or riveted into almost any shape desired if certain precautions are observed during handling. They are available in all the usual forms, such as sheets, plates, hot and cold rolled strip, bars, etc.

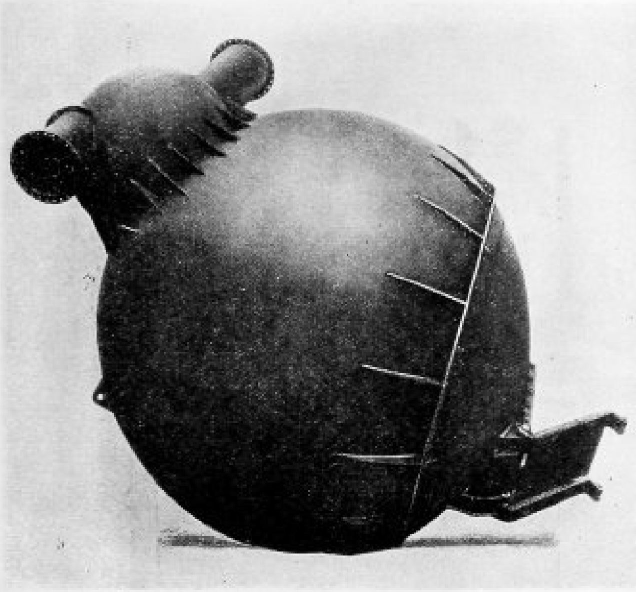


Fig. 1.—Dredge rock trap weighing 31 tons

Arc-Welded Tanks

Recent unusual vessels and tanks fabricated with the shielded-arc welding process

Unique in both construction and application, a huge dredging boulder trap of arc-welded construction was completed recently by The Graver Tank and Manufacturing Corporation, Chicago. The unit was built for use on the suction line of a large dredge to be used on the Cape Cod Canal.

The trap shown in Fig. 1, is installed directly in the bottom of a large sea-going dredge. The trap door at the bottom of the ball opens through the hull of the boat directly into the ocean.

At the upper portion of the large 18-foot ball there is a smaller sphere approximately 5 feet in diameter fully reinforced, which acts as the intake and outlet attachment for the regular dredge line. This smaller sphere contains in its interior a large grill or grizzly which serves to separate from the incoming stream of dredge material, all boulders and other bulky objects of a size too great to be passed by the sump on the dredge proper.

In operation, the stream of incoming dredge materials from the cutter head is drawn through this smaller sphere where the larger particles are screened out and dropped into the main ball below. Whenever the accumulation of these larger lumps is sufficient to fill the larger ball, the vessel is disconnected from the dredge

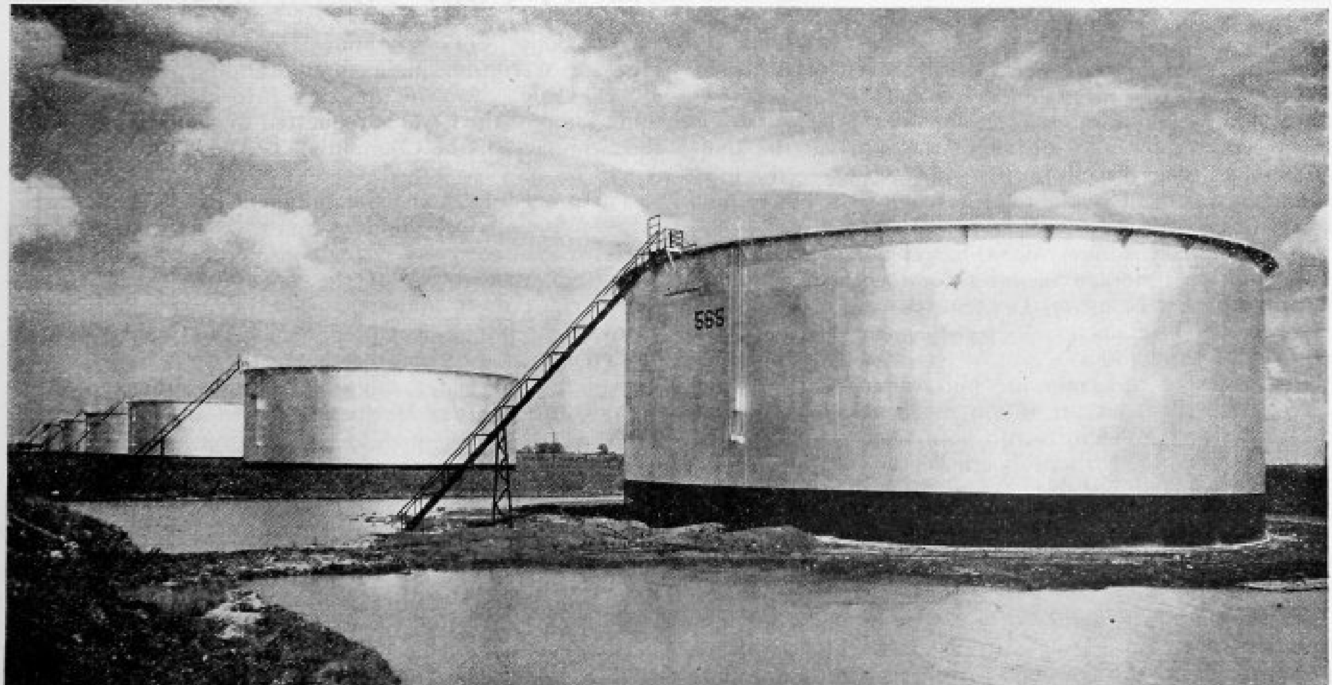


Fig. 2.—Seven arc-welded, 93,000 barrel tanks at Houston, Texas

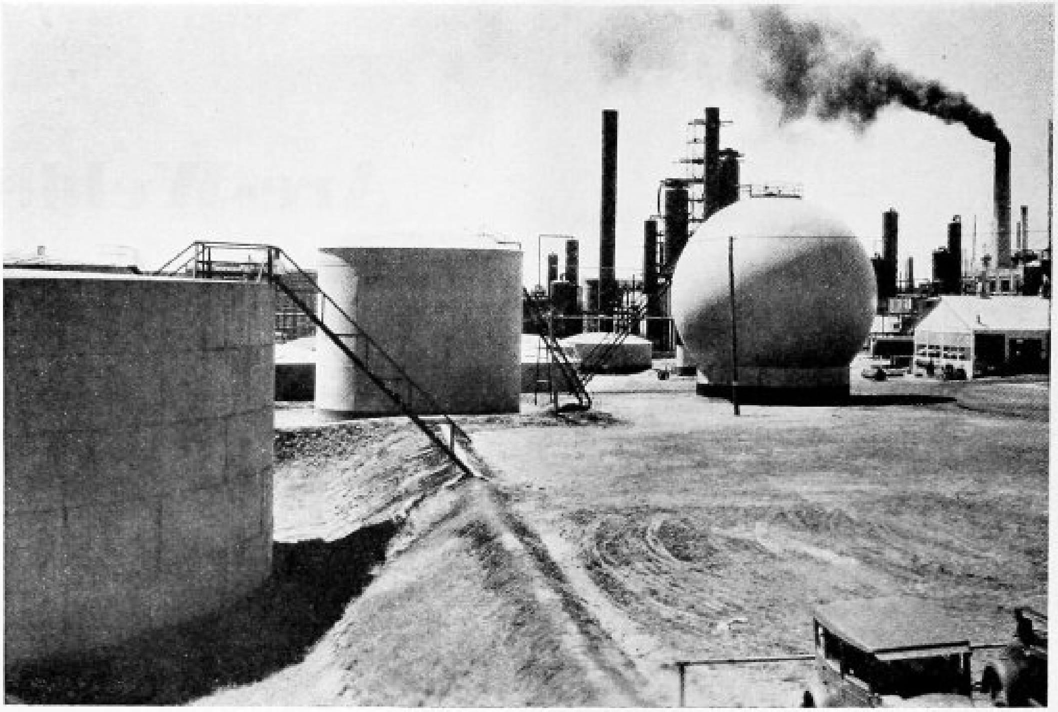


Fig. 3.—Arc-welded tanks and Hortonsphere

line, run out into deeper water, the bottom dropped, and the load of boulders spilled into the open sea, after which the trap door is again closed and the dredge returns to its point of operation. The unit operates under a vacuum of 15 pounds per square inch. Heavy steel plate was used for the trap. The shell plates of the large sphere are 1¼ inches thick. The entire unit was assembled by arc welding. The shielded-arc process was employed.

Very great skill was exhibited in the forming of the plates and the welding of these individual fragments together to make a perfect sphere, as the stresses set up in ordinary welding are great enough to have distorted the unit had it not been for exceptional care in applying the welding operation. On account of the large size, it was necessary to fabricate all of the units in the shop and deliver them directly to the shipyard where the final assembly was made. The total weight of the entire unit is 31 tons.

In Fig. 2, seven new 93,000-barrel tanks which provide additional storage facilities for the Sinclair Refining Company at Houston, Tex., are shown. These tanks are 120 feet in diameter, 46 feet 4 inches high and are arc welded throughout.

The sides of the tanks are butt welded. The plates were made flush on the inside to form a cylinder of uniform diameter from top to bottom, a condition very desirable for the efficient operation of floating roofs. All tanks are equipped with Wiggins floating roofs. The roofs as well as the bottoms are lap welded.

These tanks which add 651,000 barrels capacity to Sinclair facilities were built by The Chicago Bridge and Iron Works.

The results of a century of progress in tank construction are shown in Fig. 3. In the left foreground are two arc-welded storage tanks; in the center is the most recent of all developments in tank construction, the Hortonsphere. This tank was built for the Empire Refining Company, Ponca City, Okla., by the Chicago Bridge and Iron Works. It is completely arc welded by the shielded-arc process.

All equipment used for the construction described was manufactured by The Lincoln Electric Company, Cleveland, 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. Anyone 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 given records of the interpretation of this Committee in Cases Nos. 727 (Reopened), 756 to 760 as formulated at the meeting of September 14, 1933, all having been approved by the Council. In accordance with established practise, names of inquirers have been omitted.

Case No. 727 (Reopened). *Inquiry:* In the application of a fusion-welded nozzle which requires stress relieving, to a Class 2 unfired pressure vessel which is not required to be stress relieved, is it permissible to heat locally the nozzle and an annular ring of the shell or head around the nozzle?

Reply: It is the opinion of the Committee that recent experience justifies a modification of the original reply in this Case so that on Class 2 vessels, nozzles or welded attachments for which stress relief is required may be locally stress relieved by heating an annular ring around the nozzle or attachment, provided any part of the welded edge thereof is not less than $12t$ (t = thickness of plate) from the nearest adjacent welded joint or other element that would tend to restrict the free expansive movement of the heated area. The outside dimensions of this annular ring to be heated shall be at least $6t$ away from the outermost weld but not less than 5 in., and the entire area shall be heated simultaneously.

CASE No. 756 (In the hands of the Committee)

CASE No. 757 (In the hands of the Committee)

CASE No. 758 (In the hands of the Committee)

CASE No. 759—*Inquiry:* Par. U-59*b* is not quite clear as regards the stress relieving of connections attached by welding to riveted vessels that are used in Class 3 service. Do such connections require to be stress relieved?

Reply: It is the opinion of the Committee that under the requirements of Par. U-59*b* connections attached by fusion welding to riveted vessels used in Class 3 service are not required to be stress relieved. However, all the provisions for welding nozzles in Class 3 welded vessels must be complied with and the vessels shall be stamped Class 3.

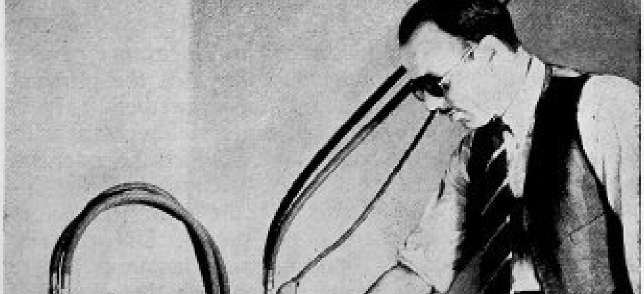
CASE No. 760—*Inquiry:* Is it permissible to use cast steel in water heads, shell heads, and floating heads of unfired pressure vessels, and what is the allowable working stress therefor?

Reply: It is the opinion of the Committee that under the terms of Par. U-12, cast steel may be used for water heads, shell heads, and floating heads of unfired pressure vessels with an allowable working stress of 7000 pounds per square inch.

New Portable Cutting Machine

A portable cutting machine weighing but 43 pounds has been announced by The Linde Air Products Company, New York, as an addition to its Oxweld line of apparatus. It is known as the Secator.

Combining the portability of a blowpipe with the accuracy and finish of a cutting machine, the Secator makes it possible to do high quality cutting anywhere in the shop or in the field. It should be of great use in plate shops, tank shops, steel plants, moderate size metal working plants or any organization that needs a cutting machine which can be brought to the work.



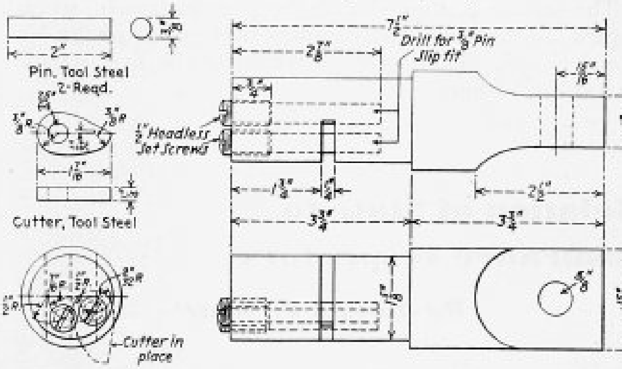
The Secator portable cutting machine

Essentially it consists of an Oxweld Type C-14-H blowpipe (especially designed for it) mounted on an electrically driven, air-cooled, dust-proof chassis. It is equipped with a direct drive and runs either on a 1½-inch angle-iron track, furnished with it, or on any relatively smooth plate. When operated on the track, it does straight-line cutting automatically. For cutting simple shapes it can be guided with a hand-grip. For automatic circle-cutting, a center and a radius rod are furnished. For convenience of control, the oxygen and acetylene valves are on the chassis rather than on the blowpipe. The blowpipe can be adjusted vertically and horizontally and also to cut bevels up to 45 degrees. Its cutting range is that of the C-14 blowpipe and the cuts are so clean and smooth that for many purposes machining is unnecessary.

A universal motor that may be used on either 110- or 220-volt circuits operates the Secator. Even inexperienced workers can quickly learn to handle this machine with ease.

Flue Cutter

A flue cutter of the same general design as commonly used, but incorporating certain dimensions and proportions which greatly increase its efficiency, is shown in the illustration. It consists of a soft-steel body with a square shank for driving purposes, and a slot in the cylindrical portion designed to receive a special cutter made of tool steel to the shape and dimensions illustrated. This cutter is pivoted on a ⅜-inch tool-steel pin, 2 inches long and held in place by a ½-inch headless



Tool for cutting off boiler flues

set screw. An additional positioning pin of the same size is also inserted as shown, being held by a similar headless set screw.

This tool is used for cutting off flues at the flue sheet. The flue cutter is bolted to a universal knuckle joint which is connected to a drive shaft operated by an air motor. The flue cutter is placed in the flue so that the shoulder on the cutter butts against the end of the flue. When power is applied the flue cutter rotates to the right, letting the cutting tool drop out of the slot to the cutting position. When the power is reversed the cutting tools drop back into the slot so that the cutter can be removed and placed in the next flue.

National Board of Boiler and Pressure Vessel Inspectors Expanding Its Influence

The ninth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, held at the Hotel McAlpin, New York, October 17 to 19, was noteworthy in the scope of the discussions on all phases of inspection in the boiler construction and pressure vessel fields which demonstrated the expansion of its activities since the last meeting, three years ago. More than 125 members and guests interested in the work of the organization were in attendance. C. D. Thomas, chief boiler inspector, State of Oregon, Salem, Ore., chairman of the National Board, presided over the sessions, although during discussion of special papers he turned the chair over to other members.

During the last session on October 19 W. H. Furman, chief boiler inspector of the Department of Labor, State of New York, was elected chairman of the National Board for the coming year. Other officers elected were F. A. Page, supervising engineer of the Boiler Section, San Francisco, vice-chairman; C. O. Myers, chief of the Division of Boiler Inspection, Columbus, O., secretary-treasurer; and L. C. Peal, chief boiler inspector, City of Nashville, Nashville, statistician.

The meeting was opened by C. D. Thomas, chairman, who, after delivering an address, introduced George W. Bach, vice-president and general manager, Union Iron Works, Erie, who represents the American Boiler Manufacturers' Association on the National Board. Mr. Bach's address was followed on the program with addresses by James A. Beha, general manager and counsel, National Bureau of Casualty and Surety Underwriters, New York, and Dr. D. S. Jacobus, vice-chairman, A.S.M.E. Boiler Code Committee. These addresses as yet have not been made available for publication but will appear in an early issue.

The session continued with the presentation of special papers and comments by members and guests of the National Board. The papers delivered at the first session, October 17, follow:

Relation of State to Insurance Inspectors

By Joseph F. Scott*

Looking back through the years since 1918 when New Jersey made steam boiler construction, installation and inspection a statutory requirement, under which insurance inspectors were placed on the status of authorized responsible inspectors after once being accepted by the state, to my mind, the relation between a state inspector and an insurance inspector should be a most cordial and co-operative one.

It is true that a state inspector is directly responsible to the state; it is also true that an insurance inspector has the same status even though he is not employed by the state and is subject to the state's regulations under the law in equal measure with the state inspector.

It is recognized that the insurance inspector is interested in his employer's welfare to the extent of giving good service and having satisfied clients for his employer, keeping in mind the state laws and regulations under which he functions. Therefore, he is placed in the position of having a double interest, and it goes without saying that by giving proper service and satisfying his employer's clients by safeguarding his interests consistent with the state regulations under which he operates, he is also obviously giving good service to the state.

In New Jersey we do not have dual inspections. If it is found essential to require state inspection as well as insurance inspection, it is obvious from the state's viewpoint, there must be something wrong with the insurance carrier and its inspector. On the other hand under our system, where an insurance inspector is placed under the same status as to responsibility as the state inspector, manufacturers of steam boilers and users can be reasonably assured of competent advice and inspection service either by a state inspector or an insurance carrier inspector.

In the matter of qualifying inspectors, especially those employed by insurance carriers, where a state or city has the same laws and standards, and especially where those standards are the ones adopted by the Boiler Code Committee of the American Society of Mechanical Engineers in conjunction with the National Board of Boiler and Pressure Vessel Inspectors, it would appear that, when an inspector has qualified in a code state or city, the inspector should not be required to be further examined for authority to inspect boilers in any other state or city.

The very purpose of creating the National Board of Boiler and Pressure Vessel Inspectors was to eliminate the practices that prevailed before the National Board was created, making it possible to accept boilers that were built in accordance with the regulations of the Boiler Code Committee and the National Board of Boiler and Pressure Vessel Inspectors and to accept inspectors in any state who had qualified in any other state that was recognized as operating under the same standards as those of the A.S.M.E. Code.

We realize that state inspectors and insurance carrier inspectors are vitally interested in checking the physical condition of boilers when they inspect them. It is natural for a state inspector to be more conversant with the regulations of the state under which he operates than the insurance inspector, especially when the insurance carrier is in the habit of transferring inspectors from one state to another. I am stating this primarily for the reason that we find in many instances where insurance inspectors are new in our state that they will invariably go out on field inspections and immediately make recommendations for new appliances, valves, etc., on boilers that have been operated and have, therefore, been inspected and passed by their brother inspectors employed by the same insurance carrier. This method creates confusion and the bolier user is at a loss to understand why the insurance inspector makes these recom-

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* Chairman, Engineers' License, Steam Boiler and Refrigeration Inspection Bureau, Trenton, N. J.

mendations and changes since the boilers had been previously considered as acceptable. He is faced with considerable expense not to mention the loss incurred by the closing down of his boiler plant to make these changes, with the result that he becomes a dissatisfied client. We realize the inspector has made these recommendations as he sees them, but in view of the fact that these appliances and fittings were acceptable before, it is rather difficult to convince the boiler user from the angle of the new inspector.

We are not offering this as a criticism of any inspector. We are mentioning it to bring forth this viewpoint to the inspector whether state or insurance in order to prompt him to be more alert to the best interests of the boiler user when it comes to having him spend money, which he feels and in many cases has proven to be unnecessary.

We have travelled a long way since statutory boiler regulations were incorporated in the various states and while we have had our difficulties and misunderstandings at times between the insurance carriers and their inspectors and state inspectors, I believe it safe to say that all these controversies have been mutually solved. I do not believe there is any branch of inspection service in the United States that gives better service, has a higher percentage of competent men than those employed in steam boiler inspection.

Comment on Mr. Scott's Paper

By V. W. Knapp*

It has been my good fortune in twenty years' inspection work to know and associate with many state chief boiler inspectors. While we may not always agree I have found we always have a common ground of understanding. I heartily agree with Mr. Scott's statement that there should be the most cordial and co-operative relation between the insurance company inspectors and the state boiler inspectors.

In speaking of the qualifying of inspectors and interchangeability of commissions between states, he touches on a subject close to the hearts of all insurance inspectors. States operating under the A.S.M.E. code, with one exception, will now accept for operation a boiler built under that code, outside their jurisdiction, when certified by a National Board inspector. Plans are now under way in that state, which when adopted will make this procedure uniform, country-wide. If an inspector certified by the National Board is considered competent to inspect a boiler under construction and certify it for safe operation, why should the same National Board certificate not qualify him to inspect the boiler for operation after it has been installed?

Mention has been made of the elimination of dual inspections in New Jersey. It is pleasing to note that the general tendency has been towards the removal of this burden on the boiler operators and through the joint effort and co-operation of the state boiler departments and insurance companies, this condition has almost entirely disappeared.

Reference has been made to confusion, dissatisfaction and downright rebellion on the part of the assured when some new inspector comes into the field and makes recommendations applying to conditions which have been passed as acceptable by previous inspectors. We realize that this has happened and every effort should be and, I am sure, is being made to prevent unnecessary annoyance from this cause. There is another angle, however, which should not be overlooked. As we have often heard, "to err is human". In other words, no inspector is perfect and he may overlook defects or hazardous conditions which another man may readily see. For this reason, it may be good policy, occasionally, to send a new man over the territory.

Mr. Scott has expressed the thought that insurance inspectors and state inspectors may see this job from different angles. It is true that both aim toward the same result, namely, safe operation of the boiler, but they have, perhaps, two methods of approach which may in the past have led to certain misunderstandings. While they are both looking for unsafe conditions, in the past the state inspector, being thoroughly versed in the specific state laws and orders, may have looked more to code requirements, while the insurance inspector may not have been quite so strict where he noted some minor code infraction but might perhaps be more insistent on remedying certain operating conditions with which he has experienced difficulty. This occasionally led to complaint by the state department. These misunderstandings are now practically eliminated and I feel that this desirable condition and the present friendly feeling existing between state inspection departments and insurance company inspectors is the direct result of joint meetings such as this where we can get together and discuss our problems.

* Superintendent, Inspection Department, London Guarantee & Accident Company, New York.

Relation of Insurance to State Inspectors

By W. Ferguson*

As I view the relation of insurance inspectors to state inspectors from the standpoint of the insurance inspector, I have no hesitation in stating that the relationship between the state and insurance inspectors, and the personal friendship which exists between them, was never on a higher plane; nor has there ever been closer co-operation than exists today. The adoption of the A.S.M.E. code and the organization of the National Board have done much to draw them together for a friendly discussion of construction, installation and operating problems and has increased their mutual respect for each other's opinion.

The qualifying by means of an examination and the issuance of a commission by various states to insurance inspectors and the acceptance of their reports of inspection of boilers and pressure vessels imposes upon all insurance inspectors the closest co-ordination with the state department of inspection and a close study of the state and A.S.M.E. Code and of keeping up to date on all code revisions, changes, or rulings. This applies not only to the shop inspector but also to the field inspector. It is their duty to see that not only are boilers and pressure vessels constructed and installed in accordance with the state and A.S.M.E. Code and operating certificate posted, but also at time of re-inspection to check oper-

* Assistant superintendent, The Travelers Indemnity Company, Hartford, Conn.

ating conditions and see that there are no code violations or unsafe conditions.

If violations are found, they should be reported to the state and recommendations submitted to the boiler user for their correction and every effort should be made by the insurance inspector to have the boiler user comply with recommendations before notifying the state that he cannot secure compliance.

Boiler accidents should be reported immediately to the chief inspector of the state in which the boiler is located, together with a detailed report giving the cause of the accident.

Insurance inspectors should, immediately upon being assigned to a district, call upon the state inspectors and new state inspectors should do likewise, for a discussion of mutual problems in their district.

If a state inspector finds a serious code violation or an unsafe condition, he should at first opportunity phone, call upon, or get in touch with the interested insurance inspector in whose territory the boiler is located and prompt action should be taken by him to correct sub-standard or unsafe conditions. In any state, inspectors follow this practice and this friendly gesture is appreciated, for no inspector willfully passes violations of the state code, or passes defective equipment. Oftentimes valves and fittings are changed, or replaced without the inspector's knowledge and frequently within a few weeks after internal inspection.

My experience has shown that Par. I-33 of the A.S.M.E. code "Inspection During Construction"—"The inspector shall examine all parts of the boilers during construction to determine that all material and workmanship comply with code requirements," has caused more misunderstandings between state and insurance inspectors than all the rest of the boiler codes put together. Yet the paragraph is simple and could not be stated more clearly. However, it opens the way for a difference in opinion as to what constitutes good workmanship. One state inspector insists that a cylindrical shell be rolled a perfect circle and the shop inspector insists that cannot be done and points out that the code committee in their wisdom, realizing this, qualified Par. I-9 by adding a nearly perfect circle.

Another insists upon heads on small boilers being fitted metal to metal before riveting, which is not always possible unless heads and shells are turned.

Then we have the state inspector who insists that all rivet heads be in accordance with Fig. L-4, "acceptable forms of finished rivet heads", and rejects rivet heads larger in size than those shown, whereas if he referred to L-54, it is clearly stated that "rivet heads shall be at least equal to those shown in Fig. L-4" and again we note on the same page that dimensions of finished heads may be larger or 1/10 smaller than those shown.

The foregoing shows the necessity for the closest co-operation between state and insurance inspectors and the need for getting the other fellow's point of view before advising a purchaser that the boiler or vessel does not comply with the code and raising a doubt in the purchaser's mind when there only exists an honest difference of opinion between inspectors over an interpretation of a paragraph in the code, or a minor defect which the manufacturer should be pleased to have called to his attention for correction.

Annual meetings of local state and insurance inspectors should be held at remote points in a state such as Buffalo and New York, Pittsburgh and Philadelphia San Francisco and Los Angeles, thus giving all inspectors an opportunity for discussion of local problems and latest code changes and rulings.

Comment on Mr. Ferguson's Paper

By M. A. Edgar*

Sincere co-operation, fair dealing and courtesy on both sides are all that is needed to weld us into one, happy and efficient family. It must be admitted that boiler inspectors have about the same number of faults that are to be found in an equal number of men engaged in any other occupation, but I am happy to say that after twenty-one years in this line of work, I do not know of a single inspector whose certificate of competency has been revoked on account of willful neglect of the boiler rules of any city or state. Of course these inspectors make mistakes and occasionally overlook technical details, but the fact that they are able to make satisfactory and acceptable explanations is not only good evidence of their sincerity and good intentions, but it is also pretty good proof that state inspectors are fair and reasonable in their judgment of the other fellow.

Both men have a duty to perform and the responsibility that rests on each of them should and does draw them together, so that they not only work harmoniously but are actually showing satisfactory results in stepping up the standards of safety in boiler plants and in reducing accidents.

These National Board meetings are of great benefit because of the fact that they bring together the various state, city and insurance inspectors, and in this way each one learns that the others are not such bad fellows after all.

Sectional meetings to come in between Board meetings would be fine practice, but economy programs and the fact that inspectors spend so much of their time on the road makes this feature rather difficult. I believe, though, that the practice of holding state meetings will be given consideration when times again become normal, and I believe one is justified in expecting satisfactory results.

After seventeen years as boiler inspector for the Wisconsin Industrial Commission, I am happy to state that the insurance inspectors with whom I have come in contact were all very fine men and eager to do the right thing.

In spite of the fact that boiler rules adopted by a state are not very elastic, it is my belief that chief inspectors, who have the confidence of their superiors, are usually in a position to be reasonably tolerant where unimportant items are involved and to have corrections made without unnecessary strife. It is our purpose also to work in harmony with the manufacturer, and I believe we can show our appreciation of the satisfactory way in which they adhere to the code by not being too hasty and doing something on the spur of the moment that will impair the good will these manufacturers have built up amongst the trade over a long period of years. Boiler shops have a very small labor turnover considering the nature of the work, and labor difficulties are practically unknown, and I believe these conditions can be kept in mind when dealing with the managers of such establishments.

Boiler manufacturers and insurance inspection departments can do much to help make things run smoothly for the state inspector. They can exert themselves to keep abreast of code requirements and see to it that they are put into practice. Doing things wrong or carelessly and then expecting the inspector to shoulder the

* Chief boiler inspector, Industrial Commission, Madison, Wis.

responsibility should not become a habit, for you must remember that the state inspector is between several fires, namely, his boss, the buyer of the boiler and a second insurance company which takes over the inspection of the boiler at a later date. I believe that if we will all show a little more trust in the other fellow and not be eager to take hasty or spectacular action, we will all get along without strife and bad feeling.

Advantages of National Board Stamping

By D. L. Royer*

The fundamental purpose of every state, city and insurance company boiler inspection department is the safety of the boilers under its supervision.

Boiler safety requires the supervision of design, of materials, and, of the methods of fabrication of every boiler built. This supervision is just as important as the regular inspection that must be made after the boiler has been placed in operation to prevent the development of unsafe conditions that may result from improper operating methods or the effects of years of service. To obtain this supervision in an effective manner, every inspection must be made in strict accordance with an effective code and must be reported completely and accurately. The inspection reports and records must be available to interested parties for the life of the boiler.

It is evident that the boiler that is safe in one state should be safe in another regardless of the fact that each state has a different set of law makers, and it should follow that the same boiler should be acceptable in all states operating under the same code if it is acceptable in any one of them.

Furthermore, an inspector who is upon examination considered competent to pass upon the safety of boilers in a state operating under the code should also be competent to perform this function in connection with boilers that may be installed in other states operating under the code, regardless of the fact that the various states must of necessity have separate groups of men in charge of boiler inspection.

It is a natural development that several companies specializing in boiler building should grow up and prosper in this activity because of this age of specialization and transportation. This accounts for the fact that you will find few boilers built in Oklahoma operating in that state. But suppose that an oil-field boiler built by Broderick in Ohio is installed in Oklahoma and later moved to Arkansas, what about supervision and safety. There would be a complicated entanglement unless the three states involved co-operate through some central agency.

The National Board of Boiler and Pressure Vessel Inspectors is this central agency. Inasmuch as the National Board is made up of the state and city inspectors and engineers in charge of the safety of boilers in their various jurisdictions, its fundamental purpose is also the safety of boilers. To this end, the National Board recognizes one code, the A.S.M.E. Boiler Code, for the materials, design, and methods of fabrication of boilers. It is the clearing house for the problems that are bound to develop, the central bureau with which data and records are filed, and the central authority for the licensing of inspectors.

It is believed that every man attending this meeting is aware of the advantages of National Board stamping. You are familiar with the numerous identification and state numbers that were required on portable boilers at one time. (When the shell of the boiler had been exposed to the weather for several years it was impossible to make out any of the numbers.) The stamping of all these numbers on the boilers and the filing of records in many states imposed unnecessary inconvenience and work on the manufacturers and the insurance companies who provided shop inspection service. You all are familiar with the difficulty that frequently resulted when stationary boilers were built outside of the states in which they were purchased and in which they would be operated. The endless correspondence that frequently developed between manufacturers, state departments, purchasers and insurance companies, when the records were confused or lost was unnecessary and did nothing to make the boilers safe. These and many other difficulties have been eliminated since the organization of the National Board.

A by-product that is worthy of mention is the demand for A.S.M.E. Code construction and National Board stamping in states having no boiler legislation and in foreign countries. The National Board inherits all of the prestige that attaches to A.S.M.E. boiler construction and is desirable in outside jurisdiction because National Board stamping is a guarantee that A.S.M.E. Code requirements have been fulfilled, and also that the identification of the boiler has been filed in a recognized national organization. It is safe to say that as our more backward agricultural states adopt boiler legislation to protect themselves against the objectionable dumping of sub-standard boilers by unscrupulous second-hand dealers they will do so by adopting the A.E.M.E. Code and joining the National Board.

The many advantages of National Board stamping cannot be obtained, however, unless all parties interested co-operate. For example, at the present time, there is one state that will not accept National Board stamping unless every inspector who passes upon boilers for installation in that state holds a certificate of competency issued by the state. This same state requires that credits be given in boiler inspectors' examinations for experience, whereas this is not a requirement of other states. It is pleasing to note, however, that this situation is to be corrected in the next meeting of the state legislature. The difficulties that face any voluntary organization that endeavors to produce uniformity where state legislatures with their attendant politics are concerned are appreciated. It is evident that all of these difficulties will face the National Board from time to time. However, the benefits that will follow a drive for uniformity in the requirements for boiler safety cannot be realized unless these difficulties are overcome and they can be overcome if all concerned will co-operate to this end.

* Chief engineer, Ocean Accident & Guarantee Corporation, Ltd., New York.

Comment on Mr. Royer's Paper

By George W. Bach*

Those of us who have been in the boiler business long enough to remember the earlier days before the adoption of the A.S.M.E. Code welcome the A.S.M.E. Code and the National Board.

In the earlier days each manufacturer had his own shop practices, standards and specifications, which in many cases for competitive reasons were designed to

* Vice-president and general manager, Union Iron Works, Erie, Pa., representing the American Boiler Manufacturers' Association.

build a boiler at the lowest possible cost rather than for the highest quality. While the insurance companies attempted to enforce certain standards in shop practice and factor of safety, there was a great deal of difference in the design, construction and workmanship of boilers made in various shops.

The boiler manufacturers realized that this state of affairs was not conducive to confidence on the part of the public or best results from their product, and through the American Boiler Manufacturers' Association started the work of standardization for boiler specifications and construction details.

The American Boiler Manufacturers' Association early realized that this work should be carried on by some qualified neutral body, and naturally turned to the American Society of Mechanical Engineers for help, and that splendid body with its high ideals of service, took on the work, with the result that the A.S.M.E Code is now the standard boiler code throughout practically all of the United States. I want to qualify that and mention Massachusetts.

However, the adoption of this Code by the various states and some municipalities, with certain reservations and changes from the code, made it necessary to build boilers in compliance with the regulations in such states and municipalities, resulting in duplication and in some cases contradictory practices, which made it extremely difficult, if not impossible, to build a boiler that would pass all of the states operating under the A.S.M.E. Code and their own particular regulations.

Boilers so built had to be stamped with the A.S.M.E. symbol and the various state's stamps for which the boiler was designed, resulting in many cases in a profusion and confusion of stamps and symbols that made the front of a boiler look like a Chinese laundry stamp. This was particularly true of boilers of the portable or semi-portable types, such as used on steam shovels and equipment of that nature which is frequently moved from state to state and the boiler had to comply with regulations in each state where the machine operated, frequently limiting the sphere of usefulness of such a machine to certain states only.

This was a hardship not only on the manufacturers of the boilers and this equipment, but on the owners, who had to carry machines built for different districts, and resulted in unnecessarily high investments and operating costs for construction work.

It was also necessary to file a copy of the manufacturer's data report with all of the states for which the boiler was stamped which caused a great deal of detail office work and filing, not only when the boiler was built but frequently afterward when the equipment was moved from state to state, and the state inspectors checked up on the boilers.

Some one then had the happy thought of having a National Board of Boiler and Pressure Vessel Inspectors, consisting of all of the authorized chief inspectors of the various states, who would authorize one stamp as the mark of authority for a boiler to be used in any state where a National Board chief inspector is in authority. I believe it was Carl Myers who first approached me on this subject when I was President of the American Boiler Manufacturers' Association, and Mr. Myers was given an opportunity to appear before one of our semi-annual meetings to explain his ideas and the advantages of such an organization, which were favorably received by the boiler industry, as they would relieve the condition of chaos confronting the industry, in the matter of boiler stampings.

Joint committees were then appointed, and after some preliminary work a plan for the original financing of the National Board was worked out, and this body became a reality.

The splendid work done by the National Board and the complete fulfillment of its purpose is so obvious and so well known to us all that it needs no special comment, and I am authorized, as the representative of the American Boiler Manufacturers' Association, to state that the work of the National Board is highly appreciated and will continue to merit the support and co-operation of every boiler manufacturer in the boiler industry.

The National Board officers are anxious to have the complete co-operation of the boiler manufacturers, insurance companies and other interested bodies, and have provided in their by-laws that a representative of such bodies be on the executive committee of the National Board and have a voice in its policies. It is my privilege to represent the American Boiler Manufacturers' Association on the executive committee of the National Board, and in that position I have ample opportunity to observe the earnestness, zeal, and high ideals of real service on the part of the officers of the National Board, all of which is greatly appreciated by the American Boiler Manufacturers' Association.

We are therefore in full accord with the National Board aims and activities, with a view of standardizing inspection service in all of the states operating under the A.S.M.E. Code, and we are particularly interested in having the National Board follow the A.S.M.E. Code with its amendments in its entirety without change or special interpretation on the part of any one state or group of states, which would defeat the very purpose of the A.S.M.E. Code and National Board aims.

We therefore trust the National Board will carry on the splendid work it has been doing on behalf of the boiler users and manufacturers, and it can count on the full whole-hearted support of the American Boiler Manufacturers in this splendid work. I thank you for the opportunity of presenting the case of the boiler manufacturer.

Comment on Mr. Royer's Paper

By Carl O. Myers*

By the stamping of boilers and pressure vessels the National Board has solved the problem of interchangeability of such vessels between the states and cities that have boiler inspection laws and ordinances.

When I took charge of the Boiler Inspection Division in the State of Ohio in 1917 there were about seventeen states and as many cities that were enforcing boiler regulations and all of these states and cities were operating under the A.S.M.E. Boiler Code as their standard for the construction of boilers. The A.S.M.E. Code has never provided qualifications for inspectors who are depended upon for the enforcement of its regulations when making shop inspections. The states and cities have always felt that uniform enforcement of the code is just as important as the provisions of the code itself. In fact, before any state or city official could assume the responsibility of accepting an A.S.M.E. Code boiler, it was necessary that they know that the person representing them in making the shop inspection was properly qualified to interpret and apply this code.

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When the states and cities accepted the A.S.M.E. Boiler Code as their standard code for construction, they retained the system they had in effect for qualifying inspectors and properly to identify a boiler that was inspected by a person authorized under their respective qualifications, required that the boiler be stamped with their individual state or city standard.

For each and every one of the state and city standard stampings upon a boiler it was necessary for the manufacturer to fill out at least four manufacturers' data reports which had to be checked and signed by the inspector who made the shop inspection. One of these data reports was filed in each of the state or city departments that had a stamp upon the boiler. This data report had to be checked and filed in the records of the state or city department. Naturally there would be a great number of these data reports upon file that were never used, as the boilers they represented never were installed under their jurisdiction. Upon the face of it, a system involving such complications had to be simplified.

The question of interchangeability of boilers between political sub-divisions never greatly affected the state or city boiler inspection department. On the other hand, there are no good reasons why a boiler built for one state should not be accepted by another. The merits of this question appealed to the various state authorities so they agreed to lend their assistance to solve the problem and to do this it was necessary to form the National Board of Boiler and Pressure Vessels Inspectors which would provide the necessary means for them to get together and work out a system of uniform qualifications for inspectors, a system of properly recording such inspectors and a means of uniform stamping that would be accepted in lieu of their individual state standard stamping. Through this organization the membership of which is purely voluntary, they have co-operated in the solution of this problem by working out a system of uniform qualifications and the commissioning of inspectors making the shop inspection and such qualified inspectors may witness the National Board stamping. This system properly safeguards the interests of the state and city authorities so they can safely accept the responsibility for the safe operation of boilers in their respective districts.

Prior to the states and cities adopting uniform inspectors qualifications for shop inspectors it was necessary for an inspector to qualify under the regulations of the various states and cities, a number of which required that the person appear before a Board and take a written examination. It was rather an expensive procedure for insurance companies to qualify their inspectors so they would be properly authorized to stamp boilers for the various states and cities. Mr. Royer did not make it altogether clear that an inspector may now qualify by taking a written examination in any of the states who are members of the National Board that have a board of two or more members and, if successful in passing the examination, he is eligible for a National Board commission, which commission entitles him to shop inspect boilers and stamp them National Board. They will be accepted by all of the states and cities who are members of this board. This has reduced considerably the necessary expenses involved properly to qualify a man as an inspector, so his inspections will be accepted by all of the states and cities.

The questions of the National Board stamping involves a number of details which are sometimes not clearly understood. I have been called upon a great many times to refuse to accept for operation a boiler that was not stamped with the state standard or National Board stamping.

The question invariably asked is "Does this stamping make the boiler safe?" The owner always feels his boiler is absolutely safe for any pressure that he should happen to need, and it is a difficult matter to explain that because his boiler does not happen to bear the proper stamping it is not safe to be operated. The mere stamping of a boiler in a certain manner would seem to be a rather insignificant thing if all the details required to bring about this stamping are not understood. The only thing the stamping is for is to direct state and city authorities to the records where they can obtain detailed information as to the construction of the boiler, the name of the inspector responsible for the enforcement of the construction requirements, and such other data as will assure the boiler has been safely constructed.

Prior to the organization of the National Board each individual state and city depended upon the stamping for identification; such stamping indicated that the boiler met with their requirements and was shop inspected by a person qualified under their regulations. In developing a uniform standard of stamping we had to combine seventeen state standards and as many standard stampings into one stamping. To do this is was necessary to obtain a thorough knowledge of the details of the qualifications for inspectors in effect in all of these political sub-divisions and to incorporate in our uniform standard of qualifications for shop inspectors requirements that met with all of these different conditions.

The success or failure of a boiler inspection law and ordinances depends entirely upon the quality of inspectors who are charged with the enforcement of regulations. The details of a particular form of stamping are not of great importance, but it is of vital importance that a particular form of stamping be properly protected, and it is the protection of this stamping that is our main object. We do so by maintaining a high standard of qualifications for the inspectors who are delegated as state and city representatives to witness such stamping.

It should be a great satisfaction to a state official to know that a dealer of boilers in his locality is in a position to purchase a supply of boilers from one state and that they can be sold and operated in any other state without question. It should also be satisfying to know that they have lent their support to a system whereby a boiler manufacturer in their state is in a position to manufacture boilers for stock which will be accepted by all of the other states providing they are stamped National Board upon completion.

The cost of boilers is greatly reduced by building them under this system compared to the old system when they had to be built to order and to meet the special requirements of the various states. From every angle National Board stamping has advantages without any disadvantages or at the sacrifice of any authority or responsibility vested in the Chief Inspector of boilers in any state or city.

Comment on Mr. Royer's Paper

By W. Ferguson

As Mr. Royer so ably stated, the advantages of National Board stamping on a boiler from the viewpoint of the insurance inspector, who represents the purchaser, are too numerous to mention in a brief paper, or to be crowded into a few minutes discussion, as many of the older inspectors will recall the hectic life of a shop inspector, prior to the organization of the National Board, when he was required to jump from state to state passing examinations and trying to do the impossible and make a boiler conform to many state standards.

The inspector welcomed the uniform A.S.M.E. and National Board stamping. Some states will require state stamping in addition to A.S.M.E. which works a hardship upon the purchaser or user, whom I fear has been overlooked in considering the various codes.

Let us consider for a moment the disadvantages of stamping a boiler for an individual state and not A.S.M.E. or National Board.

A manufacturer in New York has plants in Massachusetts, Pennsylvania, New Jersey and Ohio, and being a booster for his own state and knowing nothing of A.S.M.E. or National Board requirements, he places an order in his own state for a locomotive boiler to be used for industrial work within the state and specifies that the boiler be built and stamped N. Y. STD. His instructions are carried out by an inspector holding only a New York commission and the boiler is stamped as required.

A short time later the manufacturer finds that he has more need for this locomotive in any of his other plants than in his New York plant, so he decides to ship it to his nearest plant in Massachussetts, but learns that as the boiler was not stamped Mass. Std. and in accordance with Massachussetts code he cannot do so, he then tries Pennsylvania and finds that the boiler should have been stamped A.S.M.E. or Pa. Std. and construction checked by a certified Pennsylvania inspector, so he next tries Ohio and learns that the boiler must be stamped A.S.M.E., Nat. Bd. or Ohio Std. and, as shop inspector did not possess a Nat. Bd. or Ohio commission during the construction of the boiler, he cannot ship the boiler into Ohio.

In despair he turns to his insurance inspector or Chief Inspector Furman saying, "the boiler builders assure me that New York state has adopted the A.S.M.E. code and the boiler complies to the letter with the code both in design, construction and workmanship. I specified N.Y. STD. and received a boiler built for 300 pounds pressure in accordance therewith, and now I learn that, while my boiler is safe for operation in New York state, it is apparently unsafe in all other states where I have plants. What must I do?"

Take another case of a railroad company, a national food products company or a contractor having several portable or power plant boilers five years of age, originally intended for use in New Jersey and stamped N.J. STD. Later it is necessary to ship these boilers into surrounding states—New York, Pennsylvania, Delaware, Ohio. The boilers while built in a code shop and inspected by a man holding N. Y. and N. J. commission, did not carry a National Board commission and he has since died. What advice can the present insurance carrier give in this case?

It is beyond the realm of reason to ask a manufacturer to believe that because of his oversight in failing to insist upon A.S.M.E. and National Board stamping, his boilers will be unfit for service if shipped into another state, other than that for which they were originally built and stamped as it would be impossible to prove that the boilers would be unsafe for operation if moved a few miles from their present location, therefore, on behalf of the insurance inspectors, I would urge that all state boiler boards or bureaus of inspection give official recognition to A.S.M.E. and National Board stamping, and that manufacturers of boiler and pressure vessels and Insurance inspectors impress upon all purchasers of boiler and pressure vessel equipment the advantage of and need for A.S.M.E. and National Board stamping and thus relieve the chief inspector of the state into which it is desired to ship a boiler not bearing the state standard stamp from embarrassment or of assuming the responsibility for acceptance.

Place all necessary safeguards around the qualifications of the shop inspector and the boiler manufacturer, but let there be only one standard boiler inspector's examination, one standard method of giving credit for experience and questions answered; one standard certificate acceptable in all states and cities for both shop and field inspection; one standard stamp and that National Board.

Reports to Be Published

The remaining papers, comment and discussion delivered at the Tuesday afternoon session and the sessions on Wednesday and Thursday will be published later. These papers included the following:

"Inspectors' Commissions and Uniform Examinations." By W. H. Furman, chief boiler inspector, Department of Labor, Albany, N. Y. *Comment:* J. D. Newcomb, J. P. Morrison.

"Uniform Forms—Data, Suspension and Reinstatements." By B. M. Book, chief, Boiler Section, Department of Labor and Industry, Harrisburg, Pa. *Comment:* T. R. Archer, W. Ferguson.

"Experience with and the Inspection of Unfired Vessels." By F. A. Page, supervising engineer, Boiler Section, Industrial Accident Commission of California, San Francisco, Cal. *Comment:* H. H. Mills, J. D. Noonan.

"Inspection of Low Pressure Boilers." By W. Brennan, engineer, The Fidelity and Casualty Company, New York. *Comment:* C. W. Foster, G. D. Bragdon.

"Inspection of Riveted Seams." By J. P. Morrison, assistant chief engineer, Boiler Division, The Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn. *Comment:* F. A. Page, R. Milligan.

"Code Committee Practices and Progress." By C. W. Obert, consulting engineer, The Union Carbide and Carbon Research Laboratories, Inc., Long Island City, N. Y. *Comment:* M. A. Edgar, D. L. Royer.

"Characteristics of Ferrous and Non-Ferrous Alloys for Pressure Vessels. By A. B. Kinzel, The Union Carbide and Carbon Research Laboratories, Inc., Long Island City, N. Y. *Comment:* R. C. Stratton.

"Inspection of Welded Work and Training of Welding Inspectors." By W. D. Halsey, assistant chief engineer, Boiler Division, The Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn. *Comment:* C. O. Myers, J. G. Wheatley.

"Significance of the Welding Tests." By L. R. Leveen, engineer, Welding Engineering Department, General Electric Company, Schenectady, N. Y. *Comment:* H. H. Mills, A. J. Loppin.

"Certification of Welders." By C. D. Thomas, chief boiler inspector, Salem, Ore. *Comment:* C. E. McGinnis, E. R. Fish.

"Field Repairs by Welding." By A. J. Loppin, assistant superintendent, Engineering Department, The Fidelity and Casualty Company, New York.

Thursday, October 19, was devoted to general discussions at which time an opportunity was given to introduce subjects not scheduled. Standing and special committee reports were presented and the meeting closed with the election of officers.

Registration at National Board of Inspectors' Meeting

Adams, S. B., chief inspector, The Hartford Steam Boiler Inspection & Insurance Co., Philadelphia, Pa.
Adelson, J. S., chief metallurgist, Steel & Tubes, Inc., Cleveland, Ohio.
Aldrich, H. E., secretary, Committee of Industrial Recovery, A. B. M. A., New York, N. Y.
Anderson, A. R., engineer, Travelers Indemnity Company, New York, N. Y.
Andrews, E. F., Hon., State of New York, Albany, N. Y.
Archer, T. R., chief boiler inspector, Board of Boiler Rules, Wilmington, Del.

Bach, G. W., vice-president and general manager, Union Iron Works, Erie, Pa.
Barringer, L. M., chief boiler inspector, City of Seattle, Seattle, Wash.
Bayliss, W. A., chief inspector, The Hartford Steam Boiler Inspection & Insurance Co., Boston, Mass.
Beck, S. K., supervising engineer, Maryland Casualty Company, Baltimore, Md.
Becker, Samuel, chief engineer, City of New York, New York, N. Y.
Beha, J. A., general manager, National Bureau of Casualty and Surety Underwriters, New York, N. Y.
Book, B. M., chief, boiler section, Dept. of Labor and Industry, Harrisburg, Pa.
Boyd, T. M., inspector, The Hartford Steam Boiler Inspection & Insurance Co., New York, N. Y.
Bragdon, G. D., manager, steam boiler department, General Accident, Fire and Life Assurance Corp., Ltd., Philadelphia, Pa.
Brennan, W., engineer, Fidelity & Casualty Company, New York, N. Y.
Bromley, G. T., chief engineer, Employers Liability Assurance Corporation, Ltd., New York, N. Y.
Burton, C., inspector, The Hartford Steam Boiler Inspection & Insurance Co., New York, N. Y.

Cannon, T. C., city boiler inspector, City of Tulsa, Tulsa, Okla.
Cassidy, P., executive assistant, Babcock & Wilcox Company, New York, N. Y.
Cavaner, L. W., inspector, Employers Liability Assurance Corporation, Ltd., New York, N. Y.
Cecil, R. E., vice-president, Wm. B. Scaife & Sons Company, Pittsburgh, Pa.
Coburn, J. H., vice-president, Travelers Indemnity Company, Hartford, Conn.
Colleran, P., foreman of boiler dept., Bartlett-Haywood Company, Baltimore, Md.
Creveling, C. J., chief inspector, Maryland Casualty Company, New York, N. Y.
Cunningham, J. D., engineer, Ocean Accident & Guarantee Corporation, Ltd., Syracuse, N. Y.

deWindt, J. P. H., manager boiler and machinery department, National Bureau of Casualty and Surety Underwriters, New York, N. Y.
Doff, I. A., M. D., X-ray expert, City of Chicago, Chicago, Ill.
Duge, L. F., state boiler inspector, State of Maryland, Baltimore, Md.
Dunbar, Wm. A., supervising engineer, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.

Edgar, M. A., chief boiler inspector, State of Wisconsin, Madison, Wis.

Farmer, E. W., chief inspector, State of Rhode Island, Providence, R. I.
Farrell, J., senior engineer, Travelers Indemnity Company, Newark, N. J.
Ferguson, W., asst. superintendent, Travelers Indemnity Company, Hartford, Conn.
Fish, E. R., chief engineer, boiler division, The Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.
Foster, C. B., Travelers Indemnity Company, Hartford, Conn.
Foster, C. C., supt. engineering dept., Fidelity & Casualty Company, New York, N. Y.
Foster, C. W., city boiler inspector, City of Omaha, Omaha, Neb.
Frost, Vincent M., asst. to the gen. supt. of generation, Public Service Elec. & Gas Company, Newark, N. J.
Furman, W. H., chief boiler inspector, Department of Labor, Albany, N. Y.

Gearon, G., sup. mech. eng. & chief deputy inspector, Chicago, Ill.
Gillman, Frank L., engineer, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.
Goodwin, C. G., supervising engineer, Royal Indemnity Company, New York, N. Y.
Gordon, A. S., senior engineer, Travelers Indemnity Company, New York, N. Y.
Gorham, J. M., asst. to vice-president, The Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.
Gorton, Chas E., chairman, American Uniform Boiler Law Society, New York, N. Y.
Greenlaw, P. M., inspector of steam boilers, District of Columbia, Washington, D. C.
Gregg, L. T., chief engineer, The Boiler Inspection and Insurance Co. of Canada, Toronto, Canada.
Gundlach, C. J., supervising engineer, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.
Guy, R. P., asst. chief inspector, The Hartford Steam Boiler Inspection & Insurance Co., New York, N. Y.

Halsey, W. D., asst. chief engineer, boiler division, The Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.
Haman, C. H., engineer, Travelers Indemnity Company, Trenton, N. J.
Hardy, W. A., engineer, Fidelity & Casualty Company, New York, N. Y.
Howell, Frank B., Amer. Rad. & Std. Sanitary Corp., New York, N. Y.
Hunt, J. F., chief inspector, The Hartford Steam Boiler Inspection & Insurance Co., Cleveland, Ohio.
Hunt, W., engineering dept., Fidelity & Casualty Company, New York, N. Y.

Jacobus, D. S., Dr., advisory engineer, Babcock & Wilcox Company, New York, N. Y.

Keene, Clair L., supervising engineer, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.
Knapp, V. W., supt. inspection dept., London Guarantee & Accident Company, Ltd., New York, N. Y.
Kolel, Harry, chief inspector, City of Chicago, Chicago, Ill.

Leudemann, G. V., New York representative, Mears-Kane-Ofeldt, Inc., New York, N. Y.
Leveen, L. R., engineer, welding engineering department, General Electric Company, Schenectady, N. Y.
Loppin, A. J., asst. supt. eng'r. dept., Fidelity & Casualty Company, New York, N. Y.
Lukens, J. M., chief inspector, City of Philadelphia, Philadelphia, Pa.

MacQuigg, C. E., manager, Union Carbide & Carbon Research Laboratories, Long Island City, N. Y.
Malone, J. J., commissioner, City of Los Angeles, Los Angeles, Cal.
Manney, C. J., chief clerk, Ohio Boiler Insp. Dept., Columbus, Ohio.
Marsden, H. M., district engineer, The Hartford Steam Boiler Inspection & Insurance Co., New York, N. Y.
McGinnis, C. E., general manager, Board of Mechanical Engineers, Los Angeles, Cal.
McGow, A., engineer, Travelers Indemnity Company, Yonkers, N. Y.
McLaren, J., supervising engineer, Travelers Indemnity Company, Hartford, Conn.
McLean, D. D., supervising engineer, Travelers Indemnity Company, Brooklyn, N. Y.
Mears, E. W., secretary, Mears-Kane-Ofeldt, Inc., Philadelphia, Pa.
Medcalf, D. M., chief inspector of steam boilers, Ontario Government Office, Toronto, Canada.
Miller, W. A., inspector, The Hartford Steam Boiler Inspection & Insurance Co., New York, N. Y.
Milligan, Robert, supervising engineer, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.
Mills, H. H., chief safety engineer, Bureau of Safety Engineering, Detroit, Mich.
Morrison, J. P., asst. chief engineer boiler division, The Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.
Moses, A. J., director of research, Hedges Walsh Weidner, Chattanooga, Tenn.
Muller, Daniel L., boiler & mech. dept. mgr., Marsh & McLennan, New York, N. Y.
Myers, C. O., chief of division, division of boiler inspection, Department of Industrial Relations, State of Ohio, Columbus, Ohio.

Newcomb, J. D., Jr., chief boiler inspector, City of Little Rock, Little Rock, Ark.
Newton, W. L., state boiler inspector, State of Oklahoma, Oklahoma City, Okla.
Noonan, J. D., engineer, Employers Liability Assurance Corporation, Ltd., Boston, Mass.

Obert, C. W., consulting engineer, Union Carbide & Carbon Research Laboratories, Long Island City, N. Y.
Oldfield, G. A., engineer assistant, Fidelity & Casualty Company, New York, N. Y.
Olmstead, O. B., proprietor, Ontario Iron Works, Pulaski, N. Y.
Owens, James W., director, National Weld Testing Bureau, Pittsburgh Testing Laboratory, Pittsburgh, Pa.

Page, F. A., supervising engineer boiler section, Industrial Accident Commission of California, San Francisco, Cal.
Partington, James, manager eng. dept., American Locomotive Co., New York, N. Y.
Peal, L. C., chief boiler inspector, City of Nashville, Nashville, Tenn.
Pearce, C. E., engineer, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.
Pepper, Wm. F., underwriter, Travelers Indemnity Company, New York, N. Y.
Peterse, A. G., engineer, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.
Plunkett, J. H., chief of inspections, State of Massachusetts, Boston, Mass.
Price, J. N., boiler inspector, State of New Jersey, Trenton, N. J.

Rausch, J. W., manager, Maryland Casualty Company, Baltimore, Md.
Reese, D. F., vice president, The Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.
Roberts, H. A., engineer, Ocean Accident & Guarantee Corporation, Ltd., Newark, N. J.
Ross, J. A., supt. boiler & machine department, Employers Liability Assurance Corporation, Ltd., Boston, Mass.
Royer, D. L., chief engineer, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.

Sanford, H. W., supt. engineer, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.
Sawyer, E. K., inspector, State of Maine, Augusta, Maine.
Schwartz, M., engineer, New York, N. Y.
Scott, J. F., chairman, engineers' license, Steam Boiler & Refrigeration Inspection Bureau, Trenton, N. J.
Seifts, H. L., engineer, Travelers Indemnity Company, New York, N. Y.
Shaw, J. G., Travelers Indemnity Company, Hartford, Conn.
Smith, F. G., sales engineer, The American Brass Company, Waterbury, Conn.
Steinmetz, R., engineer, L. O. Koven & Bro., Jersey City, N. J.
Stratton, R. C., supervising chemical engr., Travelers Indemnity Company, Hartford, Conn.
Sturges, Thos. L., traveling engineer, London Guarantee & Accident Company, Ltd., New York, N. Y.
Sullivan, T. P., senior engineer, Travelers Indemnity Company, Brooklyn, N. Y.
Svatos, Wm., engineer, Ocean Accident & Guarantee Corporation, Ltd., Buffalo, N. Y.
Swetman, A. E., engineer, Travelers Indemnity Company, New York, N. Y.

Thomas, C. D., chief boiler inspector, State of Oregon, Salem, Oregon.
Turnbull, M., engineer, Ocean Accident & Guarantee Corporation, Ltd., Newark, N. J.

vom Stegg, Edmund, Jr., welding specialist, General Electric Company, New York, N. Y.

Walsh, W. S., chief engineer, Department of Public Works, Montreal, Quebec.
Ward, S. M., Jr., supt. boiler and machinery department, Maryland Casualty Company, Baltimore, Md.
Warnock, S. C., supervising underwriter, Ocean Accident & Guarantee Corporation, Ltd., New York, N. Y.
Weigel, A. C., asst. to president, Combustion Engineering Corp., New York, N. Y.
Welter, Gustave, asst. vice president, The Bigelow Company, New Haven, Conn.
Wheatley, J. G., chief engineer, Royal Indemnity Company, New York, N. Y.
Wilcox, G., chief inspector, State of Minnesota, St. Paul, Minn.
Wilson, James W., traveling inspector, Bureau of Navigation and Steamboat Inspection Washington, D. C. . . .

Pressure Vessel Repairs By Fusion Welding*

By fusion welding is meant a process of welding metals in the 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.

The Executive Committee of the National Board of Boiler and Pressure Vessel Inspectors has adopted the 1931 Edition of the A. S. M. E. Code for Construction of Power Boilers and Unfired Pressure Vessels. Fusion welding, except where such controlled welding as permitted by the A. S. M. E. Code is used, shall be limited in its application to those cases where the stress is carried by other construction which conforms to the A. S. M. E. Code and where the safety of the boiler or vessel is not dependent upon the strength of the weld. Firms having in their employ welders who have demonstrated their fitness to produce sound welds, the results of which would meet the requirements of approved welding codes, will be considered satisfactory for the execution of repairs by fusion welding in accordance with the foregoing restrictions.

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.

The following examples of the possible application of fusion welding, not specifically covered by the code, will serve to illustrate where in the opinion of the National Board such work should be accepted or rejected. No repairs by welding of any kind except where welding is specifically sanctioned by the code or where specified herein shall be permitted on any part or parts of any boiler or its appurtenances operated at pressures in excess of 15 pounds per square inch.

1. Any fusion weld of reasonable 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. It is necessary for the inspector to use judgment in interpreting the meaning of reasonable length as given above, since it may vary in different cases. In the average case, it should be not more than 3 feet. Fusion welding will not be accepted in unsupported flat surfaces.

2. Fusion welding of cracks and fractures in cast-iron heating boilers or cast-iron members of power boilers or unfired pressure vessels shall be referred to an authorized inspector.

3. Cracks in girth seams extending from the edge of the plate to the rivet hole may be fusion welded provided the cracks are properly prepared to permit fusion through the entire thickness of the plate. Similar cracks in girth seams 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. 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. In all 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 re-driven.

4. Cracks in the shells or drums of power boilers, except as otherwise specified herein, shall not be welded. Leakage at riveted joints or connections shall be carefully investigated to determine the cause. The building up of a grooved or corroded area of unstayed internal surfaces, other than widely scattered pit holes, by means of deposited metal will not be permitted.

5. 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.

6. 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 shall come completely through the reinforcing metal so as to be plainly visible to the inspector. When necessary to replace stays, such stays shall comply with the requirements of the A. S. M. E. Code.

7. In firetube boilers whose 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. The above mentioned 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.

8. 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. Such patches shall not be set in the shell flush with the surrounding plate.

9. On firetube boilers re-ending or piecing of tubes will be permitted as follows:

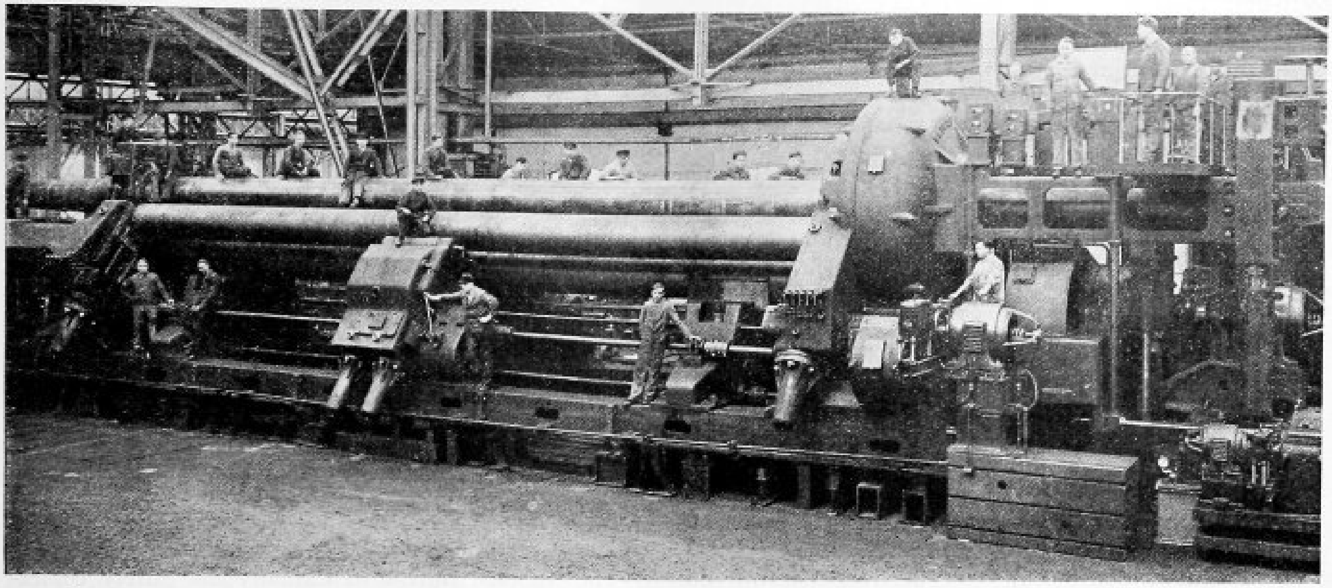
(a) Tubes which have been re-ended by the electric resistance butt welding method.

(b) Tubes which have been re-ended by the metallic-arc or oxy-acetylene process will be acceptable when said tubes have no more than two circumferential welds.

*Requirements for use of fusion welding of boilers and other pressure vessels as issued by the National Bureau of Casualty & Surety Underwriters, New York.

The Edge Moor Iron Company, Edge Moor, Del., has acquired the exclusive right under the Irwin patents, to manufacture and distribute the Irwin automatic gas-fired boilers for all purposes including industrial, commercial and domestic use. The Edge Moor-Irwin Gas Boiler division has been formed with George H. Irwin as chief engineer and Frank S. Luney as his assistant.

Torchweld Equipment. — A new price list for Torchweld welding and cutting equipment and accessories has recently been issued by the Torchweld Equipment Company, Chicago. This list includes prices on a new line of gas welding and cutting equipment, together with carbonic gas regulators for the dispensing of draught beer and other beverages. The company now is located in its new plant at 1035 West Lake Street, Chicago.



World's largest bending rolls built in Germany

Four-Roll Bending Machine

German engineers design and build the world's largest bending rolls

By Oliver P. van Steewen

Owing to the use of water power the protection of large diameter pipes has become a matter of increasing importance. The tubes made of bent plates, often of considerable thickness, can be either electrically or water-gas welded. Furthermore, the increase in the working pressures of modern boilers has also led to the use of welding rather than riveting. It is, therefore, not surprising that machine tool constructors have turned their attention to the design of machines for bending large plates of various thicknesses for tube making and for boiler construction.

Although in the years 1905 to 1908 plate bending machines had been built in lengths up to nearly 23 feet, for those times extraordinarily large dimensions, technical progress led to a demand for machines with still longer bending lengths, and for the development of bending machines capable of working thicker plates into tubes.

Between 1908 and 1914 bending lengths had been increased to 27 feet, and in 1920 to 30 feet. The design of machines used up to then limited further development. Greater lengths and thicknesses of plates meant greater deflection of the upper bending roll and the diameter of this was, of necessity, limited by the dimensions of the tube or boiler to be made. In 1920, therefore, it was the general opinion that a further increase of the bending length beyond 30 feet would be impractical.

Meanwhile, the requirements demanded of high-pressure turbine tubing, and high-pressure boilers became still more exacting. The demand for greater lengths of tube and boiler was indisputably recognized. This placed before machine constructors a most difficult problem, for which, however, after a short space of time a complete solution was found. A very simple but none the less effective method was employed to reduce the natural deflection of the upper bending roll to a mere fraction, by extending this beyond its bearing and applying a hydraulically controlled reaction operating in the opposite direction. The practical realization of this idea enabled machines to be constructed in which for the first time bending lengths of 30 feet were exceeded, and a machine was built with a bending length of over 40 feet, which in a subsequent machine was still further increased to 43.5 feet. This latter machine is shown in the accompanying illustration.

The illustrations show plainly how both ends of the top roll have been extended beyond their bearings. The bearing at one end can be tilted downwards and the upper section of it is hinged so as to enable removal of the bent tube. The bearing can be tilted down after this section has been swung back, the roll then being supported free by a hydraulically applied downward pull on the end of the opposite extension. The machine shown has four working rolls, and is the biggest plate bending machine ever constructed. The effective roll length is 43.5 feet, so that tubes and boilers of that length can be dealt with. The maximum thickness of plate of the above length that can be bent cold is 1.5 inches. When bent hot plates up to 2.75 inches can be handled. These figures apply for material having a tensile strength of 99,000 pounds per square inch.

Owing to its special construction, particularly in respect to the use of the fourth roll which lies underneath the top roll and can be forced against the latter by hydraulic pressure, the machine can furthermore be used for straightening the already welded tubes which are

Note: The illustration is published through courtesy of Messrs. Maschinen Fabrik Frorier, Rheyat, Germany.

annealed after welding, this operation also serving to smooth the joint.

To give a correct impression of the size of the machine, it should be mentioned that the top roll is 31.5 inches in diameter and is made of 5 percent nickel Siemens Martin steel with 99,000 to 114,000 pounds per square inch tensile strength. Its weight is 80 tons and the total weight of the machine is 450 tons.

The main motor for driving the upper roll is 300 brake horsepower, while the motor for adjusting the slide rolls is 100 brake horsepower.

All the controls for the machine, both hydraulic and electric, are grouped on a platform from which all operations can be effected.

Uniform Boiler Law Society Bulletin

In October, Charles E. Gorton, chairman of the American Uniform Boiler Law Society, New York, issued a bulletin to members of the society, informing them of action in its field since the adjournment of legislatures earlier in the year. The bulletin follows:

Never in the history of the American Uniform Boiler Law Society have we been called upon to look after such an assortment and amount of legislative matter as we have during this year. From one to nine bills were introduced in some fourteen or fifteen states, (in which some section of our membership was interested) which passed through our hands. We were able personally, or through correspondence, or representatives to contact each of these bills.

It is very gratifying to state that not one bill that was inimical to the best interests of our membership passed, while those sponsored by the society became law.

United States Senate Bill No. 1129 had for its object the repeal of all statutes relating to steamboat inspection (which were more or less obsolete) and delegated power to the Steamboat Inspection Department of the Bureau of Navigation and Steamboat Inspection to formulate new rules. The new rules in all probability will be those drafted by the "Committee to Co-ordinate Marine Rules," and will conform as nearly as possible to the A. S. M. E. Code.

This society was one of the active sponsors of this bill and naturally we feel pleased at its passage, in view of the fact, in so far as we know, it was the only bill other than Administrative Matters that was passed by the 73rd Congress and was approved by the President on Tuesday, July 13, 1933.

The Advisory Committee to the New York Industrial Commission of which your chairman is a member, has held several meetings the object of which was to revise the state boiler rules in accordance with the latest revisions of the boiler code. The work is practically completed and the commission will, we hope, in the near future proceed to public hearings.

During the closing days of the Louisiana Legislature we understand that a tax on prime movers was passed and established the A. S. M. E. Codes as the method of rating these prime movers. We have been unable to get a copy of the bill, although our representative is still trying to get one.

The National Board of Boiler and Pressure Vessel Inspectors held their ninth annual meeting in New York City, October 17 to 19 at the McAlpin Hotel, New York.

We are advised by the California authorities as well as the Los Angeles authorities, that the work of revising the state safety orders has progressed to such a point that final action may be taken in the near future.

This society has furnished the Chief Division of Fire of the City of Miami with a copy of an A. S. M. E. Code ordinance and are looking forward to the passage of an ordinance along these lines.

The 1933 Edition of the Power Boiler Code (sections 1, 2 and 3) has been issued in linen cover form by the A. S. M. E. and copies can be obtained from headquarters.

There was a meeting of the Michigan Board of Boiler Rules of the Department of Labor and Industry in Detroit, at which time papers in connection with the manufacture and operation of steam boilers were given.

The basic code under the N. R. A. for the boiler manufacturing industry was submitted by the American Boiler Manufacturers Association and Affiliated Industries. This code was approved by the President on October 3, and became effective on October 16, 1933.

The National Bureau of Casualty and Surety Underwriters of One Park Avenue, New York City, has issued in sheet form "Requirements for Repairs by Fusion Welding of Boilers or Other Pressure Vessels."

The National Board meeting held at the Hotel McAlpin, was well attended and interesting and valuable papers and comments were given. It afforded all interested in code and inspection matters, the opportunity to talk shop. The members of the board are conference members of the Boiler Code Committee and many were in attendance at the meeting of the committee on October 20.

The City of Omaha is about ready to adopt a new ordinance covering boilers, etc. This society has furnished data and suggestions, which we hope will be incorporated in the new ordinance.

While there will not be as many legislatures in session next year as in 1933, nevertheless there is always the chance that a lot of undesirable bills may be introduced and in all probability will be. We are going carefully over this situation and will take action when the necessity arises.

We have had an increase in general correspondence from our members during the past year, due no doubt to the unusual conditions that have prevailed. Reports received would indicate there are bright spots in certain sections of the country and we, with others, hope conditions will continue to improve.

The following legislatures will convene during the year 1934:—Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, New Jersey, New York, Rhode Island, South Carolina, and Virginia.

It may be of interest to know that some three or four hundred "U" stamps have been issued to manufacturers by the A. S. M. E. to be used on vessels built in accordance with Section 8, (welding rules) of the Boiler Code. The welding art is advancing rapidly and manufacturers are alive to this situation.

(Signed)
CHARLES E. GORTON,
Chairman.

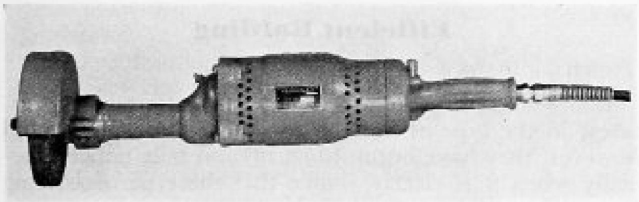
Ninth Annual Conference on Welding

Purdue University has announced its Ninth Annual Conference on Welding to be held at Lafayette, Ind., on December 7 and 8. This conference will be held under the direction of the Engineering Extension Department and the Department of Practical Mechanics, with the manufacturers of welding equipment co-operating. The conference will include talks, exhibits and demonstrations, and is open to all manufacturers and welding shop operators of Indiana and neighboring states. Programs will be ready about November 25. Address inquiries to Engineering Extension Department, Purdue University, Lafayette, Ind.

Hercules High Frequency Grinder

The Buckeye Portable Tool Company, Dayton, O., has just placed on the market another new tool of the high-frequency electric type—the No. 61 Grinder built in two speeds, 3800 revolutions per minute for use with 6-inch vitrified emery wheels and 5400 revolutions per minute for use with 6-inch elastic bonded emery wheels. The 3800 revolutions per minute tool can also be used with 8-inch elastic bonded wheels.

The outstanding features claimed for these tools are the cool running motor, the stream-line ventilation system and the mounting of the stator on insulating pads within the motor housing, resulting in an extremely low temperature rise in operation and thereby naturally increasing the efficiency of the tool.



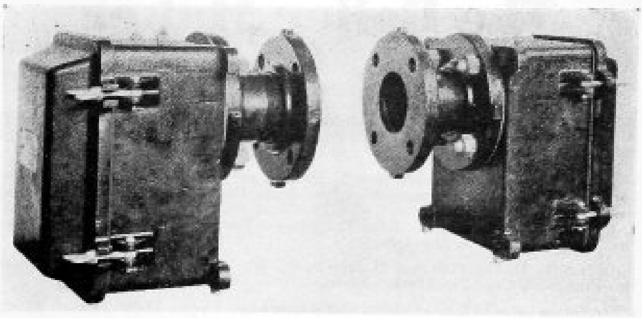
New Buckeye electric grinder

The Hercules plug-in cable is another decided improvement, as it makes it possible to change cables on the job instead of sending the tool to the tool room to have a new cable installed, saving both time and money.

G. E. Smoke Density Indicating and Recording Equipment

Photoelectric equipment for indicating and recording the degree of density of smoke passing through the stacks or breechings of power and heating plants, has been announced by the General Electric Company. Changes in smoke density are indicated on a meter. A running record of the amount of smoke passed up the stack may be obtained by the addition of a recording instrument.

The essential elements of the apparatus are a light source and a photoelectric relay unit. The recording instrument is optional. The photoelectric unit and the light source are designed for mounting on opposite sides of the stack so that the light beam from the light source passes through the stack and falls on the phototube. When there is no smoke in the stack the full intensity of the light is directed on the phototube and the indicating or recording instrument will register zero smoke density. As the smoke density increases, the phototube receives less light from the source and the instrument indicates or records the increase of smoke.



Photoelectric equipment for indicating smoke density

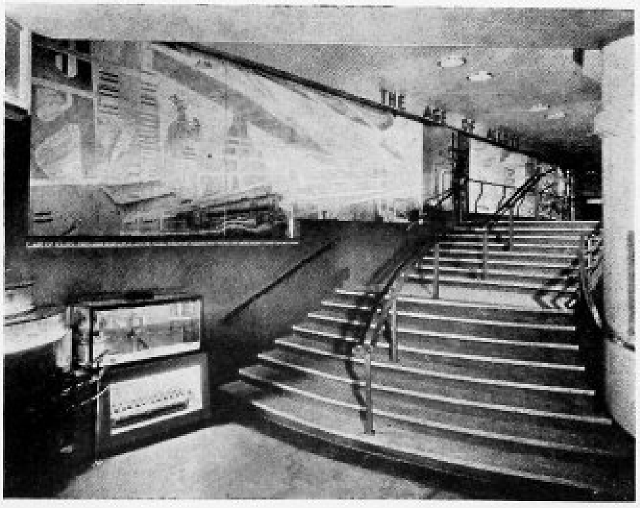
Lenses are provided in front of the phototube and light source. Clean air is drawn by the induced draft of the stack across the lenses, which assists in keeping them clean. The lenses will require some cleaning, however, and therefore the apparatus has been designed so that the lenses are easily accessible.

The light source and photoelectric relay unit are enclosed in cast iron cases for durability and also for protection against dust and moisture. The cases are provided with heavy flanges for mounting on the stack. An adjustable electrical contact for operating an alarm circuit is provided which can be adjusted to any print between 20 to 60 percent of full smoke density. Adjustment can be made by the use of a screwdriver.

The Age of Alloys

We have progressed from the stone age through the age of copper and brass, through the steel age and we now stand on the threshold of the age of alloys.

The progress in industry and transportation brought about through the use of alloy steels and other alloys was depicted in the Union Carbide and Carbon Corporation exhibit at A Century of Progress in Chicago in the largest carved glass mural ever made. This pictorial representation of the age of alloys is engraved in special plate glass and colored. It is 55 feet in total length, and is said to be the largest mural of its kind ever manufactured. It shows how commercial advancement has been brought about through the use of lighter, stronger metal alloys.



Carved glass mural at A Century of Progress depicting progress in industry and transportation brought about by use of alloys

The Boiler Maker

VOLUME XXXIII 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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Communications

Inspection by National Board Inspectors

To the Editor:

I noticed a very interesting editorial in the September issue of The Boiler Maker in connection with the National Recovery Act and the code of fair practice for the boiler and pressure vessel industry. The opinion which you express in this editorial is based upon sound judgment, and if the boiler and pressure vessel industry would include in their code a minimum construction requirement using the A. S. M. E. Boiler Code as their standard and provide that the shop inspection shall be made by National Board authorized inspectors it would insure fair construction competition.

There are a great many concerns in this industry that do not seem to appreciate the importance of uniform construction requirements and uniform inspection. Some of them agree to uniform construction requirements such as following the A. S. M. E. Code, but they do not agree that the shop inspection should be made by an authorized National Board inspector.

It is gratifying to the writer to know that you understand the importance of shop inspection by competent inspectors.

If the Code of Fair Competition only included construction requirements in accordance with the A. S. M. E. Code, it would mean that any State, Municipal or Insurance inspector could make the shop inspection regardless of whether or not he was qualified to do so. There is no inspector's qualification provided for in the A. S. M. E. Code, and the enforcement of the A. S. M. E. Code depends entirely upon the ability of the inspector to enforce its provisions To do this the inspector must be thoroughly acquainted with the provisions of the A. S. M. E. Code.

This is the point I brought up about 12 or 13 years ago which brought about the organization of the National Board, and through the National Board we have been able to establish inspectors' qualifications, and by so doing we have been maintaining the standards of construction set forth in the A. S. M. E. Code.

Columbus, O. C. O. Myers.

Efficient Baffling

To the Editor:

Boiler makers at one time did not indicate much interest in the type of baffling used in boilers. Recently, however, they have begun to sit up and take notice especially when it is clearly shown that the type of baffling does make a difference in fuel consumption.

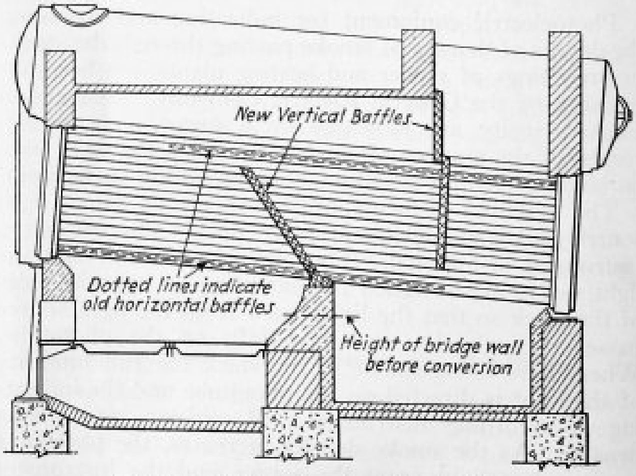
An excellent example of the effect of baffling on fuel consumption under boilers is shown in the accompanying sketch. The dotted lines show the position of the old horizontal baffles. The solid lines show the position of the present cross baffles.

This simple change, increasing the height of the bridge wall, tearing out the old baffles, and installing the new cross-baffles, has resulted in a saving of 20 tons of coal per month.

In four months the cost of the alteration was entirely paid for, so that now the saving is "pure velvet."

In view of the above there can hardly be any further question about the superiority of cross baffling over parallel baffling. Always see to it that the gas flow is across the tubes and that the baffle walls are flexible in order to prevent cracking and breaking.

Newark, N. J. W. F. Schaphorst.



Example of adequate and efficient baffling

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

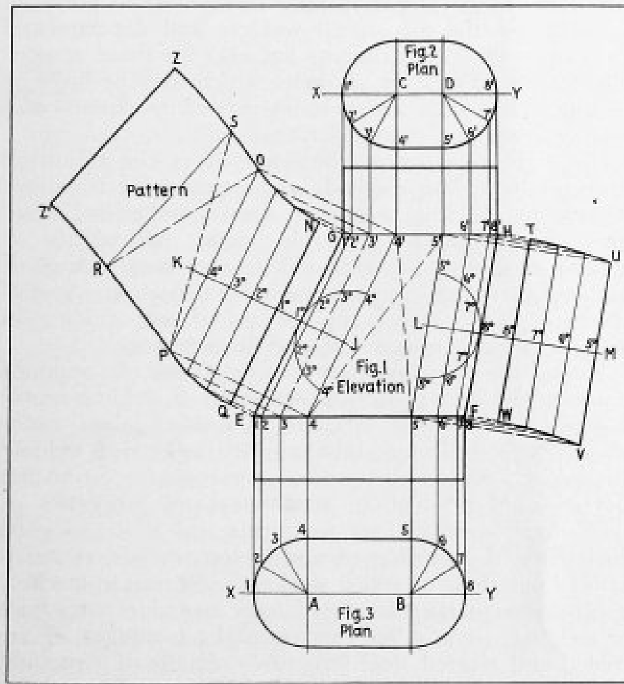
Developing Offset Transition Piece

Q.—Please show method of developing an offset transition piece, oblong with semi-circular ends. E. R.

A.—Fig. 1 shows the elevation of the offset transition piece as outlined in the question.

First draw Fig. 2, showing a plan view of the top and then Fig. 3, showing the plan view of the bottom. *A* and *B* represent the centers from which the semi-circular ends of the oblong are struck in the bottom plan, Fig. 3, and *C* and *D* represent the same centers in the top plan Fig. 2.

Draw the center lines *X-Y* through both plan views, thus dividing the transition piece into two symmetrical halves. It will now be seen that if a development is made of one half, a duplicate of the resultant figure will be a complete development.



Layout of transition piece

Next divide the circular portion of the bottom plan, Fig. 1, into any number of equal spaces, six being taken in this case, and number same from *1* to *8* as shown. Erect perpendiculars to the center line *X-Y* through the points *1* to *8* in Fig. 3, extending same cutting the base lines *E-F* of the elevation, Fig. 1. Number these points *1* to *8* as shown.

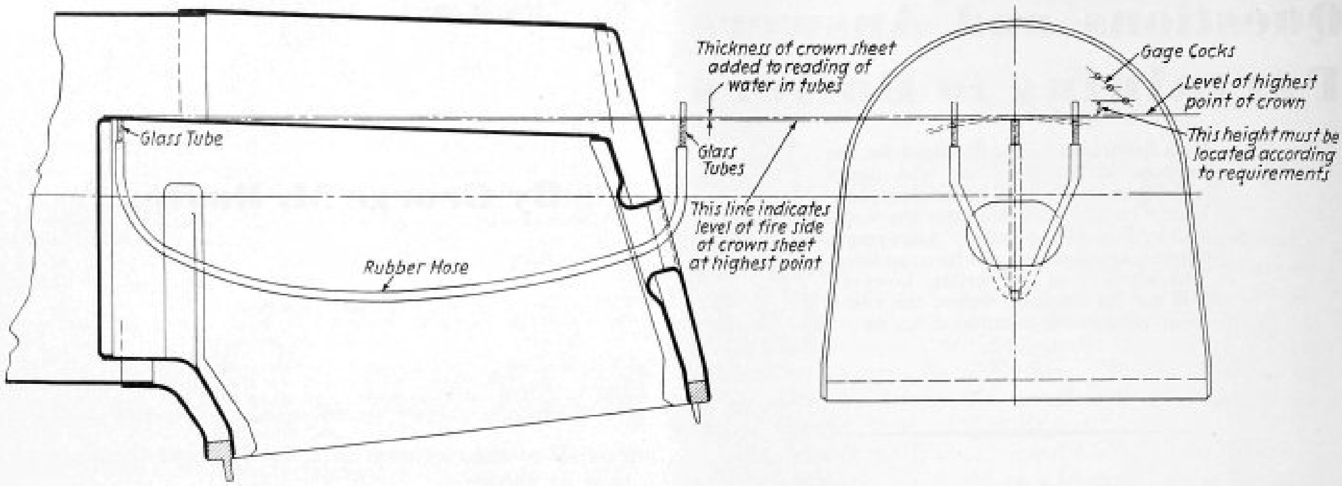
Then divide the circular portion of the top plan, Fig. 2, into the same number of equal parts as was taken for the bottom plan and number same from *1′* to *8′* as shown. Drop perpendiculars to the center line *X-Y*, Fig. 2, through the points *1′ to 8′* in Fig 2, extending same cutting to top line *G-H* of the elevation, Fig. 1. Number these points *1′* to *8′* as shown.

Connect the points *1-1′*, *2-2′*, *3-3′* to *8-8′* in the elevation.

Now obtain the true profiles at each end at right angles to *E-G* and *F-H* of the elevation, since the semi-circular ends shown in the plan views, Figs. 2 and 3, represent the sections on the horizontal planes *G-H* and *E-F* of the elevation. These true profiles can be obtained direct in the elevation as follows: At right angles to *E-G* and *F-H* draw the lines *J-K* and *L-M* respectively. Measure from the center line *X-Y* in plan and take the distances to points *2*, *3* and *4*, which are equal to the distances to points *7*, *6* and *5* and place them on similarly numbered lines in the elevation on either side of the lines *J-K* and *L-M*, thus obtaining the points of intersection *1°* to *4°* and *5°* to *8°*, through which trace a line, thus producing the desired true profiles *J* and *L*.

The half pattern may now be developed as follows: On the line *J-K* lay off the girth of one half of the true profile *J* as shown by the small figures *1°* to *4°* on *J-K* through which points, at right angles to *J-K*, draw lines which intersect by line drawn parallel to *J-K* from similarly numbered points of intersection at top and bottom of the transition. Trace a line through the points thus obtained, as shown by *N-O-P-Q*. Now with a radius equal to *4-5* in the elevation and *P* in the pattern as a center scribe an arc; then with a radius equal to *4′-5* in the elevation and with *O* in the pattern as a center scribe an arc cutting the arc just drawn locating the point *R* in the pattern. Next with a radius equal to *4′-5′* in the elevation and with *O* in the pattern as a center scribe an arc; then with a radius equal to *4-5′* in the elevation and with *P* in the pattern as a center, scribe an arc cutting the arc just drawn, locating the point *S*. Draw the line *R-S*.

For obtaining the pattern for the opposite semicircular end, take the girth from *5°* to *8°* in the true profile *L* and place it on *L-M* as shown by similar numbers, through which at right angles to *L-M*, draw lines which intersect by line drawn parallel to *L-M*, from similar intersections at the top and bottom of the transition piece. *T-U-V-W* shows the half pattern for the right side semicircular end. Transfer this to the pattern on the left, placing the line *V-U* in the right pattern, upon the line *S-R* in the left pattern. *N-O-S-Z-Z′-R-P-Q* is then the complete half pattern.



Method of locating gage cocks

Marking Off Gage Cock Location

Q.—When making a new back head for a locomotive boiler, is it satisfactory to mark off the location of the gage cocks from the old back head? If not, how are the gage cocks located? G. M.

A.—The locating of the gage cocks holes from the old back head would not be advisable, as any variation, either in laying out or in fitting, would affect the height of the water over the crown.

A method of locating the gage cocks after the new back head is in place, illustrated in Fig. 1, is as follows:

Fasten securely and watertight a piece of glass tubing about 12 inches long and of as large a diameter as possible, in each end of a rubber hose having suitable length. The ends of the glass tubes should be ground a little uneven in order to allow water to leak out when the tube is held against the crown sheet.

Fill the hose with water and bring the glass tubes side by side to observe the water level. If this is not the same, there is an air bubble or other obstruction in the hose which should be removed. The boiler must be leveled both longitudinally and laterally.

To obtain the height of the crown sheet, place the glass tube against the crown and hold the glass tube in the other end of the hose against the back head and slowly raise until water runs out of tube against crown sheet. Hold quiet until water ceases to run out. Then the level of water in the tube at the back head will show the height of the under side of the crown, which should be marked on the back head. Do this several times, moving the tube against the crown to several positions to make sure that the highest point of the crown has been used.

Above the line on the back head thus obtained, measure up the thickness of the crown sheet obtaining the second line which would be the top of the crown sheet at its highest point. From this line lay out the gage cocks and water glass cocks, as per requirements for grade, etc.

New Handbook of Arc Welding

Marking a milestone in the literature of welding, the publication of "Procedure Handbook of Arc Welding Design and Practice" makes available in one volume complete and up-to-the-minute information on both design and procedure for arc welding.

The book is encyclopedic both in conception and contents. It contains 434 pages with about 500 illustrations and drawings. The book is divided into eight principal sections or parts. Each of these deals with an important phase of arc welding and its application in a clear, concise manner, amply illustrated with detailed drawings and photographs.

Since the history-making developments of the last few years in arc welding have made most available books on the subject obsolete, the publication of the new "Procedure Handbook" is particularly timely. It is prepared not only for the use of all welders and departmental heads of welding departments but also for those responsible for the design of products which may be built by welding. The data included on procedure, speeds and welding costs are particularly valuable.

The eight sections of the book cover the following subjects: Welding methods and equipment; technique of welding; welding procedure, speeds and costs; structures and properties of weld metal; weldability of metals; designing for arc-welded steel construction of machinery; design for arc-welded fabrication of steel structures, and typical applications of arc welding in manufacturing construction and maintenance.

Among the subjects treated in detail are, descriptions of various welding processes, definition of welding terms, classification of welds, strength of welded joints, methods of stress relieving, tabulations of speed of welding all type of joints in all positions, methods for estimating cost of weld production, structures and properties of weld metal, specifications for steels and alloys of good weldability, the welding of non-ferrous metals, comparison of limitations of rolled steel and cast iron in machine design, construction details of basic machine parts built by welding, treatise on fundamental advantages of arc welded and riveted steel structures, details of structural arc welding, welding of automotive parts, construction and repair of bridges, use of arc welding in cement plants, gas plants, machine shops, mines, refineries, pipe lines, railroad shops, steel mills, shipyards and hundreds of other interesting subjects.

To make the book convenient for both desk and shop use, it has been made 5¾ inches by 9 inches and bound in semi-flexible simulated leather embossed in gold. A comprehensive index has been included.

This book is published by The Lincoln Electric Company, Cleveland, Ohio. It is sold for $1.50, domestic postage prepaid. Foreign postage 35 cents.

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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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States

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

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.		Tampa, Fla.

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

States

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

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.	

STATEMENT of the ownership, management, circulation, etc., required by the Act of Congress of August 24, 1912, of THE BOILER MAKER, published monthly at Philadelphia, Pa., for October 1, 1933.

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 that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and, if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 411, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are:
   Publisher, Simmons-Boardman Publishing Co., 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, 1625 Ditmas Avenue, Brooklyn, N. Y.; P. A. Lee, Hopatcong, N. J.; Henry Lee, Hopatcong, N. J.; E. G. Wright, 398 N. Walnut Street, East Orange, N. J.; S. O. Dunn, 105 W. Adams Street, Chicago, Ill.; C. E. Dunn, 3500 Sheridan Blvd., Chicago, Ill.; B. L. Johnson, 105 W. Adams Street, Chicago, Ill.; W. A. Radford, 407 S. Dearborn Street, Chicago, Ill.; L. B. Sherman, 375 Sheridan Road, Winnetka, Ill.; Mae E. Howson, 105 W. Adams Street, Chicago, Ill.; F. H. Thompson, 643 Terminal Tower, Cleveland, Ohio; 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.; S. Bayard Colgate, special partner, 52 Wall Street, New York, N. Y.; Percival Gilbert, William E. Stanwood, John Nightingale, all of 50 Congress Street, Boston, Mass.

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H. H. BROWN.

Sworn to and subscribed before me this 4th day of October, 1933.

H. D. NELSON.

[SEAL] (My commission expires March 30, 1935.)

The Boiler Maker

Reg. U. S. Pat. Off.

Annual Index

The annual index of THE BOILER MAKER for the year 1933 will be mailed without cost to each subscriber whose request for it is received at our New York office on or before January 15, 1934.

Flame Cutting Fabricated Shapes

During recent years the process of oxy-acetylene and hydrogen metal cutting in industry has made tremendous advances principally because of its flexibility, the simplicity of equipment and its adaptability to the shaping of complicated metal forms at low cost. In the plate fabricating field where the wide miscellany of cutting operations on shapes irregular in outline would make the machine operations tedious and, in some cases, impractical, flame-cutting represents a marked development in production procedure.

This is particularly true for such plates as are subsequently to be fabricated by welding with either the electric arc or oxy-acetylene process. Gas cutting is particularly adapted to repetitive work where templates can be provided for use with pantograph equipment of various types, both manual and automatic in operation, for the quantity production of fabricated shapes.

Many of the leading boiler, tank and pressure vessel manufacturers have used the process of flame cutting to marked advantage and have found it especially useful in shaping and preparing plates for welding. However, the various codes governing welding at present require machining of all gas-cut surfaces before the welding operation is undertaken. This provision works a hardship against welding since the machining of odd shapes is, in many cases, extremely difficult and even in the case of straight production is a costly operation. This condition is particularly in evidence when the U or V-type grooves, so widely used in welded joints must be machined or planed. The cost of such operations is prohibitive and largely overcomes the advantages of low production cost accruing from the use of welding.

The basis for the argument against welding gas-cut surfaces, it is understood, lies in the thin film of ferrous oxide resulting from the cutting operation. It is claimed that this impurity presents difficulty in making sound welds on surfaces so coated. Actually the most logical analysis of the condition would indicate that the quick fusing ferrous oxide is an aid rather than a detriment in producing good welds. So true is this fact that certain of the better grades of fluxed welding rod include ferrous oxide in the coating, taking advantage of its low melting qualities to insure better welds. The slag formed from ferrous oxide serves as a protective coating over the welded surface and does not remain as an impure inclusion in the weld itself.

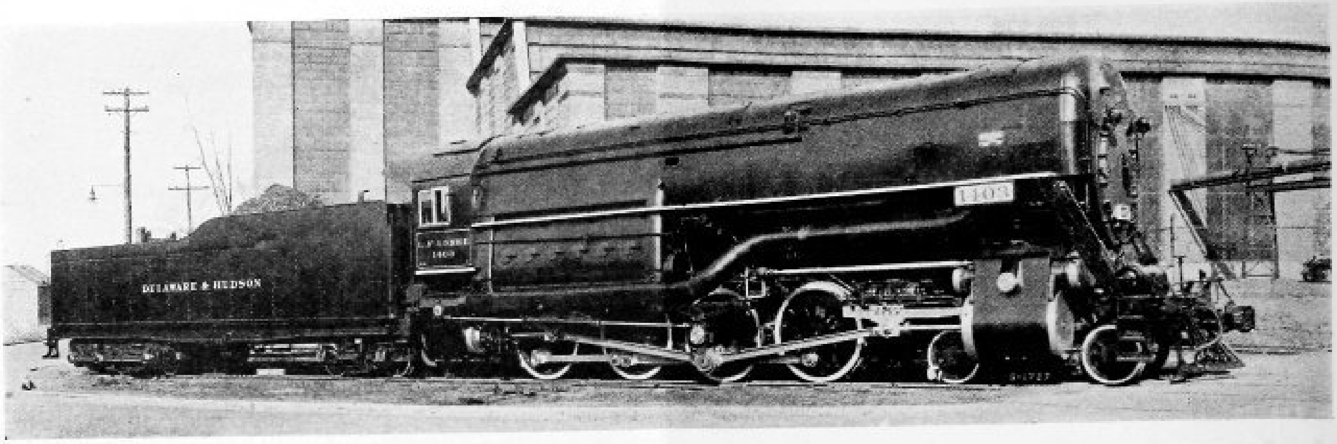
Consideration is now being given by each of the codes for the removal of this restriction which is delaying widespread use of a process for cutting metals that offers so much in simplicity and efficiency. This work will be speeded if those interested in using the process will enter the discussion of the subject and outline their practical experience with vessels or structures fabricated from plates and shapes cut by the flame process.

Boiler Maker and Plate Fabricator

With the January issue THE BOILER MAKER, having to its credit thirty years of service to all branches of the boiler manufacturing industry, will undertake a similar service to the broader field of heavy plate fabrication under the name BOILER MAKER AND PLATE FABRICATOR. The purpose of this publication has been, and will continue to be, the co-ordination of thought and activity throughout the industry—to reach the executive and the man in the shop.

The changes that have occurred during recent months in the fundamental philosophy governing business in general make more necessary than ever co-operation within the ranks of any given industry. To inform the entire field of boiler and plate manufacturing of developments affecting the industry will be a function of this publication. To make available the best information on tools, equipment, materials and methods as they apply in this industry will be the endeavor of the editorial department. The dissemination of information on every phase of the work of regulatory bodies in this field, upon which depends much of the success of the manufacturer producing boilers and welded-pressure vessels, will be an important function of this publication. In addition, each issue will contain practical suggestions to the superintendent, foreman and shop man as to the simplest and best methods for performing a great variety of shop operations. The most advanced developments in this field from European practice will be a special feature of the service to the plate fabricating field. Of utmost importance in a co-ordinated industry is the fullest possible participation of the supply branch. It will be a definite objective in the service to be performed to bring all branches into closer relation with each other.

No publication now serves a similar function as is within the scope to be performed by BOILER MAKER AND PLATE FABRICATOR. The columns will be open at all times for the discussion of any subject pertaining to problems of the industry and our readers are invited to use these facilities as the forum of the field.



Delaware and Hudson locomotive equipped with watertube firebox

Considerations Governing the Use of High Pressure in Locomotive Boiler Design

By Louis A. Rehfuss

From the number of experimental locomotives that have been placed in service of late years, it is evident that departures from orthodox practice have received wide consideration. In so far as these changes have affected the boiler, they have been largely actuated by a desire for higher pressures, in the belief that by their use greater thermal efficiency and more abundant power within given space and weight limitations would ensue.

Recognizing this tendency, it seems pertinent, particularly in view of the approaching obsolescence of so much of the power now in service, to analyze from a viewpoint of general principles the possibilities that lie in the experimental locomotive boiler designs tried out of late years and to estimate their capabilities and fitness for an extended usefulness in the future.

These experimental boilers show definitely a trend away from the extensive use of the flat stayed surface and a substitution therefore of watertube surface. In Europe, where owing to higher fuel costs the need for fuel economy has been greater, some of the designs have been much more far-reaching, but in America experimental designs for high-pressure locomotive boilers so far tried out may be grouped largely into two classes:

(a) *The Combination Firetube-Watertube One-Pressure Boiler.*—This boiler has a conventional firetube barrel connected with a watertube firebox. In this type, all water and steam are under the same pressure and may circulate freely to all parts of the boiler. A number of locomotives of this type have been built for the Delaware & Hudson, the Baltimore & Ohio, and the New York, New Haven & Hartford railroads.

(b) *The Schmidt Two-Pressure System.*—These boilers have a conventional firetube barrel furnishing steam to low-pressure cylinders and feed water to a high-pressure watertube firebox, entirely separated therefrom, which furnishes steam to the high-pressure cylinder or cylinders. The exhaust from the latter joins the low-pressure steam from the barrel for operating the low-pressure cylinders. There are thus two distinct pressures of steam furnished. The high-pressure section is indirectly heated. This section comprises a series of watertubes containing distilled water, and operating as a closed regenerative system, furnishing steam at extreme pressures and temperatures to coils in a closed drum, which evaporate the surrounding hot feed water to high-pressure steam. Originating in Europe, the Canadian Pacific and New York Central have each built an engine with this system of boiler.

While these two types represent roughly experimental work in America so far in the search for a high-pressure locomotive boiler, neither one can be looked on as more than a transitional type, and neither one, because of fundamental limitations, seems likely to be the final answer to the problem.

The first type is not adapted for really high pressures because at such pressures it would be an inefficient heat absorber and permit too much heat to go to waste in the high temperature of the smokebox gases. This is indicated from the following:

Steam Pressure	Temperature of Hot Water at Evaporation
200 pounds	388 degrees
800 pounds	520 degrees

With a conventional firetube boiler working at 200 pounds per square inch pressure, which means 388 degrees water temperature, our smokebox gases leave the flues at 550 to 600 degrees. What the gas temperatures would be with water temperatures of 500 degrees or more can well be imagined. Plainly a firetube barrel where both water heating and evaporation take place indiscriminately all through the flue area (so that the water right up to the smokebox flue sheet is at the evaporation temperature) is not economically adapted for high-pressure work unless very radically preceded by an economizer. Further, because of its large diameter, a firetube barrel tends with increasing pressures to excessive weights and in the event of rupture to potentially more disastrous explosions. It suffers also from poor natural circulation. For increasing pressures this class of boiler makes a good transitional type between low and high pressures, but that is all.

The second style, or Schmidt two-pressure system, avoids high smokebox temperatures to some extent by the use of a low-pressure barrel, but cripples its overall efficiency in so doing. Why produce only half our steam at 800 pounds pressure and the other half at 200 pounds, if the higher pressure is at all superior? One gets the net effect of a 450-pound single-pressure boiler, although feed purification becomes less a problem. Also, in the high-pressure end of the boiler two sets of tubes must be used to accomplish the one evaporation of motive steam. Frankly this seems like undue complication.

This is why we say these two types seem merely transitional in the gradual progress of the locomotive boiler into higher pressure zones. Both possess limitations that restrict their ultimate reach. From the experience in other fields of steam generation, it seems evident that the ideal high-pressure boiler should be watertube throughout, both from reasons of safety and weight. Assuming that this is so, it might be well to see what the heat problem is that we have to face in the production of high-pressure steam.

In generating steam, we must first furnish so much heat to the water to bring it to the evaporation point, then so much to evaporate the hot water into steam. Curiously enough the sum total of the heat thus required is approximately the same whether we produce steam at 200 pounds pressure or 1000 pounds. Therein lies the real economy of high pressure steam. However the amount of heat furnished the water (because of the higher temperatures) and that required for evaporation vary widely in the two cases as shown below:

Steam Pressure Pounds per square inch	Heat in Water B.t.u.	Heat of Vaporization B.t.u.	Total Heat (Saturated Steam) B.t.u.
200	361	838	1199
800	507	687	1194
1200	564	615	1179

Thus it takes less heat to evaporate high-pressure steam in the same proportion that it takes more heat to bring the water to the higher boiling temperatures. The heat of vaporization grows progressively less with increasing pressures, finally reaching a vanishing point at some 3500 pounds per square inch pressure and 700 or 800 degrees temperature. This gives us a significant clue to the proper design of a high-pressure boiler. Emphasize the feed-water heating.

Now it is a well known fact in the conventional locomotive boiler that because of the higher temperature head (difference in temperature between the hot gases and the water being heated) and also because of the radiant heat available that the firebox area plus 25 percent of the barrel tube area nearest it absorb about 75 percent of all the heat absorbed by the boiler. Expressed in another way the rear half of the boiler absorbs three times as much heat as the forward half.

Consequently in the high-pressure boiler, where evaporation becomes less important and preheating more so, it becomes evident that the rear half of the boiler is ample for evaporation and that the primary function of the forward half of the boiler is really preheating.

It may well be asked here why these two functions—water preheating and evaporation—should be separated at all? It is of course to avoid the waste of heat in the smokebox gases spoken of earlier—in trying to heat mixed steam and water through the entire boiler length. In a low-pressure boiler, this is not vitally important, but with high pressures where water temperatures mount to 500 degrees or more it becomes very much so.

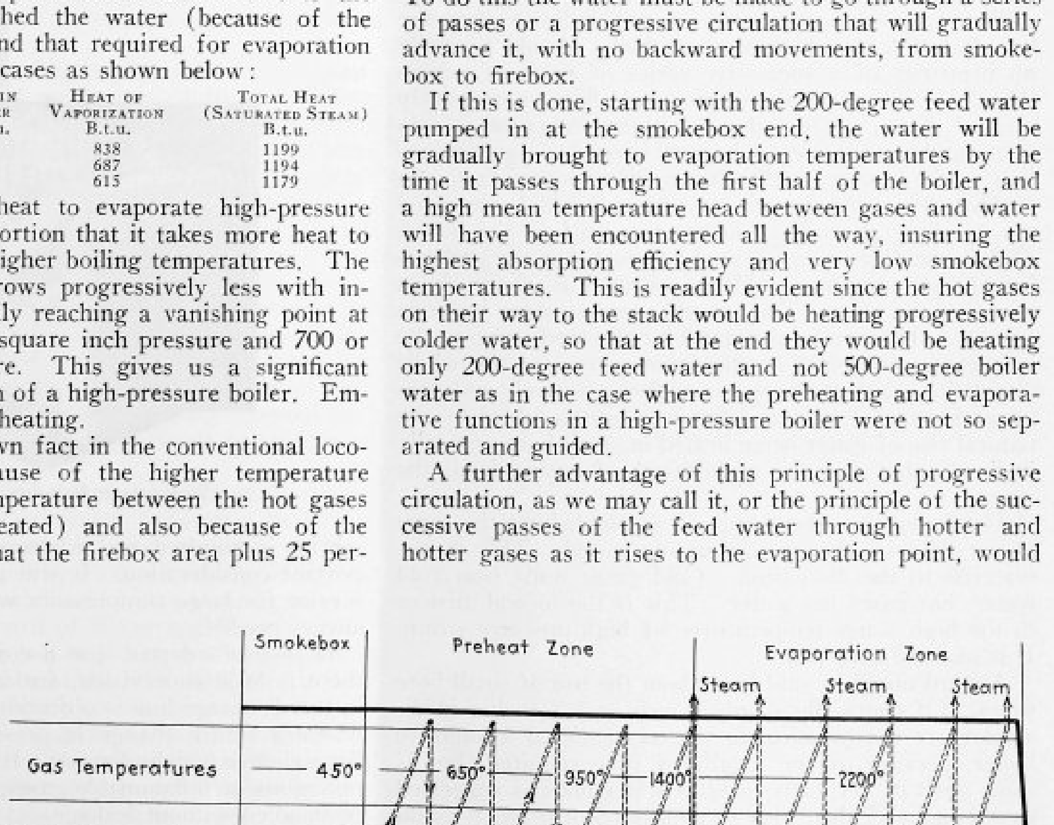
Actually we do not want to separate the two functions at all in the sense of having a break between the two. It should be a continuous operation in which preheating merges into evaporation at the proper temperature stage, separated only from the fact that the feed water entering the smokebox end at comparatively low temperatures (say 200 degrees) will first have to traverse the lower zones of heat before it can move with adequate water temperatures into the hotter zones for evaporation. In other words the water must move countercurrent to the flow of hot gases at all times.

How may this be accomplished? It is evident that the water cannot be left to whirl aimlessly about as in the conventional firetube barrel. It must be kept under control. Each drop of water must spend an equal amount of time in each successively hotter zone of heat. To do this the water must be made to go through a series of passes or a progressive circulation that will gradually advance it, with no backward movements, from smokebox to firebox.

If this is done, starting with the 200-degree feed water pumped in at the smokebox end, the water will be gradually brought to evaporation temperatures by the time it passes through the first half of the boiler, and a high mean temperature head between gases and water will have been encountered all the way, insuring the highest absorption efficiency and very low smokebox temperatures. This is readily evident since the hot gases on their way to the stack would be heating progressively colder water, so that at the end they would be heating only 200-degree feed water and not 500-degree boiler water as in the case where the preheating and evaporative functions in a high-pressure boiler were not so separated and guided.

A further advantage of this principle of progressive circulation, as we may call it, or the principle of the successive passes of the feed water through hotter and hotter gases as it rises to the evaporation point, would

Schematic diagram of temperature conditions in locomotive boiler of the complete watertube type



lie in its potentialities for feed purification. The contained solids in the feed water would be largely deposited in the preheating sections and kept out of the evaporative zone where they would be most harmful. This of course is due to the fact that both carbonates and sulphates of lime are precipitated in water heated to 300 degrees, so they should not reach the rear zone at all. The preheating sections might then be made removable for cleaning.

When we say move the water gradually through the increasingly hotter zones, we refer of course only to its rearward movement. Actually the water should circulate swiftly in whatever passes it makes through heating surface (watertubes) in order to maintain a high absorption efficiency of individual surface. Settling drums at the bottoms of individual passes would provide the necessary retardation in the swift flow for the separation of the lime precipitate.

The circulation path must be as long as possible to permit swift flow. To do this the water would have to be passed up and down or back and forth. Plainly it must be up and down to keep the water a sufficient length of time in a given heat zone. For a given pass a nest of tubes, vertically or preferably steeply inclined, could then be used, and a connection made from the top of one nest to the bottom of the next, and so on. But water rises on being heated. Hence it is plain that the upward passage should be through a large number of small, closely spaced tubes in a given nest doing the real heating, while the downward passage could be accomplished by a large diameter downflow pipe on the right and left sides doing relatively little heating. The bottom header of a given nest might then serve as the settling basins for lime precipitate spoken of above.

These considerations then would indicate that the barrel section in a high-pressure boiler should be made up primarily of a successive series of nests of watertubes, through which the water would flow progressively up and down, up and down without interruption into hotter and hotter zones of heat till it reaches the evaporation section and is finally drawn off as steam from the firebox steam drums. No provision would be required for handling steam save in the rear half of the boiler. There would be no break in the system, but the preheating and evaporation would be separated as effectively as though there were. They would merely merge into one another. The powerful impulse of the feed pump at the smokebox end would be the prime mover of the whole circulation, causing the water to flow positively and progressively to the rear, and having impetus added by the natural rise of water being heated in small-bore vertically inclined tubes and the withdrawal of steam from the rear.

There may be other ways of accomplishing the same object than by the specific means stated. This is immaterial to the discussion. Cold gases must heat cold water, hot gases hot water. This is the logical answer to the high water temperatures of high-pressure steam. It is also the safe way.

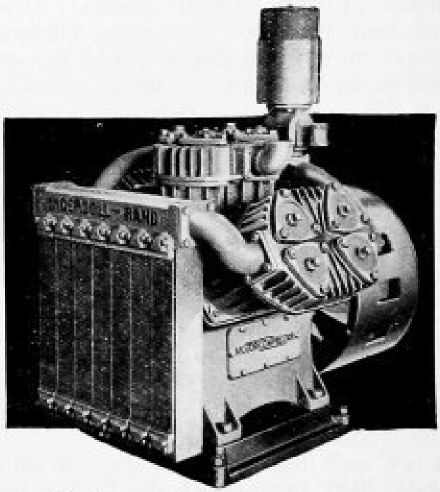
A word might be said here about the use of small bore tubes. Of course flues only 1 inch or 1¼ inches in diameter are not practical in the conventional locomotive boiler, because of the length of tube required, but if short nests of vertically inclined watertubes as suggested were employed, their very shortness (5 or 6 feet) would permit the use of these small bores without interfering with our ability to keep them free from scale. The advantage of the small bore lies of course in the increased heat absorption per unit of surface through increase in the rapidity of flow. A thousand square feet of heating surface of tubes 1 inch in diameter and carrying the same amount of water in a given time and under the same heat conditions as a thousand square feet of 2-inch tube surface will absorb approximately 20 percent more heat, weigh less and occupy roughly one-third less space. The space thus saved might well be used to remove that present bugbear in locomotive design—lack of combustion space—which has cost the railroads so dearly in high unburnt fuel loss.

This question of bore of tubes of course is only a detail. The main thing as we see it in the design of high-pressure locomotive boilers is the application of the principle of progressive counter-current circulation, which might be employed in various ways. However employed, it seems ideally adapted for the design of boilers which might reach to any pressure, attain any hoped for power within limited space compass, and show a heat transfer efficiency well in advance of what we have today.

New Ingersoll-Rand Compressor

A new single-stage, belt-driven compressor designed for heavy-duty service is announced by Ingersoll-Rand Company, 11 Broadway, New York. It is designated the Class ES. It has one horizontal, double-acting cylinder and operates at moderate speeds. It is available in sizes from 10 to 125 horsepower, and for discharge pressures from 5 to 150 pounds.

The machine is suitable wherever full-load, continuous



Single-stage, belt-driven compressor

service is required and wherever power cost is an important consideration. It will give economical stand-by service for large compressors whose full capacity is not always needed.

It is well adapted for use in isolated plants where there is little supervision, for all applications where oil in the discharge line is objectionable, or for installations where a future change in pressure conditions may call for a change in cylinder size. It will satisfactorily handle poisonous or inflammable gases, or any others that must be handled without leakage.

Low air speeds and small pressure losses obtained by liberal design of air passages and valves insure maximum economy. These features and effective water jacketing also insure low air temperatures, which simplifies lubrication problems and lengthens the service life of valves, cylinders, and piston rings.

Safe-Ending Boiler Tubes*

Procedure-control recommended for reclaiming tubes after removal from firetube boilers

In all boilers of the firetube type, the boiler tubes have to be removed at intervals for various reasons, such as: accumulation of scale on them; to permit access to the interior of the boiler shell for cleaning or repair; pitting or splitting of tubes in service; or to allow inspection under legal requirements. The frequency of such removal depends upon the character of the water used and the service to which the boiler is subjected. Few boilers of the firetube type operate for periods longer than five years without re-tubing, while in the case of boilers operating under bad water conditions, annual re-tubing is frequently necessary.

In the removal of tubes from boilers of the firetube type for cleaning or repair of the interior, loosening up the beaded or flared ends of the tubes invariably damages them so that they cannot be replaced. Usually, however, the bodies of the tubes, exclusive of the damaged ends, are found after cleaning to be in sufficiently good condition to warrant replacing in service. In such cases, it is customary practice to trim off the damaged ends and piece out the tubes to the required length by welding on short lengths of tubing. This process is known as safe-ending.

The method of safe-ending used in the past for many years before the general acceptance of fusion welding, was a forge welding process which involved scarfing the tube ends to an angle of about 20 degrees, one scarf external, the other internal, then heating the scarfed ends in a forge fire and welding them by hammering or rolling under pressure. This was an expensive method and in recent years has been rapidly replaced by fusion welding.

Safe-ending of tubes by the oxy-acetylene process has grown to extensive use, as it has proved highly satisfactory. In one great industry the use of fusion welding has shown such advantages from the viewpoint of both economy and time saving that it is now reported that fully one half of the safe-ending work is performed by the oxy-acetylene process.

Code and regulatory bodies have recognized this growing practice and definite provisions for such a method of repair have now been made in the new rules, entitled, "Requirements for Repairs by Fusion Welding of Boilers and other Pressure Vessels" which has recently been issued by the National Board of Boiler and Pressure Vessel Inspectors. These rules, in so far as they pertain to safe-ending of boiler tubes of the firetube type, (it is to be noted that the use of safe-ended tubes in watertube boilers is not permitted) are quite definite as regards the use of the oxy-acetylene process. Part "B" of the section relating to re-ending or piecing of tubes on firetube boilers states that tubes which have been re-ended by the oxy-acetylene process will be acceptable when said tubes have no more than two circumferential welds.

The following procedure control has been prepared to guide the welding operator in the proper method of applying oxy-acetylene welding to the safe-ending of tubes for boilers of the firetube type in all commercial sizes of tubing. It is recommended that this procedure be closely followed for work of this character, and that where boilers are covered by insurance or are under state or other governmental inspection, the local inspector be consulted before proceeding with the work.

* Published through the courtesy of *Oxy-Acetylene Tips*, Linde Air Products Corp.

Procedure Control of the Safe-Ending of Tubes for Firetube Boilers by Oxy-Acetylene Welding

A. Check of the Welders

1. *Experience*

Operators should have experience in welding steel pipe and preferably experience in welding on boilers, and should be capable of meeting the qualification requirements for Class 2† welding as specified in the A.S.M.E. Boiler Construction Code, Section 8, Unfired Pressure Vessels.

2. *Qualification Tests*

The following qualification tests should be made where conditions do not warrant qualifying operators according to the requirements for Class 2 welding of the A.S.M.E. Boiler Construction Code. These tests are designed to be simple and easily made, but they demonstrate the competency of the operator, and follow closely the requirements specified in the A.S.A. and the A.W.S. tentative Code for Fusion Welding Pressure Piping.

Qualification tests should duplicate in so far as possible the conditions encountered in actual safe-ending of boiler tubes.

The welders shall make one or more butt type weld specimens for test by welding together two sections of tubing not less than 9 inches long which should be prepared for safe-ending, set up and welded in the manner described in this procedure. A complete weld should be made under the inspector's observation.

Four or more test specimens, approximately 1 inch wide should be cut from the test weld, one of the specimens being taken from the finishing point of the weld. The cutting blowpipe may be used for this operation. Before testing, the reinforcement of the weld, if any, must be removed making the weld surface flush with the surface of the base metal, and the edges of the specimens machined or ground to give a smooth surface with the corners rounded to a radius of 0.10 inch thickness.

The test bars should be tested by bending under pressure in a vise or compression machine, or by other suitable means producing a gradual uniform bending across the weld.

† This requirement for qualification of welders may be demanded by insurance or state inspectors as the Rules for Repairs by Fusion Welding of Boilers or Other Pressure Vessels state: "Welders who have demonstrated their fitness to produce sound welds, the result of which would meet the requirements of approved welding codes, will be satisfactory for the execution of repairs, etc."

Two of the test specimens shall be bent so that the outside of the weld is in tension or on the convex surface. The surface of the weld shall show an elongation of 15 percent without cracking (cracks less than 1/16 inch not included). Elongation should be measured between gage marks set in the weld metal as near as possible to the edge of the weld on each side.

Two test bars should be bent so that the inside of the pipe is in tension or on the convex surface. These bars should not break when bent 90 degrees. After this test, the bars should be nicked at the center of the weld surface and should be bent back and forth until broken in the weld. The fracture should be examined and should show the following characteristics:

Penetration of the weld to the inner corner of the joint.

Thorough fusion of the weld to the base metal.

Fracture shall be clean and dense, free from irridescent colors and of fine, even crystalline or fibrous structure, *clean* metal, *substantially* free from gas pockets, cold shuts or slag inclusions. The sum of all the above faults present shall not exceed eight gas pockets or equivalent per square inch of area of the fracture. The maximum dimension of any such defect shall not exceed 1/16 inch.

3. *Special Checks*

Additional tests may be made, if required by boiler inspectors, to comply with other qualification requirement tests for welding Class 2 Vessels. These additional tests are the full section tensile tests and the reduced section tensile tests, the reinforcement being retained in the specimens of the first, and removed for the latter test to cause failure in the weld. The A.S.M.E. Unfired Pressure Vessel Code requirements for these tests are that the full section tensile test specimens shall develop tensile strength not less than the minimum of the tensile strength range of the base metal; and for the reduced section tensile test the specimen shall develop a tensile strength of not less than 95 percent of the minimum of the specified tensile strength of the base metal used.

B. Selection and Inspection of Material

1. *Tube Material*

Tubing used for safe-ending shall conform to Specifications S-17, S-18 or S-19 of the A.S.M.E. Boiler Construction Code.

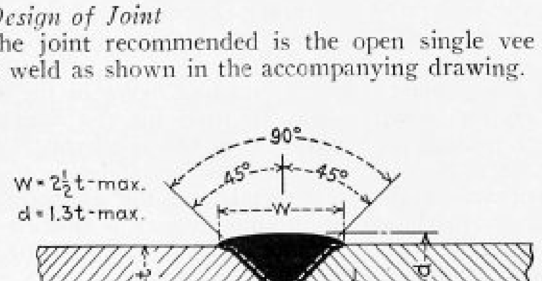
2. *Welding Rod*

Welding rod should be Oxweld No. 1 High Test or Oxweld No. 7, low carbon rod or equivalent.

C. Design and Layout of Welded Joint

1. *Design of Joint*

The joint recommended is the open single vee butt type weld as shown in the accompanying drawing. The



Recommended single vee butt weld

pipe ends should be squared accurately and beveled to an angle of 45 degrees to within 1/16 inch on the inside wall.

2. *Specification for Spacing and Tack Welding*

Pipe ends should be accurately alined and properly spaced to permit fusion to the bottom of the joint. The pipe ends should be tackwelded at three points to maintain this alinement and spacing.

3. *Weld Metal*

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.

D. Preparation of the Tubes for Welding

1. *Cleaning*

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.

E. Welding Technique

1. *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 pipe wall.

F. Inspection and Test

1. *Inspection*

The shop foreman or other disinterested inspector should be in charge of inspection, and should be responsible for the quality of the work and see that correct practices are followed as recommended herein.

2. *Tests*

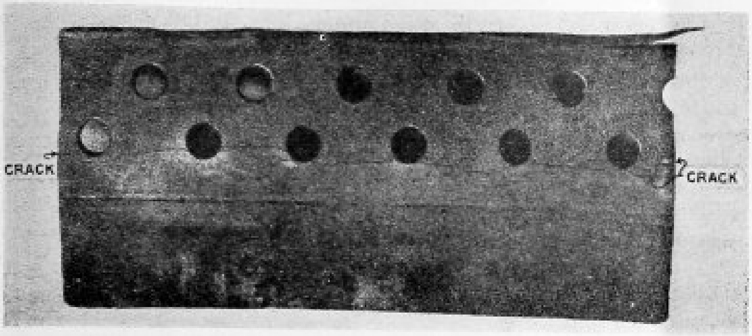
It is recommended that each tube be subjected to a hydrostatic pressure test of twice the permissible pressure of the boilers in which they are to be installed.

With this test pressure on the tube, the welded joint should be struck with a 3-pound hammer with sufficient force to jar the welded joint but not injure the tube. The joint should show no pinhole leaks or defects under this test.

Due to space limitations it has not been possible to publish a further discussion of the individual points contained in this procedure control, but those who wish to write in for it may obtain without obligation a further detailed discussion of some of the various items, such as qualification tests, welding rods, and technique. Refer such requests to The Linde Air Products Company, New York.

Industrial Uses of Stainless Steel

Under this title a lecture was delivered before a meeting of the American Society of Mechanical Engineers at Cincinnati, November 23, by C. C. Snyder of the Central Alloy Division, Republic Steel Corporation, Massillon, O. Prefacing his address with a brief history of the development of stainless steel, Mr. Snyder then divided the present large number of different types of stainless steel into the proper main groups, giving their general characteristics and properties. The latter part of the talk stressed the rapidly increasing use of stainless steel in various industries, such as building, meat packing, brewing, automotive and the chemical and allied industries. Lantern slides were used to illustrate a number of typical installations of Enduro stainless steel.



Cracked seam from drum of watertube boiler

Boiler Failures

By L. W. Schuster*

Failure of Plates from Purely Mechanical Cause.—A study of the fracturing of boiler plates shows that faulty manipulation during manufacture of the boiler accounts for more failures in service than does faulty material. It is not uncommon to find serious cracking of plate of excellent quality. To ascertain the cause of the trouble when a plate has failed is often helpful in determining to what extent reliance can be placed on the remaining plates of the boiler. It is not proposed to deal with grooving, corrosion troubles, and the overheating of metal caused by scale or insufficient circulation.

A prolific cause of failure is ill-fitting of the plates at a joint and the consequential drifting, heavy calking, and flogging of the ends to which resort is taken to remedy the initial fault. The ill-fit of plates leads to the drifting of rivet holes and to the use of excessive pressure during riveting; it is common to find that cracks at rivet holes have been set up in consequence.

An example of a cause of failure lies in a 2-inch boiler plate, which had been bent cold; it contained an indentation made by a tool used during the bending process. As a result, a crack had broken out opposite the tool mark. At this section the Brinell reading near the tool mark was found to have been raised from 131 to 179. Though in this instance there was a foreign constituent present that had led to intergranular weakness and assisted fracture, that is no excuse for the ill-usage. The thickness of the plate was one twenty-eighth the mean diameter of the drum; the normal stretch of the outer fibers at parts bent circular was therefore about 4 percent. Though when steel is work-hardened to this extent by cold bending any ill-effect may not be serious, it is always to be remembered that the residual ductility is correspondingly reduced.

Another cause of failure at lap-jointed longitudinal seams is lack of circularity. This, with the breathing of the boiler, leads to cracks. Similarly, the eccentric pull due to the use of a single butt strap may lead to the same result. The relief of longitudinal seams from breathing stresses is most easily effected by the use of double butt straps. These are, however, not always fitted with due care. In one case the metal was far too thin, and along the longer edges had been raised by heavy calking, with the result that the strap had been buckled. In addition, the grain ran longitudinally, instead of transversely, as it should do in a butt strap. The strap had never been correctly bedded, and, as a result of the heavy calking, cracks had been formed in the line of the outer rows of rivets. In consequence of the ill-treatment, the Brinell reading near the rivet holes had been raised from 110 to 222.

Chemical Embrittlement of Boiler Plates.—An interesting cause of failure of plates, where stress plays an important part, is chemical attack that leads to intergranular cracking or embrittlement. The embrittlement of plates has been known to metallurgists in this country for many years, one well-known work being published by Andrew* in 1913, while earlier experiments still are described by Stromeyer.† In more recent years the attention of engineers has become focused upon the subject as a result of the wide publicity given to the researches carried out in America by Parr and Straub, their first report being dated January, 1917. The question, unfortunately, for a period passed into the political arena, and especially in America, fierce arguments took place. Though, as a result, alterations to the design of boilers have been considered, the controversy has, even in this country, left a certain amount of uncertainty of opinion on the part of those not in direct touch with all sides of the question. It has been considered that an impartial review of the more important facts might usefully be included in the paper, especially as the subject does not appear to have been treated upon in any previous paper laid before an organization of mechanical engineers in this country.

Naturally this kind of failure can take place only below the water level, or at a part to which the boiler water may reach as a result of ebullition or priming, and at which it can become highly concentrated. The facts as the author has experienced them differ in no respect from those found in America. They may be summarized as follows: (1) The usual crack in a boiler plate is cross-granular, and therefore where intergranular failure is found some abnormal circumstance has arisen. (2) Intergranular fracture takes place only when the plate has been overstressed by some such cause as faulty construction or excessive riveting pressure, or when the plate is subjected to a concentration of stress, say at an initial crack at a rivet hole. (3) A network of intergranular cracks is formed, if locally only, round the main line of fracture. Though in an ordinary case of failure a crack may happen to travel along a grain boundary here and there, this is not in itself evidence of chemical attack. (4) It is usual to find a dark oxide scale at the landings near cracks, and sometimes traces of a white deposit giving an alkaline reaction. As, in plant other

* From a paper on "The Investigation of the Mechanical Breakdown of Prime Movers and Boiler Plant" presented before the Institution of Mechanical Engineers, London, Eng., April 28, 1933.

* *Transactions, Faraday Society*, 1913, vol. 9, page 316.
† *Journal Iron and Steel Institute*, 1909, vol. 79, page 404.

than boilers, intergranular cracking can be caused by a large number of chemicals, the author recognizes that, in boilers, though caustic soda may be the most prolific cause of the trouble, it is not necessarily the only cause. He therefore has always preferred the term "chemical embrittlement" to the American "caustic embrittlement." (5) It is common when plates fail in this manner for heads to be broken off rivets at the affected seam or seams. It is remarkable that cracks in the rivets near broken heads are found to be intergranular. That is sure proof, first, that this form of intergranular cracking is not dependent upon the quality of the steel used, and second, that some agency has been at work that is not present in the usual boiler seam. The liability for more than one boiler of a group to fail with the same peculiar feature, though the individual boilers may be of different age and the steel used also different, is further proof. (6) This type of failure is easily imitated in the laboratory by immersing a stressed specimen in boiling caustic soda, when it breaks after a few days with an intergranular fracture. Under these circumstances cracks are formed at atmospheric pressure; in the joints of boiler plates in service the author has encountered them where the pressure has been only 120 pounds per square inch. In America they have been found to occur at 30 pounds per square inch.

As boiler plates are subjected to an elevated temperature the failure of a plate that has been overstressed will in service be assisted by ageing. Though claims have been made that, when a plate has been strained and aged, particular forms of stress can lead to intergranular failure, the author has never found cracks other than transgranular in sound material that has been strained and aged in the absence of chemical attack. Naturally, however, if material contains oxide or other impurity at the grain boundaries, or has a defective structure, intergranular cracks may be formed. Even when extensive cracks are formed over the whole of the seam, the cracks are transgranular, if there has been no chemical attack. It would therefore be difficult to visualize why an embrittled plate should be so widely and rapidly affected as it is, if ageing alone were the cause of the trouble. Likewise it would be difficult to explain the large number of instances where rivets and plates fail together with the same form of crack, be it transgranular or intergranular. The author has never been able to reproduce intergranular cracks near the affected parts of boiler plates that have failed by "embrittlement" in service, *i. e.,* when the attempt has been made independently of chemical agency. With the tests made by alternating bending it is difficult to produce cracks sufficiently fine for the course to be established completely, but no tendency for the course to be intergranular has been traced. In an instance where a plate broke in service at the seam with pronounced intergranular cracks, with the aid of a Wöhler fatigue testing machine fine cracks were produced within the joint, as close as possible to the affected part. These were always cross-granular and no sign of intergranular weakness was shown. Among tests made to notice the course of fracture, was a series in which four qualities of steel were used. These were subjected to various methods of ageing, which failed to produce intergranular cracks. In the single instance where a crack passed round the boundary of one grain, pearlite lay completely round the grain boundary. A transgranular crack passing round a single grain is at no time typical of an embrittlement crack.

Reference should perhaps be made to a very pertinent research by Rosehain,* who subjected plates to stress for 5¼ years in air at a temperature of 300 degrees C., in order to ascertain whether intergranular cracks would be formed; no cracks, however, developed. An example of an actual embrittlement failure is given by the photograph, illustrating a portion of a plate from a drum of a watertube boiler, six years old, working at 180 pounds per square inch. The cracks lay at a lap-jointed longitudinal seam and started at rivet holes, breaking out at the landing, or just the part where concentration of any alkali can take place. The cracks near the line of break are very similar to artificially produced cracks. Every crack examined was intergranular. Fatigue tests were made on specimens of plate taken away from the landing, the tests being continued until cracks were formed; in no instance was the crack intergranular, showing that the intergranular cracking of the plate was not due to any inherent weakness of the plate. Two portions immersed in caustic soda and subjected to stress, however, developed intergranular cracks after eight and nine days, respectively. In this instance the stress necessary for the fracture of the plate was set up by improper bedding of the plates and the punishment they received when riveted. Analysis of the water from a sister boiler showed alkalinity to the extent of 420 grains per gallon, while the sulphate content was relatively low. The ratios of the sodium carbonate and the sodium sulphate content to the sodium hydrate content were, respectively, 0.265 and 0.547, a combination that lies considerably within the zone that Straub considers to be dangerous.

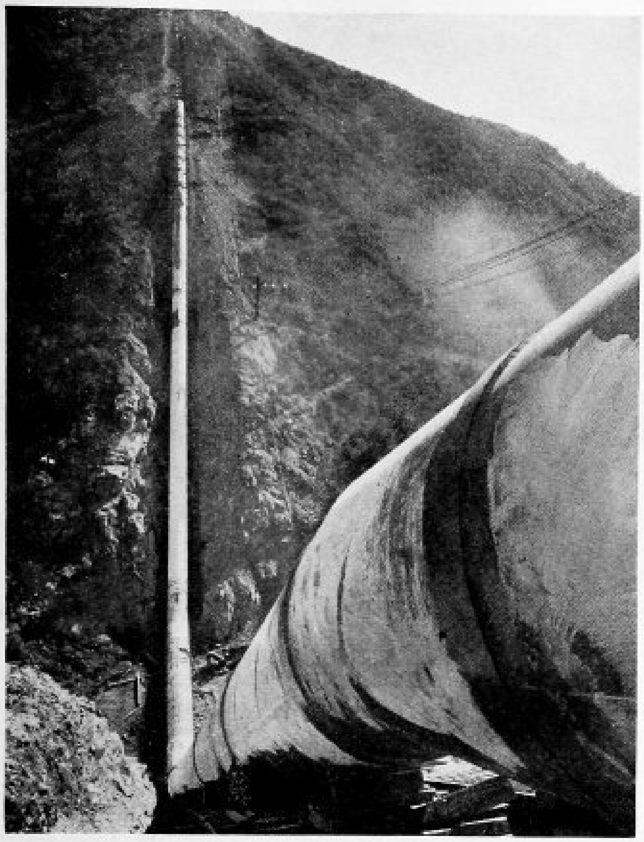
Now this case had an important sequel. A short time after the failure a second boiler of the same battery, which had been made six years before the first, failed in a similar manner, failure starting at the landing. Intergranular cracks were revealed by a microphotograph. If the particular form of cracking had not been due to an action of the feed water, it would have been difficult to explain why this boiler should have failed in the same way as the first, especially as the respective steel plates were made at a different period. A microphotograph, showing a crack at the head of one of the rivets, gave further convincing evidence. The rivet had obviously been made from different material, and yet it failed similarly. This boiler, as did the first, showed a black oxide scale and an alkaline deposit at the landing. In this instance also the plates had been severely distorted owing to inaccurate assembly. Other examples of this type of cracking could be cited. In one instance a battery of twelve Lancashire boilers, 11 years to 23 years old, which had been worked at a pressure of 200 pounds per square inch with water rich in caustic soda, is at present being renewed; several of these had been discovered to contain extensive intergranular cracking at the seams, placing the remainder under suspicion. The conspicuous point is that, where the damage to a seam has been accompanied by broken rivets, the fracture of both materials has been intergranular.

* *Journal Iron and Steel Institute,* 1927, vol. 116, page 117.

Ryerson Buys Bacon and Company

Joseph T. Ryerson & Son, Inc., of Boston, New York and Chicago has purchased the stock and good will of Bacon and Company, iron and steel company of Boston.

Bacon and Company was organized in 1868 by Josiah E. Bacon. The original company was located on Fulton Street in Boston. In 1869 the firm of Bacon and Brown was formed and about 1873 moved from Fulton Street to Purchase Street and continued at this address until 1878. Mr. Bacon then retired from the firm of Bacon and Brown and formed Bacon and Company at 127 Oliver Street. Early in 1881 he built his new plant now located at 107-119 Oliver Street.



Seven-foot arc-welded water line

Arc Welding in the Field

Conquering canyons and straddling mountains, a 4½-mile arc-welded pipe line will soon join Bouquet Canyon Reservoir with the Owens Valley Aqueduct, near Saugus, California. The line will form a part of the gigantic system of the Department of Water and Power, City of Los Angeles.

The new Bouquet Canyon Dam replaces the San Francis Dam which was destroyed several years ago. Water will be carried from the reservoir back of the dam to a power house surge chamber where the Owens Aqueduct also empties.

The pipe line under construction is said to be the largest in the West. It varies in diameter from 7 feet 10 inches to 6 feet 8 inches, depending upon the pressure. The 80-inch pipe is used where the pressure is the greatest. There the pipe is 1$\frac{1}{16}$ inches thick. At the bottom of one of the canyons crossed, the pressure is equal to 400 pounds per square inch. The pipe and the welds must be able to withstand this tremendous pressure.

Fabrication of the pipe is handled by the Western Pipe and Steel Company. Laying of the line and field welding are being done by the Los Angeles Department of Water and Power, using Fleetweld electrodes manufactured by The Lincoln Electric Company, Cleveland. For both the pipe fabrication and the field welding, the shielded-arc process of welding was adopted.

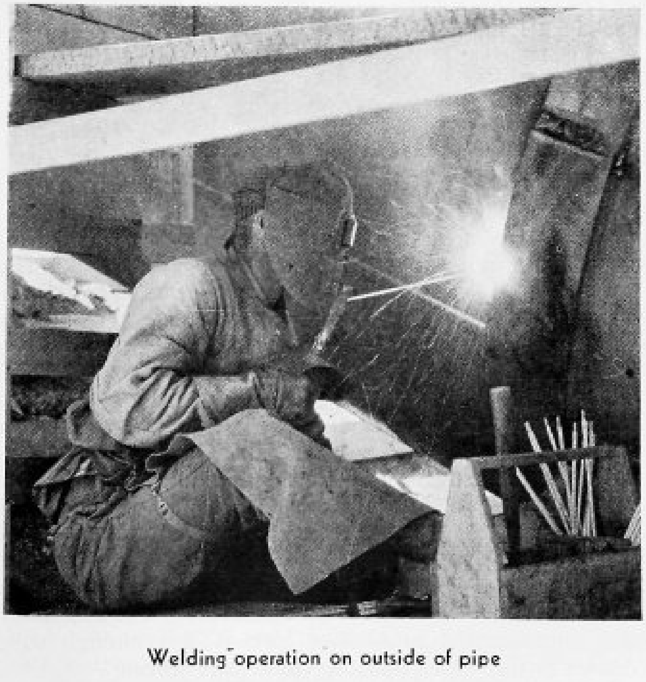
Sections of pipe each weighing approximately 12 tons are hauled to the job by trucks where the City of Los Angeles, Department of Water and Power have a sandblasting and painting plant which cleans and paints the pipe before being placed. When painted it is hauled on trucks to the top of the mountains and then lowered by a hoist down the canyon sides with carriers called "straddle bugs" designed for handling this pipe.

An idea of the size of this pipe is gained when one learns that it takes 450 pounds of electrode to weld each joint on the job. Thirty-two man hours are required to weld the outside of each joint and 24 hours for the inside. The welding is being carried on 24 hours a day in three 8-hour shifts.

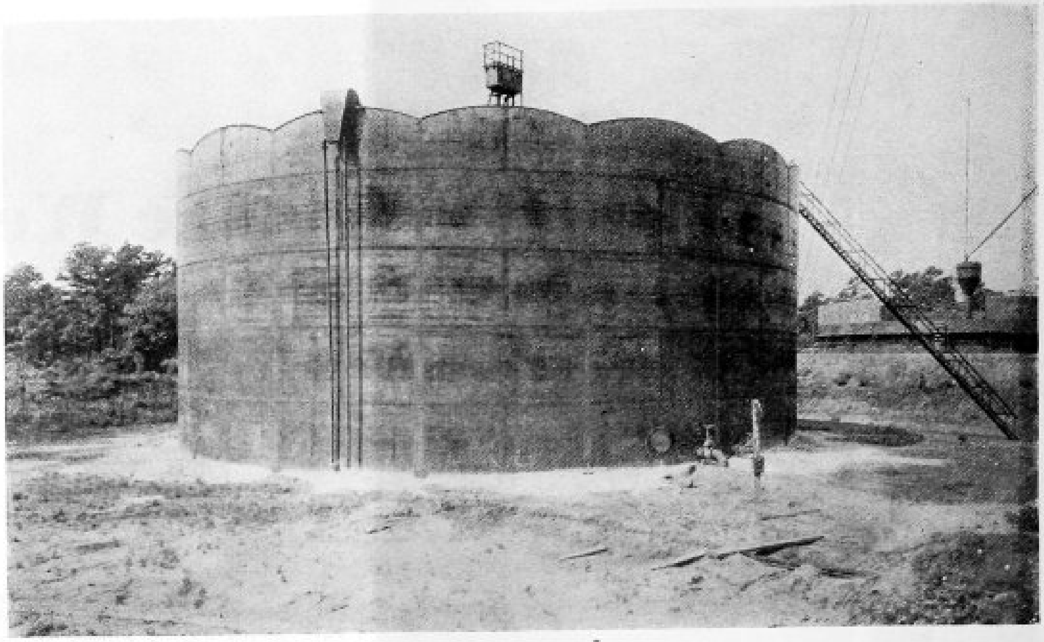
Two new pressure storage tanks, the first of their type ever constructed, were completed recently at Houston, Tex. The tanks, used to store casing head gasoline, were built for the Warren Petroleum Company by The Chicago Bridge and Iron Works.

One of the tanks is of 38,000 barrels and the other of 55,000 barrels capacity. They were fabricated throughout by the shielded-arc process of welding. This process eliminated the buckling and warping which is sometimes encountered in welding.

The most unusual of the features of these tanks is the design, which eliminates the loss of liquid by evaporation. The tanks operate under a working pressure of 6 pounds per square inch. The tops of the tanks are convex and the bottoms concave so that they form a pressure dome of the radial cone type. The convex top also provides excellent water drainage.



Welding operation on outside of pipe



Storage tank designed to eliminate loss of liquid by evaporation; capacity 30,000 barrels

In the center of the tank is a small storage tank containing glycerine. This is used in connection with an automatic pressure regulating device. When pressure is applied to the tank, the glycerine rises to the top of the column and acts as a safety vent to permit the gas to vent to the atmosphere when the 6-pound pressure is exceeded. When the pressure is released, this liquid returns to the storage tank.

The smaller storage tank has been in operation for a long enough period to give it a thorough test, and has not lost a fraction of an inch of liquid by evaporation.

The construction of the tanks is unusual. The bottom is reinforced with radial I-beams welded to the bottom plates and tied to the roof beams with vertical tie angles, acting as staybolts. Each of the cone-shaped sections of the bottom has a concave curve. The top is of similar construction to the bottom. The appearance of these tanks is unusual, compared to that of the type ordinarily used.

The 38,000-barrel tank is 86 feet in diameter and 38 feet in height. The larger tank, shown under construction, is 100 feet in diameter and 42 feet in height.

Stream Pollution Leads to Boiler Accident

Temporary diversion of the contents of a 24-inch sanitary sewer into a small stream from which a southern cotton mill was taking boiler feed water, was blamed for a recent tube accident that not only damaged the boiler in which the accident occurred but, for a time, put a companion boiler out of service and curtailed plant production.

Some days prior to the accident power plant attendants began to have trouble with the boilers foaming and priming. An investigation disclosed that in order to make a sewer available for repair, workmen had diverted sewage into the stream from which the plant obtained its boiler water supply. As soon as this was discovered a temporary connection was arranged so that feed water could be taken from the city main, but the water from the contaminated brook had already left enough solid matter in the boiler tubes to cause overheating.

A fireman had just blown down the water column and was standing directly in front of the boiler when the tube burst, showering around him a quantity of bricks blown from the upper part of the setting. He was fortunate enough to escape injury, but the debris broke the feed line between a stop valve and the feed water heater so that the damaged boiler rapidly emptied itself and there was no way to feed water either to it or to its companion boiler. Therefore, the plant was entirely without power during the two hours that it took to repair the feed line.

The bursting tube pulled out of the top drum, whipped around and struck other tubes and superheater elements with sufficient force to damage them. However, the greater part of the damage sustained by the boiler resulted from the overheating to which it was subjected after the loss of water. It was necessary to replace 96 tubes, re-roll most of the others, and repair the damaged setting and superheater.

Besides the two large watertube boilers comprising the main battery, the plant had also a third, smaller boiler which was regarded as an emergency stand-by unit. This boiler was immediately fired up and put on the line with the undamaged unit, but their combined steam capacity was not sufficient to maintain full production. As a consequence the plant output was seriously curtailed. This was a sufficient reason for rushing repairs, but another good reason was the fear that the larger of the remaining boilers might at any time sustain a similar accident. It, too, had used the contaminated feed water, and although it had probably accumulated an equal quantity of solid material, it could not be spared then for a cleaning. Were it to go "down," production would cease, for the stand-by boiler was too small by far to keep even the looms running.

Fortunately, the boiler held out. By working steadily, several shifts of repairmen succeeded in retubing the damaged boiler without further mishap. To obtain and expedite the shipment of new tubes "Hartford Steam Boiler" had made available the services of a representative in a distant city and the tubes had come through promptly. The local "Hartford Steam Boiler" inspector remained on the job continuously for a stretch of 48 hours while the repairs were under way.—*The Locomotive.*

Necessity of Rules for Uniform Inspection of Boilers and Pressure Vessels

The report of the ninth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors held in New York, October 17 to 19, which was commenced in the November issue, continues with the following abstracts of papers and discussions as presented at the second session:

Inspectors' Commissions and Uniform Examinations

By W. H. Furman*

The National Board of Boiler and Pressure Vessel Inspectors was organized to promote uniformity of rules and regulations as applying to the construction, installation and operation of steam boilers operating in the several states of the Union, which had adopted rules and regulations as formulated by the A. S. M. E. Boiler Code Committee.

To protect this uniformity and permit of the exchange of vessels within the several states it was necessary that a special stamp be applied to each vessel when so constructed. Naturally it was then necessary that steps be taken for the examination of inspectors, which would be uniform. To this end the National Board of Boiler and Pressure Vessel Inspectors set up certain rules with regard to the nature or make-up of the examining board. Where provision could not be made to comply with the same, the secretary of the National Board arranged with the member of the National Board conducting the examination without a board, to issue the questions and have same, with the answers of the candidate, returned to the secretary of the National Board for rating. This method permitted of a more or less uniform examination and the issuance of a National Board commission, which commission permitted of shop inspection only by the holder of same.

Although this method worked quite satisfactorily, still there was, at times, more or less doubt in the minds of some as to the type of examination an inspector had taken. This was due, no doubt, to the fact that in some cases where inspectors were called before some state board to explain their failure to enforce certain requirements, their lack of knowledge caused the board to question the inspector as to his knowledge of the rules for construction and operation, and to inquire as to the nature of the examination he had taken to secure his commission to inspect and as to whether the several states that had recognized same, had not been too hasty in such recognition.

It was, therefore, natural that steps be taken properly to safeguard the state boards which were recognizing and accepting other states inspectors' commissions, and to this end the National Board appointed a committee in 1926, to prepare a uniform examination which would be alike as to its make-up, time for completing same and the date of holding the examination.

* Chief boiler inspector, Department of Labor, Albany, N. Y.

Unfortunately, the recommendations of the committee were not carried out in detail by all member states. However, a major step had been taken in the attempt to conduct uniform examinations and as a consequence a further attempt at uniformity of examinations was made at an executive meeting of the National Board at Columbus, Ohio, in June, 1932, at which time certain recommendations were made as to the changes necessary to secure uniform examinations for inspectors, all of which were acted upon favorably by the Executive Board of the National Board and adopted by the various state boards conducting examinations, with one exception where it was found that legislative action would be necessary before a change could be made. We have every assurance that this condition will be corrected in the near future.

With the completion of this work, the National Board had advanced another step in its program for uniformity in our particular field, and which will be of material benefit to all and tend to strengthen the cordial relations of the several states and cities, who conduct these examinations.

It is sufficient to say that we are now holding examinations which are uniform as to the number of mathematical questions, shop inspection questions, and field inspection questions. The same credits are given in all cases and the candidate is allowed the use of a code for the mathematics as it is possible that he may have forgotten the formulae of some particular problem. However the code is taken up at the end of the mathematical questions. It is further intended that no so-called trick questions be used to tax the time of the candidate.

The writer has been the acting chairman of the Board of Examiners as provided for under Rule 807 of the New York State Boiler Code for the past thirteen years. During that time many candidates have been examined and some rejected, the percentage being about 65 percent approved and 35 percent failed.

It would seem that too much stress cannot be given to the fact that the employer should provide for proper instruction of the candidate before the examination, which would materially assist the boards of examiners and reduce the cost to the employer in that the candidate would pass and could be placed in a gainful occupation by the employer, rather than have him fail and necessitate his replacement, or holding him over until the next scheduled examination.

In view of the recognition as now given the art of welding in both construction and repair of boilers and pressure vessels, it would seem that some steps should be taken to require all inspectors to become conversant with the methods employed to the end that he would be qualified to pass on same, especially as applying to repairs which are made by all types of so called mechanics, who know nothing of metals, stresses or structures and the danger involved in the improper repair of same. I would, therefore, suggest that some knowledge along the line be required of all applicants for commissions and that steps be taken by the present employers to see that their commissioned inspectors receive practical instruction in the art of welding.

Comment on Mr. Furman's Paper

*By J. D. Newcomb, Jr.**

The National Board has succeeded in ironing out most of the differences in enforcement of boiler laws, the Code acceptance being nearly uniform, and the National Board commission is recognized in most states for shop inspections.

I believe that examinations for inspectors' commissions should be held in such a manner that there can be no reasonable doubt that they are conducted properly and that the inspector receiving the commission after passing the examination is well qualified for his work. In justice to the insurance companies, who now as a rule want a National Board commission issued from the examination that is taken by their inspector, we think some provisions should be made so that the examination held in any A. S. M. E. Code state, that is affiliated with the National Board, can be recognized. The insurance companies now want National Board commissions for their field inspectors as well as for their shop inspectors.

We believe the National Board commission should be recognized for field inspection as well as for shop inspections, to this extent, the inspector who has possession of a National Board commission is presumed to have qualified by having passed a National Board examination, which is presumed to be uniform and equal regardless of where it may be held. Therefore, the inspector who has passed such an examination, should be as well qualified to inspect boilers in one state as another.

Mr. Furman's comment, as chairman of the Board of Examiners of the State of New York, for the past thirteen years, that about 65 percent of the candidates examined have been approved, and 35 percent have failed, and in the case of those who failed, on inquiry it was found in most cases to be due to a lack of preparation on the part of the applicant or indifference to the state regulations on the part of the employer, or it was so inferred. During the early years of our department, the percentage of failures was nearly 50 percent. However, during the past few years the percentage of failures has not exceeded 5 percent.

In the matter of the issuance of commissions to insurance inspectors, and that the commission be retained by the employer while the inspector is in his employ, I believe the inspector should be permitted to keep the commission in his own possession.

Just a few years ago it was doubtful whether welding could ever be developed to such a stage that it could be used in the construction and repair of boilers, to replace riveting with any degree of safety. However welding is now recognized by the code, it has a recognized part in the construction and repair of boilers. Therefore the inspector of today must have a knowledge of welding, and some way must be provided so that he can be properly instructed on the subject. The National Board examination in the future should determine that the inspector is properly informed on this subject.

I do not believe that there should be any objection to the annual renewal fee for commissions. The value of the commission depends upon the life and work of the Board and the holder of the commission should be willing to contribute, especially at a time when funds are badly needed.

The National Board has accomplished much during the few years of its existence—its purpose was to secure uniformity in the acceptance of the code for examinations, reports, etc. It was a big task to undertake, but most of the obstacles have been overcome.

* Chief boiler inspector, Little Rock, Ark.

Comment on Mr. Furman's Paper

*By J. P. Morrison**

An inspector in accepting a commission assumes a solemn obligation to enforce the Boiler Code of the jurisdiction granting that commission, regardless of his personal opinion of the provisions of that code. He is not called upon to express a personal opinion but needs merely to advise the owner that violations of the legal code must be corrected.

The suggestion that the commission granted to an inspector by any legal jurisdiction or by the National Board shall be retained by his employer and returned to the authority who issued it when employment ceases, is a good one and is generally followed. However, the surrendered commission should not be canceled, but merely held in suspension, subject to reinstatement within a reasonable length of time, if the inspector is re-employed under conditions entitling him to hold a commission.

Mr. Furman's reference to the applicant's lack of preparedness for examination when seeking a commission should be of deep interest to each of the insurance companies sending inspectors to the state authorities for examination.

An inspector prior to an examination should be given a set of representative questions and required to answer them under conditions simulating those he shall encounter when the examination for commission is held.

I do not believe there is reason to complain of questions now used in any of the examinations for commissions, although I am of the opinion that too much attention is paid to those questions involving mathematics.

Recognition given fusion welding by recent revisions of most Boiler Codes was preceded, rather than followed by a thorough study of the subject and investigation of its possibilities by insurance inspectors. It has been more than ten years since tests of fusion-welded vessels to destruction and the visual, physical and chemical tests of specimens cut from or near fusion-welded seams were participated in and the results approved by insurance inspectors. Since that time hundreds of boilers and unfired vessels having fusion-welded seams have been shop inspected and accepted as satisfactory.

The fusion-welded boiler rather than the unfired vessel is of greater interest to the members of the National Board and the various state authorities. Ability properly to interpret the non-destructive test required by the A. S. M. E. Boiler Code is more essential than knowledge of the practical work of welding.

There is no reason an examination for an inspector's commission should not deal with fusion welding, but at the present stage in the development of that art, when experts are agreeing to disagree on some apparently vital points, an examination question on fusion welding should be carefully considered before being adopted.

*Assistant chief engineer, Boiler Division, The Hartford Steam Boiler Inspection and Insurance Company.

It seems to me that questions dealing with a knowledge of the rules relating to the use of fusion welding in boiler repair work may be included in an examination, but technicalities should be avoided as the success of a repair weld cannot be measured until failure, occurs regardless of the rules on the subject.

The influence of the National Board of Boiler and Pressure Vessel Inspectors through its examination committee has been recognized and appreciated, but that committee should be able to standardize the qualifications demanded of an applicant for examination, should be able to establish reasonable rules for conducting these examinations and should adopt a range of questions covering the subject so thoroughly that the holder of a National Board commission will be granted an unconditional commission as an inspector by any state or city to which application for such commission is made.

Uniform Forms—Data, Suspension and Reinstatements

By Blaine M. Book*

In the operation of a plant, the management endeavors to establish uniform practice and procedure, thereby increasing the efficiency and production as well as lowering the cost of production.

Uniform boiler and pressure vessel inspection reports were prepared by the special committee appointed by the Executive Board of the National Board of Boiler and Pressure Vessel Inspectors, adopted by the Boiler Code Committee of the American Society of Mechanical Engineers, and which are now, or will be, used by all insurance companies affiliated with the National Bureau of Casualty and Surety Underwriters, and accepted by all states adopting the A. S. M. E. Codes as their standard for the construction and inspection of boilers and pressure vessels. The use of these uniform reports simplifies and expedites the handling of the inspection reports in the field, as well as in the office, especially where the reports are handled by employees who have no knowledge of boilers and the work is more or less routine. In addition to the foregoing, the uniform reports lessen the percentage of errors.

Now that the much needed uniform inspection reports are a reality, a uniform manufacturers' data report which will meet the requirements of the enabling acts or ordinances of the various states and cities accepting the National Board stamp, should be given serious consideration by the committee. At the present time, a number of different forms are used, which make it very difficult for the states as well as for the manufacturer to furnish copies of the original data.

It has been suggested that the uniform manufacturers' data report be lined up in such a manner that the manufacturer's representative as well as the shop inspector certify to the entire data instead of the first few lines. The chemical and physical properties as shown on the mill test report should be shown on the manufacturers' data, instead of the statement to the effect that the inspector has checked the mill test report and found it in accordance with the requirements of the Material Specifications of the code. If the chemical and physical properties of the material used are shown on the manufacturers' data report, a permanent record will be preserved in the offices of the various states and cities.

In addition to uniform inspection reports and manufacturers' data reports, there should be a form to be used by insurance companies in reporting to the various law enforcement agencies the suspension as well as the discontinuance of boiler insurance. These forms should contain sufficient information to enable the chief inspector or his deputies to identify the boiler or boilers involved. This form might also be used by the insurance companies for reporting boilers which are over due for inspection. If this form is used for that purpose, it should contain space for stating why the boiler was not inspected in accordance with the requirements of the law. This procedure would lessen the number of forms used.

In conjunction with drafting the forms for discontinuance and suspension of insurance, the committee's attention is called to the necessity of a form for reporting the acceptance of insurance. The two are of equal importance from an enforcement standpoint.

* Chief, Boiler Section, Department of Labor and Industry Commonwealth of Pennsylvania.

Comment on Mr. Book's Paper

By Thomas R. Archer*

No doubt, uniform forms will be an advantage to the different states and insurance companies offices, as the employees who check these reports have, in a great number of cases, no knowledge themselves of the different types and construction of boilers.

Speaking as the head of a department in a small state, where my duties compel me to get out into the field and make inspections the same as other inspectors, and speaking from the viewpoint of an inspector in the field, as well as the head of a department, I believe that the uniform data report as prepared by the committee appointed by the executive committee of the National Board, and adopted by practically all the states and cities which have boiler inspection laws, including our own, is too detailed. I believe that we are not justified in asking for so much data, as I do not think it is necessary to have all this information to determine whether or not a boiler is safe for operation, which, after all, is the most important question.

For instance, there are a number of questions on the data form which could have been eliminated as they are already on the manufacturer's data report which is filed with the different state offices through the secretary of the National Board.

Regarding the manufacturers' uniform reports Mr. Book suggests that they contain the physical and chemical properties of the material instead of having, as we do at present, a statement by the inspector that the mill test reports of the chemical and physical properties were checked and found to be in accordance with the requirements of the code. I cannot see that this would be of any material advantage, as, after all, the only statement that is taken into real consideration is that the boiler was built according to the American Society of Mechanical Engineers' Code.

We, in our state, have recently had some very unsatisfactory experiences with tubes. In fact, we have had cases of new boilers operating less than eleven months in which the tubes have had to be renewed, in

* Chief boiler inspector, State of Delaware.

spite of the fact that the boilers which were replaced had been in service for eighteen years or longer and the tubes were never renewed, in fact had never given any trouble. I should like to say that the tubes which replaced the original tubes in these new boilers have given no better service than the original tubes, and in fact we have boilers that are not more than five or six years old that have had three sets of tubes and are now ready for the fourth, as part of the third set are plugged. I might mention here that as far as could be determined by analysis of the water and testing the boiler for electrolysis, no cause was found for this condition. This was not merely one isolated case, but there have been several in the past three or four years, and the owners have complained very bitterly that instead of the construction of boilers being improved at the present time, as it should be under the American Society of Mechanical Engineers' Code, they seem to be of poorer material than formerly. Consequently, I think that the manufacturers' reports should show from what kind of material the tubes are made, as well as the sheets and heads.

Comment on Mr. Book's Paper

By William Ferguson*

Chief Inspector Book's suggestion that the present manufacturers' data reports for boilers and pressure vessels be revised is worthy of serious consideration as also is his suggestion that the form of the report be changed to require the manufacturer of a boiler or vessel to certify that all data given on the report are correct, instead of only certifying as at present that the material and workmanship entering into the construction of a boiler or vessel complies with the code. This change can easily be made by placing the manufacturer's statement of certification under that of the shop inspector and having both men certify to the entire report as submitted.

There is a further need for revision of these data reports as no provision has been made for the data of a part of a boiler or vessel fabricated by one manufacturer and finally assembled by another such as the fusion welding of seams of boiler drums or Class I vessels being done by a manufacturer equipped to do that class of work fabricating parts of a boiler or vessel for another manufacturer, who completes and stamps the boiler or vessel in accordance with A. S. M. E. Code requirements.

A short time ago Mr. Book submitted to your committee on uniform reports a sample uniform report for notifying the chief inspector of a state when insurance on a boiler was canceled or reinstated, which information is required by several states together with full information giving the reason therefor.

Some states do not require notice of cancellation of insurance but do require notice of overdue inspections or unsafe conditions.

This report was considered by your committee and slightly changed to meet the requirements of all states, so that uniform notice may be given to the state department within thirty days when insurance on a boiler has been canceled or where an internal inspection is overdue and cannot be made.

It was the thought of your committee that the reports be printed by each state using your regular heading as approved by your budget office.

*Assistant superintendent, Travelers Indemnity Company, Hartford, Conn.

Experience with Unfired Pressure Vessels

By F. A. Page*

California's experience in the last eight years with unfired pressure vessels, including air pressure tanks, has not been an enviable one.

A number of failures have taken a toll of human lives and done a great deal of property damage. Here it might be stated, however, that none of the vessels that failed, built subsequent to January 1, 1928, bore the stamp of either the A. S. M. E. Code or the California Standard. All were what we might call nondescript vessels, with the exception of two air tanks, built prior to 1928, and, as far as our records show, had never been inspected.

In 1932, the number of recorded air tank failures was ten. One of these was a common kitchen boiler in which the bottom minus head let go, sending two men to the hospital, one for fourteen days and the other for four days. I am pleased to be able to state that both recovered. The rest of the failures were heads, not one failing in the longitudinal seam.

In 1932 the inspectors of the Boiler Section inspected 3074 air tanks, all first inspections. The number and nature of more or less dangerous conditions, as found and reported, might be of interest and are as follows:

Air tanks with no pressure gages	36
Air tanks with no safety valves	239
Neither pressure gage nor safety valve	26
Safety valves found inoperative	45
Pressure gages defective and beyond repair	31
Shut off valves between tanks and safety valves	213
Safety valves plugged	5
No drains, several had wooden plugs inserted on the inlet side	123

Four showed signs of over-pressure at some time.

Fifty-one cases of over-pressure were observed at the first visit of the inspector, as high as double that permissible under the orders.

Thirty-two vessels used for air pressure were found to be common domestic kitchen boilers.

Tanks rejected, including the 32 kitchen boilers, totaled 95, making a grand total of 924 defects, or a little more than 30 percent of the number of tanks inspected. The above should be convincing evidence in favor of safety orders based on good engineering practice to cover the construction and periodical inspection while in service.

California Develops Rules for Pressure Vessels

Six years ago, in 1927, I had the privilege of presenting a paper before this Board at its meeting in Nashville along the same line and covering the same subject, namely, unfired pressure vessels.

At that time I reported to you that California had about completed its Air Pressure Tank Safety Orders, and that these orders contained radical changes from those in the A. S. M. E. Unfired Pressure Vessel Code. These changes consisted mainly of raising the limit of diameters, stresses and pressures for tanks of welded construction, the diameter limit being raised from 20 inches to 60 inches, the stress for double-vee welds from 5700 to 8000 pounds, and the pressure from 100 to 200 pounds per square inch. I also reported at that time that unfired pressure vessels other than air pressure tanks

* Supervising engineer, Boiler Section, Industrial Accident Commission of California.

would not be covered by any California orders, but that the A. S. M. E. Unfired Pressure Vessel Code was recommended as the basis for the construction of such other unfired pressure vessels.

On January 1, 1928, the Air Pressure Tank Safety Orders were put into effect, and, up to date, we are yet to hear of the first case of failure of any tanks built under these orders.

In the early part of 1930, considerable agitation began to develop in various industries, requesting the formulation of a set of orders to cover unfired pressure vessels other than air pressure tanks.

In September, 1931, the first committee meetings were held in San Francisco and Los Angeles, and sub-committees appointed to formulate recommended rules and regulations to the general committee, which, in turn, would pass them on as recommendations to the Industrial Accident Commission for adoption. These recommended orders, if acceptable to the commission, are considered at public hearings before final adoption by the commission.

As the basis for recommendation, the following facts were brought out for consideration by the committee:

(1) The more uniform physical and chemical properties as found in the steels of today, over steels produced in years past, gives us a far superior product over that obtainable in the early days of the formulation of the codes, and, therefore, make possible more uniformly safe vessels.

(2) Vessels of riveted construction, on which the higher stresses are to be allowed, must be built under full shop inspection and by improved methods of construction, such as the drilling of rivet holes from the solid plate, improved methods of forming and power riveting, and other methods too numerous to mention here. In vessels of welded construction, the improvement of the art of welding has contributed its share towards safety.

(3) Shop inspection is more rigid today than it has been in the past, and guarantees that full compliance with the orders will result in a superior product.

(4) Thousands of unfired pressure vessels, not air pressure tanks, have been and are being operated in California in various industries under stresses as high, if not higher, than those proposed, minus shop inspection, with apparent safety. The sub-committee was induced to recommend the higher stresses on what they termed "super-construction" only, such as Class 1 and 2 vessels, high grade welded and riveted construction.

(5) By eliminating over-stress allowance permitted by the A. S. M. E. Code, in certain parts of vessels, it is believed that vessels constructed in accordance with the proposed orders will, even with the higher stresses, be as safe as though built in full compliance with the A. S. M. E. Code, as now published. Periodical inspections, being made compulsory by the new orders, should create safer conditions than exist at present.

Summing up the above statements and giving due consideration to each of them, it would appear that the stress of 13,750 pounds as fixed will give as safe, or safer, vessels, when built to the new orders, as those built prior to the adoption of any orders at a lower stress. It should be borne in mind that this higher stress of 13,750 pounds is only permissible in cases of super-construction and does not apply to Class 3.

The proposed California Unfired Pressure Vessel Safety Orders will cover various kinds of material that may be used in the construction of unfired pressure vessels, including not only low-carbon steels, but stainless and high-tensile steel and alloys, as well as copper, aluminum and their alloys—even cast iron being given a place.

Comment on Mr. Page's Paper

By H. H. Mills*

This paper is centered principally around the problems and requisites involved in the design and construction of the pressure vessel of the future.

It is common knowledge that many factors affect the safe operation of a vessel, most of which need not be mentioned. Over-stressing and the resulting fatigue and other effects are not the least. While we know fairly well what will result in riveted vessels, the time during which welded vessels of the Class 1 type have been required to carry heavy loads is comparatively short, and research is revealing conditions in welded joints which are hard to determine in the usual shop test.

The principle deviation in specifications, as now proposed by the California Rules Committee, is in the allowable stresses. There is reasonable argument in favor of this change, with reservations, for Class 1 and riveted construction of the so-called super-construction class, yet, provided due attention is given to the test pressures which are now double the working pressure and which, in some cases, could bring the stress dangerously near the yield point. A design pressure of 4½ would seem reasonable and later the same could be lowered to 4, although this would eventually lower the operating factor or shorten the life of the vessel.

For Class 2 vessels the vision is altogether different. While in all cases the first cost could be reduced, the safety and service of the vessel would in many cases also be reduced.

Comment on Mr. Page's Paper

***By J. D. Noonan*†**

Codes and orders regulating the methods of construction, installation and operation of fired vessels have been practiced much longer than any regulations pertaining to unfired vessels. So much so, that today there is a real need for joint effort on the part of all who are familiar with this subject to work for the adoption and application of uniform methods for determining the safe construction of such vessels. If each state should promulgate its own safety orders differing from those now specified by the A. S. M. E. Code, there would without doubt be great variety and considerable confusion, at a time when we are all thinking so much in terms of greater uniformity.

It was long ago recognized that fusion welding would be a large factor in the construction of pressure vessels, and for the past 20 years or more we have been going through a period of experimentation. Formerly, it was the practice arbitrarily to assume 50 percent efficiency in arriving at a value for the longitudinal welds and vessels so built were reluctantly regarded as being suitable to operate on this basis. Many of the

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vessels failed under comparatively low stresses, considerably less than 5000 pounds. The most recent case to come to my attention failed at a stress estimated to have been considerably less than 3000 pounds.

A very considerable difference exists between the limit of stress as set forth in the A. S. M. E. Code for Class 1 vessels as compared to the stress contemplated in California for vessels of the super-construction class. Assuming that the ultimate tensile strength of the material for a fusion-welded vessel is 55,000 pounds, the highest stress that is permitted by the A. S. M. E. Code is 11,000 pounds which is further reduced to 9900 pounds by applying 90 percent efficiency for the longitudinal joint as specified in the code for Class 1 vessels. Now, if we may further assume that super-construction means that the vessels will be constructed substantially in accordance with Class 1 vessels with regard to materials, quality of weld and specified test procedure, the California orders would allow a stress 28 percent greater than the amount permitted under the A. S. M. E. Code for similar vessels.

A further great difference would come in comparing Class 2 vessels of A. S. M. E. construction, for which the welded joint efficiency is taken at 80 percent. Vessels of the super-construction class would be permitted 13,750 pounds in California as compared to 8800 pounds that the A. S. M. E. Code permits for its Class 2 vessels, an excess of 36 percent.

Moreover, the vessels to be constructed under the new regulation will be expected to give service for a number of years. They will be used in applications subject to internal and external corrosion with 2 as a yield point factor of safety. This is but a small margin when we consider composite structures that go to make up fusion-welded vessels, and it would seem that we ought first to become more familiar with their behavior in service and to make our changes in standards only as correct engineering data have shown that such changes can be made.

The question naturally arises regarding the statement that section 8 of the A. S. M. E. Boiler Construction Code appears to be entirely too broad, not specific enough and too limited adequately to serve its purpose properly. I confess inability to reconcile these various shortcomings of being too broad but at the same time too limited and not specific. The only conclusion that I can make out of it is that super-construction in so far as fusion-welded vessels are concerned, means that these vessels will conform more substantially to the less rigid requirements of A. S. M. E. Class 3 vessels than they will to the more rigid test requirements of the other two classes, but will be used in Class 1 and 2 applications and with a maximum allowable unit stress of 13,750 pounds instead of the much lower limits of stress specified in the A. S. M. E. Code for various conditions. There is the further claim that, with certain changes, economical construction could be had without sacrificing any safety. If that is true it is a reflection on the present A. S. M. E. Code and it ought to be revised.

If California has data justifying the position taken, it should be presented to the A. S. M. E. Code Committee for thorough study and universal adoption if it is found to be practical and advisable. There are enough agencies interested in the universal application of a uniform code to support a move by anybody to change the code if it is proper to do so, and I am sure that if there are data to justify the proposed changes in California they will be thoroughly studied and justly treated, and in the end we will have a uniform code of reasonably safe requirements.

Inspection of Low Pressure Boilers

By W. F. Brennan*

The term low-pressure boiler is very often misconstrued by the average layman. I am very sorry to say his ignorance of the dependable strength in all parts of the pressure vessel and his ignorance in the qualification required of the person he has selected to place in charge of the boiler, to say the least, is extremely hazardous.

Unfortunately, many states have not passed laws providing for the examination and licensing of stationary firemen on such boilers used for heating and classified as low pressure. By this, I mean steam boilers operated at a pressure not in excess of 15 pounds per square inch, or hot water boilers operated at a pressure not exceeding 160 pounds or temperature not exceeding 250 degrees F.

Heating boilers, with the exception of a few states, are exempt from state inspection. Therefore, the responsibility of careful inspection rightfully is in the hands of the boiler inspector representing the insurance company. Visualizing the subject of heating boiler inspection from the standpoint of the insurance inspector, it is a recognized fact that we would reduce the accident frequency to a very low point if we could get better cooperation from the boiler owner.

It is to the interest of the boiler owner to have the boilers properly prepared for the internal examination by emptying and thoroughly drying out the boiler, removing the manhole and hand-hole plates and cleaning the fire sides of the boilers. Should the boiler be used as an incinerator during the off season, the refuse must be removed from the firebox. Furthermore, the accumulation of soot in the combustion chambers and back connection should be removed, as well as the ashes from the ash pit. It must be remembered that soot and ash absorb moisture and greatly accelerate corrosion of all exposed parts. Plugs should be removed from the water column so that a complete examination can be made of the connection of the gage glass and gage cocks. Should this be overlooked, there is a danger of a false reading of the water level. Fittings and appliances should be tested during the internal as well as the external inspection.

The shell plates, heads, and braces are hammer tested by our inspectors in order to discover any defects or weakness. He must report on all scale conditions as well as the presence of any internal pitting or corrosion which is very common where industrial water is used and the affected parts are closely watched at the time of each internal inspection. Furthermore, the inspector will note the exact condition of tube and tube ends. Should they indicate a leakage prior to his inspection, his knowledge of the many causes will provide an explanation of the trouble. In other words, the inspector gets all the facts, then determines the proper way to make corrections. The furnace lining and boiler setting will be examined for undue strain caused by the bulging of the wall, which may cause the main steam line and other connections to fail.

After the inspector has completed his work, he will make a verbal report to the owner and when his report is received by the insurance company, the verbal report of the inspector will be confirmed in writing.

The insurance company requires an internal inspection each year, same to be made during the summer and an

* Supervising engineer, The Fidelity & Casualty Company of New York.

external as soon as possible after the boilers have been placed into service.

Comment on Mr. Brennan's Paper

By C. W. Foster*

Omaha is one of the few cities requiring low-pressure inspection and licensing of low-pressure operators. It is my opinion, arrived at from observation, that there is more potential danger in the ordinary low-pressure plant, as we find it, than there is in the ordinary high-pressure plant.

I agree that most of the trouble and accidents connected with low-pressure boilers are due to lack of co-operation on the part of the owner, but we are also inclined to believe that this lack of co-operation can be laid in part at the door of the inspectors, insurance, state and municipal, inasmuch as they fail to impress the owner with the seriousness of neglecting his plant.

One of my inspectors, while inspecting a horizontal return tubular 66-inch heating boiler, discovered that, due to outside corrosion, caused by a leaking header valve, the shell plate at both lugs on the right side had deteriorated to such an extent that the inspection hammer went through with no effort. When the boiler was removed it was found that a section approximately 3 feet by 5 feet was no thicker than cardboard.

On another inspection of a horizontal return tubular heating boiler, it was found that a corroded hand-hole below the tubes had been closed by welding a plate over it. A circular patch was welded around the blow off and a flange welded to the patch for the blow off pipe. On a Pacific-type boiler, leaks developed at the top circulating pipes. Some brilliant mechanic decided the proper way to cure the leaks was to cut the pipes off and weld up the holes. In another instance the inspector found a horizontal return tubular heating boiler with a ball and lever safety valve and on the extreme end of the lever was a Ford automobile connecting rod and piston. The opening pressure was a question. On another horizontal return tubular 66-inch heating boiler with ball and lever safety valve, the ceiling of the boiler room was resting on top of the spindle and there was about one-fourth inch clearance between the end of the lever and the ceiling.

I mention these few cases to support the contention of a city boiler inspector, where low-pressure boiler inspection is required, that *all boilers* whether high or low pressure should be required by law to be inspected at least once a year.

(To be continued)

Steel Plate Fabricating Industry Code Hearing

Public hearing on a code of fair competition for the steel plate fabricating industry was conducted at the Carlton Hotel, Washington, D. C., on December 5, by Assistant Deputy Administrator Frank Upman, Jr., of Deputy Administrator Malcom Muir's division of NRA.

A committee composed of Murrel J. Trees, of Chicago; W. T. Ingalls, of Birmingham, Ala., and W. F. Perkins, of Baltimore, presented a proposed code for the industry. It establishes an average 40-hour work week, with minimum wages of 40 cents an hour in the North and 30 cents an hour in the South.

The code is another in the series of codes for capital goods industries. It contains a labor merit clause, stating that "the employers in the industry recognize that the selection, retention and advancement of employees will be on the basis of individual merit, without regard to either the affiliation or non-affiliation with any labor or other organization."

William P. McGinn, of the American Federation of Labor, speaking for P. J. Moran, president of the International Union of Structural Steel Workers, asked that the code be rejected on the asserted grounds that all phases of the industry under consideration were covered by other codes already in existence. He said the industry as defined was only a subdivision of the iron and steel fabricating industry and there was n reason why it should receive separate treatment.

McGinn charged that an "effort is being made in connection with codes for the construction steel and fabricating industries to defeat organization and unionization" in industries.

He asked that, in case the code were approved, it be amended to exclude erection operations. However, J. N. Davis, of the Boilermakers' Union, followed with the statement that, in the judgment of his organization, erection and fabrication should both be included. Davis asked that the minimum wage be put at 40 cents in the North and 34 cents in the South.

The Baldwin Locomotive Works, through its counsel, Gilbert H. Montague, objected to several provisions of the code. Objections were also expressed by C. D. Conley, representing the structural steel and fabricating industry.

The hearing was concluded at about 12 o'clock, with the understanding that conferences would be continued for the purpose of whipping the code into final form.

Orders Received by Republic Steel

An order for 2460 lineal feet of Toncan sectional plate pipe, 10 feet in diameter, has just been placed with The Tri-State Culvert Manufacturing Company, Memphis, Tenn., and Atlanta, Ga., for use on the Lake Okeechobee Flood Control project in Florida. C. Y. Thomason of Greenwood, S. C. is the general contractor, the project being under the direction of United States Army Engineers.

The pipe, a product of Republic Steel Corporation, will be assembled from No. 5 gage galvanized Toncan iron plates, with 6-inch corrugations, which will receive an asphalt coating in the field. Individual plates 2044 in number will be required, assembled into seventeen "barrels," each equipped with an automatic flood gate at the discharge end. The gates alone will weigh 4 tons each.

This job is of particular interest, not only because it is believed to be the largest order ever placed for sectional plate pipe, but due to the difficult conditions encountered.

The Berger Manufacturing Company of Canton, a subsidiary of Republic Steel Corporation, has received through its Japanese distributors a large order for "Acme" nestable culvert pipe for the South Manchurian Railroad, according to an announcement by J. B. Montgomery, general manager. The order involves approximately 30,000 lineal feet, or 5¾ miles of 24-inch, 36-inch and 48-inch diameters, all to be furnished in Toncan iron.

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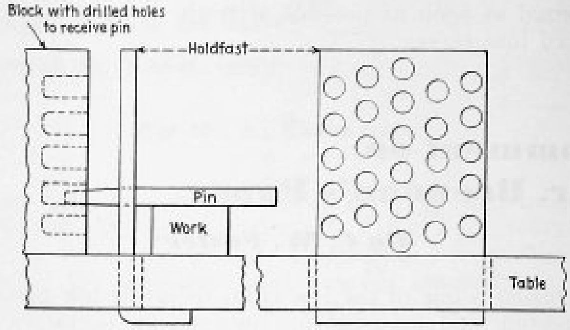
Communications

Adjustable Holdfast for Drill Press

To the Editor:

A simple but effective holdfast arrangement for drill-press work and applicable to many different forms and shapes without a complicated set-up, involving the use of bolts and the tightening of nuts, consists of three parts: a flanged steel plate, a wooden or metal block, and one or more tapered pins of desired diameter and length. The flanged plate is of a width to fit loosely in the slots of the drill-press table, the flange is about 2 inches long, and the length of the plate as desired, 10 or 12 inches is sufficient for ordinary purposes. Holes of graduated height are punched or drilled in the top area of the plate, as shown in the sketch. A block to sit on the top of the table is used in conjunction with the plate. The line-up of holes in the plate is duplicated in the block but not necessarily through the block. Blind holes will serve. The work to be drilled is secured against vertical or



Easily-made holdfast for drill press

lateral movement by driving one or more tapered pins through the most convenient holes and into a similar hole or holes in the block. Advantages are the time saved in operation and the constant safety of the operator when the drill binds or seeks to draw the work upward.

Alhambra, Cal. C. B. Dean.

A Simple Method for Tank Welding

In fitting up tanks preparatory for welding, various methods are in use, and, of course, some methods are better than others. In speaking of tanks, I refer to tanks made with plate thickness of ¼ inch or greater, heads flanged and dished, head flange and shell plate butting.

The usual method is to line up shell and head at one spot and place a tack weld there, then, if necessary, to weld clip angles or bolts at various points about the circumference to draw the two edges into place.

By the method I am about to describe no tack is placed until the whole of the circumference is ready for welding. Furthermore, with this method, even though a difference in circumference of as much as ¾ inch exists, it can be so evenly distributed that it is not noticeable after welding, with the added feature that absolutely no mark or blemish appears on the outer surfaces.

A ring should be made about 2 inches larger inside diameter than outside diameter of the tanks it is to be used on. It should be made of 1-inch by 4-inch

(*Continued on page 263*)

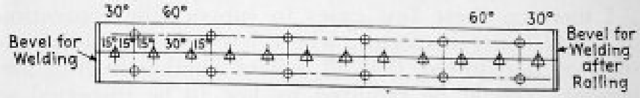


Fig. 1

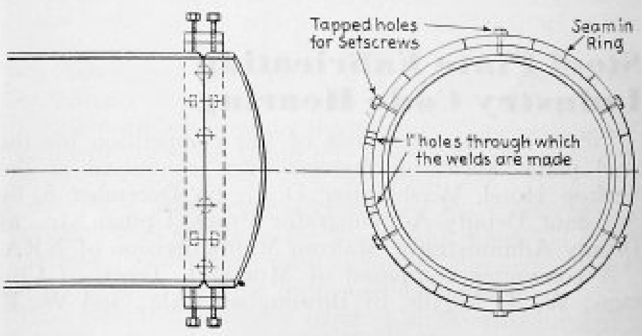


Fig. 2

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

Relative Advantages of Copper and Steel Fireboxes

Q.—Please answer the following questions:

(1) Detail description about firebox material, i. e., copper and steel, their advantages and disadvantages as relating to water, coal, repair and maintenance, etc.

(2) Why do copper fireboxes usually crack at the top flange of the tube plate? T. G. L.

A.—(1) Copper fireboxes are in general use in European countries while steel fireboxes are standard American practice.

For water and coal fuel "Holmes" gives the following data on English practice.

Evaporation 9 to 12 pounds of water from and at 212 degrees F.

Ordinary rate of combustion 65 pounds per square foot of grate per hour.

Ration of grate to heating surface 1 to 60 to 90.

Heating surface per pound of coal burned per hour 0.9 to 1.5 square feet.

"Coles," *Locomotive Ratios* gives the data on American practice.

Evaporation—10 pounds of water from and at 212 degrees F. for tube heating surface and 55 pounds for firebox heating surface.

Ordinary rate of combustion 120 pounds of coal per square foot of grate per hour.

Repair and Maintenance

Copper Fireboxes: The rate of depreciation is lower as scale is not so likely to adhere, owing to the greater movement due to expansion, and the plates will not pit in the event of the water being of a corrosive nature.

The structure of the metal is relatively less affected by the accumulation of scale.

Copper is the more dependable material and is not so liable to develop sudden defects as steel.

Although the cost is higher, the scrap value of copper is correspondingly high.

Owing to the greater thickness of metal employed, the condition of the staybolts is relatively less important, although in copper fireboxes more difficulty is experienced in maintaining tight staybolts due to the difference in the coefficient of expansion between the copper firebox and the steel shell, setting up stresses on the staybolts and staybolt fit in the sheets.

Steel Fireboxes: Steel fireboxes are less expensive.

Decreased movement arising from expansion reduces the extent of the stresses to which the staybolts are subjected, increasing the life of the staybolts.

Rivets may be largely eliminated, the firebox being fabricated and repaired by electric welding.

Galvanic action, due to the presence of dissimilar metal in the boiler is non-existent.

Tube leakage, due to mechanical imperfections of the joint between steel tube and copper tube sheet minimized by welding.

(2) The cracking in the knuckle of the back flue sheet is due—to the difference in the expansion of the boiler sheet and wrapper sheet on the one hand and the flues and firebox on the other hand, caused by the differences in material, and also by the difference in temperature between the barrel and wrapper sheet against the flues and firebox sheets. The difference is piled up in the form of stress on the flange in the flue sheet and is the reason for the cracking in the knuckle.

The expansion in the vertical direction of the flue sheet from the mud ring to the top and the sagging of the crown sheet due to the stretch in the crown staybolts, also bends the flue sheet knuckle.

Working Pressure and Through Stays

Q.—Would you be so kind as to instruct me in the correct method of solving the following problem: Find the working pressure and number of 1¼-inch through stays to support the flat heads of a boiler 64 inches in diameter, 16 feet long; tensile strength of plate, 60,000 pounds per square inch. Girth seams, lap-joint, single-riveted, 2½-inch pitch, ⅞-inch rivets. Longitudinal seams, double-riveted, lap-joint, ⅞-inch rivets. Safety factor 5. Thickness of plate, ½-inch. Take lowest percent joint as efficiency of boiler. Stays, 7000 pounds per square inch cross-section area.—G. C.

A.—The formula for determining the maximum allowable working pressure on the shell of a boiler is as follows:

$$\text{Maximum allowable working pressure} = \frac{TS \times t \times E}{FS \times R},$$

where;

TS = ultimate tensile strength of shell plates in pounds per square inch

t = minimum thickness of shell plate in weakest course, inches

E = efficiency of longitudinal joint

FS = factor of safety

R = inside radius of the weakest course of the shell or drum, inches

The efficiency of a double riveted lap joint is determined as follows:

A = strength of solid plate $= P \times t \times TS$

B = strength of plate between rivet holes $= (P - d)\ t \times TS$

C = shearing strength of two rivets in single shear $= n \times s \times a$

D = crushing strength of plate in front of two rivets $= n \times d \times t \times c$.

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 in inches

P = pitch of rivets, inches, on row having greatest pitch

d = diameter of rivet after driving, diameter rivet hole

a = cross-sectional area of rivet after driving, square inches

s = shearing strength of rivet in single shear, pounds per square inch

c = crushing strength of mild steel, pounds per square inch.

The information given in the question is not sufficient for computing the efficiency of the longitudinal seams, in that the pitch of the rivets used is not stated.

Assuming for example that the rivets had a 3-inch pitch and the rivets had a value of 44,000 pounds in single shear, and the plates a crushing strength of 95,000 pounds per square inch, and taking the other values as stated in the question, the efficiency of the seam would be:

$A = 3 \times 0.5 \times 60{,}000 = 90{,}000$

$B = (3 - 0.9375) \times 0.5 \times 60{,}000 = 61{,}785$

$C = 2 \times 44{,}000 \times 0.6903 = 60{,}746$

$D = 2 \times 0.9375 \times 0.5 \times 95{,}000 = 89{,}062$

$$\frac{60{,}746}{90{,}000} = 0.674 = 67.4 \text{ percent efficiency.}$$

Should the pitch of the rivets be different in either seam, the efficiency of both seams should be computed and the lowest efficiency obtained used in determining the working pressure.

Using the above efficiency together with the values given in the question and solving for the working pressure we have,

$$\text{Working pressure} = \frac{60{,}000 \times 0.5 \times 0.674}{5 \times 32} = 126.3$$

pounds per square inch.

For a boiler of the size stated in question butt and double strap joints, either double, triple or quadruple riveted should be used, obtaining approximate efficiencies as:

Double riveted	81.3 percent
Triple riveted	88.3 percent
Quadruple riveted	94.1 percent

To determine the number of 1¼-inch through stays necessary to support the heads of the boiler it is first necessary to determine the size of the area to be stayed.

The information given in the question does not give any data on the tube layout of the boiler.

The area indicated within the shaded part, Fig. 1, above and below the tubes must be stayed. The chords of the segments are 2 inches from the outer edge of the tubes and a distance d from the shell. The dimension of 2 inches is constant for all sizes of boiler heads, but the distance d which represents that portion supported by the flange, is dependent on the pressure and on the thickness of the head. The value d may be determined from the following formula, as given in the A. S. M. E. Boiler Code.

$$d = \frac{5 \times T}{P},$$

in which;

d = unstayed distance, in inches, from the shell

T = number of sixteenths of an inch in thickness of head

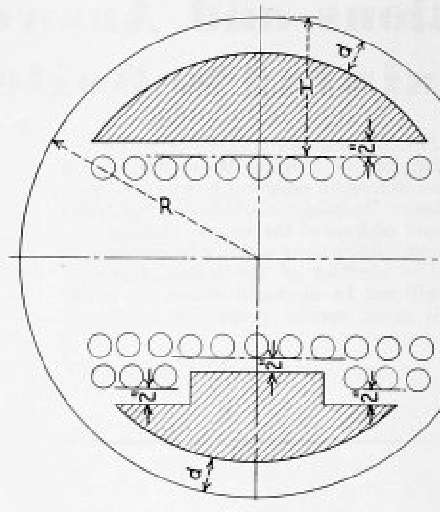


Fig. 1

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

The A. S. M. E. Boiler Code also prescribes that the outside radius of the flange of the head may be used for d, if such radius does not exceed eight times the thickness of the head.

To illustrate the meaning of the outside radius of the flange, Fig. 2 is given, in which the radius r may be

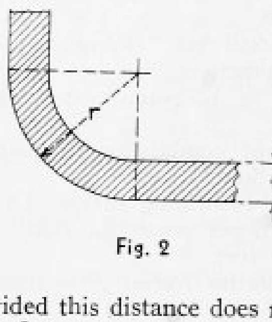


Fig. 2

used for d provided this distance does not exceed $8 \times t$ as shown in the figure.

The greater value for d as found by the two rules given may be used.

In determining the area of a segment, the following formula is used:

$$A = \frac{4(H - d - 2)^2}{3} \times \sqrt{\frac{2(R - D)}{(H - d - 2)} - 0.608}$$

in which;

A = area to be stayed square inches

H = distance from tubes to shell, inches

d = unstayed distance from shell to boundary of segment, inches

R = radius of boiler head, inches.

After determining the area to be stayed above the tubes, the number of stays required would be found as follows:

$$N = \frac{A \times P}{S \times a},$$

where;

N = required number of stays

A = area to be stayed, square inches

P = maximum allowable working pressure, pounds per square inch

S = maximum allowable stress in stays, pounds per square inch

a = cross-sectional area of one stay in square inches.

After determining the number of stays required, it is then necessary to recheck the load on each stay, so as to determine that a uniform distribution of the load has been made and that no stay has been overloaded.

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.

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 given records of the interpretations of the Committee in Cases Nos. 761 and 762, formulated at a meeting on October 20.

CASE No. 761.—*(Interpretation of Spec. S-17.)*—*Inquiry:* Subcommittee A-1 of the American Society for Testing Materials has approved a tentative revision of Par. 17 of Specifications A-83 for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (identical with Specifications S-17) for marking short lengths and sizes of boiler tubes as follows:

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, and together with the hydrostatic pressure in pounds at which it was tested, shall be legibly stenciled on each tube 1¼ inches in outside diameter and over, provided the length is not under 3 feet.

b On tubes less than 1¼ inches in diameter and on all tubes under 3 feet in length, the name or initials or brand of the manufacturer shall be legibly stenciled or indicated on a sticker applied on each tube.

Pending revision of Specifications S-17 to agree with the revision of A-83, will it be satisfactory to mark such small tubes in accordance with the tentative revision?

Reply: It is the opinion of the Committee that tubes marked in accordance with the tentative revision of Specifications A-83 will be satisfactory for acceptance under Specifications S-17 pending revision of that Specification.

CASE No. 762.—*(Special Rule.)*—*Inquiry.* The special committee appointed at the March, 1932, meeting to consider the use of higher tensile strength plate for fusion welding of drums or shells of power boilers, has reported recommending the use of high tensile strength carbon steel plates under A. S. T. M. Specifications for High Tensile Strength Carbon Steel Plates for Pressure Vessels (Plates 2 inches and under in thickness) A149-33T, and for High Tensile Strength Carbon Steel Plates for Fusion Welded Pressure Vessels (Plates over 2 inches up to and including 4 inches in thickness) A150-33T. Will it be acceptable to construct riveted or fusion welded Code boilers or pressure vessels of material to Specifications A149-33T and fusion welded boilers or pressure vessels to Specifications A150-33T?

Reply: These tentative A. S. T. M. specifications have been accepted for addenda to the Material Specifications Section of the Code, and it is the opinion of the Committee that pending final action on these addenda, boilers and unfired pressure vessels constructed of material conforming thereto will be acceptable under the Code rules.

Simple Method for Tank Welding

(Continued from page 260)

steel bar. The stretchout for the bar, previous to rolling, is shown in Fig. 1.

Holes on the center line should be drilled about 1 inch after rolling; the other two lines of holes should be drilled and tapped, after rolling, for ¾-inch by 10-inch thread to take ¾-inch set screws. The set screws for steel tanks should be cup point but on everdur or other soft material should be dog point, or, if these are not at hand, the sharp edge of the cup point should be ground off.

In use the ring should be placed on the head and held there by one row of set screws. Then the ring and head should be picked up and set on the shell, set screws drawn up as needed. Then welding all about the head is made through the 1-inch holes in the bar which come over the center of the seam or nearly so.

With this arrangement two men can place and tack weld a head into position very quickly with the added feature that the welder is not a necessary man of the group, as he is not needed until the final 5 or 10 minutes.

By slacking off on one set screw and drawing up on the opposite one (on opposite side of ring) head or shell can be shifted till the shell and head are in perfect alinement. The 1-inch dimension between the shell and the ring has been found best as this open space is an aid in seeing which way or in what direction one or the other parts needs shifting.

CALENDAR.—A calendar for the year 1934 has been received from the France Packing Company, Tacony, Philadelphia, Pa., manufacturers of metal packing for all conditions of service.

F. R. Faulk, 50 Penn Avenue, Pittsburgh, has been appointed district sales representative for universal arc welders, accessories and welding electrodes by the Universal Power Corporation of Cleveland, O. The Welding Equipment and Supply Company, 2720 East Grand Boulevard, Detroit, has been appointed Detroit distributor for Universal arc welders, accessories and electrodes. Thomas Butler of Welding Equipment & Supply Company is widely known in Detroit welding circles.

A. M. CASTLE & Co., Chicago, have been appointed exclusive sales representatives on the Pacific Coast for the Inland Steel Company, Chicago. The sales will be handled through the Castle Company's Los Angeles, Cal., San Francisco and Seattle, Wash.

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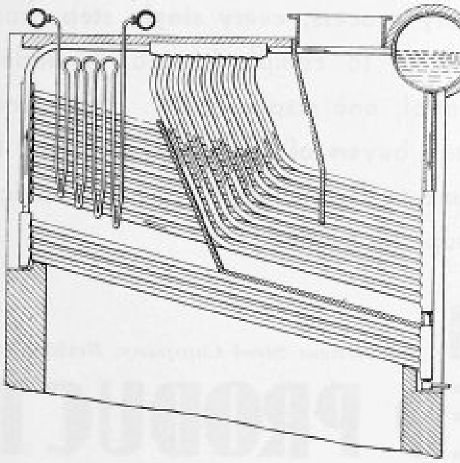
Selected Boiler Patents

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.

1,829,863. STEAM GENERATOR. JAMES F. KAVANAGH, OF CLIFFSIDE, NEW JERSEY, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

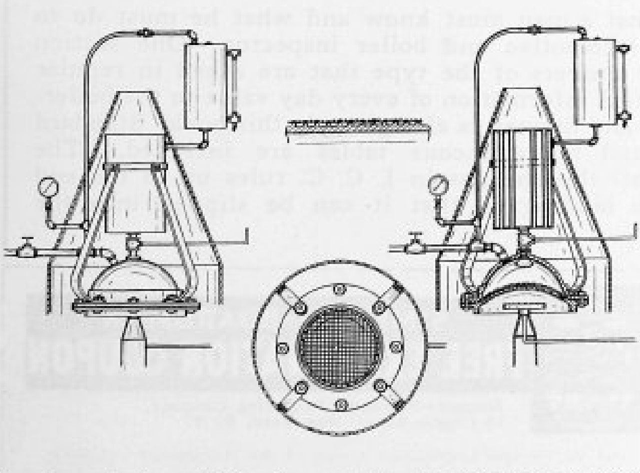
Claim.—The combination in a boiler of a bank of water tubes arranged in vertical rows and curved sharply upward at one end, a second bank of water tubes also arranged in vertical rows and having its rows inter-



mediate those of said first bank for a portion of their length, said second bank projecting beyond the upturned ends of said curbed bank at one end of the boiler, and means for causing thermal circulation through said banks when heated. Six claims.

1,829,839. STEAM GENERATOR. OSCAR RATSCHKOWSKY, OF AMERICAN FALLS, IDAHO.

Claim.—In a steam generator, a closed generating chamber crescent shaped in vertical cross section and arranged when in operative position with the concave side facing downwardly, and having a steam pipe leading



therefrom, a heater underlying the concaved under side of the generating chamber, a cylindrical water heating drum overlying the generating chamber and having a plurality of heating pipes passing upwardly therethrough, a valve controlled pipe connecting the bottom of the heating drum with the top of the chamber, a sprayer communicating with the pipe and positioned in the upper part of the chamber, means for supplying liquid to the heating drum and a cone shaped heat retaining casing enclosing the generating chamber and the heating drum.

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B.M. 12-33

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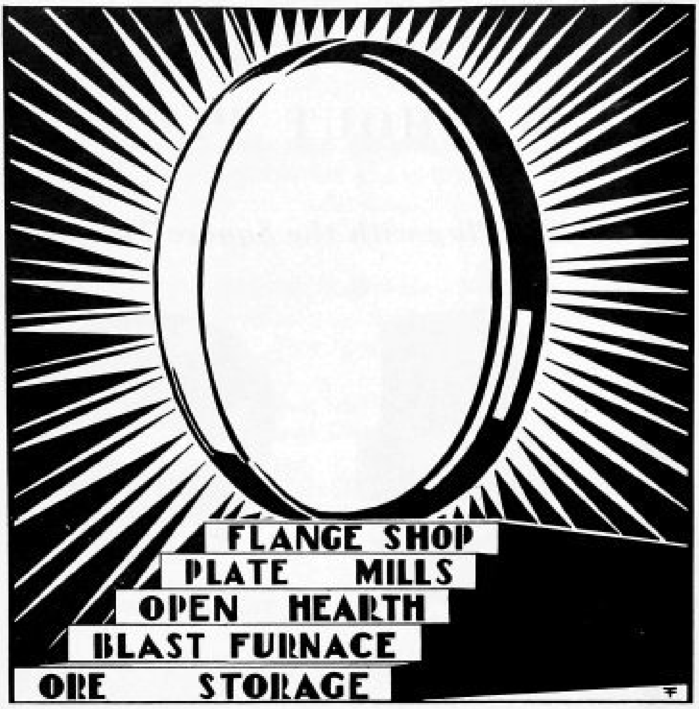

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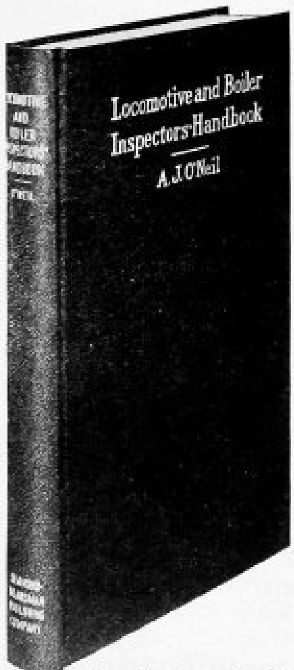

Locomotive and Boiler Inspectors' Handbook

By A. J. O'NEIL

Locomotive Inspector, New York State Transit Commission

This book explains what a man must know and what he must do to become a state or federal locomotive and boiler inspector. One section contains 162 questions and answers of the type that are asked in regular examinations. Much practical information of every day value to the boiler-maker, machinist, engineer and fireman is also given in this book. Standard rules and specifications and miscellaneous tables are included. The Second Edition contains all the changes in I. C. C. rules up to the end of 1930. It has a flexible binding so that it can be slipped into the pocket of a work jacket.

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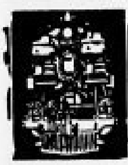
297 pages, 138 illustrations, 5 x 7½ inches, $2.50



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VOLUME XXXIV

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Boiler Maker and Plate Fabricator

January 1934.

Under Our New Name

With this first issue under the new name Boiler Maker and Plate Fabricator, we again wish to bring home to our readers the purpose behind this change, which means an amplification of the scope of its editorial influence rather than a departure from a long established policy of service in the railroad, contract and marine boiler fields.

Modern industrial demands for products of all kinds fabricated from heavy plate have injected an entirely new element into the work of the average boiler shop and in many cases have created a distinctly new type of plant to meet production demands for specialized equipment of this character. In addition to the actual physical changes occurring within the industry, the philosophy of this, as of all business at the present time, is undergoing considerable alteration almost from day to day. With the practical experience gained from serving the parent industry for thirty years, Boiler Maker and Plate Fabricator will attempt to supply a type of service to those in this broader field that is not provided by any other medium.

Briefly, the policy of this publication will be to keep its readers informed of developments in all branches of boiler and plate fabricating work; in improvements, in tools, equipment and materials and methods employed. Activities of associations, regulatory bodies, governmental and technical, which affect any branch of the industry will be treated at length. Because Boiler Maker and Plate Fabricator reaches the executive and the man in the shop, it is in a position to serve as a forum for the interchange of ideas from our readers without respect to rank. We earnestly trust that advantage will be taken of our pages, in order that a better understanding may exist within all branches of the industry.

Railroad Purchases and Operating Revenues

As an indicator of improving conditions in the railroad industry, the increase in purchases of materials and supplies by the railroads with their own funds is extremely significant. In addition, Public Works Administration projects have in the past few months still further aided the situation. Complete data covering such purchases are not yet available. However, purchases during the first 10 months of 1933 indicate that the railroads, earning 93 percent of the total operating revenues, purchased fuel and supplies to the approximate amount of $450,000,000. This is exclusive of locomotives, equipment and materials purchased by contractors of railroad work.

The most significant fact was the reversal of the downward trend and the steady monthly increase of purchases since April, excluding equipment and fuel. For the first year since 1929, purchases for the year 1933 exceeded by a small margin those for the preceding year.

From the standpoint of earnings, the Class 1 railroads for the first 11 months of 1933 had a net railway operating revenue of $435,804,479 against $294,012,783 in the same period of 1932, an increase of $141,791,696 or 48.2 per cent.

The granting of Public Works Administration loans to the railroads for the purchase of rails, cars, locomotives, and equipment construction and repair in general is having a marked effect in the development of much needed rehabilitation programs by many of the leading railroads. A complete summary of the work to be undertaken with such funds will be available shortly and will be published in the next issue.

Codes of Fair Competition

Under code operation over a period of three months, the boiler manufacturing industry found that certain trade requirements were necessary for the regulation of members that had not been included in the original provisions of the fair competition section of the code as originally approved. A trade practice supplement was therefore prepared and submitted to the National Recovery Administration at public hearings in Washington on December 27.

The proposed additions to the code cover the activities of a supervisory committee for each branch of the industry; a method of determining fair prices and elimination of sales below cost; re-sale transactions; erection; export sales and fair trade practices. Unquestionably this supplement will shortly be approved by the President.

The boiler manufacturing industry is to be congratulated upon the speed with which its administrative organization was developed and for the efficiency it has demonstrated in its work. The provisions of the code supplement should be extremely effective in advancing the welfare of the entire industry.

In contrast with the rapid organization of the boiler manufacturing industry into a functioning cohesive body has been the difficulty of organizing the steel plate fabricating industry. Having no comprehensive trade association as a nucleus, the group which has finally been instrumental in bringing the scattered units of this industry together is sincerely to be commended. The public hearing on the code to govern this industry was held early last month and the approval of this code is expected almost momentarily.

Both this code and the supplement to the boiler manufacturers' code will be published as soon as they have been approved.

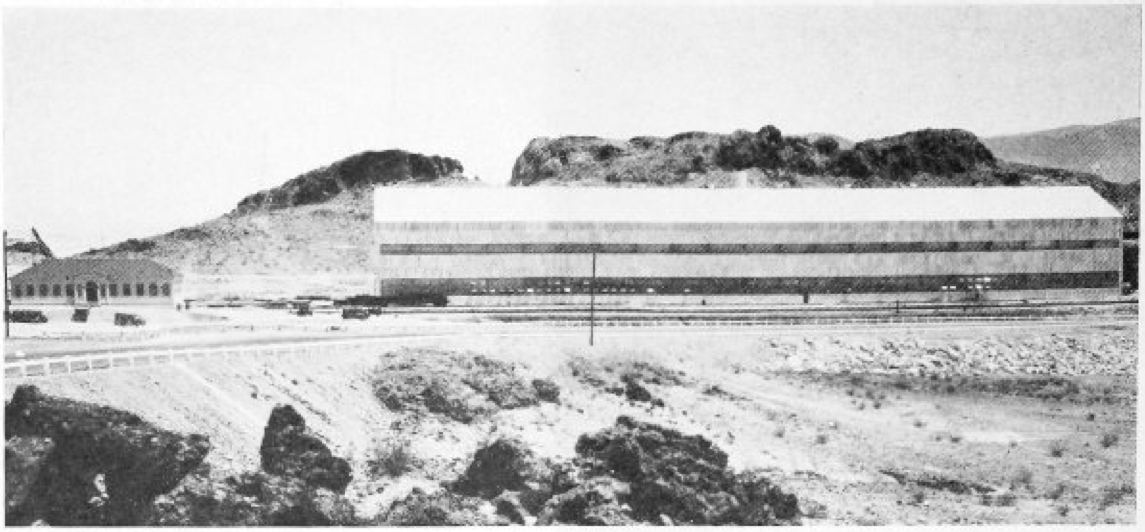


Fig. 1 —Field fabricating plant of Babcock & Wilcox at Boulder Dam

Navy boiler drum practice used for

FUSION WELDED PIPE

Since the fall of 1930, when the first announcement was made of the Navy's adoption of fusion-welded construction for the boiler drums of the scout cruisers *Minneapolis, New Orleans* and *Astoria,* the commercial acceptance of welding for this and similar purposes has grown appreciably. To illustrate, the United States Navy alone has adopted welded construction for over 200 boiler drums for scout cruisers, destroyers and aircraft carriers and The Babcock & Wilcox Company, which has made or has on order all these drums, now reports that it has furnished or has on order 1202 drums of this construction, all involving welded seams having a total length of over 51,180 feet. This does not include a number of tanks and pressure vessels built for high-pressure service, nor does it include the welded-steel pipes for Boulder Dam, the contract for which was

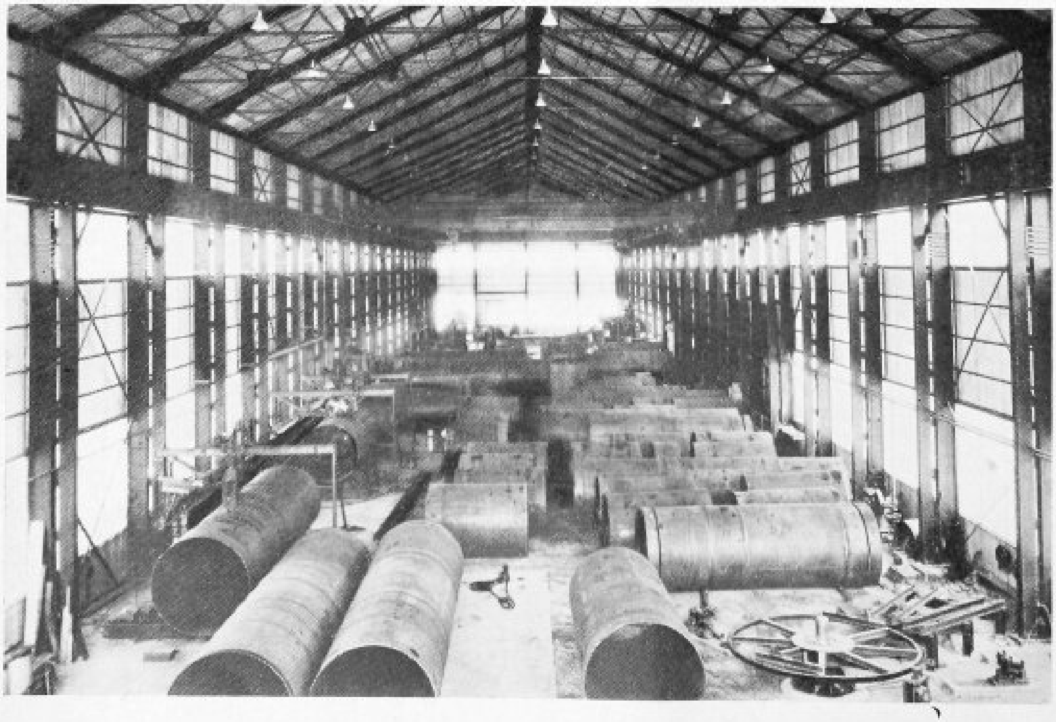
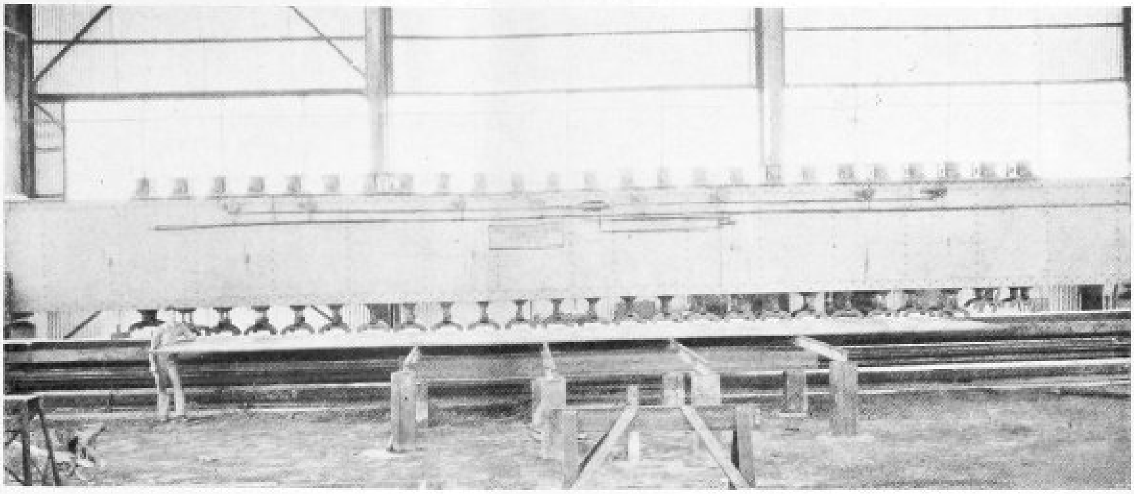


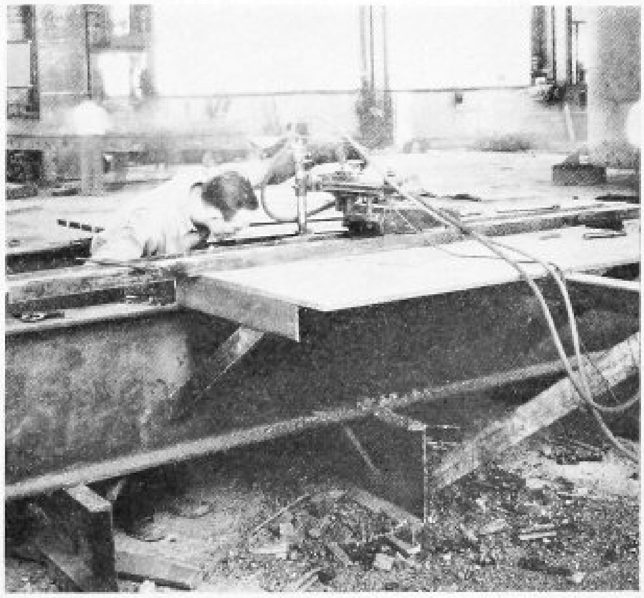
Fig. 2. — Interior shop view showing work in progress; automatic welding machines at left, and indexing and drilling mechanism in foreground

Fig 3. — Forty-foot plate planer at right. Fig. 4.—(center) Cutting web sections with torch. Fig. 5.—(bottom) Vertical plate bending rolls



awarded to this company by the Government last year.

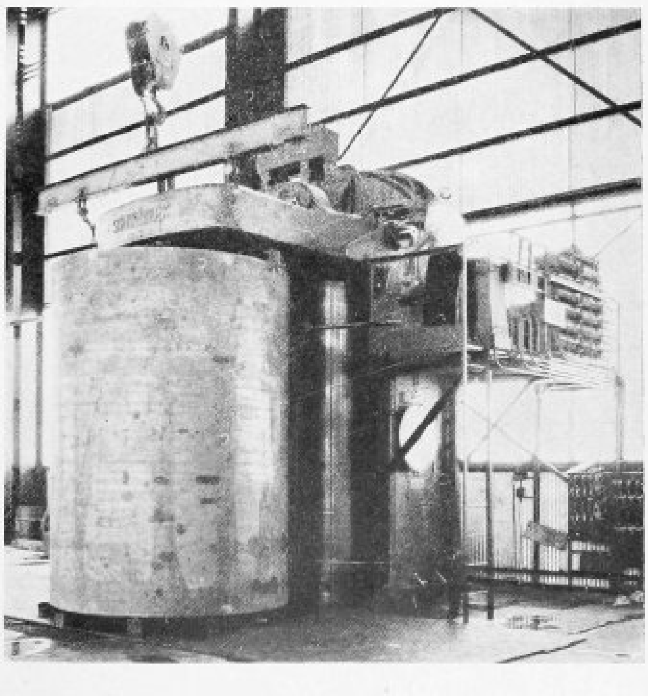
In the latter contract, the second largest ever awarded by the United States Department of the Interior, a total of over 400,000 linear feet of welding will be performed, using essentially the same method as that used on boiler drums for the Navy Department. The contract includes the fabrication and installation of fusion-welded plate steel pipes in the hydraulic-power and outlet-works tunnels at the dam, and involves such features as the construction of pipes larger than any heretofore made, the transportation and handling of pipe sections as heavy as many types of standard-gage railroad locomotives, and the exploration of welded seams by X-ray equipment of the greatest capacity and power now available for commercial work. The approximate sizes of the various pipes to be fabricated are:

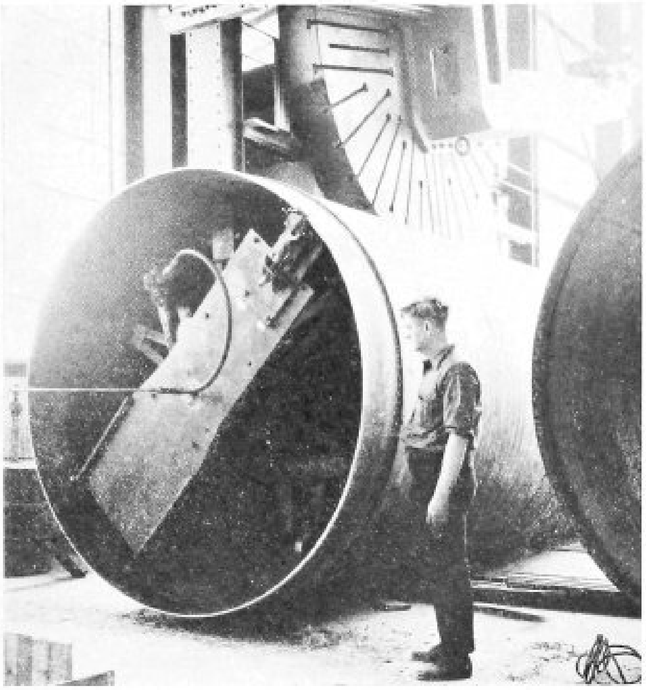


Length ft.	Diameter ft.	Plate thickness in.
4700	30	$1\frac{11}{16}$ to $2\frac{3}{4}$
1900	25	$1\frac{3}{8}$ to $2\frac{5}{16}$
5600	13	$\frac{13}{16}$ to $1\frac{5}{16}$
2300	$8\frac{1}{2}$	$\frac{3}{8}$ to $\frac{7}{8}$

As the diameters of most of this piping are too great to permit shipment by railroads, the largest pipe sections being of a size comparable with that of the average three-story dwelling, it was necessary to build a complete fabricating plant about one mile from the site of the dam. Fig. 1 shows an exterior view of this plant, and Fig. 2 a partial interior view. The building is 520 feet long by 85 feet wide with a clear inside height of 55 feet from floor to chord or roof trusses.

A short description of the fabrication of the flat plate into these great cylinders will no doubt be of interest, inasmuch as the procedure is quite similar to that used in fabricating the boiler drums for the Navy. The plate, made of special steel, is taken into the plant by one of the two 75-ton traveling cranes, is laid out to pattern, and the edges are planed to proper size and prepared for welding, by the large planer shown in Fig. 3. It is then moved to the vertical plate bending roll, the most powerful ever designed for this purpose, where it is rolled from flat to cylindrical form as shown by Fig. 5. After forming, the plates are fitted together and fusion-welded seams are made between them by automatic welding machines. This welding equipment consists of a feeding mechanism designed by The Babcock & Wilcox Company for feeding B&W flux-coated electrodes, and automatic welding control panels of 600 amperes capacity, 60-volt control and carriages, built by the General Electric Company. These automatic





machines are mounted over the seams for longitudinal seam welding. For girth seams the same automatic welding equipment is used, the sections to be welded being revolved on rollers under the arc as deposition is made. For fitting two cylinders together and for a backing-up member during the welding of girth seams, a special internal spider is used. The inside weld is also automatically deposited, a horizontal traveling beam having been developed for carrying the automatic welding machine over its course. Fig. 6 shows the method of machining pipe ends before the welding operation is carried out on the sections. Representative welded sample plates are obtained by tack-welding sample plates to the ends of a longitudinal joint in the shell. Deposition of the weld metal is made continuously through the main joint and sample joint, so that the welded seams of the test plate are thoroughly representative of the main weld seams of the shell. From these test plates the various test specimens are obtained.

All welded seams are now examined by 300,000-volt portable X-ray equipment, Fig. 8, which makes a permanent photographic film of every inch of the weld. The machine will readily make photographic representations through 4 inches of metal. The amount of X-ray film that will be used will exceed the total of all that used to date, in this country, for industrial purposes.

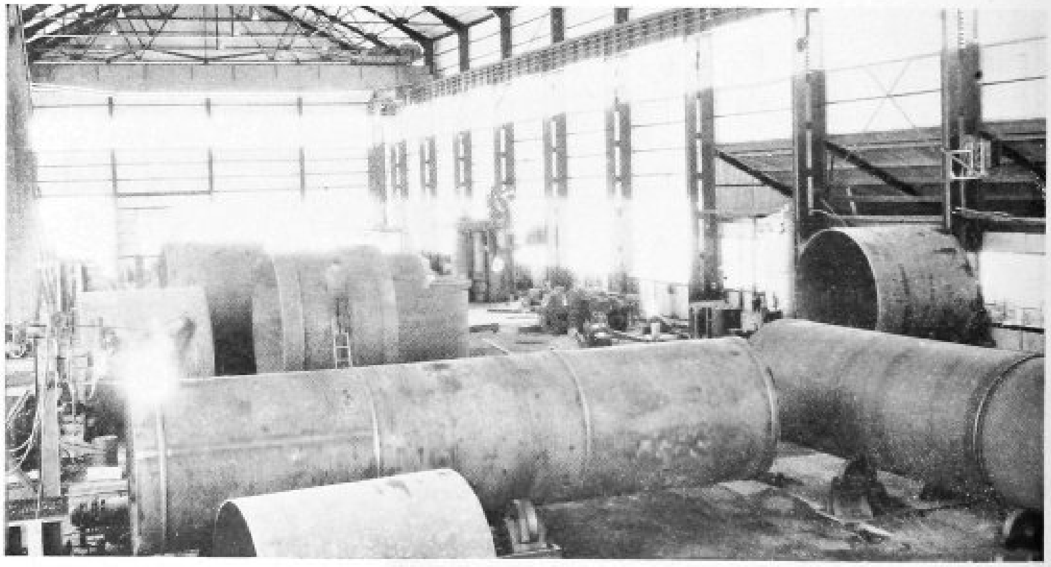


Fig. 6.—(Above) Machining the end of a pipe section. Fig. 7.—Assembling 8½-foot pipe sections

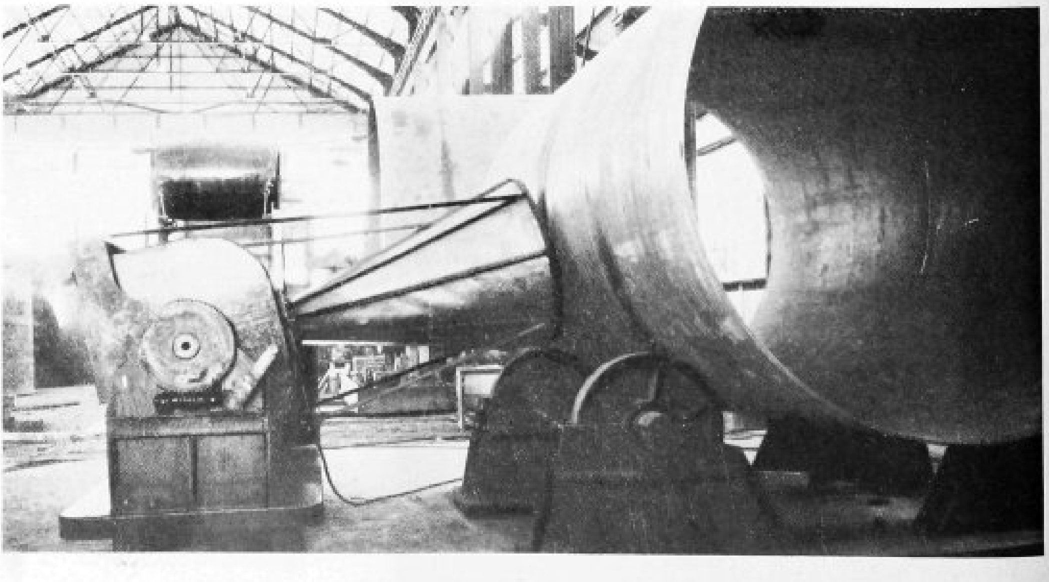
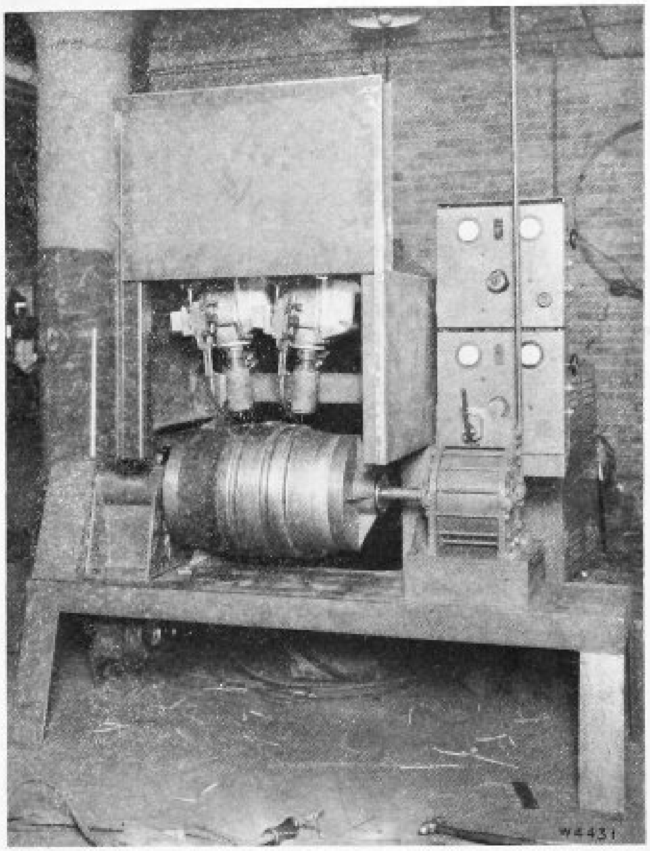


Fig. 8.—X-ray machine in position for inspection of welded girth seam in 8½-foot diameter pipe section

After passing the X-ray examination satisfactorily, the possible stresses set up in the welding or otherwise are relieved by placing the sections in a furnace, heating them to proper temperature, holding this temperature for one hour per inch of thickness, and then slowly cooling. The furnace, the largest ever built for this purpose, is oil-fired and is of the car-bottom type, with the front wall constructed integrally with the car.

The test specimens are then removed and subjected to the tests prescribed by the A.S.M.E. Code for tensile strength, bending and density, in a completely equipped laboratory. If this test is passed satisfactorily, the ends of the sections are machined and prepared for subsequent joining together with pin joints as they are installed in the tunnel.

A study of the welding procedure outlined above will show that it is essentially the same as that used on the boiler drums for the Navy scout cruisers. The marine industry, as represented by the Bureau of Engineering, U. S. Navy Department, has taken the lead in adopting modern welding for the fabrication of boiler drums and, while the use of welded boiler drums aboard ship has been confined to naval vessels to date, there is good reason to believe that we shall soon see wide spread use of this construction for boilers of the merchant marine. The American Bureau of Shipping and the United States Steamboat Inspection Service have recognized the importance of this subject and the formal approval of fusion-welded boiler drums for marine service may be expected in due course, and it is entirely safe to predict that the marine industry will adopt this construction as widely as have the country's stationary power plants.



Lincoln automatic welder

Automatic Machine Arc Welds Beer Barrels

An automatic machine for welding metal beer barrels by the shielded-arc process has been placed on the market by The Lincoln Electric Company, Cleveland. The machine, equipped with Lincoln Electronic Tornado automatic welding head, is reported to have a production capacity of 30 barrels or more per hour, depending upon the type and size of barrel.

The machine is made for producing barrels of different types of construction according to the manufacturer's requirements. They may be supplied with single or double automatic welding heads, as shown in the illustration.

Barrels welded by this machine are either single or double-shell types. Both inner and outer shells of the latter type are automatically welded with this machine. Some barrels are so designed that a single circumferential butt weld joins two half-shells to form a single piece of inner shell. Halves of the outer shell of barrels of this type when placed over the inner shell form two parallel circumferential joints with the inner shell. These are also automatically welded by the machine illustrated.

The design for another type of beer barrel is such that two circumferential seams welded simultaneously fabricate the inner and outer shell in a single welding operation.

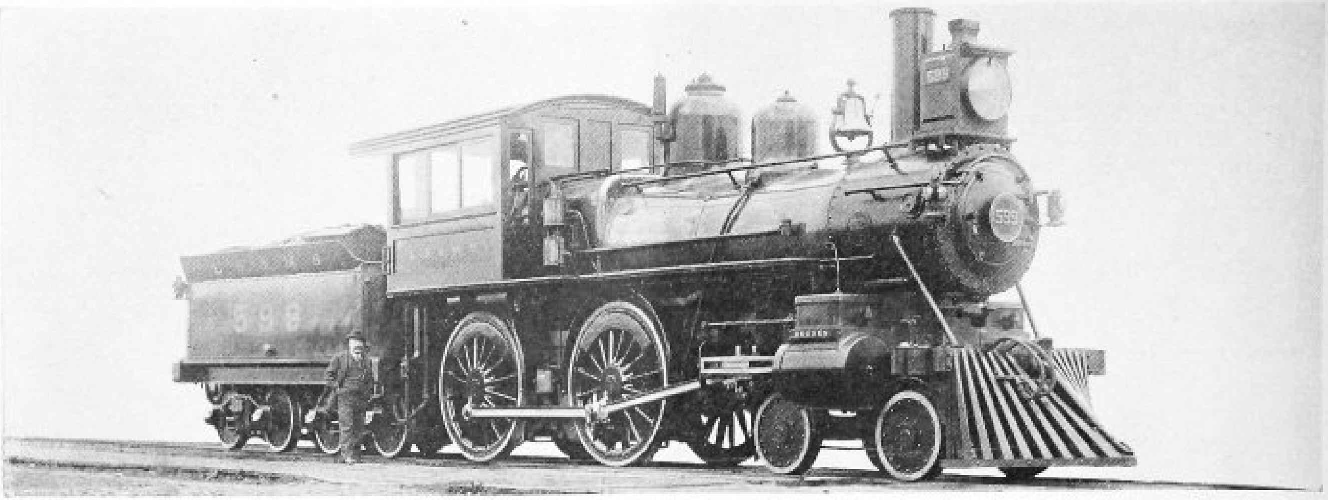
Arc-welded metal beer barrels are usually designed for either lap or butt welding. Almost always one edge forming the butt joint is coined. The resultant flange provides the necessary metal for the weld.

Lincoln machines for beer barrel welding are equipped with either one or two Lincoln Electronic Tornado automatic welding heads, the number of heads being dependent upon whether the barrels have one or two circumferential seams to be welded. When two circumferential welds in the same shell are required both are made simultaneously with automatic welding heads. The Electronic Tornado heads are so designed that, though operating simultaneously within a few inches of each other, neither arc disturbs nor affects the operation of the other. The welding heads are stationary, the barrels being revolved automatically under the arc as the welding progresses.

Welds produced by this machine are made by a shielded arc, insuring weld strength greater than the shell metal and equal to it in ductility. The welds also show greater resistance to corrosion. Barrels welded by Lincoln machines have been filled with water, dropped 10 feet and tested with air pressure, without indication of leaks.

According to latest reports from manufacturers now using this type of welder, more than 8000 barrels are being welded daily with these machines. In most installations two or more machines are attended by a single operator.

Welding Conference.—Plans now are under way for the Third Annual Welding Conference to be held at Ohio State University, Columbus, O., during the latter part of February. There will be an exhibition of welding equipment and materials, and a technical program. Professor O. D. Rickly of the Industrial Engineering Department, Ohio State University, is in charge of the conference.



A locomotive exhibited at Chicago in 1893

Locomotive Boiler Developments

The following abstracts dealing with locomotive boiler developments have been taken from research reviews presented before a meeting of the American Society of Mechanical Engineers, Railroad Division, held at Chicago during the Century of Progress Exposition:

Research Related to Locomotive Development

By W. E. Woodard*

Upon first thought the relation and influence of scientific research on locomotive development may appear rather difficult to define and trace. To many persons the steam locomotive has seemed to just grow one step upon another—apparently to some degree the result of trial-and-error methods. This view undoubtedly results from the fact that improvements in railway motive power, before obtaining any general acceptance, must not only produce the purely theoretical results forecast for them, but they must also meet the exacting requirements of safety in train operation and must demonstrate their advantages in operation under widely varying conditions. Moreover, any changes introduced must prove to be sound economic investments, or produce benefits in some other operating phases to offset their increased first cost and their maintenance.

I will cite a few examples which seem to amply justify the statement that fundamentally much of the outstanding progress is traceable to and based upon technical research work.

First, referring to materials of construction. In this field the designers have availed themselves of a vast amount of technical study on metallurgy, particularly the effect of various alloys on steel used in locomotive construction.

In the matter of train resistance a most interesting and important amount of research work has been performed. Its bearing upon motive-power development is evident in connection with the recent steps being taken in the streamlining of equipment and in light-weight construction.

The locomotive designer is much concerned with the proper proportioning of the furnace, boiler and superheater to the steam-using or engine portion of the locomotive. An outstanding contribution in this field was the work of F. J. Cole, who in 1914 proposed his locomotive ratios. I know that this was a piece of work involving real research and study, as at the time Mr. Cole was assembling the data upon which his calculations were based I was closely associated with him. The locomotive industry and the railways have benefited greatly from this work and it has been only within the past few years that advances in the art have modified the characteristics of the steam locomotive so as to place many of the modern designs outside the range of his figures and ratios. However, the general method of approach he developed and used is still applicable to the problem and his work still stands as an outstanding piece of research in the railway field and is a guide upon which all locomotive designers depend.

The contributions of the various locomotive test plants to research work is well known. In this connection it need only be mentioned that one of the handbooks of the locomotive designer is the set of Pennsylvania test-plant bulletins. Another piece of research work—possibly not so well known but of great value to the designer—is the standing boiler tests run by the New York Central at Gardenville in 1923.

Locomotive designs do not just grow. In the preparation of the basic design of the 2-8-4 type locomotive, known as the A-1, built by Lima in 1925, it was desired that the proportions of the boiler be based upon a maximum coal rate of about 100 pounds per square foot of grate per hour, but we found that little direct data were available for predicting how such a boiler would per-

*Vice-president, Lima Locomotive Works.

form. The proportions and dimensions to which the final boiler was built were worked out from assembling, comparing and extending data from the Pennsylvania test-plant bulletins and the Gardenville standing tests to which I have already referred. These figures were checked by comparisons and calculations from numerous road tests. The boiler proportions finally selected led to the use of a four-wheel trailing truck, which has now become practically standard for heavy freight and passenger locomotives.

After the locomotive was constructed eight different railroads heartily co-operated in road tests. These tests, primarily for demonstration purposes, nevertheless developed much technical information which has proved very useful in applying and extending the same principles of design to other and larger units.

These examples of research are selected simply as illustrations showing that, after all, scientific investigation has played a vital part in the development of the modern locomotive.

The Locomotive Boiler

By H. B. Oatley*

The increase in size and power of the steam locomotive has been the subject of many papers and discussions during the past several years. Comparatively little emphasis, however, has been laid upon the fact that, without the development of a more economic steam generating system in its entirety, the greatly enhanced value of the larger locomotives would not have been realized.

Much intensive study and research have been put upon the problem of making available, for the locomotive cylinders, a working medium, greater in quantity and more suitable in quality; a medium which would permit more foot-pounds of work delivered by the cylinders from a smaller number of B. t. u. in the fuel supply.

That this objective has been attained is amply attested by the steadily decreasing steam and fuel rates per indicated horsepower-hour. Recognition must be given to the greatly increased sustained boiler horsepower which has been the factor contributing most to the greater ton-miles-per-train-hour performance that has been an outstanding achievement in American and Canadian railroad operation.

The table indicates the change in boiler characteristics during the past 30 years. The values for steam pressure, degrees of superheat and pounds of steam per hour are not the maximum, but represent what was considered good conventional practice at the particular period. Boiler capacities very much above these figures have been provided; passenger locomotives with an evaporation of 86,000 pounds and freight locomotives with an evaporation of 122,000 pounds per hour have been in use.

The increased output per pound of boiler, boiler water and superheater represents the advance in effectiveness. This, for passenger locomotives, is an increase of 70 percent and, for freight locomotives, 30 percent, in the same period of time.

The major factor, not only in boiler design but also in respect to the energy supply for the cylinders, has been the integrally built superheater. While the advantages of superheated steam have been most pronounced in cylinder performance, it should be remembered that the present-day horsepower requirements could not have been met with boilers that supply only saturated steam.

Feedwater heaters have contributed, but to a somewhat lesser degree, in supplying greater sustained horsepower from a boiler of given size.

The trend toward the use of steam at higher pressure and temperature, together with the need for greater capacity, brought to the front the advantages of the present-day form of smaller flue superheater. Structural and material questions were considered in this design. The objective of greater heat-absorbing capacity of the combined boiler and superheater made possible higher temperatures for larger evaporations within a boiler of any prescribed diameter.

Notable increases in the firebox surfaces not alone caused by the increase in grate area, but by the addition of combustion chambers, thermic syphons, arch tubes, etc., have brought beneficial results in firebox and combustion-chamber efficiency. Increased capacity has resulted from stoker firing, improvement in grates and in more effective front-end draft appliances.

In the matter of materials mention must be made of the reduction in weight afforded by the use of alloy steels for shell plates as well as for fireboxes. In construction, the use of welding has effected some weight reduction, but to an even greater extent has decreased the cost of maintenance. Consideration in recent years has been given to the use of seamless drums and boiler shells and further use of such constructions may be anticipated.

The locomotive boiler has greater possibilities, and designers in this country, as well as abroad, are giving intensive study to its further development. Conventional boilers with stayed surfaces are in satisfactory service up to 300 pounds per square inch in this country and some have been recently placed in service abroad carrying 385 pounds per square inch working pressure.

The increasing use of higher steam pressures has for many years caused thought to be given to the watertube firebox. The Baltimore & Ohio and the Delaware & Hudson have gone further in this direction than other roads in this country. Watertube fireboxes for pressures running from 250 to 500 pounds per square inch are in service. More information as to their performance will prove of value and point the direction for further study and research.

Working in the direction of still higher boiler pres-

*Vice-president, Superheater Company.

Changes in Boiler Characteristics During the Past 30 Years

Year	Steam press. (lb.)	Super-heat, deg. F.	B.t.u. per lb. steam	Lb. steam per hr.		B.t.u. per hr. in thousands		Wt. boiler and sup'h'r with two gages of water		B.t.u. per hr. per lb. boiler, water and superheater	
				Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.
1900	180	...	1,198	23,200	35,000	27,793	41,930	70,000	85,000	397	493
1905	200	100	1,260	32,000	38,000	40,300	47,880	80,000	92,000	504	520
1910	200	150	1,287	37,000	47,000	47,600	60,500	88,000	104,000	541	581
1915	200	225	1,326.5	39,000	53,000	51,700	70,300	97,000	120,000	533	585
1920	210	225	1,327.9	48,000	62,000	63,700	82,300	107,000	136,000	595	605
1925	225	250	1,343.0	52,000	71,000	69,800	95,300	117,000	155,000	597	615
1930	250	300	1,373	63,500	82,000	87,190	112,600	128,000	175,000	680	643

sures, and with the aim to eliminate the possibility of scaling condition on firebox surfaces, a great deal of research and experimental work has been done leading up to the construction of several locomotives with the multi-pressure boiler. Two of these—one on the Canadian Pacific and the other on the New York Central—have been under severe service and test conditions for more than a year.

Research and Development in Locomotive Materials

By Lawford H. Fry*

Some of our mechanical brethren who have not specialized in railroad engineering point in reproach to the fact that the fundamental design of the locomotive has not changed since George Stephenson's day. That is true, but faith in that fundamental design is supported by the results of a large body of research. Much of this research is represented by road tests. A great deal of it comes from the important tests made by the Pennsylvania on its locomotive testing plant. All of it shows that George Stephenson's arrangement of a fire-tube boiler with cylinders exhausting up the stack provides a combination of steam producer and prime mover which is marvelously well adapted to railroad service.

The difficulties of the designer's task may be shown by the following statement. A modern locomotive must have a boiler which will furnish approximately 70,000 pounds of steam per hour. The engine using this steam must develop about 4,000 horsepower. Boiler and engine must be carried on a vehicle capable of traveling at 80 miles per hour. The total weight will be about 200 tons and if the locomotive is carried on 16 wheels, as is likely to be the case, the total area of contact between wheel and rail will be only about 7 square inches.

The first essential of any material to be used in locomotive construction is that it shall be reliable. With reliability assured, strength is required so that the dead weight may be reduced to a minimum. Finally, a material which is otherwise satisfactory must be available at a cost which makes its use economically justifiable.

The standard boiler steel 30 years ago was a mild steel with a tensile strength of 55,000 to 65,000 pounds per square inch. With the rise in steam pressures and increase in size it is natural to look for a stronger material, but such material must not require a radical change in fabrication methods. A step forward was made by the Canadian Pacific in 1926 when a higher tensile steel was tried. This was a 2 to 3 percent nickel steel with a tensile strength of about 78,000 pounds per square inch and sufficient ductility to permit of the usual forming operations. A year or two later the Canadian National put into service some locomotive boilers of carbon silicon steel of approximately the same strength.

Both of these steels result from a large amount of research work done by the steel manufacturers and, in the case of the nickel steel, by the International Nickel Company. The production of steels of this character is not merely a matter of dropping a shot of alloy into a melt of low-carbon steel. Careful study of ingot practice and rolling-mill operations is involved.

Some five hundred locomotives are now equipped with nickel steel and about one hundred fifty with the silicon-steel boilers. Very satisfactory results are reported. It seems inevitable that the use of high-tensile boiler steel will increase. In fact, rumors from the research laboratories predict a new steel, marking a still further advance in this direction.

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Electric Welding Developments*

By John Liston

A number of types of heavily coated electrodes for special purposes were developed during 1933. One of these is especially adapted for building up battered rail ends on railroads. By the proper combination of a base rod with suitable flux, a deposited weld metal is obtained which is tough and hard immediately after deposit. This hardness is further increased by the cold working which results from the passage of traffic over the weld.

The practice of welding battered rail ends is important to railroads because of its economy, as the ends may be rebuilt many times if necessary by arc welding until the ultimate life of the rest of the rail is reached, thus avoiding much of the expense and traffic delay incident to frequent rail replacement. The self-propelled tractor-type of arc welding equipment has been found to be fitted for railroad maintenance of way work.

The use of Thyratron control of resistance welding, both seam and spot, was extended and these control equipments have found many applications, especially in the manufacture of beer kegs of ordinary steel, stainless steel, and aluminum. The results obtained by the application of Thyratron control are much greater uniformity and higher speed, and the welding of stainless steel without discoloration.

A novel machine was designed for the automatic atomic-hydrogen welding of the circumferential seam in a stainless-steel beer barrel. The barrel consists of a stainless-steel inner shell with an outer shell of standard steel, with sufficient air space between the two shells to provide the necessary insulation.

In the manufacture of the stainless steel liners, two thimble-shaped drums are drawn from stainless steel, one to form each half of the liner. The edges of these thimbles must be accurately formed so that when butted together for welding the joint will be true. A drum is then placed in each chuck of the welding machine. These chucks have six jaws which are opened and closed by oil pressure. One chuck is mounted on a sliding tailpiece so that the edges of the two thimbles may be brought together.

The weld is made by the atomic-hydrogen method, utilizing a standard automatic welding head, but a novel feature of this machine is the application of hydrogen to the inner surface of the seam, underneath the arc, while the weld is being made. This results in a smooth, bright joint free from porosity.

At the point of the weld, the thickness of the stainless steel is about 18 or 19 gage, and a 16-inch diameter barrel can be welded in approximately 1¾ minutes. Including the time necessary for unloading and loading, it is expected that this machine will produce from 25 to 30 barrels per hour.

* Excerpt from the General Electric Review for 1933.

D. J. Almon, Paul Brown building, St. Louis, Mo., has been appointed district sales agent for Morrison Metalweld Process, Inc., Buffalo, N. Y. Mr. Almon will represent this company in the Southwest territory.

Problems connected with the inspection of

RIVETED SEAMS*

By J. P. Morrison†

The boiler inspector was one of the world's first diagnosticians. He examined the object to determine its condition. He pronounced it safe or dangerous—accepted it or rejected it—without any obligation to prescribe a treatment, perform an operation or concoct a diet if conditions were not satisfactory.

However, in addition to examining the boiler and diagnosing its ailment the inspector now must determine the nature and cause of the defect and prescribe the cheapest and best repair, which in many cases he is called upon to supervise and approve. Furthermore, he must give instructions for feed-water analysis and keep the owner advised in advance of reductions in pressure and other difficulties likely to be encountered during the progress of this boiler from the factory to the junk yard. Early boilers were made of stone, cast iron and copper. Each of those materials possessed some disadvantages and they were superseded in time by wrought iron and later by steel. The pressure carried by the boiler of cast iron was comparatively low and the boiler was of small size so the strength was of minor importance as compared to the advantages of tightness. However, atmospheric pressure soon ceased to be sufficient and large volumes of steam were demanded as the Iron Age became a reality in Western Europe. As wrought iron possessed many desirable qualities, its use appealed to the boiler manufacturers when it became available.

Those wrought iron plates were thin and of small dimensions so a number of them were needed in the construction of a boiler of any size and thus the necessity of building a large boiler of small wrought iron plates was the mother of the invention of the riveted seams.

The appearance of the first boiler seam must be left to your imagination as its designer furnished no detailed drawing of it, but we do find references to difficulties in securing tightness and indications that differences of opinion arose regarding the strength of those seams.

The earliest boiler code of which I have found a record was based upon a Royal Ordinance of France in 1823. The safe working pressure of a wrought-iron boiler was determined by the use of a somewhat cumbersome formula, as we view such calculations today. The strength of the riveted seam did not appear directly as a factor in that formula, but as the minimum factor of safety was approximately double that required today, its authors had unconsciously made ample allowance for the strength of the seam which in general appeared to be of the single-riveted lap joint type.

Some authorities pictured the two thicknesses of plate which form the single-riveted lap seam as having greater strength than possessed by the single thickness of the material found elsewhere in the boiler. This logic was based upon the thought that the nip or clamping effect of the rivet heads, due to the contraction of the driven rivets when cooling, more than offset the loss of strength incident to cutting the rivet holes in the plate.

Tests conducted with the purpose of providing the correctness of that theory were successful to an extent for while the nip of the rivet does not equal, in strength, that of the plate removed in making the rivet hole, the friction of one plate upon the other is an important factor if the rivet heads are of proper design and the plates are properly fitted together. This nip of the rivet heads depends upon the yield strength of the rivet material but is independent of the shearing strength, until slippage has actually occurred.

Early writers have indicated more or less clearly the state of the public mind as one violent boiler failure followed the other. Some engineers attributed each accident to a deficiency of water and many theories dealing with the behavior of hot plates quenched with water, steam in the presence of hot plates, and water injected into superheated steam were developed. Some were inclined to blame most of the failures on defective material while others with an inquisitive turn of mind made comparatively thorough investigations into boiler design including, of course, the riveted seam. Out of those failures, some of them distressingly disastrous, and the investigations, discussions and controversies which followed, have grown, step by step as it were, our present standards of riveted seams.

It may be of interest to recall that Thomas Ewbank published his remarks, upon which our present system of computation is based, on the design of riveted seams in 1834, following the investigation into the explosion of the boiler of the Connecticut River steamboat *New England*, which occurred on October 9, 1833.

Safety of the structure depends upon the inspection of a boiler seam during the process of fabrication, for after the riveting and calking are completed, an investigation to determine the condition of a seam is expensive and inconvenient to say nothing of other difficulties encountered. The inspector assigned to shop inspection work must be familiar with all of the requirements of the code and have sufficient experience and judgment to apply those requirements with a reasonable limit of tolerance in the light of good practice.

Those having legal jurisdiction over the operation of boilers are justified in demanding equipment which will be reasonably safe to operate and have the power to prevent the operation of a boiler which is in dangerous condition. The purchaser is given to understand the boiler he buys is of the best material, design and workmanship. He should be delivered goods fully up to that representation and has every reason to expect his boiler to be useful for an average term of years without excessive maintenance expense provided he uses it under proper operating conditions.

Reference to tolerance of workmanship brings to

* Paper and discussions presented at the ninth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, New York, October, 1933.

†Assistant chief engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

mind a wrong conclusion frequently reached by a field inspector when a circumferential seam rivet has been removed and the rivet holes in the plates forming that seam are not absolutely concentric. The A. S. M. E. Boiler Code includes a rule, based upon a necessity, which permits a maximum circumferential tolerance of ¼ inch between the length of the outside of the inside ring and the length of the inside of the outside ring of a boiler shell. That ¼ inch of material must be distributed throughout the circumference of the shell during the riveting process. It follows that some of the rivet holes will not be concentric after the riveting is completed.

Furthermore, in the construction of high-pressure boilers involving thick plates, it is not possible to bolt the butt straps and the shell plates together for drilling as closely as they are forced together by the riveting process. This accounts for some lack of concentricity of the rivet holes discovered when a driven rivet is removed. The creep of the butt straps, due to pressure exerted by the hydraulic riveter, is also a factor in the case.

No riveting process will upset each rivet sufficiently to fill the hole its entire length, so invariably upon removing a driven rivet we find it is not of uniform diameter but has a slight offset at some point which is most likely to be where two sheets fit together.

A conclusion, that the rivet holes were not fair, based upon the appearance of the hole after a driven rivet has been removed or based upon the appearance of the rivet which has been removed, may be incorrect.

When we discuss the inspection of riveted seams, we imply at least that there may be some defect worthy of the effort required to discover it; so with that thought in mind let us investigate the girth seam of the cylindrical vessel which is the least important of shell plate seams exclusive of seams securing flanges and mountings.

While strength is to an extent an essential factor of circumferential seam construction, the principal function of such a seam is to prevent leakage. Any defect or weakness of a riveted girth seam is most likely to result in leakage before its development reaches the danger stage. So within reasonable limits "the tight girth seam is a safe girth seam."

The defect ordinarily referred to as a fire crack which extends from a rivet hole to the calking of the girth seam of a horizontal tubular boiler is a source of nuisance when leakage follows, but I know of no case of a boiler exploding or of one being condemned as unsafe on account of weakness resulting from fire cracks. Ordinarily, when the development of those defects has reached a stage where leakage is troublesome and cannot be prevented by reasonable repair, the boiler is retired from service.

Fire cracks were at one time attributed to the injury done to the boiler plate when rivet holes were punched full size and to the use of the drift pin. Those ideas may have had some foundation in some cases but not when the rivet holes were drilled from the solid with the plates in permanent position.

Oily sediment, poor fitting up, long laps and inferior material, each has been accused and not without some reason, but thick plates, high furnace temperatures and exposure to radiant heat with the accompanying structural changes in the material, as well as expansion and contraction stresses, are chiefly responsible. Proper protection from high temperature is the only preventative.

The girth seam crack which extends from rivet hole to rivet hole is more of a problem and frequently leads to the discovery of cracks in the longitudinal seam, as one usually accompanies the other.

The lap seam crack in a longitudinal seam was at one time so common and so dangerous that all of the power of all the boiler inspection organizations was exerted in its detection and elimination. A lap joint may no longer be used as a longitudinal seam in the construction of power boilers of considerable size.

However, the discovery of a lap seam crack in a 30 inch diameter vertical tubular boiler a few days ago justifies a most careful inspection of each boiler having a longitudinal seam of lap joint type regardless of size and pressure.

The nip or vice-like grip of the heads of each rivet causes a concentration of the bending stresses due to the eccentric loading of the seam, along a line near the edge of those heads. As a result, the lap seam crack frequently develops in the outside sheet of the seam close to the edge of the inside lap, but hidden by it.

The crack may pass through some of the rivet holes as its path depends to an extent upon whether the holes were punched or drilled, the method of driving the rivets, the size of the rivet head and the method of shaping the ends of the plate where the seam is located.

The typical lap seam crack is transcrystalline. It is caused by various stresses and, of course, follows the path of the greatest stress or combination of stresses. No doubt many of you are familiar with the process of investigating the conditions of lap seams, which consists of slotting the plate across the path, that the crack, if one exists, is likely to follow.

I might add that the same method has been used with great success in investigating knuckle cracks in head flanges.

A type of riveted seam which was used to a very limited extent in steam boiler construction but was quite popular in unfired vessel construction, and which is a combination of the lap seam and butt seam, is the single strap seam which has been involved in numerous failures some of them resulting in the death of persons and great property damage.

A single strap seam possesses none of the good qualities of the standard butt strap seam or of the lap seam and has all the bad features of both. Low efficiency of the net section of the plate and of the strap cannot be avoided. The stresses due to eccentric loading of the single strap are identical with similar stresses encountered in lap seam construction and often are greatly accentuated on account of the plate thickness and temperature changes.

Investigation of a number of paper mill digesters of single strap seam construction lead to the discovery of a dangerous condition of 25 percent of the total number examined.

Some years ago, I was privileged to present a paper at the Chicago Meeting of the National Board of Boiler and Pressure Vessel Inspectors dealing with another type of seam distress which has been found in girth seams and in circular seams, as well as in longitudinal seams; in lap seams, as well as in the butt strap seams; in thick plates, as well as in thin plates, in high pressure boilers, as well as in low pressure boilers; in old boilers, as well as in comparatively new boilers; where treated water was used, as well as where the water was untreated; in plates of firebox steel, as well as in plates of flange steel, of high carbon content, as well as of low carbon content. This type of seam difficulty is not confined to the boilers manufactured by any one builder nor to any one type of boiler. It is not necessary that the seam be exposed to the products of combustion nor to high temperature. Seams with the rivet holes drilled from the solid are no more immune than those having rivet holes punched full size.

There is, however, one condition common to each of the six hundred or more cases we have investigated involving a boiler value of $8,000,000 or $10,000,000. Each of the boilers had been operated, at some time, with feed water high in sodium carbonate and low in sodium sulphate.

It is not the purpose of this paper to affirm, deny, add to or detract from the theory of caustic embrittlement of mild steel used in steam boiler construction. In general that theory is accepted and suitable protective measures are adopted where the disease has been thoroughly investigated.

I do wish, however, to emphasize the fact that intercrystalline defects do develop in those parts of the boiler plates forming the riveted seams and as a result of the weakness produced by such defects, boilers have exploded with great violence, while a large number of explosions have been prevented by the timely discovery of the dangerous condition. Although the boiler inspector may not prevent the development of such defects, he can be on the alert to detect them before it is too late.

He will not go far astray if he decides to make a thorough investigation of each boiler operated with raw feed water or with treated feed water which, when cold, lathers freely with any standard soap, leaves little or no scale within the boiler and gives the plates a slimy appearance, particularly if the residue where slight leakage has evaporated has a sharp taste. Frequent analysis of the feed water should be insisted upon and the owner urged to maintain the alkalinity ratio recommended by the A. S. M. E. Boiler Code.

An inspector can develop the knack of striking a rivet head with a sharp twisting blow of his hammer which may bring surprising results. The loss of a rivet head necessitates the removal of that rivet and an opportunity is afforded for a thorough cleaning and examination of the wall of the rivet hole without exciting suspicion, of a kind to react unfavorably to the inspector if no defect is found.

Persistent leakage appearing in a boiler seam after several years of satisfactory service, during which time the seam has not been exposed to high temperatures, justifies the removal of some of the rivets as reriveting at least is necessary. Again there is the opportunity of examining the walls of the rivet holes.

Some of the defects we have discovered were startling. No optical instruments were needed to increase their visibility and one might reach the conclusion that some boilers "just don't want to explode." Reference has been made to the idea held by the early designers of boilers that the nip of the rivet head equaled, in strength, the plate removed in making the rivet hole, and accordingly, the safe working pressure of the boiler was based upon the strength of the unpierced plate. Of course this rule also neglected considerations of the resistance of the rivet to shearing stresses, but as the diameter of the rivet hole was approximately twice the thickness of the plate and the rivet pitch was twice the diameter of the rivet hole, the rule did not work so badly.

Without subscribing to that obsolete theory, we are impressed with the nip of the rivet head, which may approximate 10,000 pounds per square inch of rivet head area in contact with the plates if the rivets have been properly driven and have not been weakened by operating conditions. There is no question but many defective seams of boilers now in operation would have been weakened to the bursting point were it not for the friction of the rivet heads upon the plates and the friction of one plate upon the other.

Although in some cases the defect is easily detected, in other cases it may not be visible until examined at forty or even one hundred magnifications. After the defect in the wall of the rivet hole has been positively located, it may be seen at times with the naked eye if a proper lighting effect can be obtained.

Considerable skill and experience is required to identify those fractures in the early stage of their development even where the wall of the rivet hole has been cleaned with acid and highly polished. So until an inspector has had a special training, he will encounter difficulties which may lead to disastrous conclusions. Do not trust to the judgment of one man if he is unable to discover anything wrong. There have been many cases where four eyes were better than two, so send some one to assist him.

These microscopic, intercrystalline fractures may extend from rivet hole to rivet hole for a considerable distance. The fact that the walls of the fractures in the plate are in such close contact that high power magnification is necessary to make the fracture visible does not signify the defect may be disregarded, as the strength of the entire ligament from rivet hole to rivet hole may be entirely destroyed and the seam is being held together by the nip of the rivet heads.

The extent to which the ligaments between the rivet holes have been affected can be determined only by the removal of the rivets and exposing the hidden surfaces of the shell plates and butt straps for close examination.

These defects develop with comparative rapidity under certain operating conditions while under other conditions the boiler may be practically ready for retirement on account of an accumulation of ailments before the presence of longitudinal seam fracture is known.

The second-hand boiler may be looked upon with increased suspicion as a history of its operation including the record of the feed water used must be consulted to determine the possibility of hidden defects.

A great deal of experimental work has been done with the idea of placing in the hands of the inspector some means of determining if such defects exist without tearing the boiler apart. Seams have been photographed with the X-ray with some success but in general it is necessary to take the boiler or a part of it to the laboratory rather than to move the laboratory to the plant in which the boiler is located. The use of such equipment in the boiler plant cannot be considered as practical at least until the X-ray apparatus is greatly simplified.

Some experimental work has been done towards developing a method of discovering defects in seams by the use of metallic powder and electric current. There is no doubt but that this plan offers some possibilities but at this time it has been used successfully only to confirm the inspector's discovery after the plates have been separated and the defects are visible to the naked eye.

Discussion by F. A. Page*

After a careful study of Mr. Morrison's paper on this subject, the writer finds that, while more could be said about riveted seams, to which no doubt Mr. Morrison will agree, but little can be said on this subject along the lines followed, as the treatise is written in a broad and, at the same time, most complete manner. Nowadays, however, the inspector, in addition to his routine of inspecting, is often called upon to prescribe treatment for feed water, check operating conditions and order repairs. The subject of feed-water treatment, in some parts of this great country, is one the inspector should be wary of.

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It is my humble opinion that it will be well not to consider the possible added strength of a riveted seam, due to the nip or clamping effect of the rivet heads, especially in seams of a boiler of latter day construction. When leaks are found around rivet heads, at the hydrostatic test of a new boiler, the possible amount of nip, in the writer's opinion, is problematical, although it is true that even at this late date we still find some who seem to believe that two thicknesses of plate, as in a lap joint, are stronger than the solid metal of single thickness. Also, some still believe that the joint with the most rivets is the strongest, without regard to the limiting factors, or balance of strengths.

Eccentricity of Rivet Holes.—This is a subject dear to the writer's heart, and one that apparently is only too often ignored, or overlooked, by the boiler maker in the riveting up of boilers. Some thirty years ago, the writer conducted a number of experiments to overcome fire cracks and leaks at the girth seams of horizontal return tubular boilers, where subjected to direct contact with the products of combustion. It was found that these defects could be averted by starting the riveting of these seams right at the lowest point, or the one in the direct path of the source of heat, working both ways to a point no longer subjected to the direct action of the products of combustion, pushing the slack metal ahead into that section where the heat would be less, or no longer impinging, then stop riveting and allow the shell to cool. After the metal had cooled off, re-ream the rest of the rivet holes in that seam, then tack rivet first opposite the first rivet driven, then midways, repeating until not more than three to five holes remained between tacks, depending on the amount of slack, before closing up gaps. This method did stop, as far as I have been able to ascertain, all fire cracks and seam leaks in not only horizontal return tubular boilers, but other boilers subjected to like conditions, as well.

The method for the detection of lap seam cracks, as described, is up-to-date the most successful one and at the same time the cheapest and easiest way that I know of.

I agree with what Mr. Morrison has to say about the equal width butt strap seam.

Caustic Embrittlement.—For years I have scoffed at the idea of caustic embrittlement, and was of the opinion that the real cause of this ailment of boilers was mostly due to manufacturing stresses, until I had time to check up on the feed-water conditions in the districts in which this condition was found. I am now willing to concede that the chemicals in feed waters do have considerable to do with this malady.

The question uppermost in the mind of engineers today is, will welding of seams eliminate caustic embrittlement? Will it? We hope so, but time will tell.

Discussion by R. Milligan*

Mr. Morrison told us that the method of slotting the plate, occasionally used in locating any lap seam cracks, "had also been used with great success in investigating knuckle cracks in head flanges." The advantage of this method in locating lap seam cracks, or cracks which do not show on the surface, is easily seen but, frankly, it seems to me that there are many simple, non-destructive tests which are preferable in identifying knuckle cracks. For instance, it is an easy matter to drill a hole across the crack and search the hole much in the same way as we would examine a rivet hole if the crack were in a seam. The hole can quickly be plugged if necessary. There is also the heat test and the acid test, both simple and non-destructive.

We appreciate the fact that little good can result from any discussion of the caustic embrittlement theory in a meeting of this kind. However, in justice to the opponents of the embrittlement theory we think that one of Mr. Morrison's statements should be questioned.

Mr. Morrison told us that an investigation of 600 cases of cracking had shown that the boilers in which the cracks were found "had operated at some time with water high in sodium carbonate and low in sodium sulphate." That certainly seems an impressive proof of the caustic embrittlement theory, but when it is considered that no attempt was made to hold prescribed carbonate-sulphate ratios prior to 1926 and that soda ash (or sodium in some other form) was (and to a large extent still is) almost universally used for feed-water treatment, I feel it should be pointed out that an investigation of the feed-water history of about 90 percent of all boiler plants could be made to show that they had operated at some time with water high in sodium carbonate and low in sodium sulphate. Even today, in the modern power plant employing a chemist whose duty it is to attend to such matters, it is found to be extremely difficult to maintain carbonate-sulphate ratios so closely that it could not be shown that the boilers had so operated at some time.

Irrespective of cause, the form of cracking sometimes known as caustic embrittlement is dangerous because, as the cracks occur along the contact surfaces of the plate, they cannot be found by ordinary inspection methods.

Mr. Morrison has told us that an "inspector will not go far astray if he decides to make a thorough investigation of each boiler operated with raw feed water or with treated water which, when cold, lathers freely with any standard soap solution." I can readily see the reason for this caution, but it might have been wise to explain the statement to some extent, as waters high in sodium carbonate or sodium phosphate will lather freely whereas, according to Straub's later bulletins on the subject, sodium in carbonate form will actually inhibit embrittlement. A similar property is claimed for sodium phosphate in low concentrations, although sodium hydroxide and sodium phosphate in the higher concentrations cause embrittlement in the presence of high stresses . . . also according to Professor Straub. I feel that Mr. Morrison intended to convey the thought that boilers showing a high concentration of sodium hydroxide should be investigated and that waters which lathered freely with a standard soap solution should be analyzed, so that the hydroxide content could be checked, and that the further investigation should not immediately take the form of a search of the riveted seams by the removal of rivets, etc.

Mr. Morrison has suggested that the cause of any persistent leakage be investigated. It appears to me that this was the high point in his talk. As was pointed out in the A. S. M. E. Code when the carbonate-sulphate ratios were first promulgated, there is usually something seriously wrong with the seam that will not stay tight when carefully calked. I know of no satisfactory method of locating internal cracking without removing rivets, although the magnetic method offers some possibilities. However, you are certainly justified in asking for the removal of rivets in a seam which continues to leak after being re-calked.

At one point in his talk Mr. Morrison made the remark that "an inspector can develop the knack of striking the rivet head with a sharp twisting blow of his hammer, which may bring surprising results." It appeared to me that at this point we were in danger of

* Supervising engineer, The Ocean Accident and Guarantee Corporation, Ltd.

lightly passing over a phase of inspection that, from a practical standpoint, cannot be over emphasized. In making an examination of a boiler suspected of having cracking in the riveted area, if a rivet head is found to have fallen off after the boiler has been in service for some time, or if rivet heads can be snapped off with a hammer blow, it is very probable that a careful search of the riveted areas will reveal cracking somewhere in the plates, straps or heads. It is true that in time an inspector develops the knack of striking the rivet head at exactly the angle that will snap it off if the shank is already broken, if conditions are right. However, it is surprising just how hard it sometimes is to dislodge a broken rivet.

A rivet head adhering to the shell by the effect of the calking alone will sometimes withstand several blows from a hand hammer without loosening. If your preliminary inspection has given you reasons for suspicion and you wish to be sure that the rivets are sound, I would suggest, if possible, when testing rivets of large diameters you use an air gun and a long, round-nosed tool in making the hammer test. I have personally found the vibrating effect of repeated blows from an air hammer very effective in dislodging rivet heads if the shanks are broken or partly broken. It might also be added that in making tests with a hand hammer you should not be satisfied with the small inspector's test hammer usually employed in going over a boiler. In a rivet test of this kind a hammer at least 1½ pounds in weight is necessary and in extreme cases with very large rivets you might find it desirable to use a light flogging hammer.

I am sure it was not Mr. Morrison's intention to scare you when he spoke about lenses of 40 and 100 magnifications. Don't go away with the idea that the locating of a so-called embrittlement crack is surrounded by mystery and a job for the expert only. While I have personally experimented with all manner of lenses, I cannot say that I have found the lens a practical tool. When a rivet has been removed, clean the hole thoroughly with acid—hydrochloric, or a mixture of hydrochloric and sulphuric. When I say thoroughly, I mean that every speck of dirt or of rivet scale must be removed. After the hole has been cleaned, wet the walls slightly with fresh acid and examine them carefully with the naked eye, using a good focusing type flashlight for illumination. If your eyesight is reasonably good and a crack exists, you will find it in this way—but take plenty of time. It is true that there is a decided advantage in being familiar with the general appearance of embrittlement cracks. The company I represent, in recognition of this fact, has at different times sent typical specimens of cracked material to all of the field engineers so that they might familiarize themselves with the appearance of the so-called embrittlement crack.

Mr. Morrison has pointed out that cracks of this type are sometimes inconceivably fine and yet may be dangerously long. This is true. When you run into cracking of this nature and have to satisfy someone that a crack actually exists, it is a good plan to heat the plate in the vicinity of the rivet hole to a dull red with a blow torch. When the plate cools off you will generally find that the crack stands out plainly.

While it is only prudent to advocate maintenance of the A. S. M. E. carbonate-sulphate ratios until we have more knowledge of the part sodium hydroxide plays in this form of cracking, I would suggest that you do not put too much faith in chemical protection. Always be on the lookout for evidences of distress, or fabrication methods likely to produce distress. Be careful in your inspection of drums made up of heavy plates and using rivets of large diameters. Be particularly careful in jobs of this type built before precision methods in the boiler shop had been fully developed.

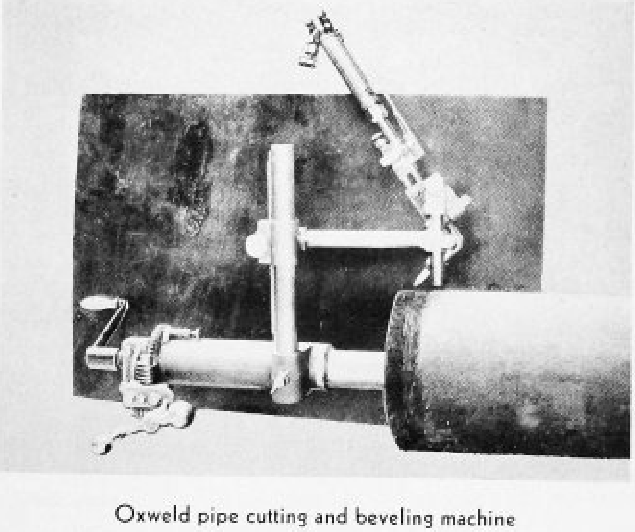
In conclusion it would be my final suggestion to all boiler inspectors present, not to theorize too much on the problem of caustic embrittlement. There has always been a wide difference of opinion between equally eminent authorities as to the primary cause of this form of cracking. Most of them, however, are united on one point—that excessive stresses play a large part. It is possible that authorities will ultimately decide that caustic soda is an accelerating agent, although maybe not absolutely necessary towards the development of this form of cracking. I would suggest that we let the chemists decide, however, just what place caustic soda has in the problem, and that we continue to encourage fabrication methods that will eliminate residual stresses as far as possible. From my observations throughout the country, there is no doubt in my mind that there are plenty of cracked boilers in operation today. Let us try to catch them before they catch us.

Note: Further reports that were presented at the meeting of the National Board of Boiler and Pressure Vessel Inspectors will appear in subsequent issues. This is the only publication in which such reports have been presented.

Oxweld Pipe Cutting Machine

Another new cutting machine has been announced by The Linde Air Products Company, New York, as an addition to its Oxweld line of apparatus, known as the Oxweld pipe cutting and beveling machine. It consists of a center rod with three spreading arms which press against the inner wall of the pipe, holding it in position, with an arm supporting a blowpipe that can be adjusted to the desired angle of the cut. The blowpipe and arm rotate without the use of a crank for quick centering of the device, and by means of a crank when doing actual cutting.

This machine will take almost any hand-cutting blowpipe, is readily portable, and its operation is extremely simple. Once centered in the pipe, the operator merely turns the crank causing the blowpipe to rotate evenly around the pipe, making a clean machine-like cut. Wherever large quantities of pipe are to be cut and beveled, this machine will save time, money and trouble.



Oxweld pipe cutting and beveling machine

Consideration of stresses occurring in

WELDED JOINTS*

By Everett Chapman†

The science of structures is concerned with the economic distribution of elastic material to connect a load to its reactions over a reasonable length of time. Intimately associated with this broad subject are the various methods used to join the component members of the structure.

Any structure built of pieces must necessarily act as a whole under its applied loads. Joint efficiencies, therefore, determine the action of the structure. As the unit stresses are raised, high joint efficiencies become more and more important. As the loading cycle becomes more and more frequent, homogeneous joints become imperative.

Properly welded joints are more nearly homogeneous than any other type of connection between two pieces of material. Homogeneous joints are eminently desirable since they particularly affect the rigidity and fatigue performance of the structure.

Consider the two methods of supporting a load over a span, as exemplified in Fig. 1. The usual truss and abutment arrangement is essentially a three-piece structure, connected by pin joints. The rigid frame bridge is a one-piece structure in which the transition

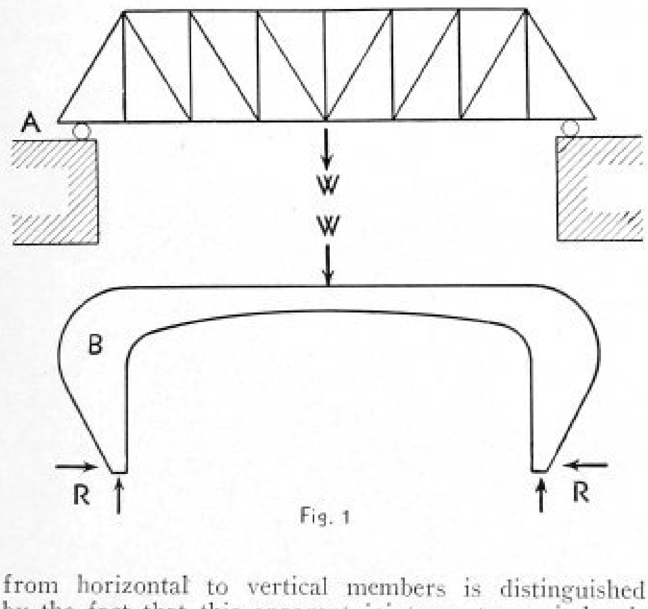


Fig. 1

from horizontal to vertical members is distinguished by the fact that this apparent joint can transmit bending moments. In the one-piece rigid frame bridge, the bending moments are distributed uniformly over the entire structure. The vertical and horizontal members interact to redistribute the bending moments. When, as in this case, adjacent members interact through a rigid junction, the redistribution of bending moments may effect an economy of material running as high as 30 percent. Considered broadly, the type of joint at the knee of the one-piece rigid frame bridge is the joint inherent in a properly welded design.

Two plates can be welded together so that the joints, as such, vanish. A homogeneous joint, or transition between two pieces of material, is a joint whose elastic behavior cannot be distinguished from that of the same configuration cut from a single piece of material. In the unattainable ideal, the maximum stress would have the same value as the average stress. The fact that this ideal can be closely approached in welded joints has two implications for the structural designer.

First, as has been mentioned, is the fact that continuity can be taken into consideration in the design of gross structures such as bridges and buildings in which the moment of inertia of each member is much less than the corresponding constant for the whole structure. Welded design is eminently adapted to the curvilinear structures which result when continuity of elastic action is considered in the design. The second implication is that the behavior of the properly welded structure, under impact and fatigue load, is similar to that of a jointless structure as far as service life is concerned. The entire structure's resistance to severe loading conditions represents the thoroughly consolidated resistance of its components.

A homogeneous joint has two characteristics. First, the material comprising the joint must have uniform physical properties from point to point; it must not have been damaged in any respect by the fabricating process. Second, the distribution of stress throughout the joint, from point to point, should be of maximum uniformity.

With a homogeneous joint of the desired characteristics, the two members are joined in such a manner that neither the elastic action nor the plastic action of the composite is distinguishable from the action of a single piece.

Three factors control the two desired characteristics of the homogeneous welded joint.

First, the parent metal is damaged by the extreme heat of the welding operation. Fig. 2 shows the transition zone between weld metal and 0.40 percent carbon base metal. The large grain size is indicative of the high temperature to which the parent metal has been raised by the heat of the arc. The metallic heat path to the body of cold parent metal forms an excellent thermal sink, and the resulting rapid heat flow away from the weld thoroughly quenches the heated zones around the weld. The net result is a zone of highly overheated and quenched material adjacent to the weld. The severity of damage in this zone is a particular function of the carbon content of the parent metal, or more generally, a function of the air-hardening ability of the steel. This damaged zone, whatever its extent, represents a discontinuity in physical properties, since the large, overheated grain is decidedly weak in resistance to fatigue and impact. In addition, the hardened micro-constituents, due to the quenching action, are very strong, but they lack the ductility necessary to compensate for the thermal stresses to which the piece is subjected in the welding operation. The

* Abstract of paper presented at the Annual Meeting, American Society of Mechanical Engineers, New York, N. Y., December 6, 1933.

† Vice-president in charge of engineering, Lukenweld, Inc., Division of Lukens Steel Company, Coatesville, Pa.

Fig. 2

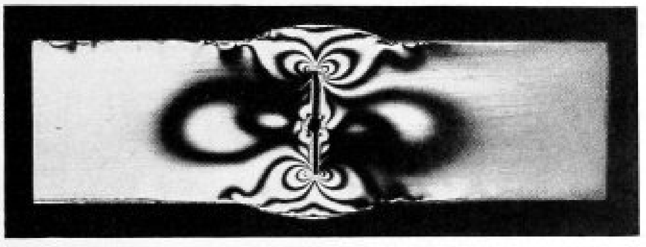


Fig. 3

joint may crack through the damaged zones during fabrication. This phenomenon may be carried over into the service behavior of the structure if the damage is not corrected.

Second of the factors controlling the production of homogeneous welded joints is the design of the joint itself. It is the rule rather than the exception that stress concentrations of a very severe nature may exist in the joint. Fig. 3 shows the heterogeneous stress condition which exists in an improperly designed welded joint. This photo-elastic study represents a loaded butt joint between two pieces of metal of equal thickness. The two welds, deposited from each side, did not meet at the center. The unfused portion forms an internal boundary which produces an extreme variation in stress over the joint. At the end of this crack, the stresses are very high. In addition, intermediate high stresses exist at the ends of the reinforcements which are usually, and vainly, applied in order to strengthen this type of joint. Such reinforcements are effective only under static load. But under impact or fatigue loads, the changes in contour at the ends of the reinforcements introduce additional stress maximums.

Third of the factors influencing the production of homogeneous welded joints is the element of residual stress introduced in the structure through contraction of cooling weld metal. Little is known of the direction or magnitude of these thermal stresses. However, there is direct evidence that the residual stresses, in many cases, may exceed the yield point of low carbon steel. When a known service load is superimposed on a structure which is already loaded by residual stresses in an indeterminate manner, the elastic conditions which exist from point to point are highly chaotic. In addition to the elastic chaos that residual strains may produce in a welded structure, severe warping will occur when the strains are relieved, either in the machining operation or by a gradual creep over a period of time.

Fig. 4 represents graphically the abortion which can result from the improper execution of a welded joint. This joint is far from homogeneous. The physical properties are not uniform from point to point, since there are zones of badly damaged metal. The stress values throughout the joint, when loaded, vary tremendously from point to point, because, in addition to the stress concentrations which exist at internal and external boundary discontinuities, the unknown residual stresses add to the concentrated load stresses, and thus produce utter chaos.

Whenever a welded joint, whatever its type, functions in a non-homogeneous manner, one or more of three destructive factors are operating—sharp changes in contour, damaged material, and pre-loading. For example, Fig. 5 represents a stress distribution usually found in a weld made from one side of a plate. Such welds frequently introduce ragged contours, since the form of penetration of the weld metal cannot be completely controlled from one side. Where the design of the structure is such that welding from both sides

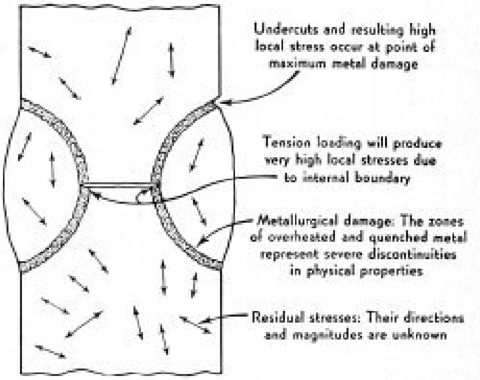


Fig. 4

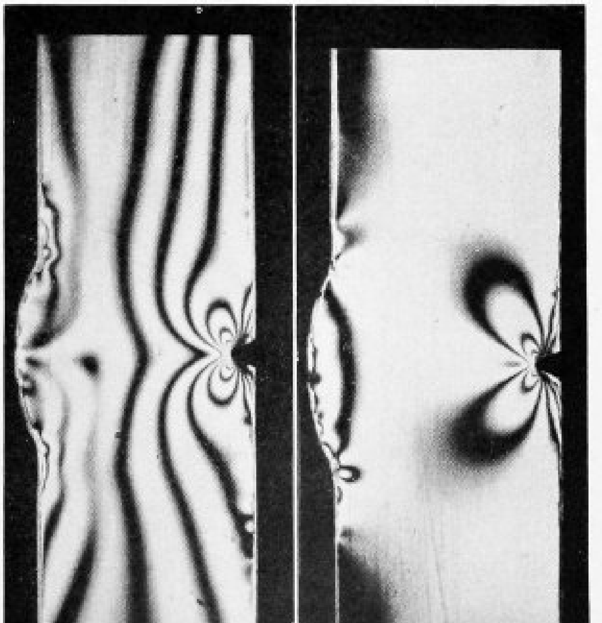


Fig. 5

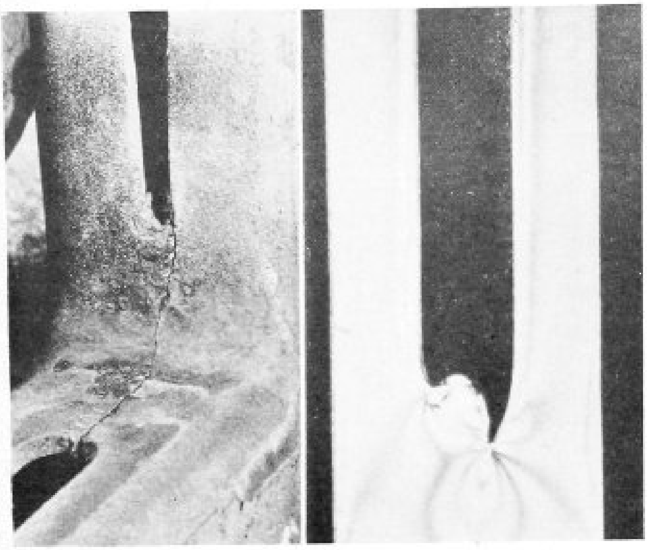


Fig. 6

is impractical, the use of backing-up strips permits the production of a compromise contour which is at least predictable.

Fig. 6 shows a failure resulting from a slovenly job of welding. The fatigue crack centered about the stress concentration produced by an extraneous bit of weld metal carelessly left by the welder to project from an important boundary of the structure.

Correction of the destructive factors which are present in non-homogeneous joints simply revolves around two elements, first, the drafting room practice, and second, heat treatment.

As it is concerned with the design of the joints, drafting room practice must be carefully supervised to insure that no defects are allowed to creep into the structure. Design practice can no more afford to neglect the stress distribution in the joint than it can afford to neglect the stress distribution throughout the gross body of the structure.

Correction of damage to parent metal necessitates a heat treatment after the structure has been welded. The series of photo-micrographs, Fig. 7, illustrates the effect of welding, stress-relief, and treatment at the two critical temperatures, of two pieces of steel of different carbon content. All the photographs in Fig. 11 were made at 100 diameters, and etched with nital. The first picture represents the as-rolled condition of 2-inch plates. All the other pictures were taken on the very edge of the weld metal and illustrate the effects which occur in the parent metal. In the as-welded condition, it is seen that the parent metal in the case of 0.40 carbon steel is in a martensitic condition, while the 0.24 carbon steel shows evidence of the original austenite with troostite forming at the grain boundaries. It is to be noted also that the grain has been enlarged considerably. The probable characteristics of these two zones are extreme brittleness, no ductility and a general weakened condition due to the large grains. With such characteristics, these zones cannot absorb any energy, as they would be called upon to do in the case of an impact, and, furthermore, they have no self-relieving properties under thermal stresses because of their lack of ductility.

The effects of the usual stress-relieving treatment at 1200 degrees F., followed by a furnace cool, are illustrated in the third group of two pictures. The temperature 1200 degrees F., is usually considered sufficient for stress-relief, since at this temperature, ordinary low carbon steels have a yield of only about 2000 pounds per square inch. This means, of course, that any residual stress greater than 2000 pounds per square inch will produce plastic deformation, and will therefore, vanish for all practical purposes. The pre-loading which was introduced by the contracting weld metal has been removed. However, 1200 degrees F., if held for a proper length of time, will serve to break down the harder micro-constituents which are formed in the damaged zones. It will not, however, refine the grain, since the carbon does not go back into solution at this temperature.

It is also to be noted, then, in the third group of two pictures delineating the 1200 degrees F. treatment, that the martensitic and troostitic phases in the two steels have been broken down to what is probably a finely divided sorbite and it is reasonable to suppose that the residual stresses after this treatment are under 2000 pounds per square inch.

Experience indicates that welded structures which have received this treatment will retain their shape during machining and indefinitely thereafter. Treatment at 1350 degrees F. partially refines the grain, while the treatment at 1650 degrees F., followed by cooling in still air, represents the maximum degree of refinement that can be obtained. Furnace cooling from 1650 degrees F. is rarely practical since light-weight, high-duty structures may suffer severe distortion in the furnace due to their own weight. The practical compromise that represents the best commercial practice is, therefore, a soaking treatment for one hour per inch of maximum thickness at 1200 degrees F., followed by a

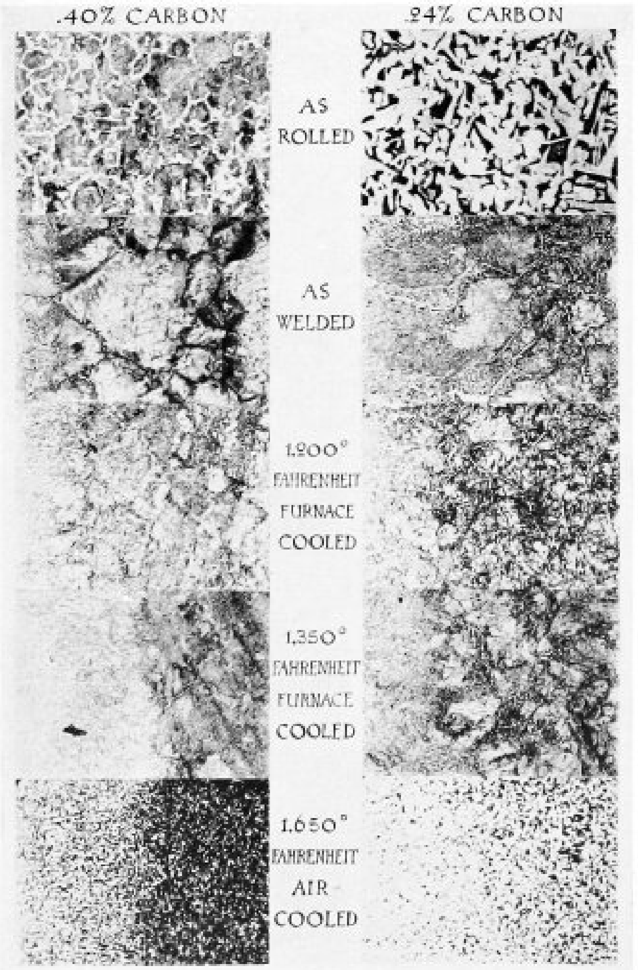


Fig. 7

slow furnace cooling. Under more rigorous service conditions a gain can practically be effected by raising the temperature to 1400 degrees F., at which temperature the grain undergoes partial refinement.

The importance of keeping the carbon content of the steel in the lower ranges is graphically represented in the series of micro-photographs. The local damage done to the higher carbon materials more than offsets the higher average properties which they represent. It is through specifications of carbon content that the welding of large structures such as bridges and ships, which cannot be annealed in a furnace, will become practical. However, even where metallurgical damage has been minimized in this manner, the problem of stress relief is not solved. As more is known of the nature of residual stresses, mechanical peening will offer a compromise solution which will enable the full possibilities of welded construction to be realized by the designer. The carefully executed ideal, in which contours have received proper attention and which has been properly heat treated, need have a lower factor of safety than any other type of construction: it is more predictable. As the service duties increase and more and more is demanded of the available structural materials, the factor of safety must be reduced. Modern transportation trends are imposing high duties on available structural materials. Careful design and selection of materials are the only path to uniform stress, one piece structures. In such structures, the joint as an entity must vanish. The behavior of a properly made welded joint under any kind of load or load cycle cannot be distinguished from a single piece of rolled steel.

Goggles as Hazard Protection*

By W. F. Weber†

The possibilities of injury to the eyes in modern industry, on the street and in the home are so manifold that no single contrivance is adequate for all. Consequently eye protective equipment varies from simple spectacles with clear glass lenses to masks with lenses of glass formulated especially to filter out injurious light rays.

In industry it is the function of the safety engineer to select the type of equipment which will give greatest protection and be comfortable. To make the correct choice he must know the raw materials used, the way the materials are worked, the products and the intangible as well as the tangible by-products. Often intangible products such as light and vapors are the most important factors. He must know also the eye protective devices that are available and how they should be used. In short he must make a thorough analysis of the job and fit the right eye protective device to it. One type of protection cannot be used for every job but on the other hand every job does not need eye protection.

Eye protective devices may be divided, according to the hazard against which they guard, into four classes: impact, dust, splash, glare and injurious rays. The goggle for protection against impact must have lenses and a frame that will withstand hard usage; furthermore, it must be so designed that the lens cannot be forced out of its seat by a blow and if the impact is so severe that the lens is broken, that all large fragments are retained and the small bits not projected back into the eye. Spectacles, with or without side screens and cup goggles when provided with hardened glass lenses are protection against impact. Spectacles are used when the flying object is apt to be propelled from a place directly in front of the face, a few examples being machine tool work, nailing, light grinding and plastering. When the object is likely to come from the side a cup goggle should be used. Such a condition will be found on chipping operations, cutting rivets and breaking concrete and stone, especially when men are working in gangs or alongside of one another at benches. A heavy wire mask without lenses has been used for protection against heavy, angular missiles projected with great force.

Devices for protection against dust must of course completely enclose the eyes. Whether to use a goggle ventilated through minute holes or baffled slots, or a full mask will depend on the composition and quantity of the dust, the size of the particles and the way in which the dust is circulated. Dust-proof goggles may be required when removing dust by air jets, sand blast operations and places where finely divided materials are packed.

There are two kinds of splashes to guard against; liquids, such as strong acids and molten metal. To exclude liquid splashes it is necessary to have a tightly fitting face piece made of a material, commonly rubber, which is impervious to strong chemicals and a tight joint between the lens and its retaining ring.

Goggles and masks which protect from glare and injurious rays are distinguished by having lenses not merely of colored glass, but of glass which is colored because it contains certain elements which have been found to give the glass the property of stopping the injurious infra-red and ultra violet rays. The depth of color does however serve to reduce the quantity of visible rays which reaches the eye; in other words it protects against glare. These filter glasses or screen lenses are made to meet the absorption requirements found necessary by the scientists of the United States Bureau of Standards and the lens manufacturers and are designated by shade numbers which depend on the visible light transmission. It is absolutely essential to use the glass which has the highest absorption factor in the invisible rays while permitting the work to be seen. The details of the uses of each of the shades would take more time than is allotted for this whole paper, so it will have to be sufficient to say that they are used by furnace and cupola tenders, and welders.

* Abstract of paper presented at the fourth annual Greater New York Safety Conference.

† Hazard engineer, Western Electric Company.

(Continued on page 25)

Qualifying Tests for Welders*

***By Ernest Lunn*†**

A pertinent question usually asked by a prospective welder is, "How long will it take me to weld and what qualifications must I have before I can be rated as a first-class welder?" A good answer is, "Only so long as it takes you to acquire the habit of subconsciously manipulating the welding appliances (the acetylene torch and the electrode) in a manner to produce welds having certain characteristics which experience has shown are required in welds free from objectionable faults."

RECORD OF WELDER'S EXPERIENCE

COMPANY ____

PLANT ____

DATE ____

NAME ____ ADDRESS ____

AGE ____ NATIONALITY ____

EXPERIENCE: (Check)

	Aircraft Tubing		Low Pressure Pipe		Small Diameter Pipe
	Boiler Factory		Oil Refinery		Structural Steel
	Boiler Repair Shop		Plain Carbon Steel Tubing		Tank Factory
	Heavy Plate Work		Pressure Vessel Work		Flat Welding
	High Pressure Pipe		Railroad		Vertical Welding
	Job Welding Shop		Sheet Metal		Overhead Welding
	Large Diameter Pipe		Ship Yard		

NATURE AND PLACE OF FIRST INSTRUCTION IN WELDING ____

EXAMINATIONS PASSED ____

CERTIFICATE OR PERMIT ____

TYPES OF EQUIPMENT USED ____ TYPES OF WELDING ROD USED ____

SPECIALTY, IF ANY? ____

GENERAL EDUCATION ____

RECORD OF WELDER'S QUALIFICATION TEST

THEORETICAL KNOWLEDGE ____

QUALITY TEST-BUTT WELD ____ QUALITY TEST-FILLET WELD ____

TENSILE TEST - BUTT WELD			TENSILE TEST - FILLET WELD	
Thickness of Plates	STRENGTH (Lbs. per Sq. In.)		Thickness of Bars	STRENGTH (Lbs. per Lin. In.)
	Minimum	Average		

Form used to determine welder's previous training and experience

The most trying time in a man's welding career is during the period when he is endeavoring to train his muscles to act in ways to which they are not accustomed, and to force them to perform at once, as they ordinarily do after weeks and months of patient effort.

The apparent simplicity of the various welding processes is likely to lead to erroneous conclusions on the part of the uninitiated operator. Directing undeveloped muscular action by will power to produce what obviously ought to be done in making good welds is not as simple a matter as it might seem to be. A certain amount of well-directed effort must be expended in acquiring near perfection in welding, and it is not an accomplishment that can be learned from observation or upon advice only, and it is desirable that physical efforts involved in learning the art be supervised, otherwise much time may be wasted in useless effort.

The beginner should learn the answers to his problems as he progresses with his exercises, and strive to make welds that meet requirements, starting with simple problems and advancing to the more difficult, as proficiency is acquired. He should learn to judge weld metal quality, to some extent from the appearance of fractured welds made by him, and should include in his studies the strength and resistance of welds in order better to understand the relation of his work and that of an expert whose rating he is endeavoring to acquire. He should also approach the many problems confronting him with an appreciation of the responsibilities which will come to his lot once he has become a qualified welder.

It is well for the beginner to make a start by depositing metal in the easiest way possible, and under the direction of an experienced welder who should know how to instruct others. This latter provision is to keep the beginner from forming wrong habits in handling the torch and electrode; habits which, if persisted in, will retard his progress. Upon acquiring ability to make a sound deposit, further progress should not be difficult.

The beginner can congratulate himself when he is able to butt-weld two pieces of mild steel, say 6 inches long, 2 inches wide and 1/4 inch thick, lying in a flat position, and have the weld metal present a sound appearance when fractured. Another significant period in his progress is when he is capable of making a good fillet weld of the simplest form. Having acquired that proficiency, progress should be rapid.

As plate and structural steel welding head the list in volume, it is logical that a beginner should qualify for the type of welds most generally used in such fabrication.

When welders are being qualified for pipe work, sheet metal, thin wall tubing, non-ferrous metal, etc., the operators should be examined as to their ability to make good welds of the type to be used in the particular field concerned.

The tests referred to later would be pertinent as qualitative, but not as quantitative tests.

Decision as to whether a man is fit to work on a certain job is not answered by how long he has gone to school or for whom he has worked, but by his ability to make welds that the particular job requires. It is desirable for the employer who wishes to qualify his welders to have as a guide, a typical method of qualifying, so that his own procedure may not be lacking in any important detail. It is also desirable for the student welder who wishes to advance into work for which qualification tests will be required, to know the nature of these qualification tests so that during the instruction period he can check his progress against the testing program which he knows must come before he can be accepted as a welder on important work.

The purpose in presenting the following specifications is to recommend a simple, standard method whereby the qualifications of an operator to make sound fusion welds may be determined at minimum expense. Where established codes have been found satisfactorily to cover

* Paper presented at a meeting of the American Welding Society.

† Consulting Engineer, Chicago.

the qualification of operators welding in special fields, it is recommended that the regulations of such codes be followed.

Recommended Specifications for Pre-Qualification Tests for Welders

Section I—Requirements

The applicant shall furnish full information regarding his previous training and experience. The form shown in the illustration should be used for purposes of record.

He shall be examined and show satisfactory knowledge on the topics listed in Section 2. In case the work contemplated is of an unusual nature, he shall also be examined on such special topics as pertain thereto. The result of this examination should be recorded on the form.

He shall prepare welded specimens in accordance with Section 3 which shall comply with the tests specified therein. In case the work contemplated will involve the making of butt welds, Test 1 shall be used, and if the butt welds are to occur in important work, such as heavy plate construction, boilers or other pressure vessels, Test 3 shall also be used. In case the work contemplated will involve the making of fillet welds, Test 2 shall be used, and in case the fillet welds are to occur in important work, such as structural steel, Test 4 shall also be used. Tests 1 and 2 may be made prior to Test 3 and 4 in order to save unnecessary expense in case the former do not result satisfactorily. Entry should be made on the attached form as to whether the quality test is satisfactory, and the strengths developed in the tensile tests should be recorded on this form.

Section II—Topics for Examination

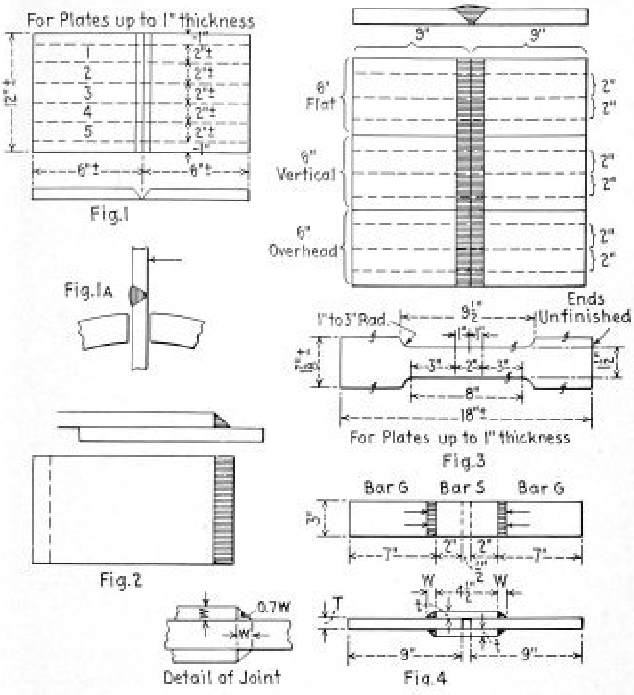
For Gas and Arc Welders—
- The meaning of "penetration."
- The meaning of "fusion."
- The meaning of "burned metal."
- The value of reinforcement.

For Gas Welders—
- The meaning of "oxide inclusions."
- Safeguarding the handling of cylinders, regulators, torches, carbide, acetylene, oxygen and the open flame.

For Arc Welders—
- Adjustment of regulating devices.
- Effect of length of arc.
- Relation between wire diameters and current strength.
- Protection of themselves and others from radiations.

Section III—Tests

General—Plates used in making specimens shall consist of low-carbon open-hearth steel, not exceeding 65,000 pounds per square inch ultimate tensile strength, whose surfaces shall be thoroughly cleaned and prepared for welding, except in cases where the operator is striving to qualify for a particular job in which other metal is to be welded, in which case welding wire suitable for the purpose should be used in making the qualifying welds. The specimens (required for Tests 1, 2 and 4) shall be welded in whatever position or positions (flat, vertical or overhead) will occur in the work contemplated. (The specimen for Test 3 shall be welded as specified below.) During the making of all test specimens the welding technique of the applicant should be observed. In the case of arc welding, he



Details of test specimens

should be able to hold an arc of proper length in order to secure proper penetration and fusion, to select and maintain a proper current and to handle the electrode with a regular movement. In the case of gas welding, he should keep the welding tip clean, use a soft, neutral flame, secure proper penetration, float out the oxides, fuse the welding rod thoroughly with the base metal.

Quality Test. Butt Weld—This test covers the preparation and testing of one specimen consisting of two plates each about 6 inches by 12 inches, connected edgewise by means of a single vee butt weld as shown in Fig. 1. The thickness of the plate, the angle of bevel and the depth of the shoulder below the bevel should be as close as practicable to those to be used on the job. Plates should be tacked or placed in position so as to insure that they will be reasonably flat after welding. Gas welders may make the weld with a single pass, but arc welders should be required to make the weld in two passes, the surface of each deposited layer being carefully cleaned with a wire brush or by chipping before applying the second layer. In both cases, the weld reinforcement should be 20 percent of the plate thickness. The weld should be made on the long dimension of the plates so that five coupons 2 inches wide can be secured. Only four of the coupons need be tested, but these should be selected so as to include at least one of the outside coupons.

The coupons cut from each specimen should be bent in a vise with the bottom of the vee on the outside in such a manner as to break through the weld metal (Fig. 1-A). The weld metal should then be examined for cleanliness of deposit, penetration, fusion and soundness.

Quality Test. Fillet Weld—This test covers the preparation and testing of one specimen consisting of two plates each about 4 inches or 5 inches wide, connected by means of a fillet weld as shown in Fig. 2. The thickness of the plate should be the same as that of the material to be used on the job.

The specimen should be prepared by laying one plate over the other so that the end of the top plate is set back from the end of the bottom plate a distance equal to four times the thickness of the plate, a full fillet weld being deposited in the corner thus made. The weld shall be tested by inserting a suitable wedge between the two plates, breaking the weld in this manner and examining the deposit for weld quality; that is, for proper dimension of the fillet, for cleanliness and dense structure of deposited metal, for uniform fusion with the base metal and for penetration at the root of the weld.

Tensile Test. Butt Weld—This test covers the preparation and testing of one specimen consisting of two plates each 9 inches wide and 18 inches long, as shown in Fig. 3. The thickness of the plate, the angle of bevel and the depth of the shoulder below the bevel should be as close as practicable to those to be used on the job. One of the long edges of each plate should be beveled and the beveled edges set nearly together, so that the completed test plate will be approximately 18 inches by 18 inches. A backing strip may be used if desired. The welding wire should either be mild steel bare-wire conforming to the American Welding Society's Specifications, the equivalent thereto, or the same type that will be used on the work for which the operator is being examined. The record of the test should indicate that wire is used. The first 6 inches should be welded in a flat position, the second 6 inches in a vertical position, and the third 6 inches in an overhead position, if the welder is expected to work in all three positions. Any welding position not required on the job may be omitted from the test. Coupons 1¾ inches wide should be cut out of the center of each of these sections. All reinforcement and all metal which has been worked through beyond the bottom surface of the weld should be ground or machined off after the weld is completed. Each coupon should then be prepared as specified by the American Welding Society Committee on Standard Tests for Welds, a copy of which may be obtained from the Welding Society's headquarters.

These coupons when pulled in a tensile testing machine should show a minimum ultimate strength (in pounds per square inch of throat) of 85 percent of the plate strength with an average of 90 percent of the plate strength for each pair. The plate strength may be determined either by test of a specimen or from the mill report.

Tensile Test. Fillet Weld—This test covers the preparation and testing of one specimen consisting of two grip bars each 3 inches wide, 9 inches long and ½ inch, ¾ inch or 1 inch thick, and two strap bars each 3 inches wide, 4½ inches long and ¼ inch, ⅜ inch or ½ inch thick, respectively. The bars are to be welded as shown in Fig. 4. Each leg of the weld should be the same as the thickness of the strap. In the case of arc welds a single layer should be used for the two thinner specimens and two layers for the thicker specimen. The ends of the grip bars in each case should be separated about ½ inch. All the pieces should be flattened if necessary and clamped to obtain perfect alinement and contact. Tack welding of the assembly is recommended. When pulled in the testing machine, the minimum load requirement should be 8000, 12,000 and 16,000 pounds per linear inch of weld, respectively.

The material in the foregoing recommendations has been compiled from the minutes of the meetings of the Committee on Qualification Tests for Welders of the American Welding Society of which the writer was chairman, and an acknowledgment is hereby made to all members of that committee for their splendid cooperation in its work.

Steel Plate Fabricating Industry

The National Recovery Administration, December 5, in the Carlton Hotel, Washington, commenced a public hearing on the Code of the Steel Plate Fabricating Industry. This code was filed by the Steel Plate Fabricators Association claiming to represent 85 percent of the industry. The hearing was conducted by Deputy Administrator Barton Murray.

The proposed code provides for a maximum work week of 40 hours averaged over six months and not more than 48 hours in any one week, for factory and construction employees and mechanical workers. Excepted from the limitations of hours are employees in executive and technical capacities, field service men, commercial travelers and watchmen and employees engaged upon emergency work of maintenance or repair. Clerical employees, service and sales employees and others on salary basis who received less than $35 a week a maximum of 40 hours on a semi-yearly basis, not more than 48 hours in any one week. The code also fixes a minimum wage of 40 cents an hour excepting the states of Louisiana, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Florida and Mississippi, where the minimum rate is 27 cents an hour, and in Southern California and Texas 35 cents an hour. These rates apply to factory and construction employees, mechanical workers and artisans. The minimum rate of wage for clerical employees is fixed at $15 a week in cities of over 500,000 population scaled down to $12 a week in towns of less than 2,500 population.

No report is yet available on the progress of the hearing, but it is expected that differences between interested groups will be adjusted and the code approved shortly. When released officially this code will be published for the information of our readers in the plate fabricating industry.

Boiler Manufacturing Code Supplement Hearing

Objections were offered by only one individual when a hearing was held December 27, 1933, at the Willard Hotel, Washington, on a proposed supplement to the code of fair competition for the boiler manufacturing industry. Neil Foster, assistant deputy administrator, presided.

An amendment to the labor provisions that would authorize the working of firemen, engineers and electricians engaged in the care and maintenance of plant machinery, and stock and shipping clerks and delivery employees more than eight hours a day but not in excess of 44 hours a week, attracted the attention of John B. Frey of the Metal Trades Department of the American Federation of Labor. He did not discuss the amendment at the hearing but indicated he would make certain observations concerning it at the informal conference, which, it was announced, would be held at the close of the hearing.

The proposed supplement contained certain provisions it was suggested be added to the adopted code, most of them having to do with trade practices. It was presented without comment by James D. Andrew, chairman of the code authority.

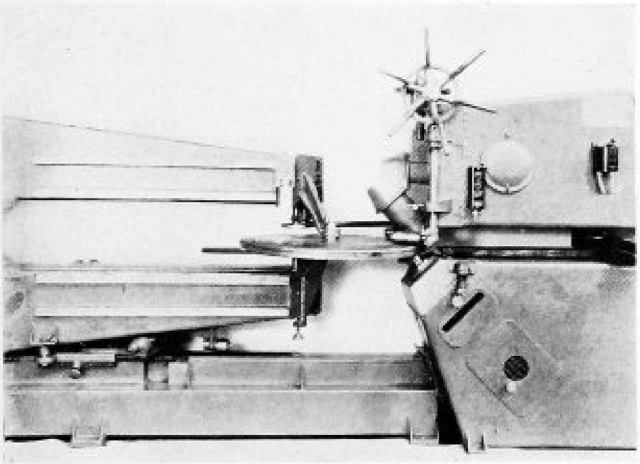
Walter J. Moyle, of the Sun Shipbuilding Company, objected to certain features of an article relating to sales below cost but suggested that it might be clarified by the insertion of a definition that would make clear just what was meant by price lists.

Other provisions in the supplement dealt with export sales, resale transactions, erection and several sections designed to avert unfair trade practices. The hearing was adjourned subject to the call of the administrator.

The results of the hearing should be available shortly and the supplement to the code as approved will be published.

Rotary Type Shear for Rapid Production

A new type rotary shear of welded steel construction is now being produced by the Quickwork Company, St. Marys, O. The outstanding points of construction of this machine are that the main frames and major parts are fabricated from arc-welded mild steel plates. The



Shear fabricated by arc welding

motive power is supplied by geared-head motors. All shafts are mounted on anti-friction bearings while lubrication is by means of a solid type of lubricant. The machine has a range of metal travel speeds of 12 to 24 and 36 to 72 feet a minute.

The importance of welded steel construction combined with geared-head motors is not only in the rigidity, strength and simplicity obtained but also in the fact that the construction may be adapted to practically any specification of the user. In other words the machine may be built with any throat depth required, with any range of speeds desired and with any diameter of cutters or rolls. It is possible to equip the machine to drive both cutter shafts or only one, to incline the upper cutter shaft or to hold it horizontal. This may all be done at a minimum of initial cost.

The operations to which the new Quickwork rotary shear is adapted are as follows: It will shear 5/16-inch mild steel, flange ¼-inch mild steel and 10 gage alloy steel, such as the new corrosion-resisting steels of high-tensile strength. It will shear straight and irregular cuts and will cut square or bevel edges. With the elliptical attachment, round heads may be cut from square blanks with a minimum of 12-inch and a maximum of 84-inch diameter. Round heads can be flanged with a minimum of 12 inches and a maximum of 84 inches diameter. Elliptical heads struck from four centers may be cut with a minimum of 42 inches by 34 inches and a maximum of 84 inches by 54 inches. The machine will also flange elliptical heads in these sizes. Finally, the new type shear will slit wide sheets or narrow strips from the edge of sheets, guiding against the gage mounted in the throat of the machine, the work being done rapidly and accurately. It will slit from 3-inch to 44-inch width strips from wider sheets.

Standards for Electric Welding

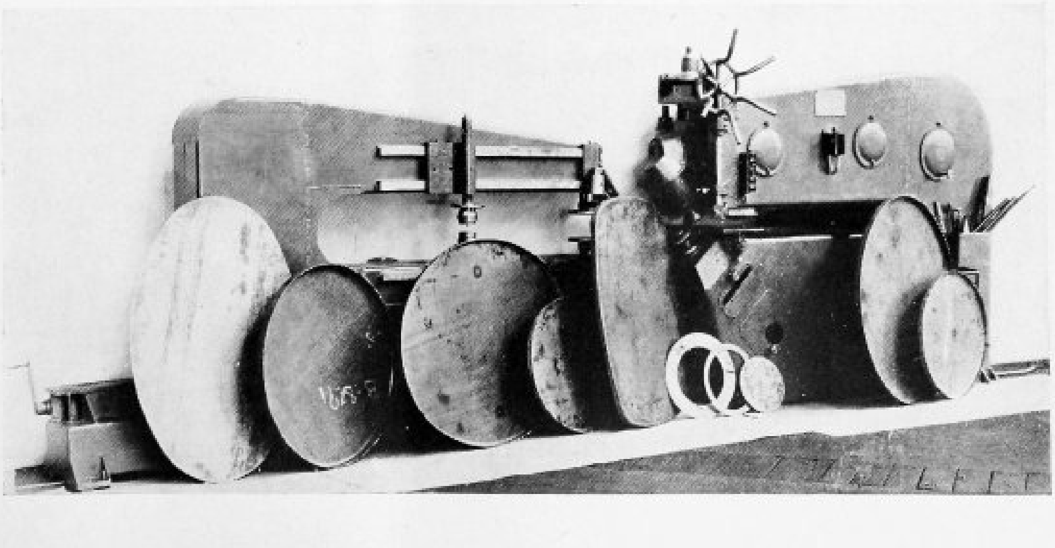
The first national standards in the field of electric welding have just been approved by the American Standards Association. These standards, covering the electrical apparatus for arc and resistance welding, are intended to assure an adequate and properly controlled supply of electric current to meet the exacting requirements of welding service. Generators, transformers, and other equipment are covered by the standards. Numerous industries, from pipe making to pressure vessel work, will be benefitted by these standards, which will help eliminate faults traceable to electrical supply.

The Sectional Committee on Electric Welding Apparatus was organized in 1931 under the joint sponsorship of the American Institute of Electrical Engineers and the National Electrical Manufacturers Association. The scope of the project assigned to it, and approved by the Standards Council on March 12, 1931, is as follows:

The formulation of standards for electrical welding apparatus, including definitions of terms, classification, rating, heating, efficiency, testing methods, dielectric test, standard values of current and voltage, and name plate data.

The committee consists of representatives of five pro-

General view of Quickwork rotary shear with numerous sizes and shapes cut and flanged by means of it



ducers, six consumers, and eight general interests. The final personnel was made up after canvassing all organizations known to have any substantial interest in this subject, in accordance with the usual procedure of the American Standards Association.

The organization meeting of the committee was held on December 18, 1931. At that meeting it was agreed that the instruction to the committee should be carried out by revising the two existing A. I. E. E. standards; namely, No. 38 (March, 1925) on Electric Arc Welding Apparatus, and No. 39 (September, 1926) on Resistance Welding Apparatus.

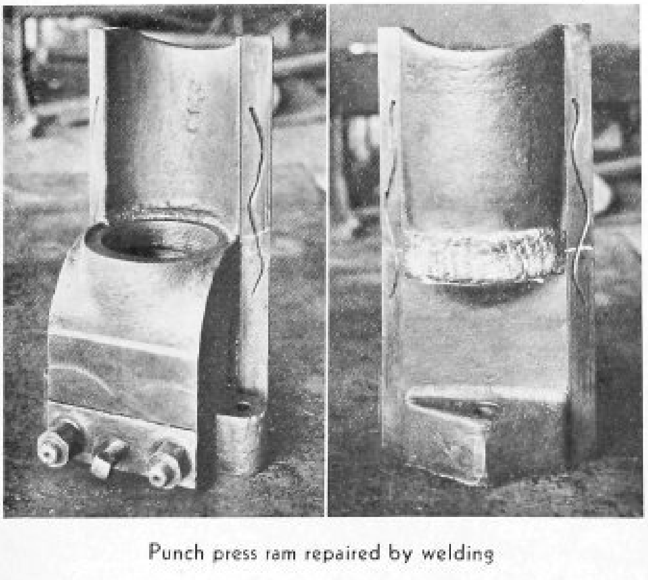
The standards as finally submitted by the sectional committee to the sponsors and subsequently approved as American Standards are in general accord with the original A. I. E. E. standards. No radical changes have been made. A number of minor changes, however, have been made in both the definitions and in some of the technical requirements—the definitions having been revised to agree with those now generally accepted by the welding industry, as proposed by the Sectional Committee on Definitions of Electrical Terms (C42), and certain of the performance requirements having been revised to bring them into accord with the generally accepted current practice.

Electrode for Welding Cast Iron

An electrode for welding cast iron by the shielded-arc process has been announced by The Lincoln Electric Company, Cleveland. The electrode, known as Ferroweld not only simplifies welding procedure on cast iron but according to claims produces a weld with greater strength and ductility than the cast iron.

Ferroweld has a steel core surrounded by a heavy flux coating which protects the arc from gases injurious to the weld which are present in the atmosphere. One of the outstanding advantages claimed is the low heat with which it can be used, thus reducing the possibility of cracking. The electrode is manufactured in only one size—1/8-inch—and is used with approximately 80 amperes of current.

Welding is done intermittently, not over a 3-inch bead being laid down at one time. As each bead is welded it is peened lightly, thoroughly cleaned and allowed to cool somewhat before the next bead is deposited. Due to the extremely low current with which it is used



Punch press ram repaired by welding

the hardening effect ordinarily present along the line of fusion is materially reduced. Thus the weld is more machinable than most cast iron welds.

The illustration shows a weld made on a punch press ram with Ferroweld. The ram is about 22 inches wide and approximately 1½ inches thick at the break. The press in which the ram is used is in constant use for punching holes as large as 7 inches in diameter in 10 gage steel. The ram was broken in operation at the point indicated by the chalk mark. In order to repair the ram the part was Vee'd out, with a Vee about 2 inches wide at the back, leaving approximately 1/8 inch of metal at the bottom of the Vee. The part was then tack welded at the inner ends of the chalk marks. Short beads were laid intermittently along the line of the break, first on one side of the ram and then on the other. The outside flanges of the ram which fit in the guides were ground down after welding. There were no signs of cracking or pulling away in the weld. No checks were present. This ram has been in use for several weeks after welding and is operating as well as when new.

Purdue Welding Conference

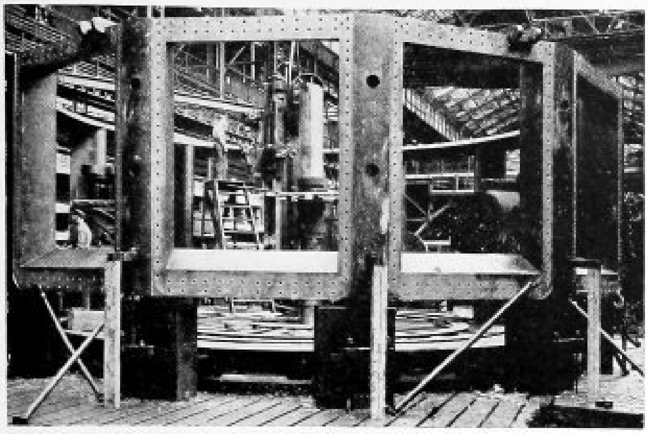
A registered attendance of 330 at the Welding Conference held at Purdue University, Lafayette, Ind., December 7 and 8, last, indicates the growing interest and importance of the conference. This is the largest registration since the first conference was held nine years ago. A number of manufacturers of welding equipment and supplies exhibited their products and conducted various welding demonstrations, such as welding aluminum, cast iron, copper, cutting cast iron, applying hard surface metals and demonstrations of atomic hydrogen, and resistance welding.

There were four sessions held, at which were presented a number of interesting and instructive papers. "Significant Trends in the Application of Welding" were discussed at the Thursday morning session by F. L. Spangler, editor *Welding Engineer*. An interesting paper on "Welding Brass and Its Alloys With Gas and Electricity" also was presented by W. C. Swift, service engineer, American Brass Company.

Fred Carl and C. A. Nichols, engineers in the Process Department, Delco-Remy Corporation, described "Special Applications of Welding in Manufacturing Operations" at the Thursday afternoon session. Harold Verson, chief engineer, All-Steel Press Company, Chicago, presented a very instructive paper on "Oxy-Acetylene Cutting as an Aid to Welded Design," and R. Notvest, welding engineer, J. D. Adams Company, presented "Arc Welding Fusion Metal." In the evening a talk and demonstration on "Metal Spraying" was given by K. D. Falk, Midwest representative, Metal Spray Company.

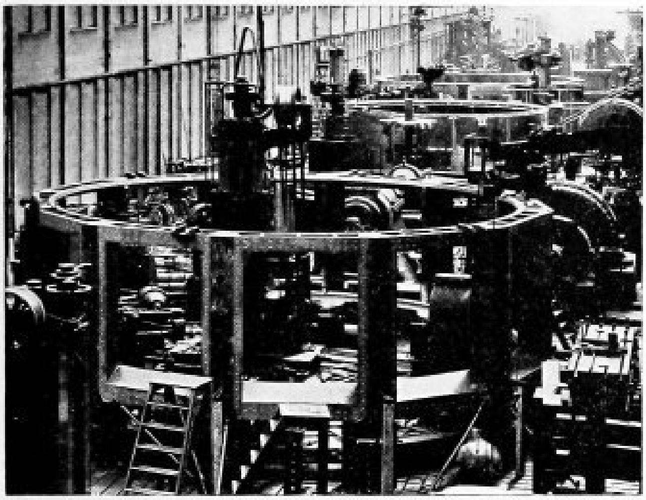
In his talk on "Selling the Services of the Job Welding Shop" on Friday morning, W. I. Brockson, manager sales promotion, Steel Sales Corporation, gave some valuable pointers of benefit to job shop owners.

Other papers presented were: "X-ray Inspection of Boilers," by G. W. Plinke, welding supervisor, Henry Voght Machine Company; "Field Welded Tanks," by H. W. Boardman, research engineer, Chicago Bridge & Iron Company; "Recent Developments in Resistance Welding," by J. A. Weiger, director of metallurgy, P. R. Mallory Company, and "Welding in Plant Rehabilitation," by George Hettrick, president, Anchor Welding Company.



Machining operation on a nose liner

Fabricating the Largest Valves in the World



Sec'ion of West inghouse, East Pittsburgh Works

More than four million pounds of steel and special materials are required in the production of the world's largest valves at the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company and to ship them to the Boulder Dam will require about ninety railroad cars. A total of eight gates, two in each intake tower, will control the flow of water to the power plant developing 1,835,000 horsepower. With the exception of the cast-steel throat liner and the small deflection plates, each gate is fabricated entirely by arc welding from steel plate.

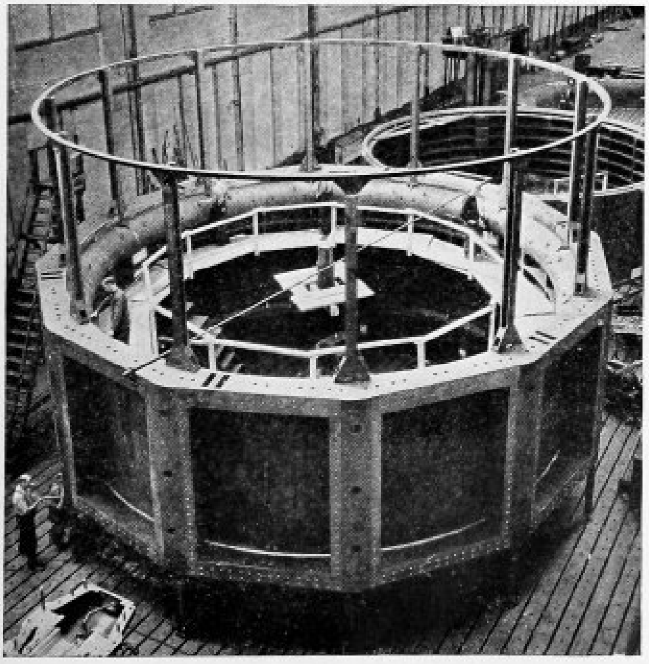
In accordance with the A. S. M. E. Boiler Code requirements for Class-2 welding, eighty welders were trained for this job for which a special heavy coated welding rod was developed. Standard steel plates rolled, cut to size and welded form the 32-foot cylindrical gates and nose liners. Because of the size and the accuracy required, the welding and machining presented many unusual problems. Due to the carefulness with which the mammoth gates were fabricated, every piece fit into place with precision and a watertight seal was secured in the test assembly at the shops.

In the construction of the gates, over 4,600,000 pounds of materials were used including steel plate, steel castings, bronze, copper, stainless steel and monel metal. More than one mile of welding is used in the fabrication of one gate. Each gate assembly consists of a throat liner, a cylindrical valve, a nose liner, valve guides and minor fittings.

The throat liner, 37 feet in diameter, is of cast steel, in twelve sections. The partings were machined on each section. Then the seats and faces were finished in position. Each nose liner is all welded and fabricated mainly from 2-inch and 2¼-inch steel plate hot formed on a 1500-ton press and fastened to the throat liner with 312 bolts. There are 28,200 inches of weld employing 252 positions of the sub and main assemblies to complete the welding on this largest stationary part of the gate. It is made in six sections bolted together. A total of 2514 holes of various sizes are drilled in the liner for bolting on the guide rails, throat liner, seats and entrance liners.

The monel metal seats making the watertight seal between the gate valve and the throat and nose liners are very carefully machined, 110,000 pounds being used for that purpose. Adjusting screws are provided for obtaining a perfect seal and locking into position on the upper seat only of each gate.

The cylindrical gate valves weigh 240,300 pounds and are formed entirely from steel plates cold rolled and



Final assembly first completed gate

welded. Each is made in six segments. Seven stiffening ribs, cold rolled from 2¾-inch by 11¼-inch stock on vertical rolls exerting a pressure of 575,000 pounds, are welded in position in each valve. To prevent water turbulence steel plates will be bolted over these ribs on the lower gates only. Also, specially cast steel deflection plates will be placed atop the lower gates to prevent turbulence and wear at the top seat.

The entire lower gate including the stationary and movable parts weighs 523,858 pounds and will be placed in the base of one of the 340-foot towers with another gate 150 feet higher. At the base the towers are 95 feet in diameter. When finished, the dam will be the highest and largest ever constructed forming a lake 30,000,000 acre-feet or about 11,000,000,000,000 gallons, the largest artificial lake in the world.

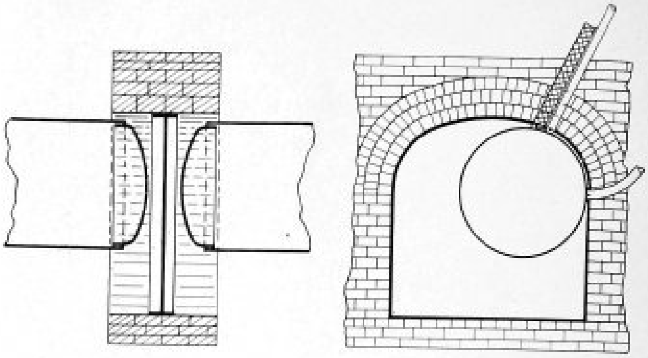


Fig. 2.—Ideal arrangement for blank heads of mud drums in battery setting

Preventing Dangerous Corrosion of Drum Ends*

In the older installations of bent-tube boilers the mud drums are usually in low positions, and like other covered parts of boilers the ends of these mud drums can be badly weakened by external corrosion before the danger is discovered, as they are not ordinarily accessible for inspection. The narrow spaces between the ends of the drums and the settings of such boilers gradually fill with soot and ashes which, in the presence of moisture, are extremely corrosive to metal. If allowed to progress, this corrosion can lead to very serious consequences, for the plate may waste away until not enough metal remains to withstand the working pressure.

In a special checkup conducted during the past two years, it was found that, of all bent-tube boilers of which the mud drums were uncovered for inspection, the drum heads of about ten percent were affected by corrosion to such an extent that expensive repairs would soon be necessary. About one percent were in such dangerous condition that the boilers could no longer be operated without immediate repairs or, in some cases, replacement of the drum.

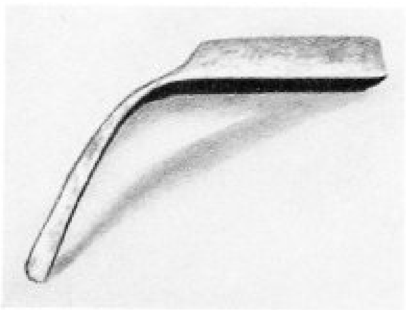


Fig. 1.—Effect of corrosion on mud drum head

Fig. 1 illustrates how serious this thinning down can become. This piece was cut from the mud drum head of a boiler which evidently could not have held together much longer under its working pressure of 150 pounds per square inch. At the bottom of the drum, and for some distance up each side, the sound metal at and near the turn of the head flange was not much thicker than a piece of heavy cardboard. In addition, the ends of the shell plate and rivet heads were very seriously eaten away. Because that portion of the head forming the skirt was protected by the end of the shell from contact with the ashes, it did not corrode. The head was originally of the same thickness throughout, so the illustration shows clearly the extent to which the half-inch plate was wasted. Over a considerable proportion of the circumference of the head at the turn of the flange about one-sixteenth inch of sound metal remained.

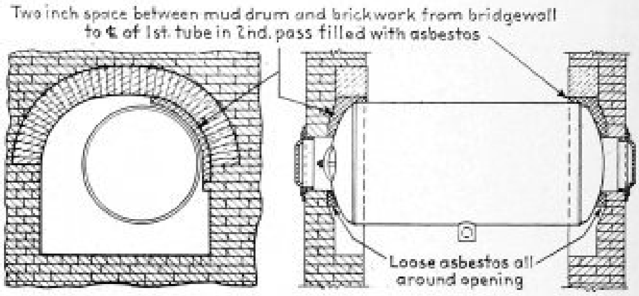


Fig. 3.—Ideal arrangement for ends of bricked in drums

When drum ends are closely encased in brickwork, there is no way in which the outside surface can be examined except by tearing out some of the bricks. In some cases an inspector can detect the presence of serious external corrosion by tapping with his hammer inside the drum. However, this test cannot be depended upon entirely, for the ashes and rust growth sometimes become packed so tightly between the outside of the head and the setting that the head will feel or sound solid under the hammer blow. For this reason it is important that provision be made for the regular inspection of the outside surface, and it is more satisfactory if some provision be made whereby inspection does not necessitate taking down brickwork.

Two such suggested arrangements are illustrated herewith. Both have the advantage not only of permitting easy access for inspection, but of avoiding pockets where soot and ashes can accumulate and pack up against the ends of the drum.

Fig. 2 shows a division wall arrangement for boilers set in battery. The division plate may be made of either steel or cast iron built solidly into the brickwork. With such a plate in position, the inspector can reach those parts of the head that are likely to corrode.

Fig. 3 shows a plan that may be used for the outside ends of boilers set in battery, and for both ends of boilers set singly. The arrangement is not difficult or expensive to install at the time a boiler is set, or to apply

* Published through the courtesy of *The Locomotive*, of the Hartford Steam Boiler Inspection and Insurance Company.

to boilers that now have drum heads embedded in masonry which must be taken down when the drum ends are to be inspected. The slight additional expense in either case is fully justified in the interest of safety.

Goggles as Hazard Protection

(Continued from page 17)

Heat and perspiration are two factors which must be considered when deciding which goggles to use. If the job is hot or the heat rays intense, the lens retaining ring and the parts which touch the face should be made of material which is a non-conductor. If the conditions are such that workmen perspire, fogging lenses can be avoided to some extent by using goggles with large air holes or extended fronts.

The requirements for different kinds of equipment have been stated in a general way. While it is not possible to give more details in this paper it is well to put more emphasis on the quality of the lenses. They should be free from bubbles and pronounced striae and the surfaces should be very nearly parallel. The colorless lenses, excepting the cover lenses, should be made of crown, i.e., optical glass which should transmit the greatest possible amount of visible light. In addition, lenses that are intended for protection against impact should not chip or break when a steel ball-bearing weighing about 0.6 ounce is dropped on them from a height of 39.4 inches. Screen lenses should meet the requirements of the United States Bureau of Standards for transmission of visible and invisible rays.

At the beginning of this paper it was stated that the safety engineer should select equipment which would give the most protection and be comfortable. Comfort and style should always be secondary to safety, but to insure the greatest co-operation from the workman and his supervisor the most comfort consistent with safety should be provided. The safety man may be able to show the operating supervisor that the feeling of security afforded by the right goggle properly fitted has increased the output.

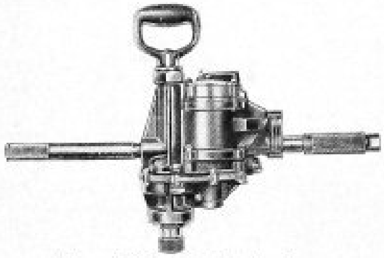
The comfort of eye protection has been greatly improved during the past few years by the development of the form-fitting goggle cup. This new cup also gives more protection by fitting closely into the eye-socket and by widening the angle of vision.

Poor fitting or improperly adjusted goggles are a real cause of discomfort and complaint. The storekeeper who handles goggles should be trained to fit spectacles. He should also know how to repair them. Manufacturers can supply various sizes of goggles, and the repair parts and tools. If it is at all possible, the safety equipment should be under the supervision of the Director of Safety. This is no condemnation of the ordinary storekeeper but even if the organization is very small and the storekeeper alert, he is so busy keeping his stock that he hands out goggles and other safety equipment as he does wiping rags. The safety man storekeeper on the other hand will find out where the goggle is to be used, note whether the requisition calls for the right type, inquire as to the disposition of the old ones, fit the new goggle on the man, show him how to wear them and send him away pleased with the attention he is getting. There may be a multitude of other questions to be answered and information to be gathered

Thor Boiler Shop Drill

A new Thor rotary-type tool developed by the Independent Pneumatic Tool Company, Chicago, is designed to eliminate rough and broken threads and leaky staybolts so often found when tapping staybolt holes with a piston-type drill.

It is equipped with power blades instead of expensive



New drill for the boiler shop

connecting rods, pistons and crankshafts. It operates smoothly and easily, causing no jerking or jarring effect on the workman. It has governor-controlled air consumption and speed, preventing the motor from racing when starting the tap. It is claimed to be the fastest and lightest weight staybolt-tapping and flue-rolling machine ever designed.

This Thor tool has a drilling and reaming capacity up to $1\frac{1}{4}$ inches, weighs 28 pounds, has a speed of 210 revolutions per minute, and is 12 inches in length.

Youngstown Expands Electric Weld Mill

The Youngstown Sheet & Tube Company plans to expand its present electric weld mill, at its Briar Hill plant in Youngstown, to include production of smaller sizes of electric welded pipe, it was announced recently by Frank Purnell, president of the company.

The mill now manufactures electric weld pipe in sizes from 18 to 26 inches. The new extension of the mill will permit manufacture of pipe from 16 inches down to 8 inches, and intermediate sizes. This will give the company a range in size of electric weld pipe from 8 inches to 26 inches. The cost of the extension will be approximately $500,000.

The company is also installing in its Struthers mill new equipment for the manufacture of railroad spikes, with a capacity of 1000 tons a month.

Short Welding Course.—A series of welding courses of eight weeks' duration throughout the entire school year is being conducted by the Ohio Mechanics Institute. This system makes it possible to enroll at almost any period of the year. Two separate courses are conducted—acetylene and electric—and the entire time is devoted to practical shop work. The shop is well equipped and the very moderate charge for the course includes the use of all the necessary equipment and materials.

A library is available for study by those who care to do additional outside work. Each student receives individual attention and is permitted to progress according to his ability.

The next class starts early in February.

Boiler Maker and Plate Fabricator

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Communications

A Disastrous Oil Tank Failure

To the Editor:

It might be of interest to the readers of The Boiler Maker to learn of the recent fire at Tiverton, R. I., which was caused by the bursting of the 80,000-barrel tank that was being tested by the contractors who built this tank.

The writer of this article is employed by the Penn Petroleum Products Company as superintendent of construction of an electrically welded steel tanker now being converted from a freighter to a tanker.

The tank which collapsed was 117 feet in diameter by 42 feet high with ¼-inch bottom. There were 7 courses, the first one being ⅝ inch thick, the second 7/16 inch, the third, ⅜ inch, etc. I was asked to inspect this tank at the beginning of the job. On my first visit they were just hauling the steel into the dike. At that time, I talked with the foreman of the erection crew. He stated they were going to use coated welding wire, of a particular brand. I told him I did not want him to use this wire in the vertical seams which were veed out to an angle of about 45 degrees. This was done on a rotary bevel shear of which I do not approve, as the operation has a tendency to crystallize the edge of the sheet. I think that all butt welds that are to carry pressure should be planed on a plate planer. The bottom was erected on horses approximately 3 feet from the ground. The first course was then erected and the bottom was welded on the inside only. The heavy angle iron ring was tacked at the heel approximately 12 inches apart. The toe was welded with coated wire to the bottom, which was only ¼ inch thick. Unless one is an experienced welder, he cannot successfully weld heavy material to light material, which was necessary in this case.

On my second visit, they had the first course erected and were welding the vertical seams with bare wire. Their process of welding was in this manner: The butts were lined up and tacked together at the center and top, then there was a weld made on the inside of the tank as a backing-up weld for the first fillet weld in the veed side. They then welded in a fillet weld, filling the vee about half full. This was then cleaned of slag and the remainder of the weld was put in by what is known as the back-step method. Then the first weld on the inside of the tank seam was chipped out with a diamond point and rewelded uphand. Now as anyone with practical welding experience knows that contraction of a weld is greater than the expansion of the metal, there was a tendency for this weld, having been done on the outside, to have contracted enough to form a convex curve at the seam. On the inside of the tank, such a curve would then be subjected to a collapsing stress instead of a bursting stress.

As near as I can determine, what happened is this: The circumferential seams were also beveled on a rotary shears and there was only what I call a skin weld made at this joint. This I do not approve of. These seams should have been left to form a 90-degree angle so as to make a 45-degree weld.

The first course let go at one of the vertical seams, then tore the bottom out on a concentric circle just inside the weld at the toe of the angle ring around to the next vertical seam, broke it at this joint and carried the plate out through the dike into the river. The other end of the weld that let go first was ripped off at the bottom on the same concentric circle as the first plate and was swung up over the dike, ripping the tank bottom around about 90 degrees from the first break. This, consequently, left the second course dangling as an outside course and this was carried on top of the water over the dike into the river.

The tank then collapsed from the partial vacuum that was created and fell in a heap on the side where the first sheet was torn out with the great onrush of water. The power house was located over the dike to the right about 90 degrees from the break. When the tank collapsed, the great onrush of water that went over the dike tore down the pump house. These pumps were connected with other tanks containing gasoline, oils, etc. These pumps were electrically driven. It is then obvious that the wires must have short circuited and ignited the gasoline which started the other tanks burning.

If you will note in the fore part of my letter, I stated that the bottom was erected on a trestle so that the bottom could be painted after the welding was done on the inside. In lowering this bottom it was necessary to start in the center and keep taking the horses out to the edge. This, of course, made a bowl effect on the bottom, so there must have been a strain at the heel of the angle iron, which was only tacked and welded at the toe.

Now, I do not condemn the welding in this job so much as I do the process of construction, as I do not consider back-step welding enough precaution to take care of the strains that are set up in the welding process of construction of butt-welded joints.

As a foreman welder of twenty years' experience, I would suggest classified licensed welders and not licensed concerns, as I have found a great many welders who, while they can weld tight work, their welds have no strength. Furthermore, a first-class welder would know how to take care of the contraction that takes place in the welding of heavy materials from 5/16 inch and up. I consider this just as important as knowing how to weld properly.

FRANK T. SAXE.

Edgewood, R. I.

A Practical Water Treatment Arrangement

TO THE EDITOR:

I am forwarding a sketch of a boiler treatment outfit and the pipe arrangement. To get the required amount of chemicals needed, use a barrel for the boiler treatment. Place this on top of a water tank. Mix the treatment with water to make a liquid. This can be blown

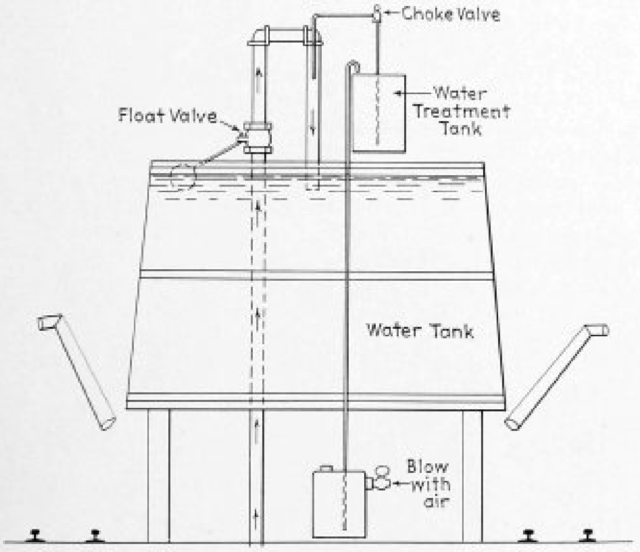


Diagram of water-treating outfit

from the ground by air pressure, as shown. The intake water pipe is to be governed by a float. As the water is drawn from the tank the float will drop, causing the supply valve to open. The rush of water through the discharge pipe will siphon the compound from the boiler treatment container. Adjust the choke valve in the container pipe to allow the required amount to pass through. The water treatment will cease to run when the water stops flowing. This will keep the required mixture at all times.

Savannah, Ga.

E. P. HILL.
Foreman, Central of Georgia Railway Shops.

Republic Metallurgical Department Program

Harry W. McQuaid has joined the metallurgical staff of the Republic Steel Corporation, according to announcement made by Earl C. Smith, chief metallurgist. Mr. McQuaid, who is nationally known as an authority on carburizing steels and case-hardening methods, is the leading pioneer in grain size control and collaborated in the development of the McQuaid-Ehn test which bears his name. He will devote his time with Republic to research and development work.

Other changes incident to the broad metallurgical program under way at Republic include the transfer of Howard W. Burkett from Youngstown to the post of metallurgical engineer of the Buffalo district; the appointment of Elmer Larned in a similar capacity in the Chicago district and the acquisition of Harold T. Blair, metallurgical engineer, who will specialize in tin plate products. Karl Kautz, ceramic engineer, also has joined the Republic organization, and will specialize in research and field service on enameling sheets. M. J. R. Morris and E. R. Johnson will continue in their respective metallurgical capacities in the Central Alloy district, where all of Republic's stainless steel and much of the alloy steel are produced.

Storts Company Welding Library

A library, the purpose of which is to aid its customers and prospective customers in the solution of welding problems and to furnish information on welding to those who do not have the necessary library facilities, has been established by the Storts Welding Company, Inc., 42 Stone Street, Meriden, Conn.

The Storts Welding Company has, in the many years during which it has been in the job welding and contract work business, been endeavoring to collect a good reference library on welding subjects. Realizing the difficulty of collecting such a library, this company decided to make the facilities available to those concerns who have no welding library facilities, the object being to aid them as far as possible to work out their own problems.

In addition to the welding text books and trade papers, a "source of supply file" with a cross index system is maintained containing a list of manufacturers of welding supplies and equipment. In connection with this is a file listing manufacturers who market other products which indirectly relate to welding.

The library is open from 8:00 a. m. to 5:00 p. m. daily, from Monday to Friday, inclusive.

Metal Radiography Course of Study

A course on metal radiography is being planned by the St. John X-ray Service, Inc., 30-20 Thomson Avenue, Long Island City, N. Y., at its laboratory, starting February 5, 1934. The class will meet twice weekly in the evenings from 7:30 to 9:30 for a period of eight weeks.

The 16 two-hour sessions will include theoretical as well as practical work. All branches of X-ray and gamma-ray inspection of engineering materials will be covered. The examination of castings, ferrous and nonferrous; welded structures, from airplane fuselage joints to pressure vessels; and other similar problems, will be dealt with.

The fee for this course includes the use of equipment and all materials.

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 the editor is given special permission to do so.

By George M. Davies

Flexible Staybolt Installation

Q.—Being a subscriber of your magazine I would like to have your opinion on the following trouble: We have three Baldwin Prairie-type locomotives; steam pressure, 200 pounds. These engines came equipped with flexible and rigid staybolts. Around in the center of the fireboxes the rigid bolts have started grooving in the fire sheet on both the water side and fire side. Our original intentions were to install flexible bolts across the firebox taking the first six rows. Because of the type engine, we ran into trouble with the expansion pads and cab braces. If we install flexible bolts back to the pads, do you think this would cause an extra strain on the rigid bolts close to the pads and braces, and would it only aggravate the condition we already have? Any suggestions you can make will be greatly appreciated.—G. A. M.

A.—From the information given in the question it is assumed that the cause of the grooving in the side sheet has been determined, and that it is the result of the unequal expansion and contraction of the inner and outer plates of the firebox under the influence of the differing temperatures.

This condition is often localized to a certain area of the firebox. In the average firebox using a brick arch there is a hot spot under the arch, with cooler metal above and below it. The hot spot is generally 3 to 5 times as long horizontally as it is vertically.

Consequently this section of the plate tends to expand more in a horizontal direction than it does in the vertical direction. But it is surrounded and confined by a cooler plate and it cannot relieve itself by bulging in towards the fire, because the staybolts hold it to a flat plane, so it just upsets and squeezes itself together when hot. Then, when it cools down, it is under strain in the opposite direction and the result is cracks running vertically from the staybolt holes.

Your explanation of the trouble indicates that the condition is localized and, if such is the case, and the expansion pad and cab brace are located well away from the zone in which the grooving occurs, I do not see any objections to using rigid staybolts under these parts.

I would use flexible staybolts, however, under the cab brace, as same is adjacent to the present breaking zone installation of flexible bolts.

Ohio Safety Valve Requirements

Q.—In the Ohio Boiler Inspection Law of 1932, on page 120, paragraph 269, it is stated that each boiler having more than 500 square feet of heating surface shall have two or more safety valves. I am writing to ask if you will explain in your column why this should be 500 square feet rather than 400 or 600 square feet? Also on this same page 120, in paragraph 5, I would like to have it explained how they comply with this ruling. W. G.

A.—The paragraphs of the Ohio Boiler Inspection Law referred to in the question are as follows:

P-269—Safety Valve Requirements. Each boiler having more than 500 square feet of water-heating surface, or in which the generating capacity exceeds 2000 pounds per hour, shall have two or more safety valves. The method of computing the steam generating capacity of the boiler shall be given in Pars. A-11 and A-12 of the Appendix.

P-272—Second Paragraph. Safety valves may be used which give any opening up to the full discharge capacity of the area of the opening of the inlet of the valve (see Par. P-273 b) provided the movement of the valve is such as not to induce lifting of water in the boiler.

The above rules are an exact copy of the 1932 edition of the A.S.M.E. Boiler Code.

The rules for safety valves are the results of conferences with the leading manufacturers of safety valves, and the limits set are the results of investigations covering the general average of operating duty for boilers in practice.

The limit of 500 square feet of heating surface for one safety valve differs in the various boiler codes in use; one boiler code provides that a boiler having more than 100 square feet of total heating surface shall have two safety valves.

To meet the conditions of Par. 272, the safety valves, as stated in this paragraph, shall be such as not to induce lifting of water in the boiler.

This condition is often caused by the sudden release of large quantities of steam through safety valves of large capacities, and is overcome by using a greater number of valves of smaller capacities.

Safety valve manufacturers, through experience, are best able to recommend the proper safety valve equipment for any given boiler conditions.

Foundation for Self-Supporting Stack

Q.—Referring to your book "Laying Out for Boiler Makers" under Chapter 9, we have been making up a number of self-supporting stacks but have not heretofore had anything to do with the foundation. We are now asked to give advice concerning the dimensions for the concrete foundation for a 66-inch diameter by 150-foot high self-supporting stack, having a total weight of 40,000 pounds. We shall appreciate your suggestions in the matter. On page 186 of the above book you have a description as to the stability of the stack, but our figures based on that give us no information, and we shall appreciate your suggestion as to how to apply the formula there given.—M. I. W.

A.—Sizes of foundations for self-supporting steel stacks are shown in Tables 1 and 2.

The part of Chapter IX in Laying Out for Boiler Makers, referred to in the question is as follows:

The stability of the stack may be determined as follows: First find the total weight of the stack and lining. This may be considered as a vertical force acting downward through the middle of the foundation. Then find

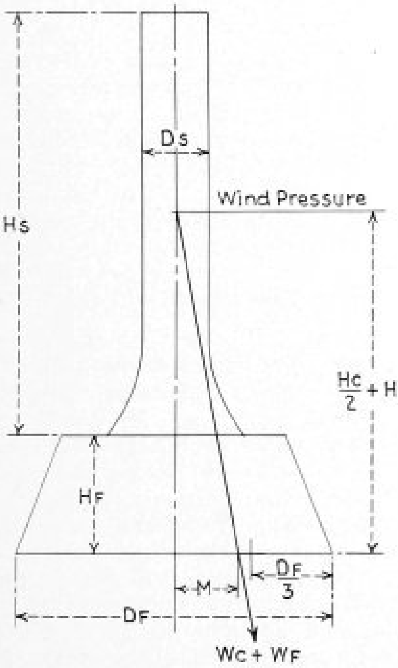
TABLE 1.—CIRCULAR FOUNDATIONS

Diameter of stack, feet	3	4	5	6	7	8	9	10	12
Height of stack, feet	100	100	125	150	150	150	200	200	250
Least diameter of foundation, feet	16	17	18	22	23	24	25	26	27
Least depth of foundation, feet	6	6	7	9	9	10	11	12	14

TABLE 2.—SQUARE FOUNDATIONS (MARKS HANDBOOK)

Diameter of stack, feet	4	4½	5	5½	6	6½	6½	7	7½	7½	8	8	9	10	10	11	11	12	12
Height of stack, feet	80	100	125	125	150	150	175	175	175	200	200	225	225	225	250	225	250	250	275
Length of sides of foundation, feet	15	17.2	19.8	20.3	22.8	23.3	25.1	25.6	26	27.8	28.3	30	30.9	31.8	33.4	32.5	34.2	34.9	35.8
Depth of foundation, feet	5	5.7	6.6	6.8	7.6	7.8	8.4	8.5	8.7	9.3	9.4	10.0	10.3	10.6	11.1	10.8	11.4	11.6	11.9

the total pressure on the chimney, which would be approximately 25 times the height times the diameter. This pressure may be considered to act in a horizontal direction at the middle point of the chimney, so that its moment about the base would be the total force times



Stack calculation diagram

½ the height of the chimney. Divide this moment, due to the wind pressure, by the weight of the chimney, and the result will be the distance from the middle of the foundation to the resultant force due to the combined forces of wind pressure and weight. For stability this force should act within the middle third of the width of the base.

The formula outlined in this paragraph is illustrated in Fig. 1, where

D_S = diameter of stack in feet
Df = diameter of foundation in feet
H_S = height of stack in feet
Hf = height of foundation in feet
W_C = weight of stack in pounds
Wf = weight of foundation in pounds
M = distance from the middle of the foundation to the resultant force due to the combined forces of wind pressure and weight. (For stability this force should act within the middle third of the width of the base or within $\frac{D}{3}$ as shown in Fig. 1.)

The formula would be:

$$M = \frac{25 \times H_S \times D_S \times \left(\frac{H_S}{2} + Hf\right)}{W_C + Wf}$$

Substituting values given in the question and referring to table of Circular Foundations for size of foundation we have; first computing the weight of the foundations using 150 pounds per cubic foot as the weight of the foundation:

$$Df = 20 \text{ feet}$$
$$Hf = 9 \text{ feet}$$
$$Wf = \pi \left(\frac{Df}{2}\right)^2 \times Hf \times 150$$
$$W = 314.2 \times 9 \times 150 = 424{,}200 \text{ pounds.}$$

Then substituting in the formula for M we have:

$$M = \frac{25 \times 150 \times 5.5 \times \left(\frac{150}{2} + 9\right)}{40{,}000 + 424{,}200}$$

$$M = \frac{20{,}625 \times 84}{464{,}200} = 3.7 \text{ feet}$$

then $\frac{D}{2} = \frac{20}{2} = 10$ feet

$$\frac{D}{3} = \frac{20}{3} = 6.66 \text{ feet}$$

10 — 6.66 = 3.34 feet—Distance from center of foundation to outside of middle third of base.

M being 3.7 feet does not act within the middle third of the width of the base, and is therefore not satisfactory.

This could be corrected by increasing the diameter of the foundation D to about 21 feet or by using a square foundation having the following dimensions:

Length of side, 21.5 feet
Height, 7.6 feet

Then substituting in the formula for M we have:

$$M = \frac{25 \times 150 \times 5.5 \times \left(\frac{150}{2} + 7.6\right)}{40{,}000 \times 527{,}000}$$

$$M = \frac{17{,}003{,}625}{567{,}000} = 3 \text{ feet}$$

Then

$$\frac{D}{2} = \frac{21.5}{2} = 10.75$$

$$\frac{D}{3} = \frac{21.5}{3} = 7.16$$

$10.75 - 7.16 = 3.59$ feet—Distance from center of foundation to outside of middle third of base.

M being 3 feet acts within the middle third of the width of the base, thus the stack is satisfactory for stability.

Elongation of Boiler Steel

Q.—Would you be so kind as to assist me in the interpretation of Par. p-193 of the A. S. M. E. Code for power boilers, or in other words, solve what is a problem to me. The following is the question:

What does the 1,500,000 represent when figuring the elongation of boiler steel? Please explain this in detail.—W. M. G.

A.—The 1,500,000 referred to in the question is found in tension tests for Material Specifications and is used as follows:

Tension Test.—The material shall conform to the following requirements as to tensile strength:

Tensile strength pounds per square inch	55,000—60,000
Yield point, minimum pounds per square inch	0.5 tens. str.
Elongation in 8 inches minimum percent	1,500,000 / Tens. strength

The constant 1,500,000 is the relation between the tensile strength and elongation.

Tetmajers criterion for a good quality of steel is: The product of percentage elongation and tensile strength in pounds per square inch equals a constant varying from 1,000,000 to 1,500,000.

Professor W. C. Unwin terms this constant as a factor of quality as follows:

The breaking stress and the percentage of elongation are the quantities on which the engineer relies, as measures of the quality of constructive material; but here a difficulty arises, as there are two quantities to be considered and attempts have been made to obtain a single figure, termed a quality figure or quality factor, combining in due proportion the breaking stress and the elongation. Wöhler proposed the sum of the breaking stress and the percentage of area as a quality factor. Others have taken the sum of the breaking stress and the percentage of elongation.

Tetmajer proposed the product of the breaking stress and the percentage of elongation, a number which, in material of the same kind, is proportional to the work done in breaking the bar, reckoned per cubic unit. An examination of tests of rail steel led Doremus to conclude that in Tetmajer's quality factor, the percentage of elongation had a predominant influence, and he proposed as quality factor the product of the square of the breaking stress and the percentage of elongation.

If V is the quality factor; f the breaking stress in tons per square inch (note: In the factor 1,500,000, f is taken in pounds per square inch) e the percentage of elongation; c the percentage of contraction of area, then the quality factors are:

Wöhler—$V = f + c$

Modified Wöhler—$V = f + e$

Tetmajer—$V = fe$

Doremus—$V = f^2e$

All these factors must be regarded as empirical and none of them can be safely used except within limits. Tetmajer's quality factor of 1,500,000 is the most generally accepted.

Trade Publications

Torch Welding and Cutting.—The Linde Air Products Co., New York, N. Y., has published an 8-page bulletin entitled "How to Figure Oxwelding and Cutting Costs." The publication shows how to set up methods of figuring costs of welding and cutting by the use of the oxy-acetylene blowpipe.

Welded Pipe Fittings.—An 8-page booklet entitled "Designed Piping" has been published by the Taylor Forge & Pipe Works, Chicago, Ill. The booklet contains a reprint of a paper presented at the joint meeting of the New York Section, American Welding Society, and the Petroleum and Power Division, American Society of Mechanical Engineers, by F. S. G. Williams of the Taylor Forge & Pipe Works.

Toncan Iron Pipe.—This new edition of "Toncan Iron Pipe for Permanence" has recently been issued by the Republic Steel Corporation, Youngstown, O. The catalogue contains 64 pages of authentic information on corrosion-resisting Toncan iron pipe. Part 1 is devoted to technical data and tests of this material and the pipe products made from it under different conditions, while Part 2 includes an imposing collection of installations and service records in a wide variety of applications. In requesting copies, readers should refer to this catalogue as Form ADV. 220-B.

Locomotive Feed-Water Heater.—The Worthington Pump & Machinery Corporation, Harrison, N. J., has issued a folder describing the Worthington locomotive feed-water heater equipment which consists of three connected units, the cold water pump, the heater and the hot water pump. These independent units are comparatively small and can be located on the locomotive to the best advantage for weight distribution, maintenance, and general appearance of the design. In the folder the units are shown diagrammatically arranged. Complete details of the units are given, together with tables of capacities, weights and pipe size.

Bronze Castings.—For many years The Superheater Company has been producing bronze castings at the East Chicago, Ind., plant for its own use and for the use of local manufacturers. As a result of increased demands on the company for high-grade, uniform castings, plant and laboratory facilities have now been extended to provide a service on a much broader basis, under the direction of the Bronze Foundry Division. The company produces bronze castings, rough or finished, in three distinct classes of mixtures, namely, standard bronzes, aluminum bronzes and super-tensile manganese bronze, under its trade name "Elesco." The facilities and Elesco bronzes are described in the new Bulletin B-1, copies of which are available on request.

Thermit Welding.—"Industry's Master Maintenance Tool," is the title of a new illustrated booklet just published by the Metal & Thermit Corporation, 120 Broadway, New York, N. Y. The booklet describes thermit welding, an alumino-thermic process which has been successfully employed for more than thirty years in the welding of heavy sections of ferrous metals. The actual welding of street railway and railroad track and the repair of large machine parts, huge marine castings, crankshafts, and similar articles by the thermit process are also covered thoroughly. Particular attention is given to the economy and permanency of thermit repairs and actual cost data are given in a number of instances.

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

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Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

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

Secretary—C. W. Obert, 29 W. 39th Street, New York.

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Chairman—William H. Furman, Albany, N. Y.

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Statistician—L. C. Peal, Nashville, Tenn.

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Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.

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Vice-President—Owsley Brown, The Springfield Boiler Company, Springfield, O.

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

Executive Committee—(Three 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. (Two years)—J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.; M. E. Finck, Murray Iron Works, Burlington, Ia.; A. C. Weigel, Combustion Engineering Corporation, New York. (One year)—Homer Addams, Fitzgibbons Boiler Company, Inc., New York; George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn. (*Ex-Officio*)—H. H. Clemens, Erie City Iron Works, Erie, Pa.

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 Nationa Board of Boiler and Pressure Vessel Inspectors

States

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

Cities

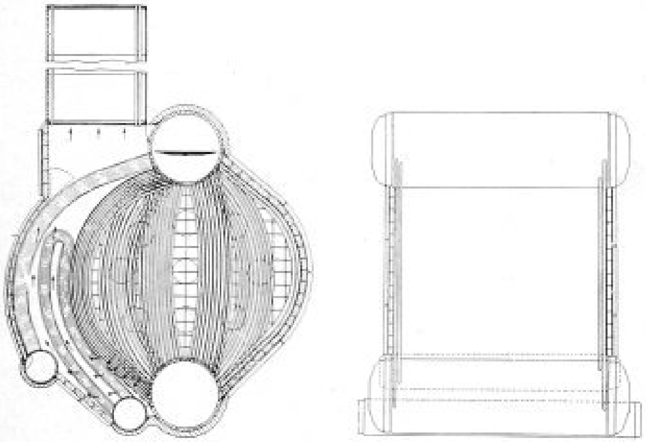
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,816,780. WATER TUBE BOILER. JOHN JOHNSON, OF WIMBLEDON, LONDON, ENGLAND.

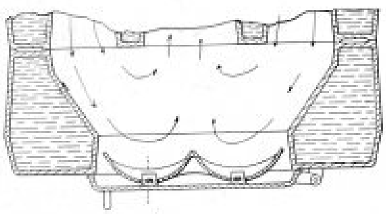
Claim.—A watertube boiler comprising in combination, an upper and a lower longitudinal drum; outwardly-curved oppositely-disposed banks



of water tubes connecting said upper and lower drums along their length in wall formation to enclose a combustion chamber laterally; and disposed within said combustion chamber other water tubes in wall formation also connecting said upper and lower drums along their length. Four claims.

1,817,150. RETURN BAFFLE FOR FLUE DOORS. FREDRIK W. HVOSLEF, OF KOHLER, WISCONSIN, ASSIGNOR TO KOHLER COMPANY, OF KOHLER, WISCONSIN, A CORPORATION OF WISCONSIN.

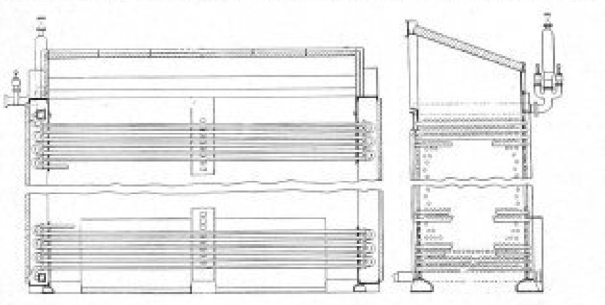
Claim.—A baffle for flue doors comprising a plate having means for



attaching it to and spacing it from the inner side of a flue door, said plate being of curved form for deflecting flue gases from one flue to another. Five claims.

1,818,769. ECONOMIZER. JAMES E. TRAINER AND IVAR L. LANGVAND, OF BARBERTON, OHIO, ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

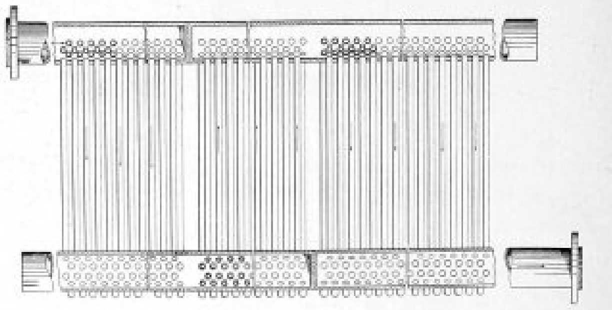
Claim.—In an economizer, rows of tubes connected by return bends, said tubes passing through gas tight openings in the walls of said



economizer with the outside surfaces of said tubes contacting with the edges of said openings, said tubes being free to move longitudinally with respect to the walls due to expansion and contraction. Twenty-one claims.

1,816,650. BOILER. HOWARD J. KERR, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

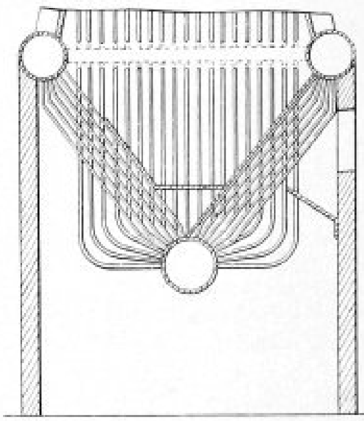
Claim.—In combination, a header having a steam inlet, a plurality of outlet tubes disposed at varying distances from said inlet, and ferrules



in said tubes projecting into said header, each of said ferrules having means to divert steam into the corresponding tubes, the ferrules nearest the inlet being constructed and arranged to divert a greater amount of steam than those more remote from the inlet. Five claims.

1,813,058. BOILER. GEORGE LASKER, OF CHICAGO, ILLINOIS.

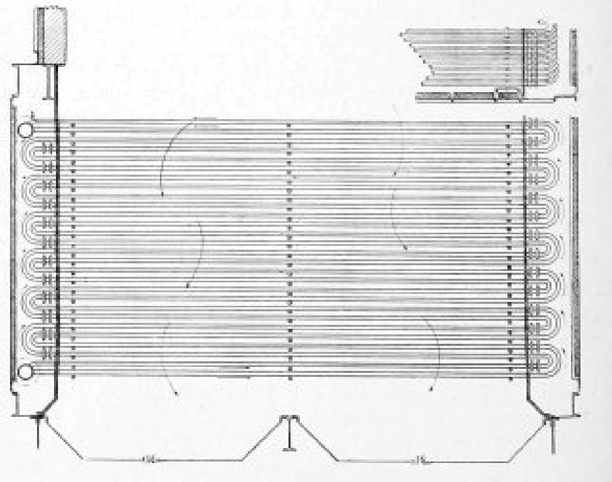
Claim.—The combination with a down draft furnace of a boiler construction comprising a plurality of vertical stand-pipes, a system of horizontal pipes and drums connected with the stand-pipes, said stand-pipes



and horizontal pipes being positioned outside of the furnace, and a system of vertical tubes positioned about the interior walls of said furnace, said tubes having their ends projecting through the furnace walls and connecting with said horizontal pipes.

1,813,405. FLUID HEATER. HOWARD J. KERR, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim.—In combination, a flue, a fluid heater comprising tubes extending transversely of the flue, and a baffle wall extending across the



tubes, said baffle wall comprising baffle plates extending across the flue and overlapping one another with the lower portion of each of certain of the baffle plates overlapping the upper outer edge of the next lower baffle plate, the edges of said plates being provided with recesses adapted partially to surround said tubes. Nine claims.

Boiler Maker and Plate Fabricator

February 1934.

WE DO OUR PART

Discussion of Master Boiler Makers' Reports

While a number of discussions have been submitted on the committee reports presented in the Master Boiler Makers' Convention in Print, which appeared in the October issue of THE BOILER MAKER, nevertheless, the response from members of the association and the supply group has not been commensurate with the importance of the subjects presented.

With the opportunity available this year to study the work of the committees carefully and at leisure, it was hoped by officers of the association that a great wealth of diverse experience on all subjects would be forthcoming. There is still time in which those who wish to take part in this discussion may submit their statements. The discussions presented in this issue do not in any degree exhaust the information on the subjects covered. It is to the advantage of members of this craft individually and collectively to enter into the spirit of this endeavor and actively support the efforts being made to bring the "Convention in Print" to a completely successful conclusion.

The "Proceedings" will shortly be published. It is to be hoped that while opportunity yet remains many members and readers at large will comment on the subject matter of the committee reports.

Crown-Sheet Failures

Possibly the trying operating conditions on the railroads for the fiscal year ending in June, 1933, is accountable for the first increase in defective locomotives and accidents that has occurred in ten years. The report of the chief inspector of the Bureau of Locomotive Inspection, published in this issue, indicates that locomotive defects increased from 27,832 in 1932 to 32,733 in 1933, and that the number of locomotives ordered out of service because of defects increased from 527 to 544.

While this phase of the report is not encouraging, nevertheless the report of the boiler division, with which readers of this publication are particularly concerned, shows improvement. The number of crown-sheet failures was 1.66 percent less than in the previous year, accompanied by a decrease of 71.4 in the number of persons killed and of 33.3 percent in the number of persons injured from this cause. Since crown-sheet failures have been one of the most prolific causes of fatal accidents in the past, in the almost total elimination of this factor in the problem of safety there is evidence of careful inspection and workmanship that merits comment. The staff of the Bureau of Locomotive Inspection can be justly proud of the part it has played in this improvement. There also is encouragement in the knowledge that even under the most serious handicaps the boiler departments of the railroads have continued to function efficiently and well.

Code for Construction of Oil Industry Pressure Vessels

Within a few weeks the American Petroleum Institute in collaboration with the American Society of Mechanical Engineers will issue a Code governing the design, construction, inspection and repair of unfired pressure vessels for petroleum liquids and gases. The need for standards to govern the construction of such vessels has long been in evidence.

This fact was recognized by the American Petroleum Institute, and the work of compiling the Code was commenced by a Joint Committee of this organization and of the American Society of Mechanical Engineers in 1931. As it will be presented to the industry, the Code is written for vessels constructed of carbon steel as this is the material most widely used. In later additions to the Code, alloy steels and other special materials will receive consideration.

When available for study, those who desire to comment on the provisions will be given an opportunity to do so by the committee. Since a Code of this character cannot be complete or perfect as it is issued, changes will be made from time to time to adapt it to the requirements of the industry.

The Code is quite lengthy, which precludes its publication complete in one issue of BOILER MAKER AND PLATE FABRICATOR. Extensive instalments, however, will appear beginning in the March issue and will be continued until the Code is complete for the benefit of our readers.

National Board Reports

While the ninth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors was held last October, the great wealth of material pertaining to the construction, inspection and repair of all manner of pressure vessels developed at this meeting precluded its publication in abstract form. Because of this fact it has required several issues in which to present the more important papers and their discussion. Since the information contained is of the widest interest and use in the field covered by BOILER MAKER AND PLATE FABRICATOR, the remaining papers of the final session will continue to appear until completed. Except to members of the National Board and to a limited group directly interested in its work, reports will not be available to the field at large in other than the form presented in this publication.

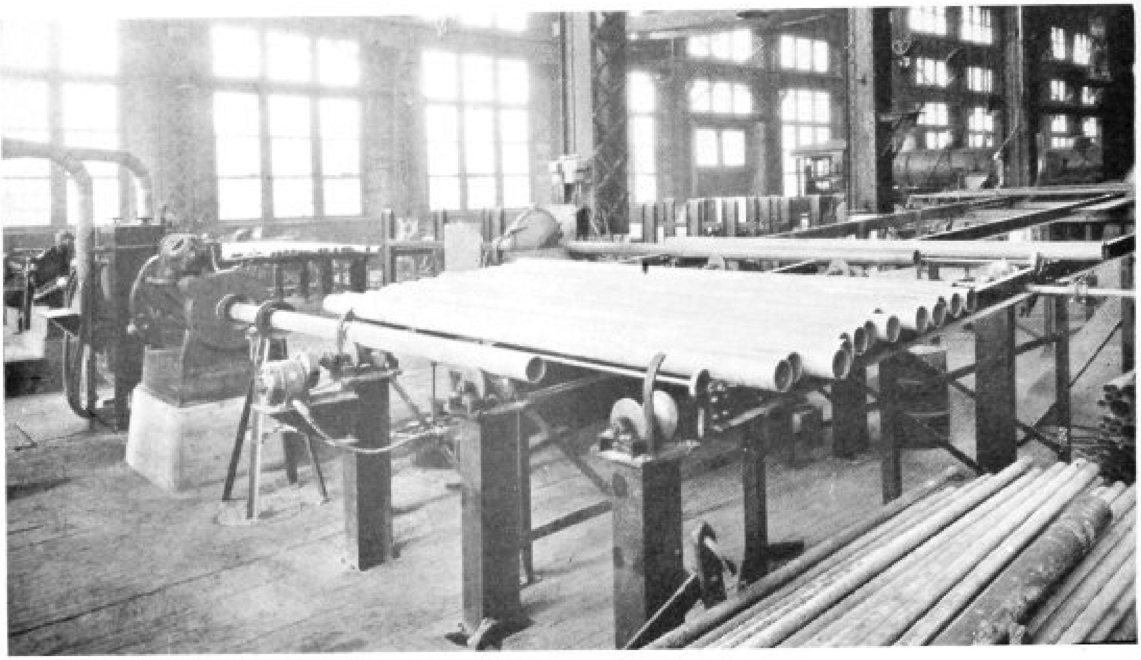


Fig. 1.—Racks used for tubes when removed from locomotive boiler

Lehigh Valley Shop at Sayre for

SAFE-ENDING FLUES

The efficient handling of tubes and flues through the various operations of safe ending has been a subject of constant and serious study on the part of railroad mechanical departments for many years. In addition to competent personnel, the factors upon which depend the productive success of a flue shop are adequate and modern machines and their proper location in a shop with respect to each other.

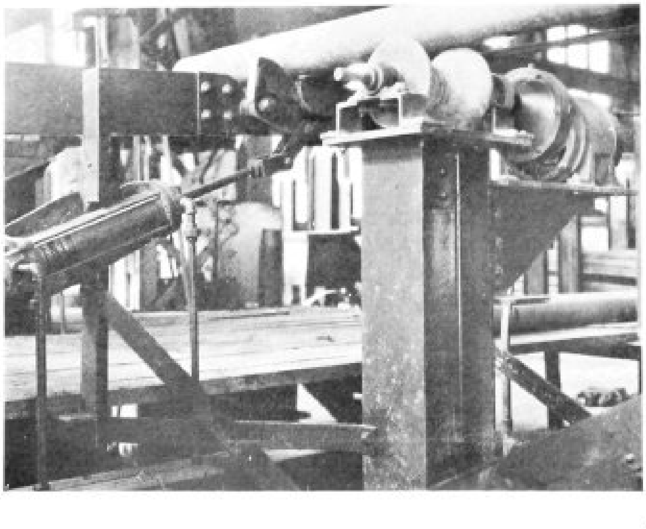
Much has been written describing shops where these principles have been embodied and the methods for performing safe-ending operations have been exhaustively treated. Most every development in this direction in recent years has emphasized some new and important mechanical device for performing certain work relative to the safe-ending of flues. The purpose of the present article is to emphasize not only the new developments in machinery for doing the welding, cutting off and cleaning of flues, but to bring out certain features in regard to the handling of flues with a minimum amount of manual labor.

The latest exposition of flue-shop layout, machines and methods was presented as a committee report of the Master Boiler Makers' Association in the Convention in Print issue of The Boiler Maker in October, 1933. This report, appearing on page 200 of that issue, described such modern flue shops as those of the New York, New Haven & Hartford, Canadian Pacific, New York Central and Chicago, Milwaukee, St. Paul and Pacific railroads.

The present detailed outline of shop layout, machinery and methods, that of the Lehigh Valley Flue Shop at Sayre, Pa., represents the most advanced practice in this important branch of locomotive boiler work and is the product, as were the other outstanding installations, of Joseph T. Ryerson & Son, Inc.

For the past fifty years this company has attempted to keep pace with the demands of railroads for developing machinery for special purposes. Many years ago, as a result of its efforts, the pit-type and overhead types of flue-cleaning machines and the barrel or rattler type of flue cleaner were developed. Both of these machines served a useful purpose for long periods of time, but several years ago certain facts were secured which proved that the item of repairs was running into a considerable

Fig. 2.—Air cylinder end tube-actuating cams



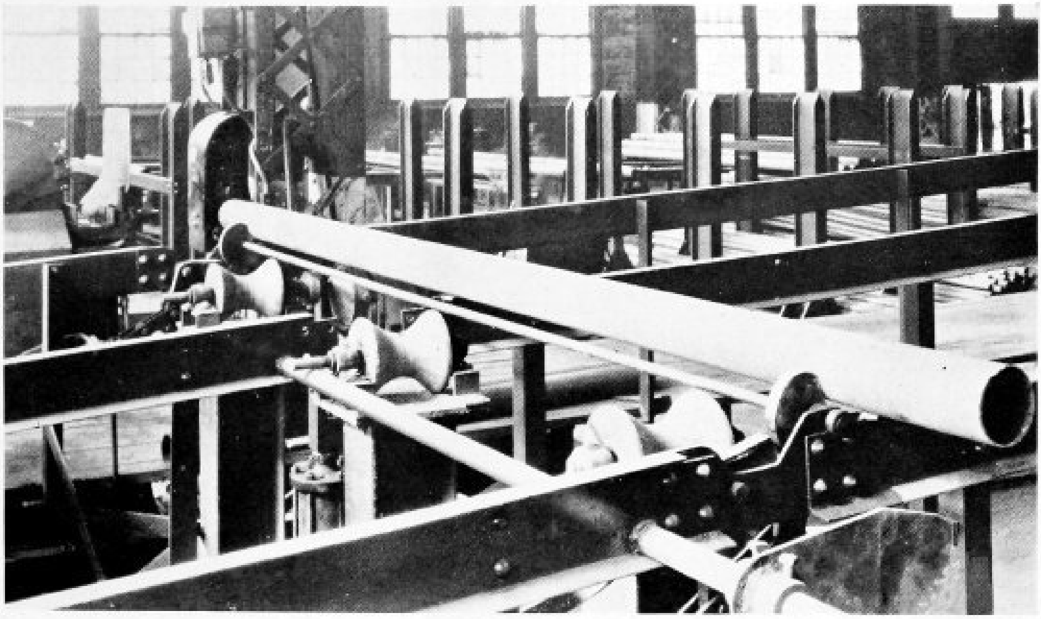


Fig. 3.—Flue in position to be raised from rack on to grooved rolls which carry it to the friction saw table

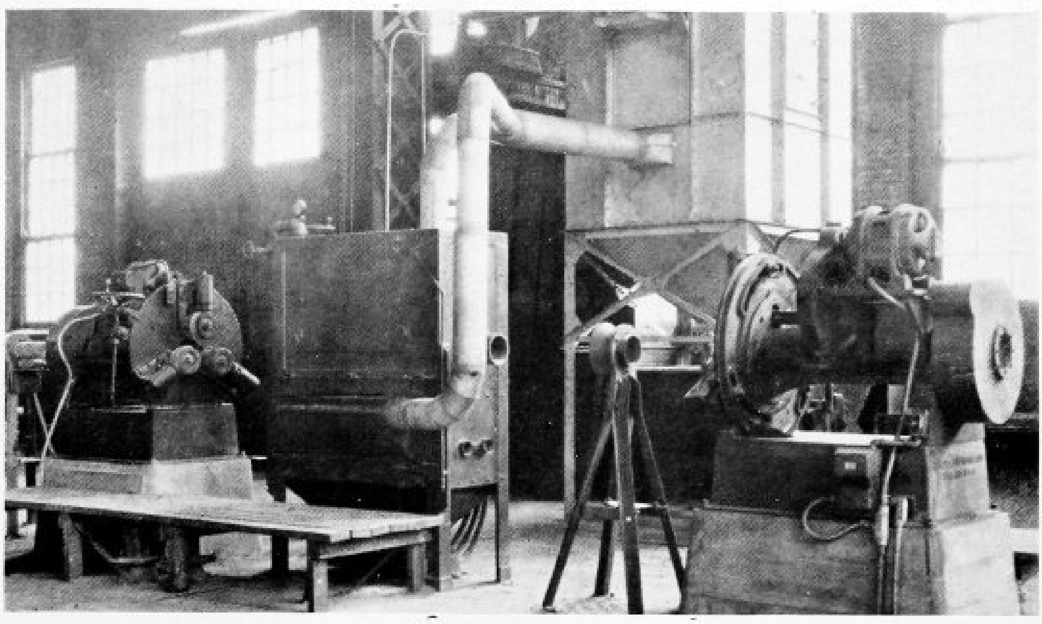


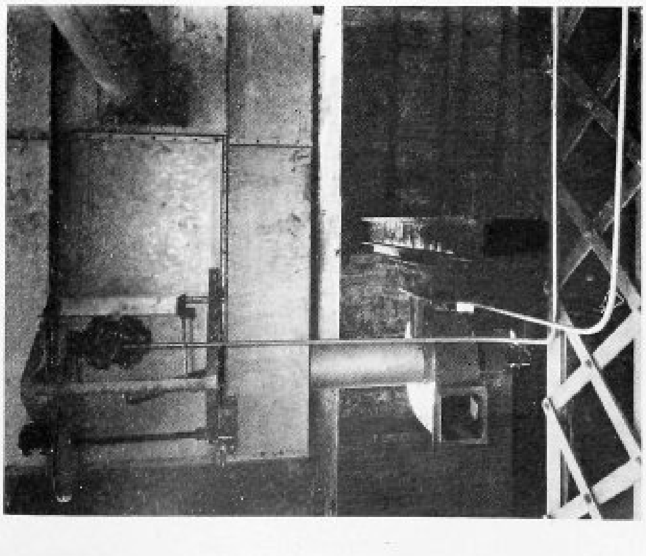
Fig. 4.—(Right) Scale-cracking machine and sand-blast cabinet and at the right of the view, the flue pulling machine. Fig. 5.—(Below) Dust arrester fitted with power shaker

figure on the pit and overhead type of rattler due to the excessive cost of chains used in connection with this flue-cleaning device.

About this time the New York, New Haven & Hartford railroad made certain experiments in connection with the sand blasting of boiler flues which proved so successful that this method of cleaning flues was adopted by Ryerson as the best and most improved equipment that could be devised for this purpose.

In addition to developing and perfecting the sand-blast method of cleaning flues, much thought was given to the proper handling of flues from one machine to another to eliminate the use of an overhead crane and to reduce, as far as possible, the manual labor used in connection with moving flues from one machine to another.

This finally resulted in Ryerson furnishing a complete unit for handling the flues from the time they are taken from the boiler until the flues are finished.



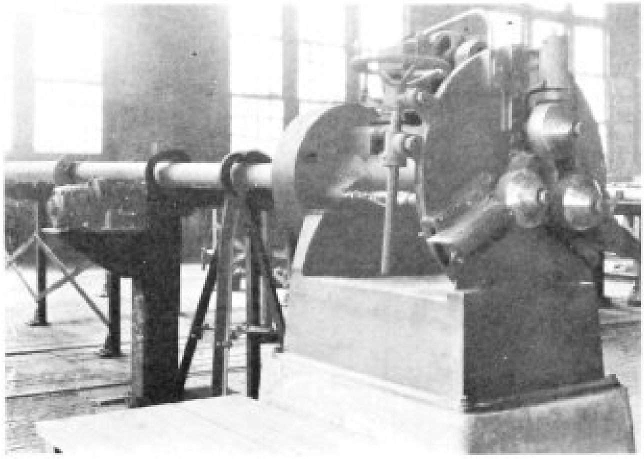


Fig. 6.—Flue leaving pulling machine

In July, 1932, the Lehigh Valley Railroad Company made certain plans for the installation of a new sand-blast flue cleaner to replace its worn-out barrel-type rattler. In considering the installation of this sand-blast cleaner, the Lehigh Valley mechanical department decided it would be advantageous to arrange a new location closer to the locomotive department for the cleaning and repairing of boiler flues.

A certain corner of the shop was selected and with the approval of the mechanical department a complete unit, arranged for the handling of flues, was purchased in addition to the sand-blast flue cleaner and other machinery for the new flue shop.

Sufficient space was provided for a layout which would allow the flues to be placed on a rack after they were taken from the boiler, and from then on an arrangement was worked out where no lifting or moving of flues by manual labor was necessary until the finished flue, cleaned, cut, safe-ended, and tested was removed from the flue tables.

Referring to Fig. 1, a general idea may be gained of the first and second operations in the repair of flues. Flues are loaded on the flue tables shown at the right of the illustration and the first operation is performed, that of cutting off one end of the flue. The flues are moved in and out of the Ryerson No. 0 high-speed friction saw by means of actuating cams which lay the flue on a series of live rolls. These rolls propel the flue onto the friction saw table where one end is cut off. Several sets of flues can be loaded on the racks ready for the first operation.

With a new and improved type of saw blade small flues can be cut without leaving a burr and the superheater flues show only a very faint sign of burr. The rolls moving the flue in and out of the friction saw are controlled by the saw operator.

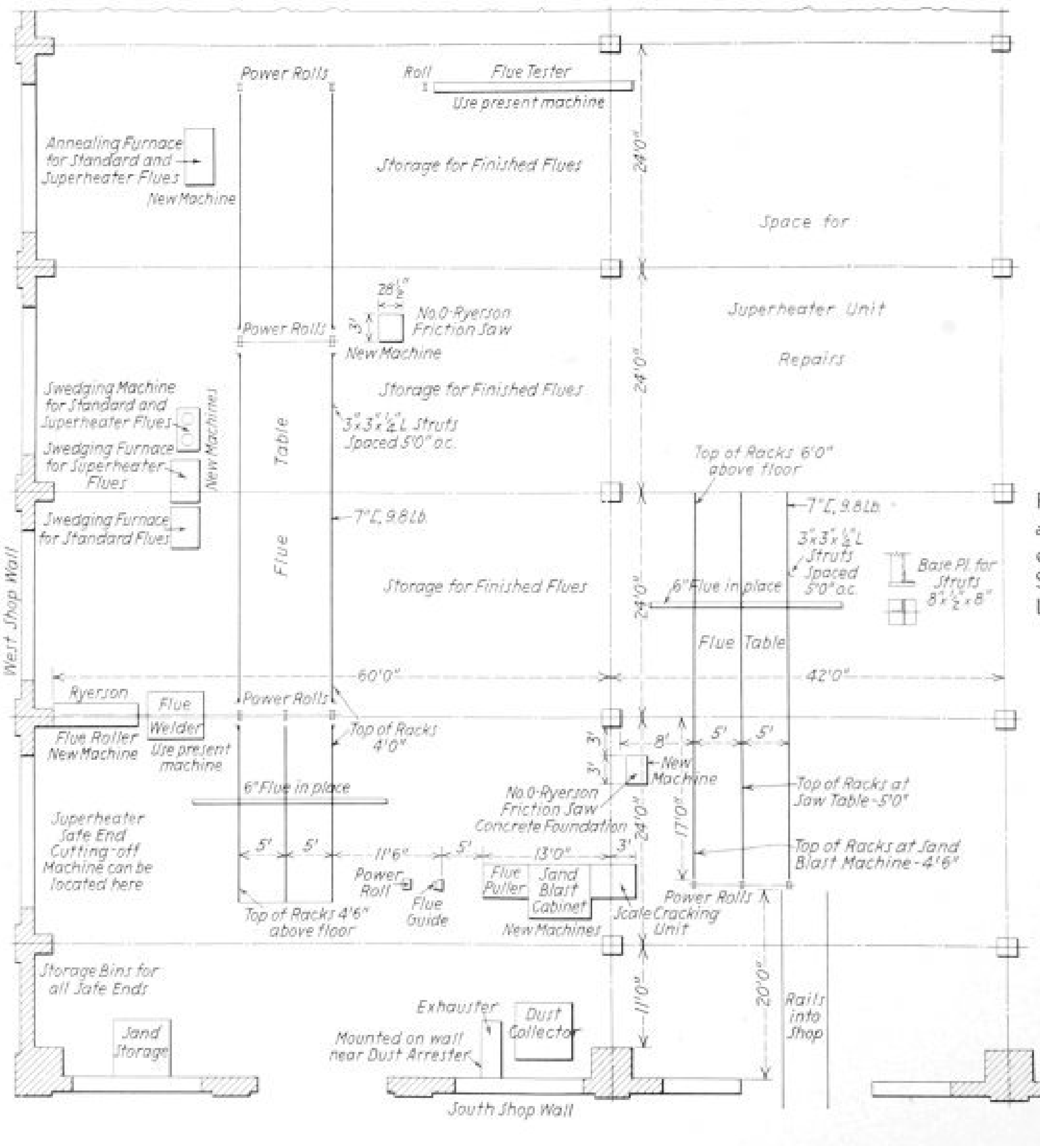


Fig. 7.—General arrangement of flue safe-ending machines in the Sayre shops of the Lehigh Valley Railroad

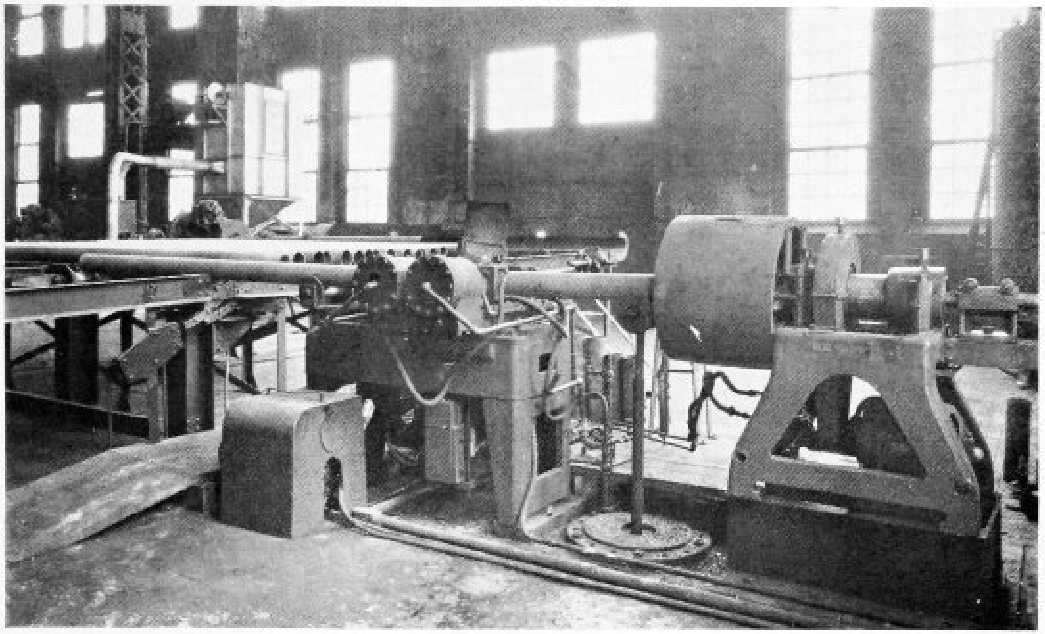


Fig. 8.—Machines for carrying out the welding and rolling operations. Actuating cams remove a flue from the rolls and place another in position for rolling

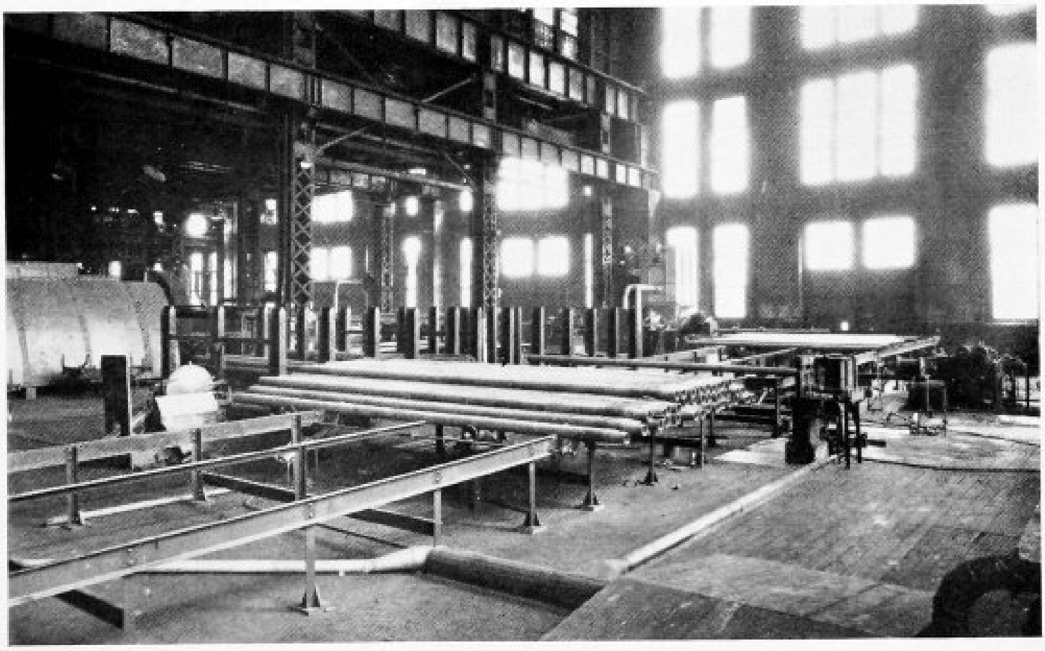


Fig. 9.—General view showing the complete layout of the shop with the exception of the annealing furnace

After the cutting operation is performed the flue moves back to a stop and the saw operator operates a lever which, in turn, operates the actuating cams as shown in Fig. 2. These cams are actuated by means of a double-acting air cylinder and the contour of the cams is such that the movement of laying a superheater flue on the rolls is a smooth operation with no appreciable jar. This view shows the small air cylinder which is used for moving the actuating cams. The position of the cylinder shows the flue at a point where the cams are lifting it from the flue table. One of the cams is in a position where it has expelled the flue from the roll to the rack leading to the sand-blast flue cleaner. The tip of the motor drive for the power rolls is also shown.

Fig. 3 shows the actuating cams which also act as a stop for flues placed on the flue table before the cutting off operation. In this illustration the flue is shown in a position ready for the air-operated actuating cams about to lift the flue from the rack on to the gravity rolls. One roll is driven by a 3-horsepower motor. These rolls carry the flue directly to the friction saw table where one end is cut off.

Fig. 1 also shows the sand-blast flue cleaning machine and the cracking roll located at the left of the shop together with the power rolls for conveying the flue into the cracking machine. The friction saw operator has the control for moving the flues from the flue table to the rolls leading to the cracking machine located so that he also operates this mechanism conveniently.

The rolls on the cracking machine are designed to remove the bulk of the scale and are arranged so that when the live-power rolls have fed the flue into the rear of the machine, the rolls automatically start rotating the flue and cracking the scale. The flue then travels through the cracking machine into the sand-blast cabinet, where the final cleaning operation is performed and on into the pulling machine, the speed of which is synchronized with the scale-cracking machine. A view of this operation is shown in Fig. 4, where the flue moves from left to right. At the extreme left of this illustration, the flue is rolled down the flue table and the actuating cams at this point have picked it from the flue table and placed it on the power-driven rolls, which are carrying it into the scale-cracking machine. From this machine the flue travels through the sand-blast cabinet and on into the flue-pulling machine.

In Fig. 4 the sand-blast cabinet is shown in the foreground with the dust arrester located at the rear. In the sand blast cabinet there is a series of six nozzles through which sand and air pass and finish the cleaning job. These nozzles are adjustable for various sizes of flues by means of the hand wheel shown at the upper left corner of the cabinet. The sand-blast action exposes the pitting of the flues and aids in the inspection.

Due to the rotary motion of the flue and due to the speed at which the flue is rotated, practically all soot and foreign matter are loosened from the inside of the flue. Inspection of several thousand flues at various times by means of an electric light placed in the inside of the flue has proven that the inside of the flue is cleaned as thoroughly as with the barrel-type rattler.

In the rear of the view, Fig. 4, is also shown the power shaker and the blower. In the dust arrester is arranged a series of canvas bags. The blower pulls up through the pipes shown all of the dust and sand which is too fine to be of service, into the canvas bags and the air is expelled through the canvas material of which the bags are made, allowing the dust to settle in the bottom of the bags.

The power shaker is arranged with a timing device so that these bags can be shaken for a period of fifteen to twenty-five minutes after which period of time the automatic power shaker cuts out, leaving the bags thoroughly clean. All dust and waste matter in the bags can be taken out of the dust arrester by opening a trap located conveniently in the bottom of the arrester.

Fig. 5 shows a recent development in arranging the dust arrester with a power shaker driven by a motor operated from a time switch. Prior to this installation one of the most serious difficulties in the dust arrester was the fact that it was practically impossible to keep the dust bags clean by manual labor. With the use of the power shaker, as shown, a time switch ranging from 5 to 30 minutes can be set and the shaking operation is taken care of automatically, so that the bags are kept thoroughly clean. Because of this the exhauster is able to expel air directly into the shop without dust appearing from the exhauster opening.

After passing through the sand-blast cabinet, the flue then enters the pulling machine, as shown in Fig. 6, and continues on to a series of power rolls which remove the flues to the flue table, where a slight incline causes them to roll to the electric flue welder. This view shows the flue leaving the flue-pulling machine and proceeding on to the flue table after having been cleaned by passing through the sand-blast cabinet. Sand blasting leaves the flue clean enough to go directly into the flue welder without a separate polishing operation.

Fig. 7 shows the shop layout and arrangement of safe-ending machines.

Fig. 8 shows the flues in position ready for welding. The flue is propelled into the flue welder and on into the flue roller by means of power-driven rolls and is placed on the rolls and ejected from them by means of air actuating cams. In the center of this view is the flue table on which the flue rolls down to the welder ready for the welding and rolling operation. The actuating cams at this point after removing a flue from the rolls place another flue in position on them. The power rolls are operated with a reversing-type motor, and a reversing switch is conveniently located at the flue welder operator's hand so that he has complete control of the movement of the flue to and from the machine. The flue rolling machine is arranged for air operation and an air cylinder actuates the three rollers which in turn produce the required amount of pressure on the weld while it is still hot. The control of this air cylinder is by means of a foot-operated pedal conveniently located near the welder operator's foot.

Fig. 9 shows the flue after leaving the welding and rolling machine where they enter an open-side furnace ready for the heating operation before swedging. The flue tables at this point are located at a height which will allow the flues to be heated and swedged without lifting them.

After the swedging operation, the flues again roll to a point on the flue tables where they are then ready for the final cutting off operation which is done with the No. 0 Ryerson friction saw shown at the left of the picture.

After this cutting off operation the end opposite the swedged end is annealed and the flues are then ready for the final test.

It will be noted from the illustrations that every attempt has been made to minimize the amount of handling, and the benefits of this flue handling mechanism are emphasized particularly when repairing superheater flues.

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 is given record of the interpretations of the Committee in CASE NO. 764: *(Special Rule).—Inquiry:* May a miniature boiler having no pressure parts other than the steam generating coil of tubing and having both the water supply and the gas fuel supply governed by a flow motor, and which cannot therefore comply with the provisions of Pars. M-11, M-13, and M-14 of the Code, bear the official Code symbol? If so, may the stampings be affixed on a plate substantially as provided in Par. H-120 since it is not practicable to apply the stamping on the pressure part of the boiler proper?

Reply: It is the opinion of the Committee that if the material used for the pressure parts of a miniature coil-type boiler complies with Code specifications and all applicable requirements of the Code for Miniature Boilers are observed, the required stampings for miniature boilers may be applied. These stampings may be placed on a separate non-ferrous plate not less than 3-inch by 4-inch size which shall be as irremovably attached as possible to the front of the boiler casing.

Characteristics of Ferrous and Non-Ferrous

PRESSURE VESSEL ALLOYS*

By A. B. Kinzel†

With the advent of modern metallurgy and the so-called alloy age it is only natural that the designer and inspector of pressure vessels should find that low carbon steel, plain copper, or relatively pure aluminum are no longer the only materials from which pressure vessels are made. Alloyed steels and copper or aluminum base alloys are the order of the day. One might venture the opinion that in the next decade mild steel and the pure metals as pressure vessel material will be replaced by alloy steels and special alloys.

Pressure vessels today are called upon to meet conditions that are more severe than ever before. This is natural, as with improving materials, more severe conditions are imposed. Let us consider the variations which have arisen in the interpretation of the strength of the material. Formerly, the ultimate strength on tensile test at room temperature was all-sufficient. Today we are interested not only in the ultimate strength at room temperature but also over a wide temperature range. In addition, we are interested in stresses that will initiate plastic flow. The ultimate strength is only a part of the story. When steel is stressed it first stretches elastically. As the stress is increased the elastic limit is passed and plastic flow follows. The plastic flow continues to its limit, at which time fracture occurs. The stress at which plastic flow occurs initially and the amount of plastic flow are radically changed by both temperature and previous stress history. For example, it is common knowledge that steel heated to some 1500 degree F. can be forged with relatively little effort. That is, the stress at which plastic flow starts is so low that hot working is readily feasible. As the temperature is gradually increased above room temperature, the strength of steel is mildly increased until approximately 500 degrees F. is reached. At and beyond this temperature the strength rapidly decreases and the stress that will produce continuous plastic flow decreases even more rapidly. Thus, at 1000 degrees F. plain carbon steel will deform continuously at a load of only 3000 pounds per square inch. Again if the temperature is lower than that already considered, the strength of mild carbon steel increases, the stress initiating plastic flow increases, and the total amount of plastic flow before failure decreases.

Another phenomenon in which strength is involved is that known as fatigue, which is accompanied by the so-called crystalline failure. If metal be subjected to an infinite number of repeated stresses of a magnitude of a certain stress value known as the fatigue limit, stress failure will take place without evidence of plastic flow. If the stress involved be less than the fatigue limit, stress failure does not take place. The mechanism of failure with these conditions seems to be that a small crack is started due to some minute irregularity in the metal. Due to the repeated stress the crack gradually grows and finally it reaches the stage at which the remaining cross-sectional area is so small that sudden failure takes place. In most steels the fatigue limit stress is from 50 to 60 percent of their ultimate strength. In view of the fact that a factor of safety of 5 or thereabouts is applied to pressure vessel design, service stresses are in general well below the fatigue limit. However, it must be remembered that the calculated stress is not necessarily the actual stress, and that local stress concentration may cause the fatigue limit stress to be exceeded unknown to the designer.

An excellent illustration is the case of the short radius basket-shaped pressure vessel head which has now been largely supplanted by the semi-elliptical head. In the short radius head service stresses were frequently well in excess of the fatigue limit stress. Even in a well-designed pressure vessel the inadvertent presence of sharp notches may cause the fatigue limit stress to be exceeded. Here, however, the ductility of the material redeems the situation in that stresses applied to the notch cause the base of the notch to undergo plastic deformation reducing the sharpness and redistributing the stresses, so that after a number of repeated stresses the stress concentration is eliminated. Actual fatigue failures are few and far between in pressure vessel work. The present increasing knowledge regarding the nature and cause of this phenomenon is such that we may confidently believe that fatigue failures in pressure vessels are a thing of the past.

From the foregoing, it is evident that today strength embraces many factors and many conditions, all of which must be taken into consideration in selecting pressure vessel material. Ductility likewise is no longer a simple conception. We have been in the habit of determining ductility by taking the elongation of a test specimen or by fracturing an impact specimen. As in the case of the ultimate strength, we know the ductility only under a given set of conditions. With an increase in temperature, for example, it may be said that in general ductility increases, but this is not always the case. Certain types of mild steel show a loss in ductility at temperatures up to approximately 500 degrees F. and an increase in ductility thereafter.

The phenomenon of strain aging is also to be reckoned with, particularly if slightly elevated temperatures are involved. This phenomenon involves a peculiar loss of ability of the material to deform plastically when it is first very moderately strained and allowed to rest. In other words, certain steels may become less ductile by the application of simple service conditions including time. The methods of testing steel for susceptibility to this phenomenon are well known and when the service warrants it this matter can readily be handled. At temperatures below atmospheric, ductility or plastic deformation, particularly under high rates of stress application, is markedly reduced in mild steel. Even at 0 degrees F. reduction of ductility is noteworthy, and at temperatures approximately minus 60 degrees F. it is so

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evident that the use of mild steel where such conditions are encountered is not recommended.

From the above it will be seen that mild steels are limited in their use because of inherent characteristics which change with temperature and stress conditions, and that copper and aluminum while free from such changes, have such low strength and are so poor in all those factors that are correlated with low strength that there is a very definite field for alloy steels and copper and aluminum base alloys. The low alloy steel of today can best be exemplified by the Cromansil type containing 0.20 percent carbon, 1.15 percent manganese, 0.80 percent silicon, and 0.50 percent chromium. It has an ultimate normal strength of 90,000 pounds per square inch as against the usual 55,000 pounds per square inch of the mild steel. This increase in strength is carried through all of the correlated properties; for example, increased fatigue limit and increased creep limit. Where a mild steel will undergo plastic deformation at 3000 pounds per square inch at 1000 degrees F. a low alloy type has a limit stress of approximately 7000 to 10,000 pounds per square inch. In other words the increase in properties is more than would be expected from the simple ultimate strength relationship. When considering ductility, the low alloy steels have even greater advantages. While the ductility at room temperature as measured need in no way be greater or even as great as the mild carbon steel, it is more than sufficient for the purpose. These steels have the added advantage that they are in general free from the strain aging phenomenon, and the ductility is retained to a much greater degree at sub-atmospheric temperatures.

Low alloy steels may be used for pressure vessel work at temperatures down to minus 100 degrees F. before the loss of ductility becomes serious. Where service involves temperatures approximating that of liquid air and the like, the austenitic steel alloy containing 18 percent nickel and 8 percent chromium, or a special copper alloy about which more will be said later, might be used. Where very high temperatures are involved such as 1615 degrees F. the austenitic alloys are again applicable in that their ductility and strength are sufficiently retained for service conditions.

Thus, we see that the greater advantage of the alloy steels over the carbon steels lies in the fact that their strength and ductility together with the correlated manifestations of these characteristics are retained over a much wider range of temperature and stress conditions than are the corresponding characteristics of mild steel. Thus not only is it possible with alloy steel to build a more practical pressure vessel because of the reduction of wall thickness presumably due to higher strength, but also a stronger and safer vessel because of the retention of the desirable characteristics under a wider set of service conditions.

The improved copper alloys are also to be considered. Perhaps the best example is the 3 percent silicon, 1 percent manganese copper alloy. Not only is the ultimate strength of this alloy markedly increased but the stress that will produce a specified amount of plastic flow is raised to a new order of magnitude. Although copper has been used for pressure vessels, it has generally been applied only to cases where low unit stress was involved so that it could hardly be considered an engineering material. The newer copper alloys are very distinctly engineering materials and they possess among other things the great advantage of retaining their ductility as well as their strength at extremely low temperatures. Improvements have also been made in aluminum alloys. Aluminum has suffered from the same lack of strength as has copper, perhaps to even a greater degree. Its great advantage lies in the very excellent weight-rigidity relationship; that is, a pressure vessel of a given strength and weight made of aluminum will be more rigid than a pressure vessel of equal strength and weight made of steel. However, the low strength is such a serious handicap that the use of aluminum has been largely restricted to low-pressure containers. The best example of the improved aluminum alloy is Duralumin. It contains approximately 4 percent copper and 1 percent manganese. This alloy, however, must be heat treated. The alloy has been slow to find its place in the pressure vessel field largely due to fabricating difficulties but it is used in gasoline tanks and the like. With improved technique in fabrication it will probably be more extensively used.

In addition to the strength and durability of pressure vessel material, the adaptability to manufacturing operations and to corrosion resistance are factors. In general the ductility of the material is sufficient so that the usual punching, reaming, and riveting operations present no unusual difficulties.

The technique of welding has been so well worked out for mild steels, low alloy steels, copper, copper alloys, and aluminum pressure vessel metals that no real difficulties persist. In the case of steel pressure vessels, however, the matter of residual stresses and the possibility of a very local hardened zone must be considered. Both of these conditions are eliminated by stress annealing which consists of merely heating to 1100 degrees F. for a sufficient length of time to heat the vessel thoroughly. Such stress annealing is generally advisable for pressure vessels intended for severe service, and the efficacy of the treatment has been thoroughly proved. In the case of copper care must be taken that only deoxidized copper is used for welding, for free oxygen will result in copper oxide grain boundary envelopes which embrittle the material. Copper that has been treated with silicon is most suitable for welding. Aluminum may be readily gas welded but considerable flux is a decided requisite. Everdur no longer presents difficulties. Duralumin still presents difficulties in welding because the heat of welding destroys the beneficial properties produced by the heat treatment.

Corrosion resistance is frequently a determining factor in the choice of pressure vessel material. In most applications the corrosion resistance of the mild steel or low alloy steel is sufficient, but for certain special cases such as are found in the chemical industries, special alloys must be used. Perhaps the most common of the special alloys is 18 percent chromium and 8 percent nickel stainless steel. This material has well nigh perfect resistance to atmospheric corrosion, salt water corrosion, and nitric acid corrosion. It also offers resistance to acetic and many of the fruit acids as well as to a large variety of chemicals. It fails, however, to give protection against certain types of caustic corrosion and will not prevent the well known caustic embrittlement which has given so much trouble in riveted seams.

Research has shown that the ferritic type of chromium iron containing more than 12 percent chromium without nickel has perfect resistance to this type of chemical attack. In certain special instances copper or copper alloys may be used where corrosion is a determining factor. This is particularly true of pressure vessels of the small water heater type where the low ultimate strength of the copper is not a determining factor

In conclusion we may say that strength and ductility are the essential characteristics to be desired for pressure vessel material. In creased strength under varying temperature conditions is obtained in low alloy steels and silicon-manganese-copper alloys. The satisfactory properties of mild steels may be seriously affected by temperature conditions other than atmospheric, or special stress conditions. Satisfactory properties can be retained to a much higher degree, under favorable conditions, in the alloy steels. Copper alloy pressure vessels are primarily suitable in applications where high corrosion resistance or extremely low temperatures are involved, and aluminum may be used where low weight and high rigidity are the determining factors.

Discussion by Reuel C. Stratton*

I agree that the alloy age is upon us and this meeting being interested not only in fabrication, shop inspection, operating use, but also in the safety of the object, must project into the future to visualize to what use these new alloys are to be put and not confine itself too much to the previous use of the so-called mild steel. A peculiar cycle is in operation. The demand for higher pressures and higher temperatures not only in power operation but in chemical production caused the search into the alloy fields for new ferrous as well as non-ferrous alloys. The production of these more efficient metals then caused a search for new uses and the search for new uses has produced a demand for new products, which in turn are still demanding further search into the possibility of new alloys.

The day has gone when a very mild metallurgical knowledge of materials would suffice to cover the design, construction, and operation of a pressure vessel. The increased commercial demand for higher pressures and temperatures has demonstrated that additional metallurgical knowledge is required.

Steel and other metals have always been considered to follow a certain law, that up to reasonable proportion of limits there was a general relationship between temperature and tensile strength, but it is now realized that at sufficiently elevated temperatures even steel under light stress may extend for a very long time. Only the metallurgical refinement of measurements have proven this and authorities now question whether or not metals are actually rigid bodies but instead are viscous substances. The chemical constituents of a material are important in resisting stress at temperatures above atmospheric. According to Chevenard, it is proven that "An alloy more nearly approaches a rigid body than does a pure metal and preserves this body at a higher temperature."

According to Cox, "Chromium is active in raising creep strength. It is the basis of most heat resisting alloys increasing strength and decreasing oxidation." For example, a 10 point carbon, 15 percent chromium alloy produces twice the creep strength of an 11 point carbon steel in the same temperature range, and in addition has a greater degree of resistance to oxidation at the same temperatures. In general, however, chrome steel, particularly with a higher chromium content while possessing a greater creep strength and resistance to oxidation may have low impact strength and show a liability to coarsening of the grain structure upon long exposure to heat. Addition of nickel may assist in restraining this particular type of grain growth. A combination, nickel and chromium alloy steel, seems to be the best ferrous alloy available in quantity at the present time.

The so-called "18-8" or 18 percent Cr, 8 percent Ni, mentioned by the previous speaker is an example of this class of material. Such an alloy is one of the austenitic types which slowly softens with heat but is relatively strong at high temperatures. Such alloys, however, require a low carbon content and special heat treating according to the temperature range within which they are to be operated.

Another property of alloy steels is their resistivity to the action of hydrogen, being considerably more resistant than carbon steel. Hydrogen, according to various references, may combine in one of three ways, electro-positive ion, electro-negative ion, or as a metal. Upon ferrous material, it may produce an embrittling action, attack and remove carbon. Its attack depends upon temperature and pressure as well as the composition of the metal. There is a variation in the effect brought about, depending upon whether the hydrogen is atomic or molecular. It is well known that mild steels rapidly suffer crystal injury at high temperatures in contact with molecular hydrogen and the attack increases with temperature rise. Increased attack may be caused by cold working of the metal. Whether this peculiar property explains some of the metallurgical occurrences under normal boiler operation where water may occur as H_2O or HOH cannot be determined in this paper, but the property to remember is that generally steels containing the usual alloy metals are more resistant to this type of action. Apparently, the 18-8 type can be considered relatively immune to such attack.

In addition to these non-ferrous alloys mentioned in the previous paper, I would include Monel metal. This is a general purpose alloy which combines high mechanical properties with excellent resistance to corrosion and, therefore, should not be considered a specialized alloy. Its properties are stable in service and seem upon test to be reasonably insensitive to the operation of manufacture and construction. This is due considerably to the simple and homogeneous character of its chemical and crystalline structure. Improved welding procedure has widened the field for the application of this alloy. Its strength range is considerably above that of common brasses and bronzes and its ultimate strength reaches the range of some of the alloy steels. It is highly ductile and is improved by mechanical working.

Another newer type copper alloy of interest to the pressure vessel and machinery manufacturer and operator is "Alcunic." This is an alloy of copper, nickel, aluminum, and zinc, having remarkable physical properties at both room and elevated temperatures, as well as a very high resistance to general corrosion. Its greatest field is in the production of condenser tubes. The approximate composition of Alcunic is 80 percent copper, 2 percent aluminum, 1 percent nickel, and 17 percent zinc. It can be hot pierced, extruded and cold worked. It has a relatively low yield point but high elongation combined with greater ultimate strength than many other alloys, in addition to its excellent resistance to chemical corrosion.

Time forbids a complete discussion of the properties of non-ferrous alloys, such as nickel and copper, nickel, zinc and copper, as well as the new alloys of copper and beryllium. As nickel and copper produce a series of solid solutions according to the variance in percentage make-up, they have a similarity of characteristics.

Knowledge is incomplete regarding the possibilities of the use of beryllium copper alloys in so far as pressure vessels are concerned, but with the more economical production of beryllium the belief is warranted that such alloys will become common owing to their ease of fabrication and their high tensile strength under temperature variation.

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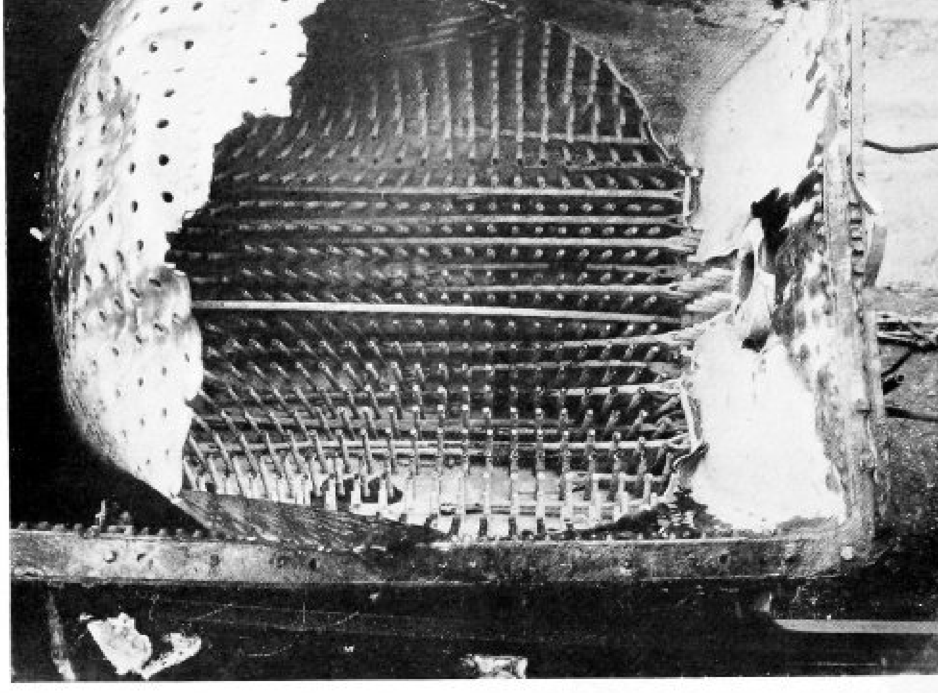


Fig. 1.—Result of a low water failure

LOCOMOTIVE ACCIDENTS

Twenty-second annual report of the Bureau of Locomotive Inspection shows that record of consistent progress in locomotive defects begun in 1923 was broken by rise in fiscal year ended June 30, 1933

The twenty-second annual report of A. G. Pack, chief inspector, Bureau of Locomotive Inspection, to the Interstate Commerce Commission shows that the record of improvement in the condition of steam locomotives and the casualties and accidents resulting therefrom, which was begun in 1923, has been broken. The report covers the activities of the Bureau for the fiscal year ended June 30, 1933, and in the case of locomotives inspected and found defective the percentage rose from 8 to 10 percent in the past fiscal year. The number of locomotives ordered out of service, the total number of defects found, and the number of accidents, the number of casualties, all have likewise increased for the first time

Fig. 2.—Chart showing the relation of defective steam locomotives to accidents and casualties resulting from locomotive defects

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	756

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

	Year ended June 30—							
	1933	1932	1931	1930	1929	1928	1915	1912
Number of accidents..........	53	43	91	105	119	150	424	856
Number of persons killed......	3	8	15	12	14	26	13	91
Number of persons injured....	55	46	122	113	133	174	467	1,005

[1] 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	Year ended June 30—					
	1933	1932	1931	1930	1929	1928
1. Air Compressors	474	417	481	873	1,202	1,282
2. Arch tubes	51	54	60	87	104	103
3. Ash pans and mechanism	40	69	81	76	132	133
4. Axles	21	13	10	12	20	7
5. Blow-off cocks	210	144	191	325	442	469
6. Boiler checks	293	214	263	521	761	914
7. Boiler shell	296	220	430	579	841	954
8. Brake equipment	1,696	1,645	1,923	2,706	3,894	5,214
9. Cabs, cab windows, and curtains	1,183	851	1,484	3,066	2,140	1,670
10. Cab aprons and decks	309	262	415	710	1,005	852
11. Cab cards	121	162	211	226	305	378
12. Coupling and uncoupling devices	67	85	98	122	154	179
13. Crossheads, guides, pistons, and piston rods	773	763	856	1,421	1,887	2,088
14. Crown bolts	67	50	96	95	129	164
15. Cylinders, saddles, and steam chests	1,084	841	1,265	2,311	3,210	3,264
16. Cylinder cocks and rigging	374	376	411	848	967	1,007
17. Domes and dome caps	76	45	83	154	227	281
18. Draft gear	318	325	568	950	1,310	1,453
19. Draw gear	357	371	640	1,003	1,367	1,650
20. Driving boxes, shoes, wedges, pedestals, and braces	1,080	821	925	1,359	1,993	1,990
21. Firebox sheets	246	235	341	471	657	730
22. Flues	150	120	187	254	334	464
23. Frames, tailpieces, and braces, locomotive	669	611	740	1,271	1,377	1,354
24. Frames, tender	80	86	105	177	297	256
25. Gages and gage fittings, air	145	156	192	290	309	461
26. Gages and gage fittings, steam	258	214	324	553	678	969
27. Gage cocks	388	330	415	783	1,114	1,413
28. Grate shakers and fire doors	245	288	410	767	295	377
29. Handholds	363	382	562	865	1,125	1,373
30. Injectors, inoperative	20	31	55	103	86	93
31. Injectors and connections	1,357	1,168	1,815	3,275	4,484	5,563
32. Inspections and tests not made as required	6,358	3,801	4,862	7,456	9,246	6,623
33. Lateral motion	269	237	289	372	618	699
34. Lights, cab and classification	76	55	77	119	121	118
35. Lights, headlights	169	119	180	373	488	571
36. Lubricators and shields	157	119	176	312	423	500
37. Mud rings	232	166	318	445	636	822
38. Packing nuts	419	402	523	828	991	1,265
39. Packing, piston rod and valve stem	592	444	706	1,429	1,708	1,904
40. Pilots and pilot beams	123	145	160	272	371	386
41. Plugs and studs	151	176	182	348	482	619
42. Reversing gear	254	202	299	579	788	967
43. Rods, main and side, crank pins, and collars	1,327	1,256	1,520	2,488	3,465	4,152
44. Safety valves	53	63	61	116	170	172
45. Sanders	376	289	314	804	1,008	1,031
46. Springs and spring rigging	2,122	1,851	2,161	3,311	4,557	4,939
47. Squirt hose	93	96	184	313	387	478
48. Stay bolts	219	181	293	395	542	590
49. Stay bolts, broken	368	552	938	1,098	1,197	1,867
50. Steam pipes	338	285	512	730	925	1,020
51. Steam valves	193	143	226	399	471	708
52. Steps	498	622	676	1,021	1,394	1,817
53. Tanks and tank valves	600	587	732	1,426	1,717	1,941
54. Telltale holes	90	108	151	183	174	241
55. Throttles and throttle rigging	448	434	574	1,175	1,554	1,889
56. Trucks, engine and trailing	664	648	714	1,141	1,605	1,914
57. Trucks, tender	747	766	1,059	1,531	2,144	2,610
58. Valve motion	640	520	497	827	1,067	1,262
59. Washout plugs	623	599	815	1,283	1,871	2,211
60. Train-control equipment	4	13	9	48	60	112
61. Water glasses, fittings, and shields	716	676	955	1,501	1,816	2,115
62. Wheels	580	603	750	1,025	1,325	1,609
63. Miscellaneous—signal appliances, badge plates, brakes (hand)	423	325	418	691	1,101	1,273
Total number of defects	32,733	27,832	36,968	60,292	77,268	85,530
Locomotives reported	56,971	59,110	60,841	61,947	63,562	65,940
Locomotives inspected	87,658	96,924	101,224	100,794	96,465	100,415
Locomotives defective	8,388	7,724	10,277	16,300	20,185	24,051
Percentage of inspected found defective	10	8	10	16	21	24
Locomotives ordered out of service	544	527	688	1,200	1,490	1,725

in the ten-year period. The total number of steam locomotives inspected by the Bureau during the past fiscal year was 87,658. Of these 8388 were found defective. The total number of defects found increased from 27,832 in 1932 to 32,733 in 1933, and the number of locomotives ordered out of service because of defects increased from 527 to 544. The increase in accidents and casualties brought about by the increase in defective locomotives and the converse are illustrated graphically in the chart accompanying this article.

There was a decrease of 16.6 percent in the number of crown-sheet failures, a decrease of 71.4 percent in the number of persons killed and a decrease of 33.3 percent in the number of persons injured from this cause as compared with the previous year. Fatalities occurred in two of the five crown-sheet failures caused by low

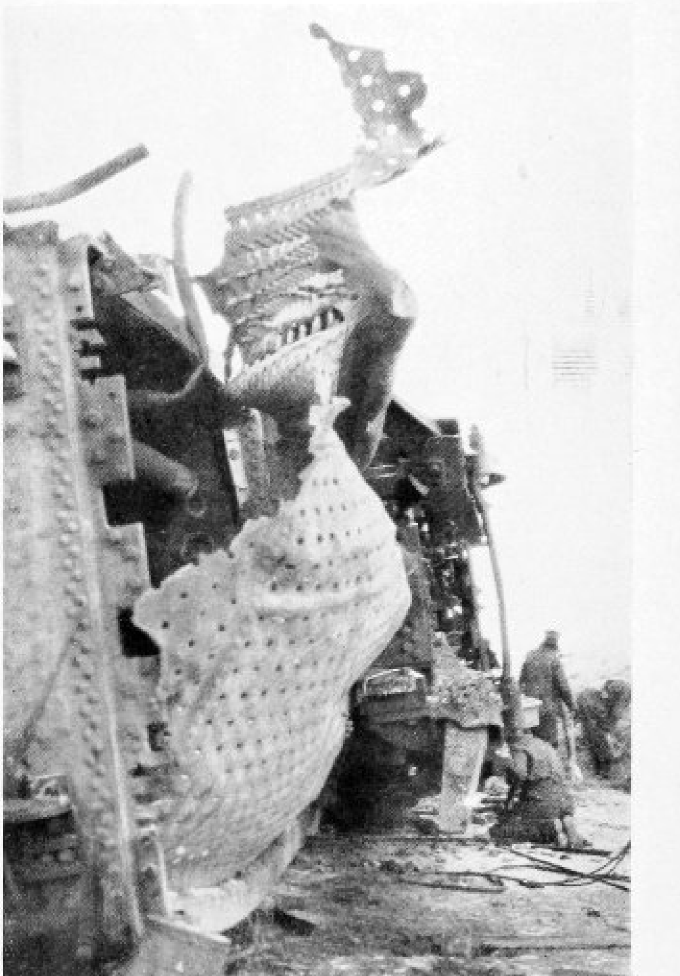


Fig. 3.—Two men were injured in this boiler explosion

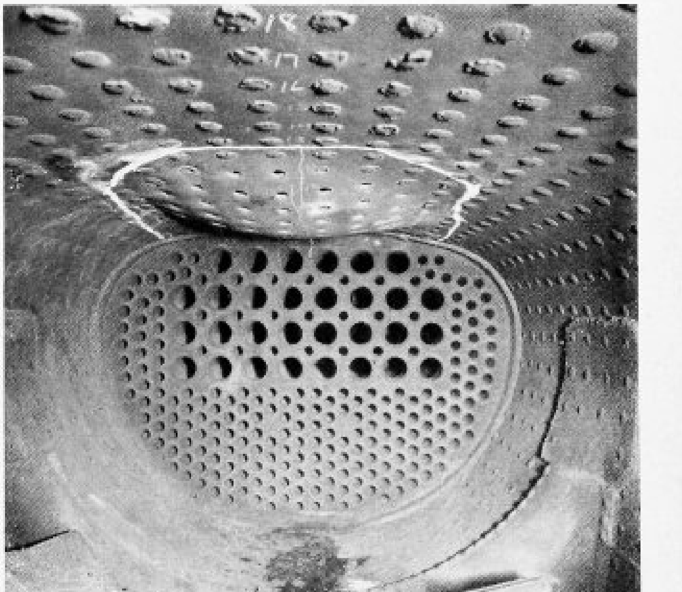


Fig. 4.—Pocketing in crown sheet due to low water

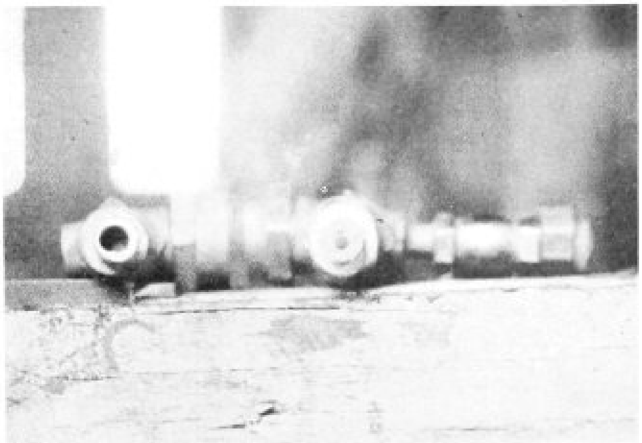


Fig. 5.—Bottom water glass plugged with scale

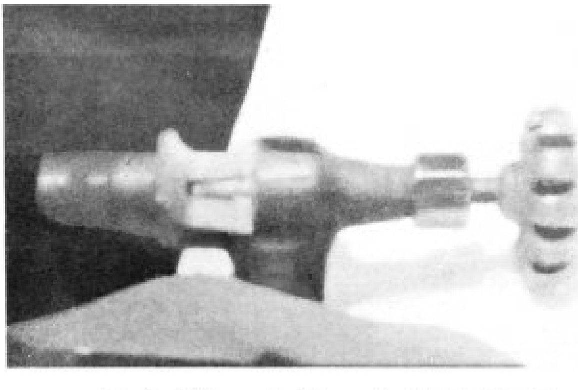


Fig. 6.—Valve seat of top water glass destroyed

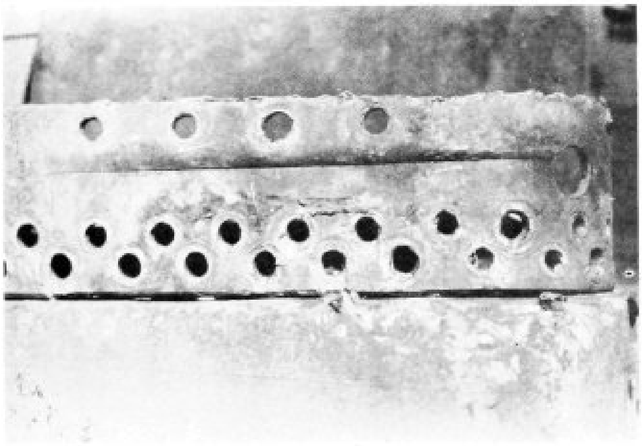


Fig. 7.—Welding used to repair back head leak

water. Both of the locomotives involved were oil fired and in each instance the locomotive was in charge of an engine watchman who was killed. The assigned hours of each of these watchmen were such as to preclude the possibilities of obtaining sufficient rest without sleeping on duty. One of the watchmen was working on a tour of duty of 40 consecutive hours. The accident occurred at about the fourteenth hour of duty. The other watchman was assigned to shifts of 18 hours each, with six-hour rest periods intervening, and had been required to perform other service during his rest period. He had worked about 36 hours when the accident occurred.

A total of 1400 applications were filed for extensions of time for the removal of flues as provided in Rule 10. The investigation of the Bureau disclosed that in 78 of these cases the condition of the locomotive was such that extensions could not properly be granted. Sixty-seven were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. Extensions were granted in 197 cases after the defects disclosed by the investigation had been repaired. Thirty-nine applications were canceled for various reasons. Applications were granted for the full period requested in 1900 cases.

Under Rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives 151 specification cards and 3601 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 98 specifications and 16 alteration reports were filed for locomotive units and 72 specifications and 71 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 inspection during the year.

Typical Boiler Failures

Fig. 1 shows the interior of a firebox that failed due to overheating of the crown sheet caused by low water, resulting in the death of the engine watchman. The force of the explosion tore the boiler from the frame and hurled it about 70 feet forward where it struck on the back head and then bounded 20 feet further. The cab was thrown forward and to the right approximately 140 feet from the point of the accident. The body of the watchman was found in the cab.

The result of a crown-sheet failure caused by overheating due to low water is shown in Fig. 3. This accident caused the serious injury of two employees. The force of the explosion lifted the locomotive from the track and forced it to the left where it came to rest on its left side at the foot of a 14-foot embankment. Parts of the ash pan and other wreckage were scattered over a radius of 300 feet and part of the front end ring, and door with headlight attached, were found 490 feet from the point of explosion.

Fig. 4 shows the pocketing of a crown sheet caused by overheating due to low water. This accident resulted in the serious injury of three employees.

Fig. 5 shows a bottom water glass cock stopped practically solid with hard scale compared with a similar cock in which the opening is unrestricted. The stopped-up cock was found by our inspector on a locomotive that was set out ready for service.

Fig. 6 shows a top water glass cock the valve seat of which has been destroyed by excessive reaming in attempts to restore the seat. The illustration indicates the valve stem wedged into the opening ¾ inch beyond the original seat. Nine full turns of the valve stem were required to make sufficient opening to permit proper functioning of the water glass.

Fig. 7 shows fusion welding applied on the outside of the back head to stop a leak caused by grooving of the sheet just above the mud ring. This boiler was found in the shop undergoing class 3 repairs with all scheduled boiler work and boiler test completed and was ordered withheld from service by our inspector until proper repairs were applied.

Boiler Rules Sent to Marine Industry for Study

On January 17, the Department of Commerce, Bureau of Navigation and Steamboat Inspection, sent copies to the marine field of a tentative draft of proposed rules to co-ordinate the Marine Boiler Rules of the department. These were issued to steamship owners, shipbuilders, boiler and steel manufacturers, classification societies and other persons connected with the marine industry. The letter accompanying the copies follows:

The Bureau is transmitting herewith a tentative revision of Rules I and II (all classes), General Rules and Regulations, which is being released in order that the marine industry as a whole may review and study it with a view to forwarding to the bureau comments, suggestions and such constructive criticism as may tend to promote improvements.

The movement to revise its Boiler Rules was initiated by this Bureau in 1928. A preliminary draft was prepared, covering the material, design, construction and inspection of marine boilers and pressure vessels. This draft was released to interested parties in 1929 and comments were invited. The consensus of opinion on this draft was very favorable. However, in order that all the various interests connected with the marine industry might be represented, a committee of eminent engineers known as The Committee to Co-ordinate Marine Boiler Rules was organized to prepare the final draft. This committee adopted the preliminary draft prepared by the Bureau as the basis on which to develop the revised draft, proceeding along the same lines which the Bureau had followed in preparing the preliminary draft; that is, making a study of all modern boiler rules, including the A. S. M. E. Boiler Construction Code, Boiler Rules of the various Classification Societies, as well as the Boiler Rules of the United States Navy and British Board of Trade. In addition, much thought was given to such scientific data and facts as were available on new developments, particularly the modern trend to high pressures and temperatures, such as had been successfully used in land practice for several years.

In view of the rapid strides made in the art of fusion welding, coupled with the fact that such organizations as the American Welding Society, American Society of Mechanical Engineers and the United States Navy had sanctioned the use of boilers and pressure vessels made by means of fusion welding, it was decided to incorporate in Rule II a complete code to govern the construction of boilers and pressure vessels by this method. This Welding Code was developed by a sub-committee on welding in marine construction of the American Welding Society and subsequently approved by that society and later adopted by The Committee to Co-ordinate Marine Boiler Rules. This code is based on the A. S. M. E. Code for welded boilers and pressure vessels. It was also decided by the committee to amplify its work by the addition of a modern Piping Code. A special sub-committee was appointed to draft this code which was reviewed by the Technical Committee to Consider Revision of Steamboat Inspection Rules, and subsequently adopted by the committee. Furthermore, a section devoted to miscellaneous data, tests, specifications, repairs, construction, etc., was also added.

The paramount objective has been to produce a code which would be comprehensive and broad enough to include all types of boilers in marine service under the provisions of which boilers constructed of better material, better design and infinitely safer could be constructed at a reasonable cost, and with this thought in mind, the standard specifications of the American Society for Testing Materials and the American Society of Mechanical Engineers were adopted, with slight modifications, to make them workable as inspection, rather than purchasers' specifications, and to eliminate the necessity of having to order material made to special specifications, which would greatly increase the cost to the purchaser. This feature of the revised Rules works to the advantage of manufacturers and purchasers for the reason that stock material can be used, thus obviating unnecessary and expensive delays.

Inasmuch as the current Boiler Rules were in part written into statute law, it was necessary that Congress enact legislation amending certain statutes in order to permit the adoption of the new code. Therefore, a bill drafted by the Bureau to enable the Board of Supervising Inspectors to adopt this new code, was introduced at the last session of Congress, passed both Houses unanimously, and was signed by the President on June 13, 1933. Therefore, final action by the Board of Supervising Inspectors is all that is necessary to make these Rules effective.

The Bureau would suggest that in commenting on this tentative revision of the Rules that the comments be specific. State in detail just what objection there may be to any part of the proposed Rules and in what way they could be amended or revised in order to overcome the particular feature to which objection is raised. In view of the urgency of having the Rules adopted, the Bureau is setting a definite date to receive the reactions of the parties to whom it is submitted. No proposed changes or alterations will be considered after March 1, 1934.

This letter was transmitted by D. N. Hoover, assistant director of the Department of Commerce.

Employee's Part in Safety

An address on the part employee representation plays in the plant safety organization will be a feature of the third session of The Fifth Annual Greater New York Safety Conference.

In the third session of the conference, which will meet March 6 and 7 at the Hotel Pennsylvania, under the auspices of the Metropolitan Chapter, American Society of Safety Engineers, the engineering section of the National Safety Council, and 56 co-operating organizations, C. S. Ching, director of industrial and public relations, United States Rubber Co., New York, will preside.

The address on employee representation in plant safety organization will be delivered by Walter S. Ames, manager of compensation and safety, Bethlehem Steel Corporation, Bethlehem, Pa. Mr. Ames' talk will embrace the field of operation and responsibilities of employee representation in relation to plant safety committee.

R. W. Black, following Mr. Ames on the program, will tell how best to reach the employee, and will summarize the practical methods of reaching the man at the bench with the safety messages. Mr. Black is chief safety engineer of the Standard Oil Company of New Jersey, Elizabeth, N. J.

George E. Sanford, closing the discussions in the Safety Organization session, will tell how to organize safety work on field jobs. Mr. Sanford, who is connected with the General Electric Company, Schenectady, N. Y., will explain why jobs conducted at a distance from the plant are not often properly covered by the plant safety organization, and why this phase of work may be more important than the job at home.

LESSONS IN ARC WELDING

It is the object of these lessons to present in a concise manner certain fundamental facts of welding, the knowledge of which will enable the operator to use the welding process successfully and economically. These lessons are based on the course in arc welding given by Arthur Madson at the plant of the Lincoln Electric Company, Cleveland, O.

Welding, as ordinarily considered, may be defined as a method of joining metals by fusing the edges or surfaces, causing them to become molten, and thereby be fused together but without pressure being applied. This is known as fusion welding.

In welding, use is made of an electrode held in a holder which is connected to one terminal of the generator, the base metal or metal, being welded, is connected to the other. The electrode to which the terminal is connected is determined by the kind of electrode used. The electrode is touched to the base metal, withdrawn and held so as to form and maintain an arc. A small pool or crater is melted in the base metal. The electrode is also melted and is deposited in the crater. The metal in the crater is agitated and so mixes the molten electrode with the base metal forming a solid joint. When the electrode is metal, the process is called metallic-arc process; when carbon, the carbon-arc process.

Obviously, the metallic electrode furnishes additional metal to the base metal; but in the case of the carbon arc a filler rod may be used, the rod being fed into the arc and melted, fused and mixed as outlined above for metallic arc.

The details of these operations are given in the lessons. A few general remarks will, however, be helpful in understanding the lessons.

When current flows across a gap in an electric circuit an arc is formed. This arc causes heat. In direct current circuits it is quite generally assumed that twice as much heat is liberated at the positive terminal as the negative; while in alternating current, the heat liberated is the same at both terminals. In some cases this relation is changed, for direct current, by the use of coatings on the electrode. Because of this heat distribution it is customary to connect the work so that the greater heat is liberated in the work, as the work in general is very much larger than the electrode and, therefore, can absorb more heat.

Welding current is obtained from special generators, the details of which are given in the lessons.

It is evident that the arc is very hot (temperature of 6500 degrees F.) and therefore it throws off both light and heat. It is necessary that proper protection be used. For eye protection a special glass (used in either a head or hand shield), is used. *It is essential that this glass be used at all times when looking at the arc.* The special glass being expensive is protected by an ordinary clear glass.

Gloves, preferably of gauntlet type, should be worn to protect the hands. A suitable leather apron is of great use in protecting the clothing, particularly when the operator is sitting at his work.

It is also important that trousers without cuffs are worn and that legs of the trousers be held down over the shoe tops. Bicycle clips are excellent for this purpose. Leather spats or leggings may be used. Otherwise there is a possibility of hot metal falling into the trouser cuff or shoes.

Where other work is done in the same shop, booths are necessary to protect the men from the arc rays. The booth and walls of the shop, which might reflect rays, should be a dull black. Canvas curtains on a pipe framework make a very acceptable booth.

Inside the booth should be a welding table; a metal top, properly supported at correct height, with provisions for good connection of ground cable, is about all that is required. The operator can construct this of structural parts. An insulated hook or something similar, should be provided for the electrode holder.

The next item is the electrode holder. This should be mechanically strong, light in weight, and hold the electrode firmly in position during welding, but allow easy removal and replacement of electrode. It must not become too hot. The connection from electrode holder to machine is made by cable, the section (usually several feet long) next to the holder being very flexible so as to offer a minimum of restraint to the operator's motions.

In addition to the equipment outlined above, there should be available; steel scratch brush for cleaning welds, removing rust, etc.; tools for removing scale and slag from welds; carbon and copper blocks for backing up strips; and the usual shop equipment, such as vises, hammers, tongs, etc.

The arrangement of table and work should be such that operator may be comfortable. A strained, awkward position interferes with the doing of good work, whereas an easy, comfortable position is helpful and results in

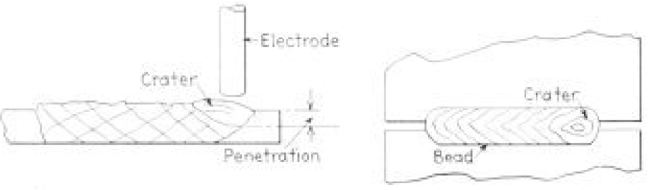


Fig. 1.—Demonstration of welding terms

Fig. 2.—Correct bead should not overlap

better production accomplished at considerably lower costs.

The following lessons outline a method of learning to use the equipment described:

Lessons in Welding

Instructions to the Operator

Do not play with the outfit. Make a definite plan and follow it through. Learn the fundamental principles and wherever possible reduce your problems to these fundamental principles. You will find the solution of your problem very much easier if you do.

Practice making samples and continue practicing and then do more practicing.

Open up the welds, examine them, criticize your work; ask criticism from others. Because you are melting a lot of metal is no sign that you are welding.

These are general suggestions. Specific suggestions will be given in the following instructions.

It may be well at this point to explain, define and illustrate certain terms customarily used by welders.

Caution—Never look at the arc without using a protective glass to shield the eyes.

Direct exposure or a "flash," will result in a very painful, but not permanent, burning of the eyes. If exposed to the rays of the arc an application of cool boric acid is helpful, or a few drops of 5 percent argyrol every 4 or 5 hours. Aspirin will relieve pain and headache and permit rest which is very helpful in promoting quick recovery.

The position assumed at work has a great bearing on the kind of work done, and the speed at which it is done. Therefore, be as comfortable as the job allows. It's easier on the operator and results in better work at lower cost.

The bead is the metal deposited by the electrode, see Fig. 1.

Where the arc strikes the parent metal, metal is melted and there is formed a pool or pocket. This is the crater. Its depth indicates the amount of penetration.

The bead may have overlap, which is the amount of deposited metal "overlapping" but not fusing or melting into the parent metal, see Fig. 2. A correct bead should have good penetration, no overlap.

The electrode is the wire or rod held in the holder. The electrode is melted, as is also the base metal, and the whole fused together without pressure. This is fusion welding.

Lesson 1

Object: The study of the Lincoln arc welder.*

Apparatus: Lincoln Arc Welder.

Material: Scrap steel, carbon holder, carbons $\frac{1}{4}$ or $\frac{3}{8}$ inch.

Procedure: It is very important that the operator understand the welding machine before he uses it.

A Lincoln Arc Welder is an arc welding generator electrically separated from the power which drives it, such as a motor. The generator may be driven by any suitable power source, and this drive has nothing to do with how the generator operates. It is not necessary to know all about the theory of the operation of the generator in order to operate it correctly, but it is necessary to know the various controls and just how these controls are manipulated so as to get the desired results.

This arc welder is a special type of generator designed for welding service. The principle of operation is that the separately excited field produces a certain voltage across the brushes of the generator. There is also a series field, but when current flows in this field it produces a voltage opposite to that produced by the separately excited field.

In other words, this series field bucks the shunt or separately excited field. It is evident that this bucking effect reduces the voltage at the brushes and therefore, when current is used, this voltage at the brushes is lower than when no current is used. By means of a current selector switch the amount of current which flows in this series field may be varied and therefore the amount of bucking series is varied. This in turn

* Since the lessons are based on the use of the Lincoln arc welder, wherever the term is used it will be understood that this equipment is referred to.

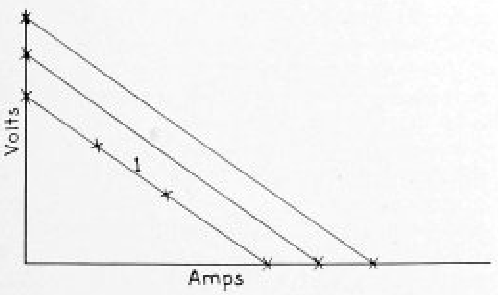


Fig. 3.—Effect of increasing voltage with no load on welder

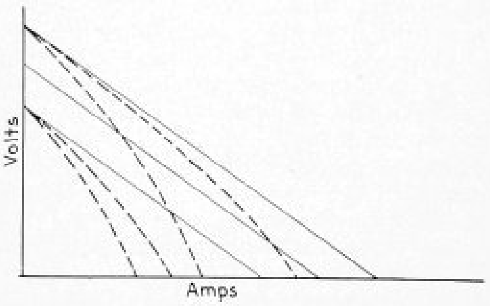


Fig. 5.—The two sets of curves superimposed

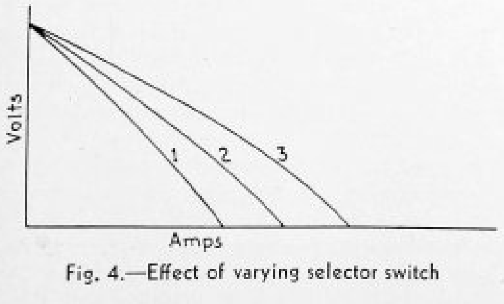


Fig. 4.—Effect of varying selector switch

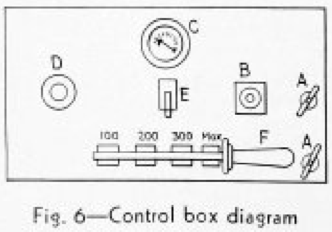


Fig. 6—Control box diagram

will vary the amount of current flowing in the arc circuit.

To make this clearer, perform the following experiment, if a welding machine is available for your use. This should be done by two students, one student reading the meters and adjusting the machine and the other operating: Insert carbon in holder with considerable length extending.

Start the machine, turn the rheostat (see *D*, control box diagram) to the lowest voltage and set the diverter switch *F* at lowest current setting. Short circuit the machine by touching the electrode to the ground plate. Note that the voltage shown on the voltameter *C* drops way down. Now press the meter button *E* and read the current. Keep this button depressed so that the meter indicates current, and gradually turn the rheostat to the left or in the direction marked to raise voltage.

Notice that the current increases gradually as the rheostat is turned. After turning the rheostat as far as it will go turn it back and watch the current go down again. This shows how the current can be varied by the rheostat. If the machine becomes warm, remove the holder from the ground and allow it to cool.

Next, set the rheostat in the lowest position with the diverter switch in the lowest current position and again short circuit the machine as outlined above. Leaving the rheostat alone, press the button to read current and keep it reading current. Then set the diverter switch in the next location and notice that the current increases.

Then set the diverter switch at the next higher setting and then at the highest. Reverse the procedure, setting the diverter switch at lower and lower ratings and notice that the current goes down. This experiment shows that the current can be varied by the diverter switch or by the rheostat. This is known as "dual control."

Dual control means it is possible to get proper welding current at welding voltage practically throughout the range of the machine in two ways. It may be likened to automobile control, where you get the major variations of speed with the gearshift and the finer gradations of speed with the accelerator.

Now, by means of the carbon, and with rheostat set for lowest voltage and current selector or diverter switch at lowest amperes, take several readings of current and volts by setting the current selector switch at various points. If these are plotted you get a curve like (1) in Fig. 3. Now increase the voltage when no load is on welder and repeat. You will get a series of curves such as shown in Fig. 3.

Next, set at a given no load voltage and with current selector switch set for lowest amperes, take a set of readings. Plot these and you get a curve (1) like Fig. 4. Put the current selector at next higher value and repeat. You get a series or set of curves as in Fig. 4.

You will note that the effect of the rheostat is to raise or lower the curves, or, to put it another way, for a given amperes the rheostat raises or lowers the voltage. The effect of the current selector switch is to change the slope of the curve, or, for a given voltage, to raise or lower the current. The combination of these two sets of curves, such as indicated, means that any desired operating point may be obtained by several settings of the controls.

Keep in mind that both controls must be used to get the most stable arc. A machine which does not have the two controls cannot have an arc of stability throughout the range of welding such as may be obtained on this arc welder.

When you are welding, set the current selector switch on the point which indicates about the current you intend to use, start the arc and adjust the voltage for finer gradations of current through the rheostat.

High open circuit voltage, that is, the voltage when the machine is not welding is an advantage; that means a stable arc. Always use the highest open circuit voltage obtainable at any given value of the welding current. Two students should do this check-up, one reading the meter and the other manipulating the controls, so that he can see what the control actually does. Then the students are to change places and repeat the experiment.

Lessons 2, 3 and 4 will appear next month.

Outlook for Steel Industry Bright

Confidence in the outlook for the steel industry was expressed by H. G. Dalton, chairman of the board of the Youngstown Sheet & Tube Company, Youngstown, O., and senior partner of Pickands, Mather & Company, at a dinner held recently at the Youngstown Club for the Youngstown Sheet & Tube Company sales representatives from all over the country, in Youngstown for a sales conference.

"There is today definite proof of industrial recovery," Dalton said. "Naturally progress must be slow, and we cannot expect too much. Nevertheless I believe there is no question but that the steel industry and general business will have a materially better year in 1934 than was the case in 1933."

The chief subject of discussion at the meeting was the steel code.

"In co-operation with the desires of the Administration and the purposes of NRA," said Frank Purnell, president of the company, "the steel industry has greatly increased wages, decreased hours, and added to the number of employees upon its payroll. This was done in the face of declining operations, and only slight advances in prices.

"In order to maintain employment and wages on this basis it is absolutely necessary that the industry be assured of a net operating income sufficient to carry these wage increases. This must be accomplished through strict adherence to the terms of the steel code with respect to competitive practices, which were formulated in accordance with the desires and provisions of the Administration.

"In past years too much steel was sold on the basis of special concessions, easy credit terms, cut prices, and the like. This was destructive to normal profits and tended to demoralize the entire industry.

"Under the code, such practices are not tolerated. Producers post prices with the American Iron & Steel Institute.

"This does not mean that there is any lack of competition in the steel industry. The fact is that steel prices are still low and competition just as keen, or keener than ever before. The point is that making prices public furnishes a foundation for fair and open competition.

"Consumers benefit because they are free of the possibility of secret lower prices given competitors. The industry benefits because by this method it achieves the price stabilization necessary to support the heavily added wage burden."

Boiler Code Committee Practices*

By C. W. Obert†

Realizing the interest that the members of the National Board have always taken in the A.S.M.E. Boiler Construction Code and in the work of the Boiler Code Committee, the author has always made it a point at these annual meetings to be prepared to present whatever interesting information or news there was to offer concerning the latest developments in the committee's work.

Those of you who attended the last annual meeting in Chattanooga in 1930, will recall the amount of attention that was paid to the question of rules for fusion welded construction, as well as also papers and discussion upon the latest developments in welding. The Code Committee was faced at that time with some real questions about the adequacy of welded construction, and after 15 years of consistent and continuous resistance had arrived at the conclusion that welding of the proper kind warranted recognition. In addition, the users of watertube boilers who had suffered losses of drums from caustic embrittlement, were clamoring for permission to use the high-grade welded drums that had been developed. The only question was as to how to specify the quality of the welding so that safe results would be secured. Most of you are familiar with what transpired —how any method of acceptance of welded construction based on the procedure followed out in welding was rejected in favor of such provisions for testing the welded joint as would demonstrate its actual worth regardless of the method used.

The reasoning back of all this is interesting to review. In the first place it will be recognized that the fusion welded joint is difficult to analyze after it is completed. It is not capable of ready measurement and computation like a riveted joint—it cannot be tested in tension or by bending without cutting out a sample piece containing a section of the weld which, of course, destroys it. This consideration had led the advocates of fusion welding to urge the acceptance of welded construction on the basis of the so-called "procedure control," that is, the detailed specification of all features of the welding including the analyses of the base metal and the filler rod, the welding technique, qualifying the welders and testing the finished vessel hydrostatically. Even this was not considered wholly satisfactory, as with all these precautions, it was recognized that there were possibilities of defects slipping by. And yet the demands from both welding concerns and users alike became impetuous.

Finally, the result that you now know so well came as a compromise: namely, that the most important, high duty vessels be welded under the most rigid requirements with all welded joints stress relieved and then examined by the X-ray non-destructive test, while the tanks of less exacting requirements, be welded by applying a slight modification of the procedure control, except that the allowable working stress be based upon the results from testing samples of the welds used. This has involved a classification of vessels according to usage, and despite certain questions that have been raised, the plan has worked out very well. The result has been a great impetus to welded tank construction, and many of the tank manufacturers are turning out satisfactory vessels with much less difficulty in making them bottle tight than with riveted construction.

These rules for welded construction were added to the A.S.M.E. Boiler Construction Code in 1931. Most of the states immediately accepted them, and so far as we are able to learn are accepting welded constructions thereunder whenever presented. In the application of these rules there have been some difficulties encountered, and minor revisions have been found desirable in a few instances. The greater part of these have been instances where the meaning of a term or requirement was not clear or perhaps it was capable of dual interpretation. Among these were certain features on the X-ray analysis requirements, the stress allowances for Class 3 vessels with single welded and double full fillet welded joints, and the requirements for stress relieving. Other than these changes, the new welding rules introduced in 1931 are still effective and stand as the pioneer welding rules in the world, for pressure vessel construction.

In the course of the redesigning of various classes and types of tanks to provide satisfactorily for welded construction, it was found by the manufacturers who specialized in large-sized tanks that while the joints, heads, etc., are not difficult to design, the rules in the Code for design of opening reinforcements, such as those around domes, nozzles, manholes, etc., were difficult to apply and inadequate. Many questions came to the Boiler Code Committee in regard to the various details involved, that clearly indicated the need of carefully reviewing this entire subject. Eventually a special sub-committee of the Boiler Code Committee was appointed to study the question of reinforcements, and the result was again somewhat revolutionary in character. There was eventually proposed an entirely new and comprehensive set of rules which provide adequately for about any sort of reinforcement that can be imagined. These new rules were issued in 1932 as addenda to the Code and comprise voluminous modifications of Pars. F-268 and U-59.

There have been some protests against these new rules which, due to the presence of a formula, may appear formidable to some of the inspectors and designers. The rules are however, very simple indeed. The Boiler Code Committee has recently prepared a brief statement explaining the origin and development of these rules and the significance of the formula. Anyone who has the problem of interpreting these rules is urged to read this explanatory statement.

Little more can be said concerning new rules and practices of the Boiler Code Committee other than to reiterate that the committee consistently and persistently refuses to approve specific designs and devices. New manufacturers come into this field every so often, who construe this as the logical duty of the Boiler Code Committee, only to be told that the National Board is the governing body for such actions. The committee offers its assistance on any such question where any interpretation of the Code rules is involved, but that is as far as it wishes to go. The evident policy of the committee is to keep its rules up to date by all needful changes to provide for the development of the art, but it must be

*Abstract of paper presented at the ninth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

†Consulting engineer, Union Carbide & Carbon Research Laboratories, Long Island City, N. Y.

realized that a code-making body must not attempt to lead the art. The best that the Boiler Code can do is to codify existing or developed practice. In spite of many handicaps it can be said that the effect of the committee's activities since its appointment in 1911 has been to place the United States unquestionably in the forefront in the boiler and pressure vessel field.

Discussion by D. L. Boyer*

Few of us appreciate the job that faces the Boiler Code Committee. To produce a pioneer welding Code, considering various interests involved, was a real job. On one side we had people who wanted to weld everything without any control. On the other side we had a group who were convinced that no weld could ever be any good and insisted on riveted construction. Through constant, conscientious consideration of the interests involved, and there were a lot of them, the Boiler Code Committee came through with a welding code. After the job was done, some are inclined to feel that the code might be revised in several places.

I doubt whether there can be any progress unless design and practice lead. Perhaps today there are untried ideas being developed behind closed doors, revolutionary in character and perhaps not according to the code. But as long as the code does not stifle progress, as long as the Boiler Code Committee continues its open-minded consideration, I am sure we are going to have safety without unnecessary restriction.

Discussion by M. A. Edgar†

Changes in the A.S.M.E. requirements for welding will of course be made as the test of time shows where the rules should be strengthened or modified, and I believe that in the interests of safety and the future welfare of the art of fusion welding that we can well afford to be patient and have confidence in the knowledge that future revisions are in the hands of capable and experienced men who are interested in seeing that our problems are properly solved.

Reference was made to loss of boiler drums as a result of caustic embrittlement, and an interesting article by J. P. Morrison in the September issue of The Boiler Maker will show the development of this hazard in the rivet holes of riveted seams. The assurance of satisfactory welding where high pressures and temperatures are met is indeed worth working for, if it only eliminates this danger to the advancement of boiler design. I believe that we already have that assurance, and I accept with considerable relief the fact that the perplexing problem of fusion welding is being taken care of by those who have the ability, the facilities and the time to handle it in a proper manner. Members of the National Board have consistently shown their appreciation of the code committee's efforts by their ready acceptance of new rules and the revision of the old rules, and I am confident that I speak for all the members of the board when I say that they will continue to do so.

Mr. Obert makes a very important statement, which I believe ought to be emphasized frequently, when he declares that the National Board is the governing body for the approval of specific designs and devices and that it is the policy of the Boiler Code Committee to develop rules and to make interpretations of those rules. The National Board has done considerable work in connection with the approval of specific design, in spite of the fact that it has been hampered due to being obliged to carry on its work largely through correspondence, and also due to the fact that its membership is widely distributed and that there are occasional changes in the membership. I am confident that continued progress will be made in this branch of our activities and means will be found for broadening this phase of the National Board's work, so that decisions will be rendered with the greatest possible promptness.

The last sentence in Mr. Obert's paper mentions the fact that the Boiler Code Committee's activities have placed the United States in the forefront in the boiler and pressure field, and no one can deny that statement. I have found that wherever boiler design is discussed in engineering papers, the reader is always referred to the A.S.M.E. Boiler Code, and even in the *American Marine Engineer*, George Davis, in solving boiler problems for his readers, generally refers to the A.S.M.E. Boiler Code. In the last issue of The Boiler Maker the editor suggests that reference be made in the new N.R.A. Codes to the A.S.M.E. Boiler Construction Code with the idea that all boiler manufacturers shall accept that code as minimum requirements so that even though some state has no boiler laws, the buyer is bound to receive a well constructed steam boiler or pressure vessel and those required to work or live in the vicinity of such a boiler or vessel will be assured of reasonable safety during its operation.

* Chief engineer, Ocean Accident and Guarantee Corp., Ltd., New York.
† Deputy, Industrial Commission, Madison, Wis.

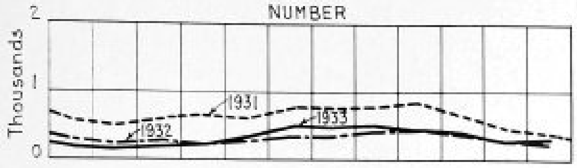
Special Report on Extending Life of Smokestacks Available to Readers

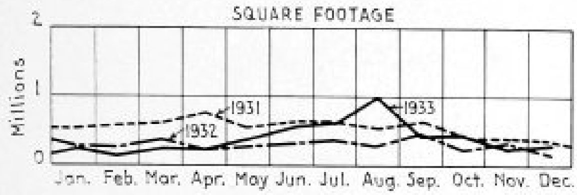
In few cases does a smokestack last more than ten years and in the majority of cases less than half that time. This fact has proven of such great interest to a manufacturer of special plate particularly adapted for long life of smokestacks that an exhaustive study of the problem has been made by engineers of the company. The results of this study are now available to readers interested in the matter in a "Special Report on Flue Gas Conductors."

Users of flue gas conductors, such as stacks, breechings and smoke jacks, have found that the metals commonly used for this type of construction are rapidly affected by the corrosive conditions encountered. It has also been found that genuine wrought iron has the ability successfully to withstand the severe corrosive influences present in such installations.

The purpose of this report is to point out the principal causes of the severe corrosive conditions to which flue gas conductors are subjected and to suggest an economical means of increasing greatly the useful life of flue gas conductors. In order to do this in as clear and concise a manner as possible the report is divided into seven sections, which are outlined as follows: Smoke stacks; boiler breechings; smoke jacks; service records of wrought iron installations; illustrations of recent wrought iron installations; specifications for wrought iron smokestacks; specifications for welded wrought iron smoke jacks, smoke pipe and smoke duct.

Requests addressed to the editor of Boiler Maker and Plate Fabricator, 30 Church Street, New York, for copies of this report will be promptly supplied.





Steel Boilers

Statistics on new orders booked for fabricated steel plate, based on data reported to the Bureau of the Census by 48 manufacturers

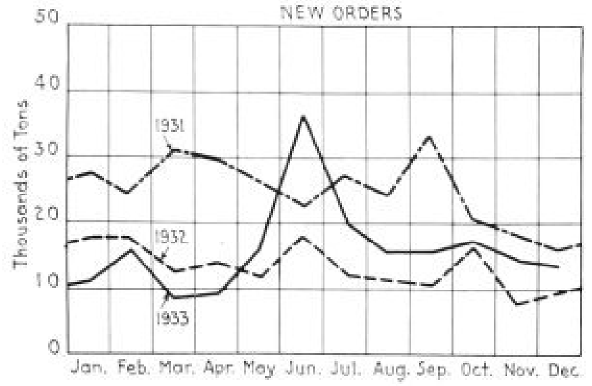
New Orders for Steel Boilers

Item	Total (Year) 1933	1932	1931
GRAND TOTAL—			
Number	4,118	3,652	7,673
Square feet	4,818,362	3,501,107	6,827,364
STATIONARY			
Total—			
Number	3,920	3,580	7,508
Square feet	4,063,818	3,377,567	6,327,262
Watertube—			
Number	551	382	672
Square feet	2,361,557	1,797,591	2,838,608
Horizontal return tubular—			
Number	393	259	487
Square feet	510,356	326,770	612,802
Vertical fire-tube—			
Number	360	373	626
Square feet	88,625	102,016	173,106
Locomotive (not railway)—			
Number	59	53	103
Square feet	35,371	45,153	87,030
Steel heating as differentiated from power boilers—			
Number	2,292	2,317	5,201
Square feet	851,071	964,131	2,300,394
Oil country—			
Number	41	7	52
Square feet	37,862	5,612	48,430
Self-contained portable—			
Number	200	166	302
Square feet	152,481	120,803	233,888
Miscellaneous—			
Number	24	23	65
Square feet	26,495	15,491	33,004
MARINE			
Total—			
Number	198	72	165
Square feet	754,544	123,540	500,102
Watertube—			
Number	132	20	88
Square feet	713,141	84,099	455,987
Pipe—			
Number	2	6	7
Square feet	2,360	11,076	8,159
Scotch—			
Number	63	44	60
Square feet	37,943	22,891	26,286
2 and 3 flue—			
Number	......	......	......
Square feet	......	......	......
Miscellaneous—			
Number	1	2	10
Square feet	1,100	5,474	9,670

New Orders for Steel Boilers—1933

Item	January	February	March*	April*	May	June	July	August	September	October	November*	December	Total (Year) 1933
GRAND TOTAL—													
Number	197	176	195	236	328	511	498	511	447	395	296	328	4,118
Square feet	218,108	128,097	245,389	225,399	395,601	549,618	611,260	994,053	428,182	427,121	286,947	308,587	4,818,362
STATIONARY													
Total—													
Number	189	162	186	228	307	496	491	441	442	377	291	310	3,920
Square feet	197,322	110,729	234,507	216,234	357,108	522,363	608,310	491,504	424,226	362,185	279,080	260,250	4,063,818
Watertube—													
Number	24	13	40	34	51	73	90	61	53	41	34	37	551
Square feet	122,324	48,816	151,580	112,394	222,373	300,352	380,090	300,713	233,473	188,721	157,460	143,261	2,361,557
Horizontal return tubular—													
Number	10	10	15	32	33	48	54	47	49	49	27	19	393
Square feet	14,185	10,951	19,318	38,555	44,720	60,682	75,732	63,135	62,761	62,454	34,831	23,032	510,356
Vertical fire-tube—													
Number	33	26	13	30	23	36	24	44	37	42	23	29	360
Square feet	5,865	4,930	3,036	6,610	6,785	8,479	7,501	12,416	8,604	12,988	4,424	6,987	88,625
Locomotive (not railway)—													
Number	.....	4	4	3	1	7	4	9	8	4	9	6	59
Square feet	.....	3,469	2,513	1,463	338	4,271	1,338	7,484	5,011	4,260	3,042	2,182	35,371
Steel heating as differentiated from power boilers—													
Number	112	105	98	109	173	310	284	245	265	222	178	191	2,292
Square feet	45,155	39,431	39,087	39,000	64,085	122,625	122,771	84,290	91,163	78,409	61,700	63,355	851,071
Oil country—													
Number	.....	.....	.....	3	4	1	7	5	10	.....	3	8	41
Square feet	.....	.....	.....	3,750	5,000	1,083	2,700	2,155	10,930	.....	2,132	10,112	37,862
Self-contained portable—													
Number	10	4	13	15	16	17	27	27	19	18	15	19	200
Square feet	9,793	3,132	10,635	14,050	12,743	11,251	17,949	20,319	11,847	15,234	14,935	10,593	152,481
Miscellaneous—													
Number	.....	.....	3	2	6	4	1	3	1	1	2	1	24
Square feet	.....	.....	8,338	412	1,064	13,620	229	992	437	119	556	728	26,495
MARINE													
Total—													
Number	8	14	9	8	21	15	7	70	5	18	5	18	198
Square feet	20,786	17,368	10,882	9,165	38,493	27,255	2,950	502,549	3,956	64,936	7,867	48,337	754,544
Watertube—													
Number	5	4	2	2	12	8	1	66	.....	16	4	12	132
Square feet	18,488	4,653	5,208	7,653	35,646	21,639	1,266	500,688	.....	64,071	7,743	46,086	713,141
Scotch—													
Number	2	9	7	6	9	7	6	4	5	2	1	5	63
Square feet	988	11,615	5,674	1,512	2,847	5,616	1,684	1,861	3,956	865	124	1,201	37,943

* Revised.



Fabricated Steel Plate

Statistics based on reports submitted to the Bureau of the Census by 68 identical manufacturers

NEW ORDERS (TONS) FOR FABRICATED STEEL PLATE

Year and Month	Total	Oil Storage Tanks	Refinery Materials & Equipment	Tanks Cars	Gas Holders	Blast Furnaces	Miscellaneous
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
1932							
January	17,613	4,783	444	11	122	129	12,124
February	17,755	4,115	525	13	1,285	40	11,777
March	12,564	1,161	197	...	1,009	150	10,047
April	14,068	1,400	604	157	710	30	11,167
May	11,788	2,360	444	...	923	...	8,061
June	18,383	2,808	11	23	1,426	...	14,115
July	12,485	3,661	702	7	1,326	2	6,787
August	11,916	4,394	471	15	53	...	6,983
September	11,109	3,753	271	...	173	15	6,897
October	16,737	5,941	918	25	255	70	9,528
November	7,873	1,446	342	...	20	...	6,065
December	*9,510	3,154	590	43	188	10	*5,525
Total (Year)	*161,801	38,976	5,519	294	7,490	446	*109,076
1931							
January	27,518	2,598	1,061	112	2,791	111	20,845
February	24,438	3,585	2,536	653	1,344	75	16,245
March	31,056	2,538	2,925	1,027	2,036	833	21,697
April	29,916	7,749	2,059	778	1,522	25	17,783
May	26,210	2,411	996	337	1,866	230	20,370
June	22,806	4,679	1,147	18	789	356	15,817
July	27,261	4,136	1,911	89	2,289	51	18,785
August	24,282	1,138	1,830	14	2,844	125	18,331
September	33,473	4,024	1,438	102	8,963	254	18,692
October	20,839	1,955	2,076	170	102	200	16,336
November	18,268	1,755	642	98	314	401	15,058
December	16,442	778	1,329	92	266	86	13,891
Total (Year)	302,509	37,346	19,950	3,490	25,126	2,747	213,850

* Revised.

Approval Given Code Authority for Boiler Manufacturing Industry

Official N. R. A. approval was given by General Hugh S. Johnson today to the Code Authority selected by the Boiler Manufacturing Industry, as follows: Chairman, Owsley Brown, Springfield, Ill.; vice-chairman, A. C. Weigel, New York City. Members: A. W. Strong, Minneapolis; R. B. Mildon, Philadelphia; Starr H. Barnum, New Haven, Conn.; Walter F. Keenan, Jr., New York City; A. G. Pratt, New York City; Charles Tudor, Cincinnati; H. H. Clemens, Erie, Pa., and H. B. Kendall, New York City.

These members will serve until they are re-elected or their successors chosen at the 1934 annual meeting of the American Boiler Manufacturers' Association.

Information on Machine Gas Cutting for Plate Fabricators

Machine gas cutting has been called the key to better design, faster production, and large economies in the manufacture of fabricated metal products of all kinds. With this thought in mind, the manufacturer of special equipment for all manner of cutting operations has prepared complete data on the subject in the form of an attractively illustrated and practical book.

The one major thing that machine gas cutting accomplishes is to enlarge immensely the scope of welded steel fabrication. It is claimed, in fact, that machine gas cutting has made welded fabrication practicable by providing a method for shaping parts of all sizes and contours from steel plate and slabs which brings the cost within reasonable bounds. These parts could be made by other methods but at a cost that would be prohibitive. So widely has this fact become known that machine gas cutting is generally thought of only in connection with welded construction. It is not so generally appreciated, however, that this method can be used to equal advantage for cutting out pieces of many shapes and dimensions for constructions in which welding plays no part.

The book covers in considerable detail gas cutting applications of all kinds, and by the use of illustrations and explanatory text describes the tremendous variety of parts that can be shaped with the aid of this process. The various types of machines developed for production operations are completely described and illustrated.

Copies of the book—"Machine Gas Cutting" may be obtained by any reader interested by addressing a request to the editor of BOILER MAKER AND PLATE FABRICATOR, 30 Church Street, New York City.

HOISTS.—The Harnischfeger Corporation, 4400 West National Avenue, Milwaukee, Wis., has issued a new bulletin on hoists for every plant and purpose. This publication treats upon the application of hoists to both general and specific problems. Profusely illustrated in color with photographs of installations and diagrams explaining simplified construction and operation, it covers the vital points in modern hoist design. The bulletin lists the ratings and operating ranges for type "R" hoists along with specifications and electrical accessories. Copies may be had upon application to the company's agents and representatives or to the factory directly. Ask for Bulletin No. RH-1.

ENGINEERING ACHIEVEMENTS.—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is distributing copies of its review of electrical developments in 1933, compiled by H. W. Reading. The scope of electrical applications extends into every possible field and many of the developments outlined will be of particular interest to our readers.

Discussion of convention committee reports of

MASTER BOILER MAKERS

The October, 1933, issue of THE BOILER MAKER contained committee reports of the "Master Boiler Makers' Association Convention in Print." While the publication of discussions of these reports by members and interested readers has been somewhat delayed, below are given several papers submitted, which, it is hoped, will influence all those who desire to express opinions on the subjects covered to send in their contributions. The discussions will be held open for a short time only, and then the "Proceedings" of this convention will be published and distributed.

Staybolt Taps

We have gone over carefully the article on page 212 of the October issue, covering staybolts, and would state this entire article is exactly in line with our experience.

With reference to the limits, we feel that these cover practical working tolerances.

On the subject of staybolt taps we feel the six fluted tap would be preferable for this work.

On the subject of Whitworth Standard would state we have noted with interest that for sometime our die orders for staybolt work have been constantly increasing toward Whitworth Standard. Our own experience has been that the Whitworth Standard for both taps and dies gives them a somewhat longer life as entirely in line with the comments in the article.

We appreciate very much the opportunity of being able to express ourselves in this matter, and thank you for your interest.

Cleveland, O. H. A. ANDERSON,
The Acme Machinery Co.

Welding, Flue Cleaning and Staybolts

Referring to your letter of October 24, calling attention to the October issue of THE BOILER MAKER, containing the "Master Boiler Makers' Association Convention in Print."

I have gone over this magazine and I find on page 198 the article on "Fusion Welding." Too much importance cannot be stressed on good welding wire. In case of failure prevention, it is the cheapest in the long run.

On page 199 I note that the method of welding tanks is quite a subject. I believe it would be cheaper than riveting with as good results.

On page 201 "Cleaning of Flues or Tubes." I note the method of sand blasting of flues as done at some shops. At one time I considered this as a practical way of cleaning. The question is—will this way of cleaning tubes remove soot from the interior of flues as well as it does the scale. This is a hindrance to steaming also.

On page 212 article on "Staybolts." Page 213 I note staybolts to be chamfered ⅛ inch to permit ready entrance of bolt. This should be done as it is also easier on the dies when threading the bolts.

I believe the method mentioned on the subject when tapping out staybolt holes on new work to tap the holes and follow re-tapping with the second tap by using a light motor and the full size tap assures keener threads and prolongs the life of the new tap used.

Cleveland, O. J. J. MAGINN, S.M.P.,
Nickel Plate Road.

Corrosion and Pitting

On page 191, of the October number of THE BOILER MAKER is the following quotation: "It is generally agreed except perhaps by those interested in boiler compounds that a film of scale up to $\frac{1}{16}$ inch thick has hardly any noticeable effect on the operating efficiency of a steam boiler. Its presence, however, may be very harmful from the maintenance point of view, due to overheating of the metal."

The above paragraph appears to be very misleading and with this end in mind, have referred to leading experts on the subject.

To quote Prof. Shealy of the University of Wisconsin: "When water is evaporated in a boiler all of its impurities are left behind as a soft mud, or more often they form a hard scale on all the heating surfaces. Scale thus formed is a very poor conductor of heat, and its presence, therefore, reduces the efficiency and capacity of a boiler by reducing the amount of heat that can pass through the heating surface. In the case of watertube boilers, scale collecting in the tubes greatly hinders the circulation of water and liberation of steam. Besides increasing the coal bills, scale causes the boiler to wear rapidly. Some forms of scale contain acids which may attach to the iron and corrode or eat it away."

Lionel S. Marks M E. says in regard to the subject: "Many tests have been made to indicate the loss in boiler efficiency due to presence of scale. Some such tests would indicate that a scale ⅛ inch in thickness will decrease the efficiency as much as 20 percent, but unfortunately the figures that have been published are not to be implicitly relied upon. This is due largely to difference in conditions between tests with clean boilers and those in which scale has been allowed to accumulate, but to a greater extent the impossibility of knowing the thickness of scale that has formed over all the heating surfaces. The rate of such a falling off of efficiency as the thickness of scale increases will depend upon the nature of the scale formed. The effect of a very thin coat of scale on the heating surfaces of a boiler would probably be impracticable in the efficiency of a boiler."

To quote the A. S. M. E. Boiler Code on care of boilers: "Scale in the tubes of watertube boilers or on plates over the fire of any boiler is particularly bad, often causing them to rupture." In using the turbine cleaner care should be exercised not to grind the metal of tubes, especially in bent tubes.

Judging from the findings of these authorities one is led to believe that the condition of the scale, that is whether hard or soft, would be of as great importance as would the thickness. But we do know that scale on heating surfaces means more fuel to maintain maximum efficiency of the boiler. A railroad using a large quantity of coal yearly should consider this question very seriously as a 10 to 20 percent loss in fuel means a heavy deficit in dollars and cents.

We have had a steel plate firebox heating boiler built for 15 pounds working pressure show corrosion on tubes which had scale approximately 1/16 inch thick.

Possibly the committee on watertube boilers feels that their individual experiences justify their statement but I believe they will find many who do not agree with them. I would suggest that the convention members continue the discussion on this subject.

Oswego, N. Y. J. A. SHANNON.

Staybolt Tap Standards

No tool used on a railroad causes more discussions than staybolt taps, as there seems to be a wide variation of opinion on this subject. Some roads prefer a straight fluted style of tap and will not consider a change mostly on account or regrinding the taps, while others prefer a spiral fluted tap because of its advantages in cutting qualities. Tests are proving that spiral taps are far superior to the straight taps, and their popularity is constantly gaining.

About fifteen years ago the spiral tap was put on the market and it met resistance from every angle because everyone was afraid it was not practical. The greatest difficulty was in grinding of the spiral, but now most roads are grinding them just as well as they did the straight tap. Every road has shops equipped with grinders that can be used for grinding the taps and all grinding machine manufacturers have the necessary information in their standard catalogues or have literature available on the subject.

Straight fluted taps have a greater tendency to whip and chatter at high speeds than a spiral fluted tap. The spiral tap having this advantage enables it to tap a cleaner and more accurate hole. This is the reason they run so smoothly and stay cool at high speeds which in turn means less grinding; thus giving longer life to the taps.

The form of thread is rapidly changing from V form and Whitworth form to U. S. form. The V form never will be a popular thread again as it will not stand up on a tap like the U. S. form or Whitworth form due to the top of the thread being too sharp. This sharp edge wears away too fast, causing the taps to go undersize on the outside diameter making a lot of trouble in fitting the staybolts. The Whitworth form has a radius on the top and bottom of the thread which must be held accurately on both the taps and staybolts or the staybolts will not fit the tapped holes; causing leaks. More roads are realizing it is important to cut their tapping costs and the only way this can be accomplished is to determine what style of thread and tap will give the most in actual dollars over a given time. With this in view it is only natural that a spiral fluted tap with a U. S. form of thread should take the lead and it seems as though this is the proper solution to the problem.

Many methods are used for checking lead error but no universal practice is used. Every road has its own method and whether it is right or wrong they continue to use it. There is only one way to measure lead and that is with a gage made for this purpose. The old way, of gaging with a rule for settling this point for all tool inspectors, is past; hence no more guess work.

The question of measuring pitch diameter on a five fluted tap is brought up from time to time. Brown & Sharpe have solved this problem for us as they have developed a micrometer for measuring the pitch diameter on a five fluted tap. This micrometer is accurate and can be operated as easily as any other standard micrometer for measuring pitch diameter.

Five fluted taps have been used as a standard on most of the roads, and now that we have a micrometer for measuring the taps it seems as though they should become standard on all roads. By being able to measure the pitch on both spiral and straight fluted taps it will be an easy matter to keep an accurate check on the taps, taking them out of service before they run undersize on the pitch diameter. This will save time in selecting and fitting the bolts; it will also help a lot in doing away with leaky boilers.

Much attention is given to tolerances of staybolts taps and no two roads have the same tolerances or do they agree on a standard set. The tolerances for cut thread staybolts taps used by most manufacturers are as follows:

Minimum major diameter—basic plus 0.001 inch
Maximum major diameter—basic plus 0.005 inch
Tolerance—0.004 inch
Minimum pitch diameter—basic plus 0.001 inch
Maximum pitch diameter—basic plus 0.004 inch
Tolerance—0.003 inch
Tolerance of lead error—plus or minus—0.003 inch

By using this set of tolerances you have something that every tap and bolt manufacturer can easily follow and, at the same time, keep his products well within the tolerance.

In retapping of fireboxes, it is not necessary to use two taps; first using an old tap and then using a new tap for sizing. There will be no trouble with dragging or sagging on the tap if the proper tap is used for the job. With an easy cutting tap you can use a small motor getting more accurate and uniform holes than you could by using two taps. One five fluted spiral tap will do this work providing it is of the proper design.

Millersburg, Pa. J. A. W. BRUBAKER, President,
W. L. Brubaker & Bros. Co.

Corrosion and Pitting—Fusion Welding—Corrugated Side Sheets

We have very little trouble to contend with insofar as failure of boiler or firebox sheets due to corrosion and pitting is concerned. In fact, I cannot recall of any sheets that were removed that could be attributed to this condition.

The corrosion of engine tanks especially in the feed-water heater compartment has been our serious problem. We had considerable difficulty getting one shopping out of the auxiliary heater and iron pipes in the feed-water heater compartment. These engines were shopped after 16 to 18 months service and at every shopping, the heater and pipes were badly corroded and pitted, which necessitated renewing.

We have more than doubled the life of the heater and pipes by applying a coat of zinc approximately 0.009 inch thick. This is a process where the parts to be coated are thoroughly cleaned and all rust, scale, oil and other foreign matter are removed by blasting with steel grit, then the zinc in molten state is sprayed on the parts to whatever thickness is desired.

FUSION WELDING

The committee's report as outlined on fusion welding, showing the proper application of sheet patches, syphons and complete fireboxes as well as the welding of mis-

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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cellaneous parts, has been and is now, our standard practice, specified for welders and those involved in preparing sheets and patches to be welded.

The welding of locomotive tender tanks especially those of a capacity of 17,000 gallons or over is quite a problem. In 1928, we had five (all welded) with cast steel water bottoms and twenty (all riveted) with a capacity for 17,500 gallons built. The riveted tanks have never given any trouble with the exception of renewing or patching a few splash plates at the time of shopping.

The welded tanks after being in service about one year started cracking vertically along tee bars on the side walls of the tanks. We were continually applying patches or welding up cracks. We then decided that the walls of the tanks were not rigid enough and due to the splash of the water were continually cracking the weld on the splash plates and eventually placing all the strain on the walls of the tank.

When these tanks were built, the tee bar, stiffening angles, cross braces and splash plates were welded 2 inches in 8 inches. In order to try and eliminate the cracking of the tank walls and breaking loose of splash plates, we chipped off all weld and rewelded 4 inches in 8 inches on both sides of tee iron cross braces and stiffening angles. We did this about four years ago and since then we have not had any trouble or difficulty with the (all welded) tanks. They have been giving just as good a service as the (all riveted) tanks.

Corrugated Side Sheets

We have had a great deal of trouble with our heavier power, with leaking staybolts and cracked side sheets. These boilers carry 240 pounds steam pressure and two or three months after going into service, side sheets started to leak. We were continually redriving staybolts and after six months, staybolts had been redriven so many times, it was necessary to renew them to keep an engine in service until it was due for shopping. After fourteen to twenty months, engines were shopped for general repairs and side sheets were renewed. After two or three months they would again start leaking. We then started experimenting with several kinds of alloy steel but we did not have any better success with these than we did with carbon steel. We then applied a new design of grates with an equal distribution of air over the entire grate area, redrafted the front end and changed over the exhaust arrangement. These changes practically eliminated staybolt leakage. We still continue to renew side sheets every shopping approximately every eighteen months.

We then started to experiment with a corrugated side sheet. We equipped three of these engines with a corrugated sheet on one side and a standard sheet on the other for a comparative test.

After twenty-one months service the engine was shopped. We removed 30 staybolts in sheets to examine both the water and fire side of sheet for cracks. Practically every hole on the standard sheet was cracked and the only defect found on the corrugated sheet was at the bottom of the corrugation extending to the mud-ring, where we found cracks. We renewed the standard sheet and applied patches to the bottom of the corrugated sheet. On the other two engines after eighteen and twenty months service, they were shopped and the sheets were found in practically the same condition as the first engine, the standard sheet renewed and the corrugated sheet had small patches applied at the bottom of the corrugation.

It is my opinion that the corrugated sheet will double and possibly triple the life of the other sheet for it has proven so far, that this corrugation or expansion rib takes care of the unequal expansion and contraction which is the cause of cracked side sheets. The first engine we applied the corrugated sheet to has been in service thirty-two months and not giving any trouble or showed any indications of weakness.

This corrugation is 1½ inches deep, 4 inches wide and 32 inches long. There are three of them in a side sheet spaced equally between the door and flue-sheet and start between the first and second row of staybolts above the mud-ring extending vertically taking in seven or eight rows of staybolts. The bulge or dish in the corrugation is toward the fire side of sheet.

Billerica, Mass. E. J. Brennan, G. B. F.,
Boston & Maine Railroad

Ferroweld.—The Lincoln Electric Company has issued a leaflet describing an electrode for welding cast iron called Ferroweld. Results of welding cast iron with this electrode are given.

Questions and Answers

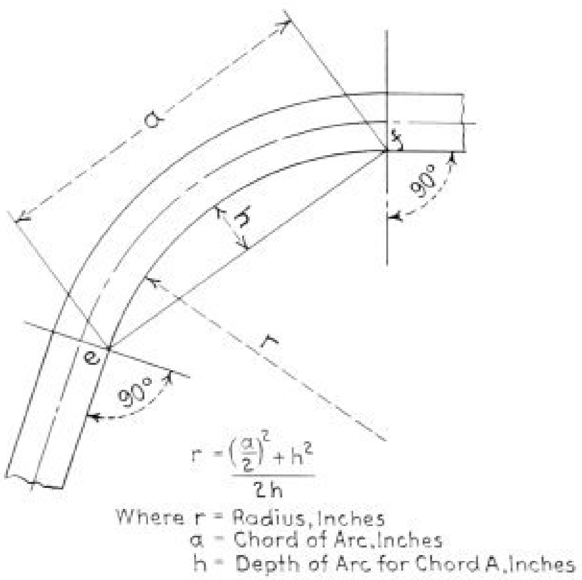
This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special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

By George M. Davies

Radius of Flange of Boiler Head

Q.—In determining the radius of a flange of a boiler head, how far, as the distance *A* in sketch, do you allow in finding the radius? When the right angles are formed, the distance *B* would be the radius.—H. H.

A.—The radius of a flange of a boiler head is determined as illustrated in Fig. 1. The maximum dis-



Determining radius of boiler head flange

tance for *a* that could be used, would be a straight line through the points *e* and *f* which are located at the tangent points of the curve and the straight lines.

It is not necessary that *a* be taken through the points *e* and *f* as long as these points are not exceeded. The distance *h*, however, should always be used with the *a* dimension by which it was determined, in computing for *r*.

Calculating Openings in Shell of Pressure Vessel

Q.—Will you please answer the following questions: Page 83 of 1932 "Unfired Pressure Vessels" A.S.M.E. In small print "Class 1. 17.5—(8.41, etc.)" Where do you get 8.41? Tenth line from top of page says diameter of opening is 8.75. Hope you can tell me why a 2-inch hole is to be deducted from the thickness, *t*, which is found by using 90 percent as the efficiency of the shell. Of course, I know it is stated in the rule, but what is your idea about the rule? Why not forget about the 2-inch hole and use 80 percent instead of 90 percent or some other percent, or for depth of flange, 3 times *t* instead of 2½? My own idea for the value of *t* (meaning the thickness of shell plate to which we are comparing the net section of reinforced plate *plus* net section for distance *AB* (17.5) of the shell plate with the hole in it) would be based on the same diameter vessel whose shell would be suitable for the same pressure but with a longitudinal seam 10 percent less efficient. (This would be 90 percent only in case the shell were seamless). In other words, in the case of an ordinary butt strap boiler, the efficiency of such strap being 85 percent, the efficiency of the manhole in the shell would be 95 percent.—H. B. B.

A.—That part of the 1932 A.S.M.E. Code for Unfired Pressure Vessels referred to in the question is as follows:

UA-15. An 8-inch riveted nozzle is located on a pressure vessel as shown in Fig. UA-1E. The shell data are as follows: inside diameter = 54 inches; thickness = 1¼ inches; working pressure = 350 pounds per square inch; working temperature = 440 degrees F.; minimum tensile strength 55,000 pounds per square inch.

Assume the nozzle to be 8 inches inside diameter, the thickness of the nozzle neck to be $^9/_{16}$ inch, the thickness of the riveting flange to be ¾ inch and the outside diameter of the riveting flange to be 17¼ inches.

Assume also 18 1¼-inch rivets on a 14-inch rivet circle with $1^9/_{32}$-inch rivet holes straddling the longi-

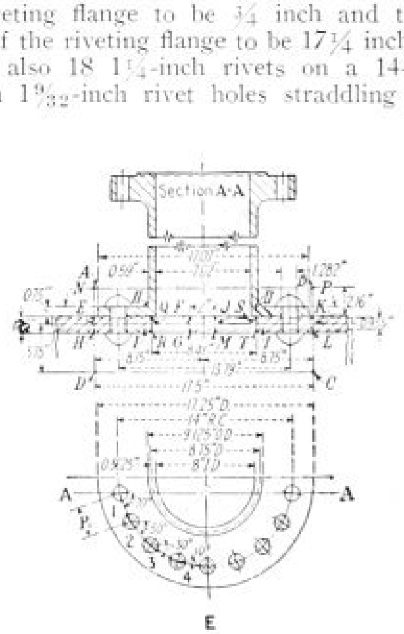


Fig. UA1

tudinal center line through the nozzle; minimum tensile strength = 55,000 pounds per square inch. The opening in the shell is 8¾ inches to provide space for calking.

The weakest section will be along a line parallel to the longitudinal axis passing through the centers of the two rivets nearest the center line of the nozzle as shown in Fig. UA-1E.

The neck of the nozzle may be considered as reinforcement for a distance of 2½ times its thickness measured from the back of the riveting flange. Therefore the distance of line AB (see Fig. UA-1E) from the outside of the shell = $(2.5 \times 0.5625) + 0.75 = 2.16$ inches.

Cross section I = $17.5 - (8.41 + 1.282 + 1.282) \times 1.25 = 8.16$ square inches

Cross section II = $(2.16 \times 2 \times 0.59) + [17.07 - (7.62 + 0.59 + 0.59 + 1.282 + 1.282)] \times 0.75 = 2.55 + 4.28$ . . 6.83 square inches

Total actual cross section. . . . . . 14.99 square inches

The required thickness when $E = 0.90$ is

$$t = \frac{350 \times 27}{11{,}000 \times 0.90} = 0.955 \text{ inch}$$

Required cross section $0.955 \times (17.5 - 2) = 14.81$ square inches.

Therefore the design meets the requirements of Rule (1) of Par. U-59b.

The Boiler Code Committee has given the following interpretation with regard to the section of the opening to be used when calculating the strength of manhole openings.

For riveted nozzles when the rivet holes straddle the center line of the opening, the section is taken through the rivet holes nearest the center line and the dimensions used in the calculation are those in this plane, except that the limit lines are defined by the diameter of the opening in the shell at the center line of the opening and the actual wall thickness of the shell or nozzle.

It is not required that the means of attachment shall be within the limit lines. For instance, in many riveted nozzles, especially those of smaller diameter, it is manifestly impossible to locate the rivets within a distance of one diameter from the center line of the opening. In such cases, the rivets are credited with their full shearing strength, regardless of their location with respect to the limit lines, but only those rivet holes or parts of rivet holes lying within the limit lines are considered when determining the area of the hole to be reinforced and when computing the reinforcement, either in the nozzle flange or in the excess shell thickness.

From this interpretation and by referring to Fig. UA-1, it is noted that the section A-A is taken through the center line of the rivet holes nearest to the center line of the nozzle and therefore the 8.41 inches referred to in the question is the distance across the opening in the shell at this point, while the 8.75 inches is the diameter of the opening on the center line of the nozzle. From the interpretation given it is correct to use 8.41 inches in the calculations instead of 8.75 inches.

The reason for deducting the 2-inch hole from the thickness, t, which is found by using 90 percent as the efficiency of the shell has been explained by the Boiler Code Committee, which I believe will fully answer your question:

"These rules are substantially what was required by those now obsolete in the 1931 combined edition of the Boiler Code, but are more explicit as to the details of calculations.

The reason that the efficiency E is taken as 0.90 is to make the revised rules conform with the old and well-established rules for reinforcement of steam domes and manholes.

The reason for deducting 2 inches from the diameter of the opening in deducting the area to be reinforced was to permit the use of many types of small openings which experience has shown to be safe, such as hydraulic couplings, welded into thin shells and welding necks without reinforcing pads."

Size of Rivets for Boiler Patches

Q.—Will you please tell me what size rivets to use in patching boilers? Should the diameter of the rivet equal twice the thickness of the plate; should the pitch of rivet equal from 2½ to 3 diameters of the rivet; should the lap for a single-riveted joint equal 3 diameters of the rivet; should the lap for a double-riveted joint equal 5 diameters of the rivet? Hope to get some modern data on this work. If it is not too much trouble to you, would you explain the layout of a properly formed patch?—H. H.

A.—*(1) Size of rivets.* Rivets fail in either of two ways, namely, by shearing or crushing. For each thickness of plate there is a critical diameter of rivet equally strong for shearing and crushing. Rivets smaller than the critical diameter fail by shearing and those larger by crushing.

Table I gives the critical rivet diameters for various thicknesses of plate.

TABLE I—CRITICAL RIVET DIAMETERS

Plate Thickness inches	Steel Rivet Diameters		Iron Rivet Diameters	
	Single Shear inches	Double Shear inches	Single Shear inches	Double Shear inches
¼	0.679	0.340	0.804	0.402
5/16	0.849	0.424	1.005	0.503
⅜	1.019	0.509	1.206	0.603
7/16	1.188	0.594	1.407	0.704
½	1.358	0.679	1.608	0.804
9/16	1.528	0.764	1.809	0.905
⅝	1.698	0.849	2.010	1.005
11/16	1.867	0.934	2.211	1.106
¾	2.037	1.019	2.412	1.206
13/16	2.207	1.104	2.613	1.307
⅞	2.377	1.188	2.815	1.407
15/16	2.547	1.274	3.016	1.508
1	2.716	1.358	3.217	1.608

The above table shows the theoretical rivet diameters for the various plate thicknesses, however, commercial

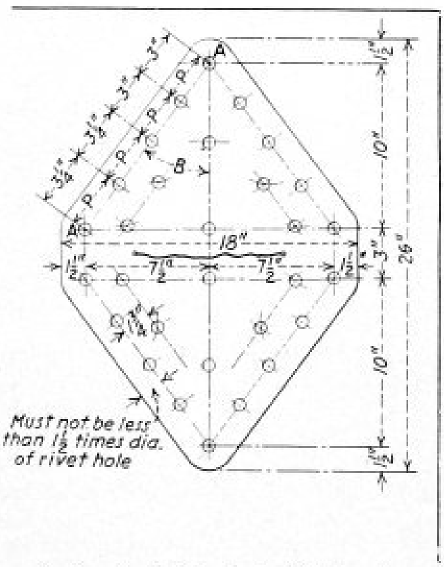


Fig. 1.—Crack 8 inches to 12 inches long

rivet diameters vary in sixteenths of an inch. In using the above table the nearest commercial size should be used after allowing 1/16 inch for the rivet hole.

(2) Pitch of Rivets. The pitch of the rivets in boiler seams is dependent upon the efficiency required and the ability to calk.

Tables giving the pitch and size of rivets for various thickness of plates, with their computed efficiencies can be found in any engineering handbook.

(3) Lap—Single riveted seams.

On longitudinal joints of all types of boilers and on circumferential joints of drums having heads which are not supported by tubes or through stays, the distance from the centers of rivet holes to the edges of the plates, except rivet holes in the ends of butt straps, shall not be less than 1½ and not more than 1¾ times the diameter of the rivet holes; this distance to be measured from the center of the rivet holes, to the calking edge of the plate before calking. The plate edge shall be beveled to an angle not sharper than 70 degrees to the plane of the plate and as near thereto as practicable.

The distance from the centers of rivet holes of circumferential joints to the edges of the plate in boilers having heads which are supported by tubes or through stays shall not be less than 1¼ times the diameter of the rivet holes.

(4) Lap—Double riveted seams. The lap from the centers of the rivet holes to the edge of the plates would be the same as in (3). The distance between the center lines of the rivet holes or back pitch would be determined as follows:

For longitudinal joints the distance between the center lines of any two adjacent rows of rivets, or the back pitch measured at right angles to the direction of the joint, shall have the following minimum values:

(a) If $\frac{P}{d}$ is 4 or less, the minimum value shall be $2\,d$;

(b) If $\frac{P}{d}$ is over 4, the minimum value shall be: $2\,d + 0.1\,(P - 4d)$

where:

P = pitch of rivets in outer row where a rivet in the inner row comes midway between two rivets in the outer row, inches

P = pitch of rivets in the outer row less pitch of rivets in the inner row where two rivets in the inner row come between two rivets in the outer row, inches

(It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced)

d = diameter of the rivet holes, inches

The back pitch of rivets shall be measured either on the flat plate before rolling, or on the median line after rolling, and the back pitch as there measured shall govern the locations of rivet holes in the butt straps.

The distance between any two rows of rivets in a circumferential joint or back pitch shall not be less than $1.75\,d$.

(5) Design of patches. The design of a properly formed patch depends entirely upon the individual case under consideration. It is important that not only the patch being applied is of sufficient strength but that the application of the patch has not weakened the shell due to presence of adjacent holes not included in the patch.

Fig. 1 shows a typical patch for a longitudinal crack and the method used in determining its proportions is typical of all boiler patches of this type.

First determine the length of the crack and drill small holes at each end. Consider the length of the crack to be from the extreme edge of one hole to the extreme edge of the other. Determine the actual value of the metal lost by the formula:

$$A = l \times t \times TS$$

where:

A = actual value of metal lost due to crack in pounds per square inch
l = length of crack in inches
t = thickness of plate in inches
TS = tensile strength of sheet in pounds per square inch

It is then necessary to determine the number of rivets needed in shear on each side of the patch based on the actual value of the metal lost. The original formula would then be

$$N = \frac{l \times t \times TS}{S}$$

N = number of rivets required in shear on each side of the patch
S = shearing value of one rivet in single shear

After determining the number of rivets required to hold the patch, it should be laid out, spacing the rivets so as to give a desired calking space and also to maintain an efficiency at least equal to the efficiency of the longitudinal seam.

To find the efficiency along the line of rivets *A-A*, Fig. 1, it is first necessary to consider it as a longitudinal seam. The efficiency would then be:

$$E = \frac{P - d}{P}$$

where;

E = efficiency of seam in percent
P = shortest pitch of rivets in inches
d = diameter of rivet holes in inches

This would be the efficiency of the rivets along *A-A*, Fig. 1, without considering the angularity. The next step is to determine the angle *B*, Fig. 1, which the line *A-A* makes with the circumferential seam; and then by the following formula determine the factor allowed for the angularity of the joint:

$$F = \frac{2}{\sqrt{3 \times \text{sine } B^2 + 1}}$$

where F = Factor for angularity

Multiply the efficiency first obtained by the factor for angularity $(E \times F)$; the result being the actual efficiency along the line *A-A* Fig. 1. In summing up, the entire formula can be expressed as follows:

$$\text{Angular Efficiency} = \frac{2\,(P\text{-}d)}{P\sqrt{3 \times \text{sine } B^2 + 1}}$$

Not more than three holes in a row may be drilled in a boiler shell without determining efficiency.

Cracks over 12 inches in length should be reinforced with inside and outside cover plates.

Under no circumstances should it be permitted to weld up cracks of rivet holes in the barrel of a boiler. When it becomes necessary to remove an old patch for the purpose of applying a new one, it is desired to use as many of the old holes as possible, leaving open all holes not used and drilling new holes where required.

ENDURO STAINLESS STEEL.—A brochure, just published by the Republic Steel Corporation, Youngstown, O., contains a large fund of comprehensive information on architectural applications of Enduro stainless steel—its fabrication, properties, shapes and finishes available, and a list of distributors who maintain warehouse stocks. The booklet was prepared in collaboration with leading architects and engineers who have specified Enduro in important building projects. Although most architects and engineers will have access to the booklet because it is included in the 1934 Sweet's Architectural Catalogues, many contractors, fabricators and building owners or managers will wish to obtain copies. Copies will be sent upon request to those interested. Please identify the booklet as Bulletin 124.

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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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

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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.
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.

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Secretary — Albert F. Stiglmeier, general foreman boiler maker, New York Central Railroad, Albany, N. Y.
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Vice-President—Owsley Brown, The Springfield Boiler Company, Springfield, O.
Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland, O.
Executive Committee—(Three 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. (Two years)—J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.; M. E. Finck, Murray Iron Works, Burlington, Ia.; A. C. Weigel, Combustion Engineering Corporation, New York. (One year)—Homer Addams, Fitzgibbons Boiler Company, Inc., New York; George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn. (*Ex-Officio*)—H. H. Clemens, Erie City Iron Works, Erie, Pa.

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

Cities

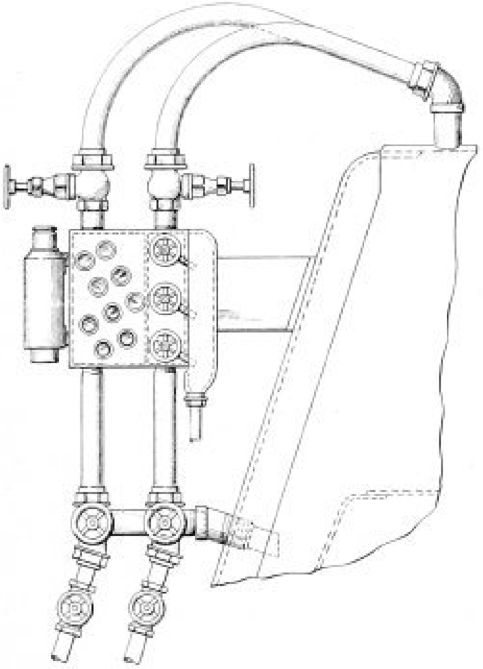
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,880,847. WATER GAUGE. JOHN J. DALY, OF VIRGINVILLE, PENNSYLVANIA.

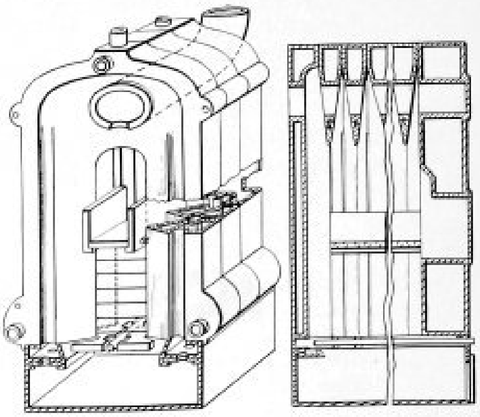
Claim.—In a water gauge for boilers, a housing, said housing including a pair of compartments each independent of the other, water level deter-



mining 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.

1,814,391. FURNACE. HANS CHRISTIAN JORGENSEN, OF MONTREAL, QUEBEC, CANADA.

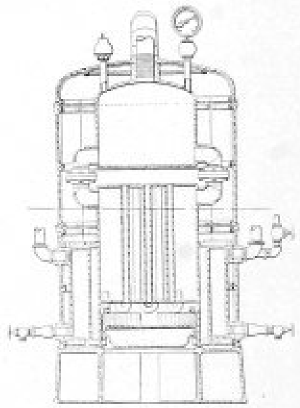
Claim.—In a furnace, a body of inverted U-shaped form forming a central fire pot and combustion chamber thereover, a grate extending across the bottom of the open fire pot, a series of vertical flues formed in the walls of the furnace body at each side of the fire pot, hollow ribs projecting into the fire pot and located between the flues and forming water spaces the interspaces between the ribs communicating with the interior of the flues and with the fire pot and combustion chamber, means for supplying heated air to the lower ends of the flues, a curtain wall located at each side of the fire pot and extending across the open inner side of each interspace above the level of the fire bed and carried by the aforesaid ribs, a removable plate carried between the curtain walls and adapted to be passed outward through the fire door opening and to form directing means whereby the hot gases are directed from the fire bed into



the interspaces between the water spaces to pass inward over said curtain walls into the combustion chamber, a preheating air chamber located at the bottom ends of the flues and within the ash pit and so formed as to receive the hot rays from the fire bed on the walls thereof, and having a perforated bottom and a slide damper provided with perforations to control the size of the opening formed by the perforations of the preheating chamber.

1,813,906. BOILER. FRED M. CARON, OF SPRINGFIELD, MASSACHUSETTS, ASSIGNOR TO RICHMOND LEWIS, OF SPRINGFIELD, MASSACHUSETTS.

Claim.—A boiler having a water-containing casing, a fire box beneath said casing, an outer casing surrounding both the water-containing casing and the fire box and connected to the fire box to receive hot gases there-



from, and a water chamber connected to the water-containing casing adjacent the bottom of the latter and positioned between the two casings at a level partly above and partly below the bottom of the water-containing casing to form a preheating and sediment collecting reservoir. Three claims.

Boiler Maker and Plate Fabricator

Welding Wrought Iron

While wrought iron is almost as old as civilization itself in its uses, the recent revival of this metal in industry has required an accompanying enlightenment in its physical and chemical characteristics in order that its application might result in the fullest advantage being taken of its qualities. For this purpose the details of procedure in welding wrought iron outlined in an article in this issue should be of interest to those engaged in designing and building tanks, stacks, retorts, uptakes and other plate products where corrosion resistance, ease of welding and like factors are of importance.

Because of its nature wrought iron is peculiarly adapted to fabrication by means of fusion welding. The procedure, while in general similar to that for steel, varies somewhat in detail and technique. Welding temperatures, the appearance of the metal when fusing and manipulation of the torch or arc must be studied carefully, but once understood the operator is assured of consistently good results. One factor peculiar to the welding of wrought iron is the self-fluxing action due to the included slag in the metal itself, which provides better adhesion and a reduction of oxide pockets in the weld metal.

Codes for the Heavy Plate Industries

While most industries are organized and functioning under provisions of the N. R. A. Codes of Practice, final approval of the Code of Fair Competition for the steel plate fabrication industry has not yet been announced. This industry, which up to the time of the formulation of its code had not been served by a trade association, was faced with the necessity of bringing within its scope in an organization many widely scattered units engaged in diverse production that logically could be considered members of the industry.

This phase of the problem was early recognized and through the untiring efforts of a group of interested manufacturers the condition was corrected by the formation of the Steel Plate Fabricators' Association. The second problem, that of obtaining approval of the code submitted some months ago to the N. R. A. will undoubtedly soon be solved. There remains, however, the necessity for those manufacturers of fabricated steel products who as yet have not allied themselves with the association to do so, in order that whatever the advantages or regulations under the code may be, the industry will at least face its problems as a unit.

The boiler manufacturing industry is faced with a more or less similar problem so far as its code is concerned. The industry because of the advantage it had of practically complete organization under the American Boiler Manufacturers' Association was able to gain approval of its code last October. Since that time occasion has been taken to clarify the provisions of the code in a proposed Trade Practice Supplement. Without this clarification the advantages to be gained from code operation are greatly lessened. Last December an application for public hearings on the supplement was made, and the hearings held. For a period of nearly three months the provisions have been in a state of uncertainty due to the difficulty of obtaining a final settlement from Washington.

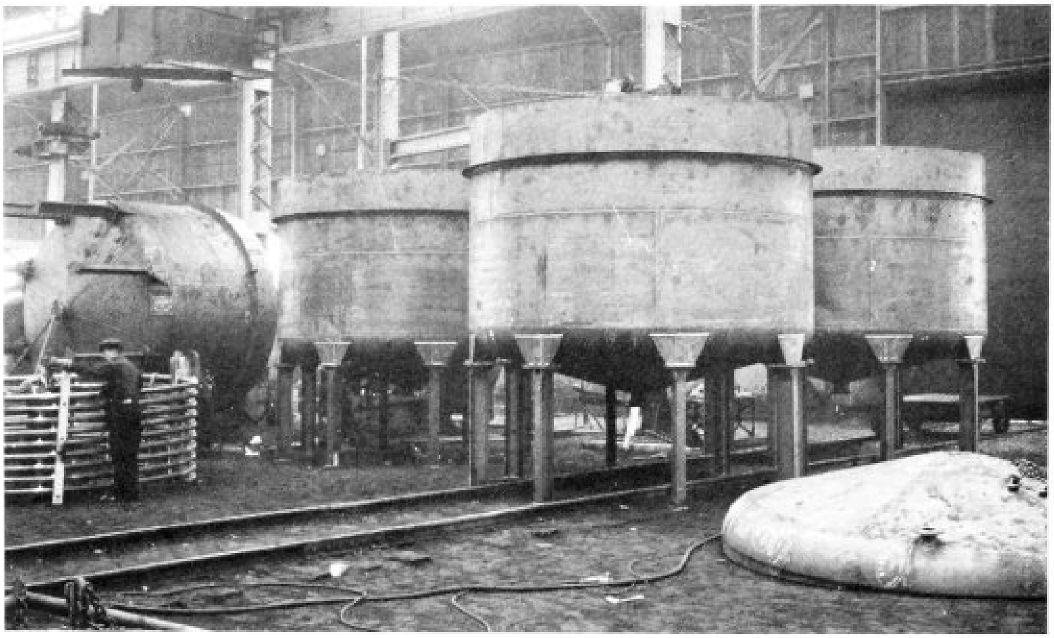
The delayed winter meeting of the American Boiler Manufacturers' Association is being held at the Cleveland Hotel in Cleveland on March 23 for the purpose of reviewing the present status of the code and to plan for the execution of the provisions of the Trade Practice Supplement when they are approved by the President. Since hearings on the matter are now considered as complete, it only remains for the Administration to give the final approval which should be forthcoming shortly.

New Locomotives Being Ordered

There can be no question but that the rehabilitation of railroad equipment is rapidly assuming major importance with consequent aid to mechanical departments throughout the country. Continued increase in earning capacity of the roads is of course a requisite for a broad attack on the depleted condition of locomotive, car and other equipment. Such increases have been in evidence now for an extended period and in addition PWA loans for the specific purpose of purchasing and repairing equipment have greatly increased the activity that normally would follow the rise in earnings.

Since the first of the year, orders have been placed by several roads for a total of 35 locomotives, both passenger and freight. Loans have been asked by several roads for a number of additional locomotives and others already granted loans have made inquiries, the total in various stages of development amounting to 73. Besides major repair and rebuilding of old locomotives, as undertaken by many railroads with their funds, PWA loans have been granted for the major rebuilding of 1241 units.

From the standpoint of the mechanical staff, these indications of increasing activity are extremely encouraging. It is well, as some shops are now doing, to organize for a more normal flow of production that shows every evidence of developing.



Fabrication of wrought iron yeast tanks

Methods developed for best results in

WELDING WROUGHT IRON

Twin wrought iron stacks

The chemical and physical properties of wrought iron make this material particularly adaptable for welding, and since advantage of this process is being taken to an ever greater extent in the plate fabricating field, the following information should prove particularly valuable to our readers:

Genuine wrought iron is a fibrous ferrous material composed of relatively pure iron and iron silicate, a member of the glass family. This iron silicate, or slag, as it is commonly termed, is uniformly distributed throughout the pure iron in the form of threads or fibers which extend in the direction of rolling. In the finished product, the slag content amounts to about 3 percent, by weight, of the total.

The term "iron" is frequently employed to describe a number of different ferrous materials. For that reason, it is necessary to call attention to the fact that genuine wrought iron is an entirely different material than any of the other commonly used ferrous metals, such as commercially pure iron, steel or cast iron. The non-rusting slag fibers in wrought iron are responsible for this difference. None of the other materials contain slag.

This difference between wrought iron and these other materials becomes most apparent when fractured specimens of each are compared. In structure, the fracture of a piece of wrought iron resembles a broken piece of hickory wood, while the fracture of a piece of steel, pure iron or cast iron has a crystalline or granular appearance very similar to the break in a lump of sugar.

Genuine wrought iron is generally recognized as a material which has inherently superior welding characteristics. This is due to the extreme purity of the base metal and to the self-fluxing action of the iron silicate or slag content. Since the efficiency of any weld depends upon the thorough union of metal with metal, it is easy to see that protection afforded the metal during heating by the self-fluxing action of the slag in wrought iron has a beneficial effect in producing a strong, uniform weld. Wrought iron is easily welded by any of the commonly used methods such as gas, electric arc, electric resistance and hammer welding.

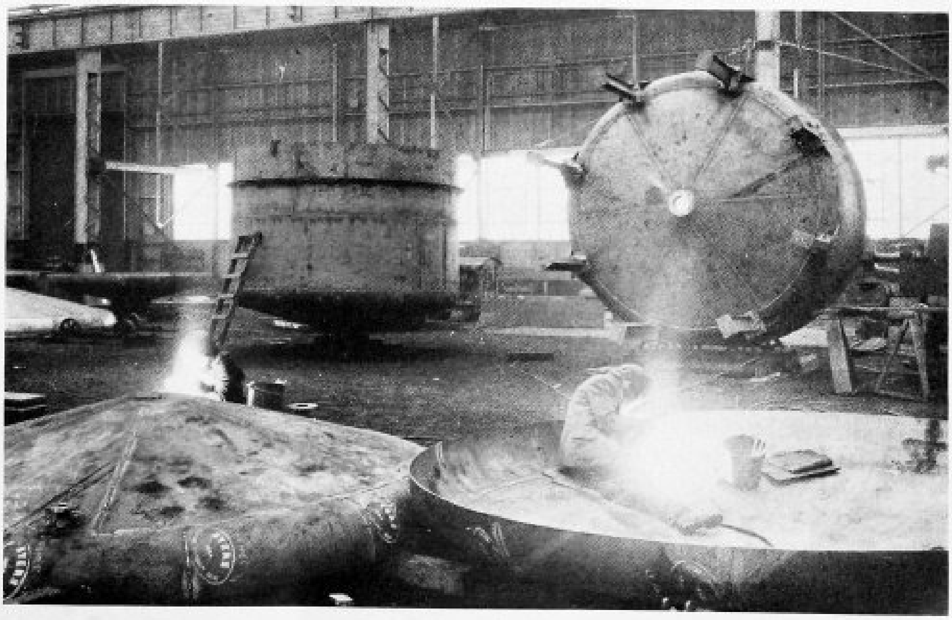
The procedure for welding wrought iron is in general the same as that used in welding mild steel. There are, however, certain slight modifications which must be observed if the best results are to be obtained. The temperature at which wrought iron is welded is particularly important. Due to the purity of the base metal the fusion temperature of wrought iron is somewhat higher than that for mild steel. The proper temperature at which wrought iron should be fusion welded ranges between 2700 degrees F. and 2750 degrees F. Wrought iron can withstand higher temperatures than other ferrous metals and in general should be worked hotter for best results.

With most other ferrous metals suitable for welding, a fluxed or greasy surface is usually an indication that the temperature is sufficiently high for welding. Such, however, is not the case with wrought iron since a greasy appearance initially occurs, due to the fluxing action of the slag content, at temperatures between 2100 degrees F. and 2200 degrees F. These temperatures are below the fusion temperature of the base metal and are too low for the application of fused secondary metal. The heating must, therefore, be continued until fusion of the base metal has been attained.

Experienced welders have no difficulty in judging the proper welding temperature for wrought iron, but an inexperienced one, judging only by the first appearance of the greasy or fluxed surface, will usually fail to continue heating until the base metal is fused. This will naturally result in low strength welds.

When welding wrought iron by the fusion method, a puddle of molten metal should always be maintained at the point where the rod is being added, the end of the rod being kept immersed in this molten puddle until

Beer cooling tank, 30 feet long, 12 feet wide, and 7 feet deep, fabricated by welding from wrought iron plates



Welding heads for 7000 gallon yeast tanks installed in world's largest distillery at Peoria, Ill.

enough metal has been deposited. The edges of the molten puddle and the surrounding colder metal should then be fused together to obtain a solid union. The weld progresses by a repetition of this procedure, care being taken to add no metal from the rod except through the vehicle of the molten puddle. In order to obtain a sound weld free from oxide which produces low strength porosity, the molten puddle should be disturbed as little as possible. Excessive rubbing or agitating of the molten pool should be avoided as this causes undue exposure of the molten metal to the atmosphere, resulting in the formation of oxide which is frequently trapped in the weld.

When welding wrought iron by the oxy-acetylene method, an important consideration in addition to those already mentioned is the selection of the welding rod material. In recent years, rods of special composition have been developed for special purposes. For gas welding wrought iron, however, it is best to choose a rod which when fused and deposited under normal conditions will show a sound structure, free from blow holes and over-oxidation and at the same time show no excessive carbon content.

Wrought iron lends itself readily to either the carbon or metallic electric arc method of welding. Since wrought iron requires higher welding temperatures than mild steel, the current densities used when arc welding wrought iron must be correspondingly higher than those used for mild steel. Experience indicates that the current densities recommended for mild steel should be increased by approximately 10 percent when wrought iron is welded.

The selection of the welding rod material used when welding wrought iron by the metallic arc method is also important. Low-carbon rods give the most satisfactory results. The special coated rods produce excellent welds although good results can be obtained by the use of uncoated rods.

In addition to weldability, wrought iron possesses certain other characteristics which make it a highly desirable material for a wide variety of services. These are described briefly as follows:

One of the most outstanding characteristics of wrought iron is its ability to resist corrosion. This important quality is attributed partly to the purity of the base metal, but of greater importance are the thousands of non-rusting slag fibers which are uniformly distributed throughout the base metal. In each cross-sectional square inch there are approximately 250,000 of these slag barriers.

Wrought iron possesses an inherent quality commonly referred to as toughness. This term is a rather loose description of a combination of several physical properties—ductility, elasticity, resistance to repeated reversal of stresses, and an indefinable cohesive strength associated with the fibrous structure of the material.

Particularly among railroad men and in the marine field genuine wrought iron is known to be an excellent material for use in those services where vibration and shock are encountered. The slag fibers in the material, which give it a structure somewhat similar to that of a stranded wire cable, are responsible.

The characteristic fibrous structure of wrought iron confers on the material directional properties which are reflected in its ductility and ultimate strength in the longitudinal and transverse directions. In the longitudinal direction (in the direction of the fiber) the ultimate strength is about 48,000 pounds per square inch and the cold ductility will vary between 12 and 30 percent in 8 inches depending on the type of material. In the transverse direction the ultimate strength is about 36,000 pounds per square inch and the cold ductility is about 5 percent in 8 inches. In either direction the yield point is about 28,000 pounds per square inch. For certain applications, however, the values given for ductility and ultimate strength can be altered by special rolling.

The American Society for Testing Materials has established several standard specifications for wrought iron. These specifications are listed as follows:

	A.S.T.M. Designation
Welded Wrought Iron Pipe	A 72-30
Wrought Iron Plates	A 42-30
Refined Wrought Iron Bars	A 41-30
Wrought Iron Rolled or Forged Blooms and Forgings for Locomotives and Cars	A 73-30
Staybolt, Engine-bolt and Extra-Refined Wrought Iron Bars	A 84-30

Since welding is so extensively employed today in the construction of piping systems, it should be pointed out that where wrought iron pipe is used the welding fittings should also be of wrought iron. Of particular importance, if the best results are to be secured from welded construction, is the selection of properly designed welding fittings.

British Improve Thimble-Tube Waste-Heat Boiler Design

By G. P. Blackall

Many marine waste-heat installations incorporate thimble-tube boilers in which the heat is combed from the exhaust gases by forcing them through an annular tube space arranged between a circumscribing water space and a central baffle. Experiments recently carried out by the British Department of Scientific and Industrial Research have shown that exchange of heat between liquid in tubes and streams of gas flowing past them is accelerated by increasing the amount of turbulence in the flow and is also greater in the tubes first meeting the moving gases. Recent developments in thimble-tube boiler design have sought to take advantage of this discovery and, in addition, have greatly increased the efficiency of this class of waste-heat recovery plant by entirely eliminating the need for a bulky central baffle.

A fundamental requirement which any waste-heat boiler apparatus must satisfy is that it shall impose no back pressure on the engine, whose exhaust passes into it. The velocity of the escaping gas must not be retarded by restriction of the area available for its passage, and yet the water-containing elements must be introduced into the path of the gas in such a manner as will compel it to part with the heat it is carrying away with the products of combustion from the engine cylinders. In the newest thimble-tube boilers a radical departure is made in the method of controlling the flow of gas through the thimble-tube space. Streamlined devices help to maintain the speed of entry of the gases, while prearranged tube nests ensure that the gas shall not be able to settle down to a regular flow, but that, on the contrary, it shall be compelled to move with a series of spasmodic changes in direction calculated to assure that there shall always be a maximum amount of turbulence throughout the entire height of the thimble-tube space.

This effect is achieved simultaneously with another important improvement, viz., the elimination of the center baffle, by an ingenious choice of the sizes and spacings of the thimble tubes according to a design covered by a recent British patent. This invention involves the use of thimble tubes of different lengths and sizes, combined with a system of spacing which permits of the whole of some selected part of the normal circular tube space being thoroughly combed for the whole of its length.

With this baffleless design of thimble-tube space, the difference between the sizes of the individual tubes is employed to assure that the gas is induced to change its direction of main flow through a right angle at every third or fourth tube row, the opportunity still remaining open to it of taking minor deflections at each successive row of tubes. As a consequence, the gas is speeded up in velocity of flow at short intervals and then made to alter its direction by being opposed by a closely spaced row of the largest tubes through which, as an alternative to changing direction, some proportion of the gas stream may succeed in passing at the cost of increased turbulence.

A number of practical and commercial advantages arise from the development of this new system of using thimble tubes. There is a substantial reduction of over-all diameter for a thimble-tube boiler of given heating surface. Weight is reduced through elimination of the baffle and shortening of the inner and outer shell plates to an extent proportionate to the reduction in diameter, and there is an even greater percentage reduction of the weight of water carried in the annular water space because this weight is a function of the square of the diametral dimensions.

It is usually possible with the new system to obtain the required heating surface with a smaller number of tubes and with a greater efficiency per tube, because the dimensions chosen are such as give a larger proportion of heating space to weight of water carried in each tube. Steam-raising is both more rapid and more uniform as a result of the better relation of heating surface to water content in each individual tube, and the general design of thimble-tube waste-heat boilers is distinctly simpler than that of boilers in which a baffle must be fitted to secure the annular tube space hitherto regarded as essential to achieve satisfactory combing of the hot gases. The probable increase in the future cost of Diesel engine fuel must insure for waste-heat recovery plant a permanent place in the equipment of vessels which cannot afford to allow such expensive energy to run to waste.

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 is given record of the interpretations of the Committee in Cases Nos. 717, 763, 765, 766:

CASE No. 717 (Annulled).

CASE No. 763 (In the hands of the Committee).

CASE No. 765. *(Interpretation of Par. A-21).*

Inquiry: Par. A-21 of the Code specifies that the location of a fusible plug in a vertical fire-tube boiler shall be in an outside tube not less than one-third the length of the tube above the lower tube sheet. Is this distance to be measured from the top side or the bottom side of the lower tube sheet, or is it to be measured from the lower end of the tube itself either before or after beading?

Reply: It is the opinion of the Committee that the distance of the fusible plug above the lower tube sheet should be one-third the length of that part of the tube between the inner surfaces of the two tube sheets, measured from the top side of the lower tube sheet.

CASE No. 766.—*(Special Rule)*

Inquiry: Par. *3a* in A. S. T. M. Specifications A 149-33T for High Tensile Strength Carbon Steel Plates for Pressure Vessels (Plates 2 inches and Under in Thickness), the use of which is covered by Case No. 762 calls for uniform heat treatment of all plates over 1 inch in thickness. If it is possible to obtain the physical properties desired without heat treatment, is such heating compulsory?

Reply: The Committee has under consideration a change in this paragraph in the specifications referred to so that heat treatment will be required only when necessary to obtain the desired physical properties. Pending action on this revision, it is the opinion of the Committee that such heat treatment is optional.

Decrease in Business Failures

Analysis of business failures in the United States just completed and submitted to the National Recovery Administrator Hugh S. Johnson shows a marked decline in commercial mortalities during the last six months of 1933 as against the records of the same periods in 1932 and 1928.

Especially interesting in view of the claims recently made that small businesses have been squeezed under N. R. A. codes, is the finding in the analysis, made by Division Administrator A. D. Whiteside, that the decline in failures was sharper among such small businesses than in the larger groups.

The analysis is included in Mr. Whiteside's preliminary report of plans for the study to which he and Colonel Robert Hiester Montgomery, chief of the research and planning division, were recently assigned by General Johnson—to determine methods of liberalizing the extension of monetary credit for the benefit of industries and trades operating under codes.

Inasmuch as no codes became effective before July 1, 1933, and the President's Reemployment Agreement did not become effective until August 1, the National Industrial Recovery Act could not, Mr. Whiteside pointed out, have contributed to business failures prior to July 1.

In the last six months of the year, it is disclosed, the failure total was 6805 lower than the total during the same period in 1932 and 3420 below the total for the last half of 1928, a decline of 47 percent from 1932 and 31 percent from 1928.

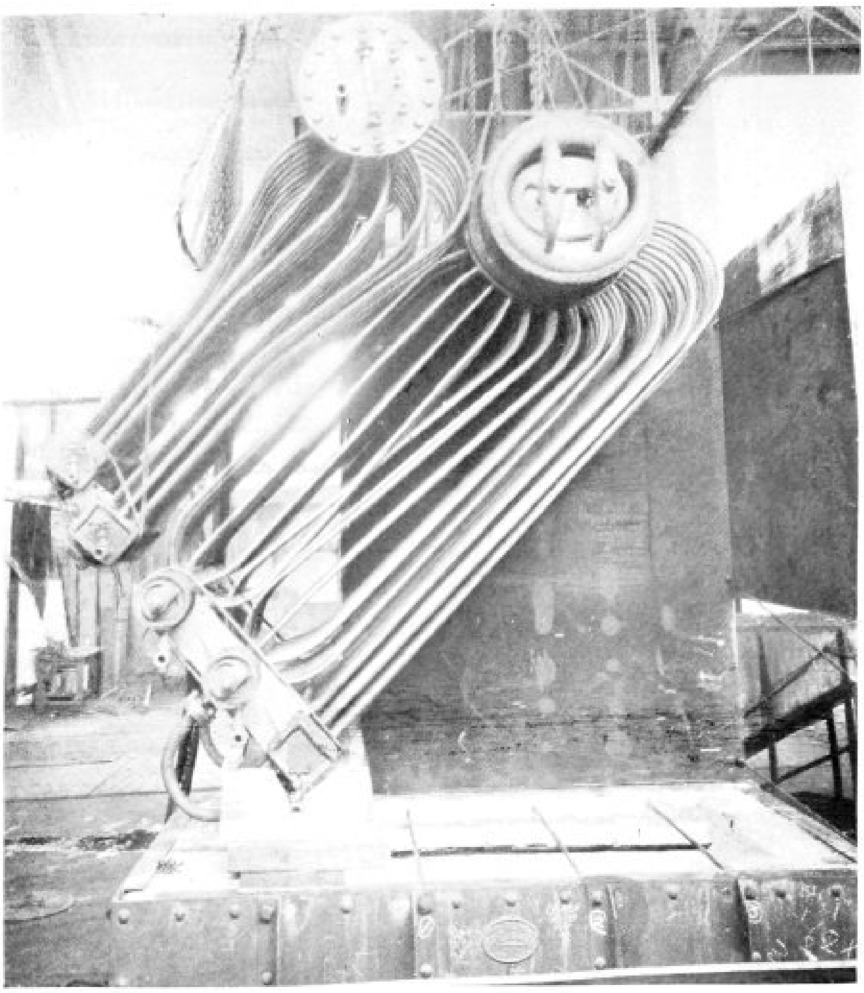


Fig. 1.—Working model of two-stage watertube boiler in course of erection

TWO-STAGE BOILER

By Captain H. C. Dinger, U. S. N. (Retired)

In considering the machinery of new naval construction, there are certain conditions that are to be met. The power will depend upon the speed selected and the displacement and lines. For battleships, if we have a speed of 22 knots and with the limitation of the Washington treaty the horsepower would be approximately 40,000. For cruisers this power may be doubled or trebled.

The things to achieve are a reliable installation on moderate weight and space and the highest practical economy in fuel consumption, and especially a great radius. The machinery must fit into suitable subdivisions to permit proper protection and all machinery must go beneath the protective deck.

As a basis, the oil-burning, steam turbo-reduction gear seems to offer the best possibilities. The power can be provided on two shafts and with four boilers.

A steam pressure of 500 to 600 pounds per square inch and a steam temperature of 750 degrees F. are practicable. Higher temperatures are undesirable on account of the behavior of metals which seem to have a decided falling off in strength as the temperature of 750 degrees F. is approached. The gain by going to pressures higher than 600 pounds is relatively small. While these higher pressures require very special boilers, turbines, feed pumps, etc., the cost of which becomes quite high and which are more or less uncertain, this pressure of 600 pounds would not be introduced without certain special arrangements (which have not hitherto been proposed for marine work). With this pressure some heat recovery apparatus is necessary on the boilers. Instead of fitting rather heavy economizers or air heaters, it is proposed to meet this by a two-stage boiler—a high-pressure part with a working pressure 600 pounds and a low-pressure part with 200 pounds pressure. Both of these parts are, however, in the same casing and occupy about the same space as the ordinary single-stage express boiler.

The idea of the two-stage boiler is described in general as follows:

The low-pressure boiler acts as a steaming economizer, reducing the uptake temperature to about 350 degrees F. All make-up feed will be introduced into this, so that the main boiler would be fed only by clean uncontaminated condensate. This would tend to maintain the heating surfaces of the high-pressure boiler in clean condition. The steam generated in the low-pressure boiler and that from auxiliary boilers would be utilized for driving small steam auxiliaries, for the high-pressure stage feed heater, for the distilling plant, cooking, heating, etc.; any excess would be introduced into the low-pressure turbine at a suitable point. This steam would then be the make-up for the main boilers. There would be an auxiliary feed system for the low-pressure boilers separate from that of the high-pressure boilers. This would be used under way and also in port when the main boilers were dead. With this arrangement the high-pressure evaporating surface could be operated at higher rates and could therefore be reduced. They would be maintained in cleaner condition and more free from deterioration. A boiler efficiency approaching 90 percent could be secured for the combined boiler. The dirt, scale, etc., picked up from make-up feed and the auxiliary system would lodge only in the low-pressure boiler not subjected to high temperature or high rates of evaporation and from which it can be more readily removed.

Due to the much lower uptake temperature less heat insulation is required to protect adjacent spaces from the effect of high uptake temperatures. This is a very material advantage.

The design of boiler here contemplated also has special arrangements for settling out any foreign matter in the feed water before this water has access to the fire row tubes, also special arrangements for accelerating the circulation in the fire row tubes are contemplated.

The boiler would have welded or seamless steel drums or boxes, each tube with normal entrance into the tube sheet, each tube with an easy bend and with a straight section at the lower end to facilitate cleaning and examination. No baffles would be fitted, but a proper decreasing gas path would be provided in the design.

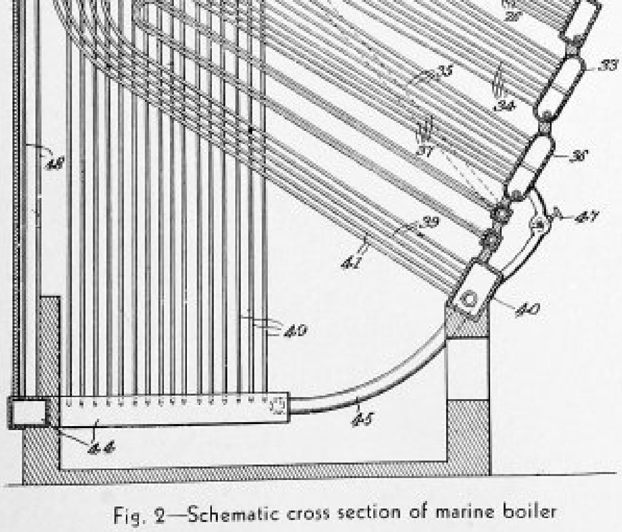


Fig. 2—Schematic cross section of marine boiler

A small working model of such a boiler is shown in Fig. 1.

In order to simplify and save weight as well as to secure the best furnace conditions, relatively large boilers are proposed. There would be four boilers of about 11,000 square feet of heating surface, each fitted with superheaters to give a steam temperature of 725 degrees F. The low-pressure boilers would contain about 25 percent of the total heating surface. Oil burners with the usual pumps, heaters, etc., would be used. There would be four propeller-type forced-draft blowers, electrically driven. Arrangements would be made to have these blowers exhaust from the engine rooms and take suctions from a space about the smoke pipe.

The boilers would be very carefully lagged and this, with low uptake temperature, would avoid the very high temperatures now often encountered in the upper parts of boiler compartments. It is proposed to utilize as much of the heat as possible in making steam instead of allowing a considerable amount of it to go up the stack and unduly heat the surrounding spaces. The final uptake temperatures would be from 300 to 350 degrees F. instead of the 500 to 700 degrees now usually encountered.

Fig. 2 shows the arrangement of the two-stage boiler. Feed water enters the low-pressure boiler at 18 behind the feed baffle, flows to water box 23, then up to the steam drum, then down tubes 24 and up tubes 26. The low-pressure dry pipe is at 27.

Hot uncontaminated feed enters the high-pressure boiler at 30, flows down tubes 32 to the lower header 33, then up tubes 34, down 35 and up 37. From header 36 downcomers supply water to the lower cross box 40, to the side box 45 and to the rear cross box 44.

The circulation is up in tubes 41 and 48, which discharge above the water level as indicated. Tubes 39 may become down-flow tubes, also every alternate tube in the rear wall is a down-flow tube to ensure a flooding of the rear cross box should the supply from 45 ever become inadequate.

The side water wall tubes 49 are optional but are considered generally desirable. The number of rows of tubes in each group may be varied and the spacing would be somewhat closer away from the fire. The position of the superheater may be varied within limits.

A small motor-driven pump 47 is installed in each of the downcomers, which, when in operation, accelerates the natural flow of circulation and thereby causes greater evaporation.

The boxes can be of forged or welded construction or cylindrical drums can be substituted. It is intended to have hand hole plates opposite the tube ends for cleaning and examination. The vertical spaces between the various front boxes are expected to be utilized for cleaning doors through which the fire sides may be fully examined and cleaned.

The boiler is designed to utilize all floor space fully and therefore lends itself to installation in confined spaces. The special features that commend attention are as follows:

The low-pressure arrangement enables a high pressure to be used without the complication of air heaters or economizers. The low-pressure unit provides low-pressure steam for auxiliaries or process and provides a unit where raw water, not fully conditioned, may be used without dangerous results. The stack temperatures may be reduced quite low, making it possible to secure a very high boiler efficiency with a relatively small, simple and low-priced boiler. The use of the low-pressure boiler for the raw water feed makes it possible to give clean uncontaminated water to the high-pressure boiler without extra expense for evaporators. This feature therefore produces higher efficiency, greater output per unit of surface and provides a ready means for protecting the high-pressure heating surface from the effect of contaminated feed water.

Sediment is collected before it reaches the highly heated parts. By a simple series of sediment collectors, from which sediment can be removed, such sediment is retarded to a great extent from getting to the containers next to the fire. The sediment, therefore, is largely trapped before it reaches the location where it may do most harm. This point is of major importance in high-pressure watertube boilers, where the feed water is not above reproach. In most boilers, this sediment collects on the hottest surfaces.

The full counter-current natural circulation is complete and definitely guided by the arrangement of the parts. This will cause greater speed of circulation, an equalization of circulation and guards definitely against a reversal of flow. This better circulation together with the sediment trap arrangement will tend to keep the water heating surfaces clean and will improve the average heat transfer. Steam, as it is formed, has a definite and ready access to the steam drum. There is no possibility of a steam pocket forming.

The forced-feed circulation, which may be utilized when desired, furnishes a ready means for increasing the boiler output without adding much to expense, or detracting from boiler efficiency. By using this the evaporation may be safely raised materially beyond what would be considered safe in an ordinary boiler. The heat transfer per unit of heating surface can therefore be augmented and a smaller boiler can therefore carry a higher load.

The discharge of the fire row tanks above the water level is logical and tends to a more uniform water level, and a prevention of bumping and surging. From 25 to 40 percent of the steam is formed in these fire rows, and, if this steam has ready access to the steam space, dryer steam than otherwise will be formed. In the small test model of this boiler operated at the Experiment Station, Annapolis, Maryland, the steadiness of the water level was conclusively indicated, as was also the dryness of the steam. This arrangement permits the steam drum to be made smaller and is one step toward the drumless boiler. This feature also contributes to the ability of this boiler to be forced beyond the limit that can be used in the boilers where all tubes discharge below the water level.

With this two-stage boiler the high-pressure boiler is subject to higher temperature difference in that the gases leave at a higher temperature than in an ordinary boiler—hence for the same steam output less heating surface is required. The low-pressure section also requires less surface than an economizer for extraction of heat, for the reason that here again there is a greater temperature difference. Therefore, this improved boiler will require only about 90 percent of the heating surface of a conventional boiler fitted with an economizer for the same output. By means of relatively simple devices the temperature of the water in the various nests of tubes is stepped down successively as the gases are cooled. In the ordinary watertube boiler the outer rows of tubes evaporate only a small percentage of the steam because of the very low temperature difference. By providing the outer rows for feed heating and the low-pressure boiler with its lower feed and steam temperature, the temperature difference is increased without any real expense.

This type of boiler can be fitted into existing low-pressure plants where a new high-pressure unit is desired. In such cases the low pressure part supplements the low-pressure units already installed and the high-pressure part can be operated at any pressure desired.

The two-stage boiler is especially adaptable to conditions where a lower steam pressure is desired for heating or process work. The pressure of the low-pressure unit can be varied at will without changing the working pressure of the high-pressure unit. Also it provides for superheated and low-pressure saturated steam from the same boiler without desuperheaters and other complications. It is ideal for a factory generating its own electricity and also requiring process steam, since the steam from the low-pressure unit can be turned into the line for process.

This type of boiler is especially adaptable for marine work by reason of its economy in space, and its ready ability to give high-pressure steam for the main units and low-pressure saturated steam for auxiliary purposes and for heating. It also gives a boiler of high capacity in a very small space.

This boiler can be easily and cheaply constructed and its various parts can be altered to suit a variation of requirements. It is especially adaptable for service in large buildings and factories. It provides a relatively small boiler with the economy secured by the very large plant boilers and without their complications. It is believed that with airtight casing and efficient burners a boiler efficiency of 90 percent can be obtained with this design, when burning 5 pounds of oil per square foot of heating surface.

It is especially desired to stress the ease with which this design may be thoroughly cleaned both on the fire and water side. There are many small watertube boilers that are efficient when clean, but which can be cleaned only with the greatest difficulty. A boiler that cannot be readily cleaned both on the fire and the water sides does not operate economically because it is never clean and in good condition to render proper service. It will be noted in this design that the possibilities for collection of soot and slag on the outside and sediment and oil on the inside have been eliminated to a very large degree. The fire tubes are curved and at a considerable angle to the horizontal so that they do not readily collect soot, and where soot may collect provision for its removal is readily made. There is a gradually diminishing area of gas path to maintain the velocity of the gases as they are cooled. This adds to the efficiency of the heat transfer.

This boiler is adaptable to either coal or oil burning, stokers or powdered fuel.

It will be observed that all tubes have a suitable curvature to allow for expansion and that those subjected to the higher temperatures have greater provision for expansion. This provision serves to avoid stresses which may be encountered due to heated parts not being free to expand. No part is held rigidly by reason of some other part failing to move with it. Fatigue stresses are therefore avoided as far as practicable. This feature makes this a specially safe boiler.

The shape of the furnace is such as to give the best furnace efficiency in a boiler of restricted dimensions. Hence greater furnace capacity and efficiency are secured. The tubes are placed so as to avoid direct impingement of the burning fuel. It also provides for the maximum of radiant heat surface thereby adding to the capacity to absorb heat. The furnace is so shaped that all its volume is efficient and effective burning space.

Shears for Use on Heavy Plate

To meet the exacting demands of the industry for shearing heavy plate, the Niagara Machine & Tool Works, Buffalo, N. Y., has developed a new M Series shears. Semi-steel castings made in heavily ribbed and well filleted sections form the housings. The use of castings in these members permits proper distribution of weight, giving the maximum strength at the points where stresses are the greatest.

The box section bed and crown, also made of semi-steel castings, are securely bolted and doweled to the housings, making a frame that complies with every requirement for rigidity and strength.

A feature, worthy of more than passing mention, is the independent chuck carrying the lower knife. It is this construction that permits permanent location of the bed and facilitates adjustment for proper knife alinement.

The box section crosshead carrying the upper knife is counterbalanced with air cylinders mounted in the crown. These cylinders, directly connected to the regular shop airline, operate with practically no loss of air in that the down stroke forces the air back into the line. This type of counterbalance offers the particular advantage of balancing the crosshead in all positions.

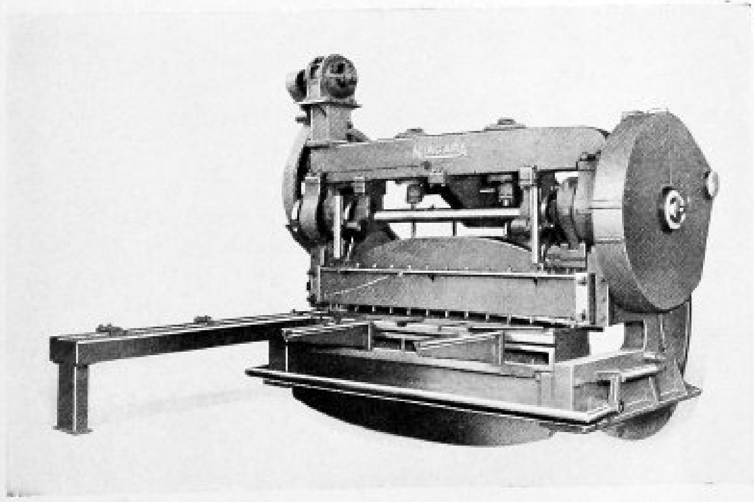
The large eccentrics operating the crosshead are forged integral with the main shaft and are supported on both sides with substantial bearings to give the maximum strength at the point of load application.

One of the outstanding features of Niagara shear construction, incorporated in this shear, is the patented holddown. Each foot of the holddown is arranged with an individual spring cushion. The feet are self-adjusting for different thicknesses of material, building up pressure as the thickness of material increases. Sheets of shorter length than the maximum cutting length of the shear are gripped with uniformity without tilting the holddown, regardless of whether the sheets are cut in the center of the shear or at either end. The shear may be used for cutting full capacity plate at one end and light gage plate at the other in the same stroke.

All the gears have generated teeth produced by the hobbing method to insure quiet, smooth operating gears with maximum strength for shock loads.

A powerful jaw clutch, with hardened tool steel inserts on both striking and backlash surfaces, drives the main shaft. The operator trips the clutch mechanism by means of the foot bar conveniently located in front of the shear, and, unless the foot bar is held in a depressed position, the main shaft will make one revolution and stop at the top of the stroke.

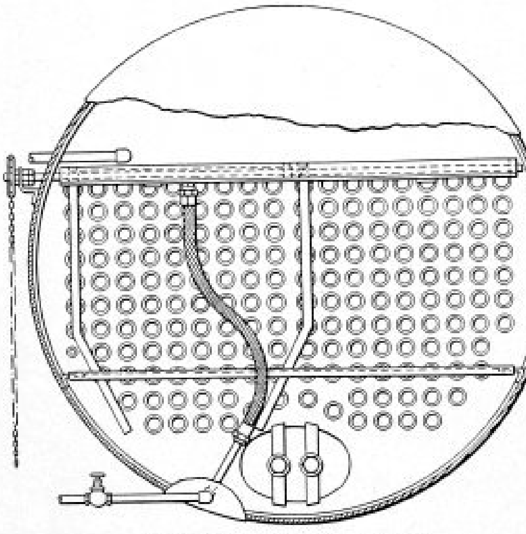
The shear is furnished with a belted motor drive arrangement. The illustration shows the short center flat belt drive, with the tension maintained by a ball-bearing idler pulley actuated by a compression spring. This drive is extremely quiet in operation and has proven particularly efficient in the sense that it relieves the duty on the motor and the motor bearings and operates at full capacity with no perceptible slippage of the belt. Complete information on this line will be sent on request.



Niagara heavy-plate shears

Boiler Tube Cleaner

The B.E.T. boiler cleaner, manufactured by the Boiler Equipment Trust, North Amherst, Mass., is equipped with double arms which reduce time and eliminate clean-



The B.E.T. boiler tube cleaner

ing or wiping of the rods. This cleaner has no swinging or sliding joints; no carriage; no head. The screw rod is placed in the coolest part of the boiler near the front; the supporting bar and rod are also near the front, which leaves a clear passage for gases to the stack. All nozzle arm joints are welded and have flexible stainless steel steam connections.

Supports are attached to the extended shell of the boiler or to the front above the doors, leaving the doors free from attachment and all tubes uncovered and unrestricted. The nozzles are situated 4 inches out from the tube ends and travel in a straight line across the centers of the tubes, causing entrainment of more than 17 pounds of gas per pound of steam. Velocity is increased through the confinement of jets thus forcing all expansion of steam to take place in a straight line.

Inspection of Welded Work and Training of Welding Inspectors*

By William D. Halsey†

In considering the inspection of welded work it must be clearly recognized that, except for fusion welded power boiler drums and Class One pressure vessels, the acceptance of fusion welding in the pressure vessel and pipe line fields today is based upon the assumption that safe welding will be obtained if an approved technique of welding is followed by trained and tested welders. That this is a reasonable and safe assumption to make has been proved by the very large number of fusion welded Class One vessels and power boiler drums that have been built and on which X-Ray examination and tests of the welding have been required. While comparatively few, if any, fusion welded Class One vessels or power boiler drums have been built in which the X-Ray has not found some defect, at the same time the results of this X-Ray examination and the physical tests have clearly indicated that by the use of proper materials, careful control of the welding process, and employment of welders who have been carefully trained and tested, the chance that a serious defect will develop is extremely small.

With the above fundamental principles in mind, it will be clear that the inspector of fusion welded construction, particularly if such construction is not to be X-rayed, must obtain satisfactory proof that the technique of welding or procedure control will secure the desired results, and that the individual welders have demonstrated they can apply the accepted technique and obtain those same results. Having satisfied himself as to these facts, it is then the inspector's duty to see, by actual observation of at least a part of the actual work of welding, that the approved technique of welding is being followed and that only welders qualified for that technique are used.

It is true that a welding operator, after long practice, acquires a proficiency in producing a weld with an evenly rippled appearance. Such appearance should not, however, be used as the basis of acceptance or rejection of the weld. The writer has seen many test welds with a poor exterior appearance but which upon careful examination were found to be quite sound. Other welds with a very smoothly rippled exterior surface were extremely defective on the interior.

The starting point for inspection of welded work should be to require the manufacturer to set forth in writing, with sketches where necessary, the technique of welding which will be followed. This may be written as a "Specification for Welding." Such specification should cover the following items, at least:

1. The plate specification; this may be a reference to Code or A. S. T. M. specification.
2. The method of welding, whether oxy-acetylene, carbon-arc, metallic-arc, etc.
3. The kind of rod or wire; this should be a reference to a trade name and the manufacturer's specification number for the rod or wire.
4. The shape of the welding groove.
5. The number of layers or beads of welding to be laid down and the order in which they are applied. This is most conveniently done by the use of sketches for various thicknesses of plate.
6. The size of rod or electrode and the voltage and amperage value for each bend.
7. Peening; when and to what extent will it be used.
8. The removal of defects and the treatment of the underside of the welding groove in double butt welding.

Having received from the manufacturer a specification covering the details of welding, it is incumbent upon the inspector to ascertain that acceptable welds will be obtained by the application of the specification. This may require that the manufacturer have one of his welders make some welds by the process outlined and to test the welds so made. The inspector should be present during both the fabrication and the testing of these welds. On the other hand, the inspector may be able to ascertain through his company files that a witnessed test has already been made and the results found satisfactory.

Finding satisfactory evidence that a given specification for welding will produce acceptable results, it is then the duty of the inspector to ascertain that each and every welder who will be employed on the particular work to be inspected has demonstrated his ability to make welds, in accordance with the specifications, that will meet the requirements. Here again, the inspector must use his discretion as to whether he will require every welder to make a test weld in his presence, or whether, in the inspector's opinion, recorded results supported by test specimen, may be accepted as satisfactory evidence.

Assuming that the requirements of the A. S. M. E. Code are to be met, it will generally be necessary in a qualification test that a welder make specimen or test welds in plate thickness of ¼ inch and ⅝ inch and also in the maximum plate thickness for which he is to be qualified. The Code, of course, limits Class Two vessels to 1½-inch plate thickness and Class Three vessels to ⅝-inch plate thickness, so that the test plate should not exceed those thicknesses.

A word regarding the method of testing some of the specimens may not be amiss at this point. In making the nick break test the specimen should be broken, if possible, by a single blow. The fracture of the nick break specimen can be most satisfactorily done under a steam hammer, although some shops use a heavy weight suspended between guides. When using the steam hammer it is the usual failing of the operator to strike too light a blow. He is quite apt to "pull his punch" as the head of the hammer nears the specimen. What should be done is to allow the hammer to follow through to the completion of its stroke.

The bending of the free bend test specimen sometimes gives difficulty in locating the maximum bending at the weld. When the free bend testing is done in a regular tensile-testing machine, it is well to use a machinist's square to set the specimen and to check it during welding. A mark should be made at the center of the weld and this point of the specimen kept tangent to the square. By following this procedure while the specimen is being bent, it is not difficult to force the bending into the weld.

The limitations of the free bend test have been mis-

* Paper presented at ninth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

† Assistant chief engineer, Boiler Division, the Hartford Steam Boiler Inspection & Insurance Company.

understood from time to time. The Code states that—"When a crack is observed in the convex surface of the specimen between the edges, the specimen shall be considered to have failed and the test shall be stopped. Cracks at the corner of the specimen shall not be considered as a failure. The appearance of small defects in the convex surface shall not be considered as a failure if the greatest dimension does not exceed 1/16 inch. It has been noted upon numerous occasions that the person testing the specimen continues to bend it even after the 1/16-inch crack has appeared. It is possible by continuing the free bend test until the specimen actually separates into two pieces, and then making the final measurement by putting the two specimens together, to obtain a very high measure of ductility. Such method of testing, however, is not in accordance with the intent of the Code. The test should be stopped at the instant that a crack 1/16 inch long develops in the weld surface between the gage marks.

It cannot be too strongly emphasized that only qualified welders may be used on Code work and further that the technique of welding the qualification test plates of such welders must be the same as that used in actual construction. The differences between the technique of welding in the gas process and in the metallic electric arc are so great that it is not to be expected a welder who has demonstrated his ability to make a weld by one process is, thereby, qualified to make a weld by the other process. In the welding of mild steel, the variations of plate quality within the ranges permitted by the Code specifications for plates acceptable for welding, are not so great as to require that there be close correlation between the analysis of the plate used in the test and the analysis of the plate in the vessel. However, the material in the test plate should meet Code specifications. On the other hand, a welder who has demonstrated that he can make a weld in mild steel plate is not thereby qualified for welding in alloy steel or non-ferrous material.

The question of the kind of welding rod or wire used is extremely important. With the advent of heavily coated wires in the electric-arc process, there has been a very rapid development of welding with such wires and the results obtained are constantly improving. Certain manufacturers, at the expenditure of enormous sums of money, have developed wires which are almost foolproof if properly used. It cannot be assumed, however, that just because a rod carries a heavy coating it will give acceptable results. It is only by the repeated testing of welds made with such rods that definite knowledge can be obtained.

In regard to the qualification test of a welder, one of the most important points to be considered is the position in which the test weld is made. Given modern equipment and the proper set-up for welding, a reasonably intelligent man can soon be trained to become a fairly good welder if the work is confined to a flat position. It is true, his ability will improve with practice. On the other hand, the ability to weld in the vertical or overhead position is difficult to acquire and can be obtained only after a great deal of practice.

There is altogether too great a tendency to overlook the importance of the position in which the test weld is made. If a weld is to be made in the vertical or overhead position, it is extremely important to know that the welder has satisfactorily demonstrated his ability to make a weld in that position by the process of welding which is to be used.

In the fabrication of fusion welded vessels in a shop, it is practically always possible to do the welding in the flat position, so that the question of qualifying the welder for other than the flat position seldom enters in shop inspection work. However, in assembling large vessels or repair work in the field, where the position of the vessel cannot be changed, or in the making of a fixed position weld in a pipe line, it is highly essential that the ability of the welder to weld in the vertical or overhead position be positively known.

Since thorough fusion with the base metal is by far the most important requirement, observation of the welders while they are at work on the vessel is of great value. On the other hand, inspection of every inch of the welds as they are made would involve prohibitive expense, and if it can be positively known that an approved technique was followed and only qualified welders used, there should be no doubt as to the safety of the welded joints.

The Code recommends but does not make mandatory the requirement that each qualified welder be assigned, by his employer, a number, letter or symbol and that the welder stamp such identification of his work alongside the welds he makes. We are strongly in favor of this practice as we believe it to be not only of assistance in checking the work but also of value in encouraging high standards among the welders.

It is characteristic of electric arc welding that results depend, to no small degree, upon the arc voltage used. The use of a recording voltmeter is of great value in checking this important item. The instrument need not be used continuously for every welder, but the periodic testing of the arc voltage by such an instrument, without the welder's knowledge that such a check is being made, is very helpful in inspection and beneficial to the manufacturer and the individual welder. The record obtained from a recording voltmeter will indicate not only whether the correct arc voltage is being maintained but also whether the individual welder is developing an unsteadiness of hand. A welder who is mentally or physically incapable of doing good work or who is not following instructions as to correct arc voltage will instantly write a statement to that effect on the voltmeter chart.

The discussion thus far has been with regard to the inspection of welded vessels during construction and usually in accordance with Code requirements. There are, however, many welded vessels now in service bearing no stamp or indication that they were inspected during construction and these vessels present quite a problem. Many of these vessels, it is true, were built during recent years and even though they may not bear a Code stamping, it is quite possible that they were welded by modern methods and are entirely safe. There are others, however, of various ages, which are quite questionable.

In the case of these unstamped vessels of welded construction, it is suggested that inquiry be made of the manufacturer to determine the method of welding used and whether the work was done by qualified welders. If such inquiry develop satisfactory evidence that the welders were qualified and that a proper procedure of welding was followed, it is believed that the vessel may be considered reasonably safe for operation.

On those vessels for which no satisfactory evidence can be obtained from the manufacturer, an examination of the weld should be undertaken to determine whether it is sound. This in itself presents a problem and there is no thoroughly satisfactory method to obtain conclusive evidence.

This brings us to the discussion of different methods of non-destructive testing of welded joints. The most generally accepted method for non-destructive testing is by means of X-ray or gamma-ray. While this method is applicable to shop inspection it is quite impractical at the present time for use on vessels in the field because of the relatively cumbersome and expensive equipment required. Furthermore, it is necessary that there be access to the interior of the vessels to place the film holders. For the present time, this method of examination, while giving satisfactory and conclusive evidence, cannot be considered applicable for field inspection.

Various methods of electric testing, such as electric resistance, magnetic reluctance and magnetic dust methods have been tried. These give some promise, but the equipment required is either expensive or unwieldy or both and the indications of the test are often difficult to interpret.

There is also the stethoscopic test. This method requires very simple equipment but experience is necessary to interpret the various sounds obtained. Furthermore, the sense of hearing varies greatly in different individuals. This method of testing is also one which may be considered to have promise but is not yet fully developed.

About two years ago the insurance company which I represent adopted the practice of requesting that one or two 4-inch by 6-inch oval specimens be cut across the longitudinal welded joints of questionable welded vessels, thus providing a specimen of the weld for examination.

This method of examination was based on the assumption that if a poor technique of welding was used or if the work was done by an inexperienced and untrained operator, the weld would show defects at practically any section. An opening so made in a welded vessel can be quickly and safely closed by inserting a 6-inch by 8-inch oval plate through the hole and bringing it against the inside of the shell, fillet welding it in place for tightness. The great trouble with this method is the objection of the owner to the expense involved and he also objects strenuously to cutting any size hole in the vessel. However, we have been successful in a few instances in having such specimens cut from a longitudinal welded seam.

It has been suggested that the safety of a welded vessel may be determined by an application of the standard Code test for welded vessels, namely, a hammer test under a hydrostatic pressure of 1½ times the working pressure to be followed by a simple hydrostatic test at twice the working pressure. The ease with which such a test may be applied recommends it and the owner of the vessel can usually be persuaded to submit the vessel to such test.

While the application of the hydrostatic hammer test on new vessels is not questioned, it is doubted very seriously that such a test should be applied to some of the older vessels. If a serious defect exists in the welded seam, the hammer blow under hydrostatic pressure may cause that defect to progress somewhat, and it may even progress to the point of just barely coming through, causing a slight leak. If no such leak develops, however, the assumption is made that the vessel is sound, whereas the actual fact may be that the hammer test has extended the defects and made the vessel weaker than it originally was.

There is another type of hydrostatic test which has been tried from time to time. In this test the welded seams are first painted with a coating of whitewash or white cement mixed to a consistency of paint and applied with a brush. When the whitewash or cement coating is dry a hydrostatic pressure is applied. The pressure is gradually raised in increments of 20 percent of the desired working pressure until a pressure of twice the desired working pressure is reached. At the end of each increment, the pressure is held constant for about one minute and the coating is carefully examined to see if any cracks have developed in it.

The principle underlying this hydrostatic test with a cement or whitewash coating is that if a serious defect exists in the welded seam, the hydrostatic pressure will stress that point of the seam to the yield point. Such stretching of the metal will take place, however, before actual extension of the defect occurs. However, this slight stretching of the metal when transmitted to the brittle coating causes that coating to break. In other words, this kind of a test should detect the yield point of the defects in the welded seam without actually extending those defects. It would seem reasonably safe to allow a working pressure of ½ that at which cracking of the cement coating takes place.

Our company has applied the hydrostatic test with a whitewash coating in a few instances but we are not as yet satisfied that it gives the real answer to the problem. Consequently, we are still recommending that the specimens be cut from the welded seams.

It will be interesting to note that by one test or another we have been successful during the past two years in obtaining a critical examination of about a dozen questionable welded vessels. In about half of these vessels we have found reasonably sound seams; whereas, in the other half we have found very dangerously defective welds.

An inspector of welded work need not be an experienced welder and in fact unless he is of the newer school of welding, experience as a welder may even be to his detriment. The inspector of welding must, however, appreciate what constitutes a good weld and the fundamentals which must be observed to obtain a good weld.

The inspector must, of course, have a thorough working knowledge of the requirements of the A. S. M. E. Code. He must understand and appreciate the refinements necessary in the preparation of the weld test specimens and the methods whereby they are tested. His training should preferably start with a study of welding manuals both as applied to gas welding and to electric arc welding. Care must be used in the selection of a manual for arc welding since all instruction books do not adequately cover the question of welding with the heavily coated wires. The inspector should be given proper instruction on the preparation of joints and the reasons for using different shaped joints. There should be pointed out to him the precautions necessary in the general fit up for welding, and particularly as regards the welding around nozzles and in other constrained locations.

Undoubtedly the best method of training an inspector for welding is to have him do some welding himself under the instruction of an intelligent operator. He should be shown the effects of various lengths of arc and of too high or two low welding current. The three main causes of defects in welds such as slag inclusions, lack of fusion and porosity should be made clear to him and the causes of these defects and the means of overcoming them should receive careful attention.

For the inspector who is to make shop inspection of Class One welded vessels requiring the examination of X-ray films, a special course of instruction should be given, explaining in detail the principle of X-ray photography. He should be trained properly to read X-ray films and he should know the precautions that must be observed to obtain a true image of any defect which may exist.

The shop inspector should be thoroughly coached in the question of locked up stresses and stress relieving.

This is a bone of contention in welding and the inspector should hear both sides of the argument.

In general, the basis of an inspector's training for the inspection of welding should be an understanding of the fundamentals involved and the practices which must be avoided. His attitude in inspection work should be not to tell the operators how the welding should be done but rather to observe them carefully to see that they are following a technique of welding which has been proved satisfactory and to see that they do not use any improper practices. The average welder takes the attitude that he knows considerably more about the work than the inspector and the inspector will do well to avoid argument, but to gain his point by simple demonstrations which may be readily carried out in any welding shop.

Safety in Pressure Vessel Construction*

By C. O. Myers†

The essential purpose of inspection of welded work, is to insure safety. There is no such thing as absolute safety, and all that we can do is to provide rules, the carrying out of which will result in reasonable safety at reasonable expense. A fusion welded code of rules should be concerned with results, it would be impracticable for a code to set up rules and regulations to instruct the management concerning the details of its responsibilities or lay down all the methods by which welding shall be done, and it would be likewise impracticable to place the responsibility of accepting or rejecting details of a welding procedure control upon the inspector. Results are what we are interested in and, if the management develops a welding procedure that will give the desired test results, the details of such procedure are of no interest to the inspector.

Mr. Halsey's statements to the effect "that the inspector must obtain satisfactory proof that the technique of welding or procedure control will secure the desired results" might be taken to mean that it is the duty of the inspector thoroughly to examine the details of the procedure such as the method of welding used, electric or gas, the kind of rod used, the voltage and amperage, the number of beads, the thickness of the beads, etc., and from this information determine if the desired results can be obtained. The inspector should not interest himself in such details as the responsibility of providing means for obtaining certain results. This rests with the management. After a procedure has been developed that will obtain the desired results, it is the duty of the inspector to see that the details of this procedure are followed throughout the construction of the vessel. The success of fusion welding depends entirely upon the proper carrying out of all the details of a procedure which may be likened to links in a chain. If any one of the items of the procedure is defective or neglected it means failure to the entire operation.

In the early stages of welding, good results depended almost entirely upon the welding operator. As the art of welding progressed the variables that entered into the problem which produce poor welding were corrected, in a large degree, by improving the quality of welding rod materials, coating the rod to shield the arc as the metal passed through to the joint reducing the possibility of oxide and nitride contamination which are highly undesirable in a weld, providing brittleness and if in sufficient quantities reduces the tensile strength.

The qualifying of welders is an important factor to be considered to produce good welding. The inspector should follow the requirements of the A. S. M. E. Code for qualifying welders and the test specimen should be prepared under the procedure control set up for a certain job. The welder should demonstrate his ability to produce a sound weld under the provisions of the procedure used. If a person is qualified under a certain procedure it does not mean that he can be depended upon to produce sound welds under all conditions.

This brings up the question of the method for qualifying welders that will properly safeguard the interests of the states and cities against poor welding operators. It is the opinion of some of the members of the National Board that approved welders should be licensed. To do this it would be necessary to set up general qualification rules and when complied with the welder could not be depended upon to do all kinds of welding. It would be impracticable to assume that it would be possible for any state or city to provide a system that would assure them that all licensed welders are keeping abreast with the development as the art of welding advances. There are a number of other factors that enter this problem which makes it questionable whether it is advisable for a state or city to give their stamp of approval to welders and thus directly assume the responsibility for all work performed by such welders. The same results and, in fact, more effective results can be obtained if the responsibility for the testing of welders is placed upon the inspector, who is qualified to represent the state or city in this capacity.

The question of welded vessels that are in service, which were not inspected during construction and properly stamped upon completion, is a problem that confronts the states and cities for such installations that were made prior to the enactment of regulations providing that all vessels shall be constructed in accordance with the A. S. M. E. Code and stamped upon completion with their State standard or National Board.

An inspector of welding does not necessarily need to be an experienced welder any more than it would be necessary for a boiler inspector to be a boiler maker. The A. S. M. E. Code definitely sets forth rules and regulations governing the inspection requirements. The inspector should thoroughly familiarize himself with these requirements and determine a definite working knowledge so he can apply these rules in practice.

* Comment on paper before the National Board of Boiler and Pressure Vessel Inspectors.

† Chief inspector of steam boilers for the State of Ohio.

Technique of Welding Pressure Vessels*

By J. G. Wheatley†

In the presentation of such a wide and varied array of problems it is, perhaps, difficult to grasp properly the many important points made, and I would like to emphasize the meat which is contained in the first paragraph of this paper, viz; that it must be clearly recognized that the acceptance of fusion welding in the pressure vessel and pipe-line fields today is based on the assumption that welding will be safe if an approved technique is followed by trained and tested welders. That statement covers the problem—approved technique

* Comment on paper before the National Board of Boiler and Pressure Vessel Inspectors.

† Chief engineer, Royal Indemnity Company, New York.

in welding to be followed by trained and tested welders.

To ask from the manufacturers, in writing with sketches where necessary, the "Specifications for Welding" they propose to follow, is not unreasonable. The specifications being available and the materials—plates, welding rod and welding equipment, etc., being found acceptable, there is then the problem of the fitness or otherwise of the welders to be considered, and the method of testing these very important links in the chain is clearly outlined in the Code and must be followed without question.

Manufacturers generally in the past have selected their welders carefully and the ranks of skilled welders will undoubtedly be increased steadily in the future, because with the more general acceptance of welded construction and the greater importance of sound welding with the material increase in temperatures and pressures to which these vessels are to be subjected, must inevitably follow an appreciation of the monetary value of dependable welders to manufacturers.

The point made by Mr. Halsey that the Code recommendation, that welders be assigned by the employer a number, letter or symbol in order that his work be identified, should be made mandatory, is worthy of serious consideration, because it is unquestionably a step in the right direction.

There can be little argument as to the requirements necessary to prepare our men for the difficult task of inspecting welded construction and I very heartily endorse the method outlined by Mr. Halsey, although I feel that one needs to have done actual welding to be capable of promptly detecting faulty welding technique. It is essential that welding inspectors be trained in both electric arc and gas welding and thoroughly grounded in the underlying principles of welding procedure and, like any other apprentice, the thoroughness of his apprenticeship determines his future value to his employer.

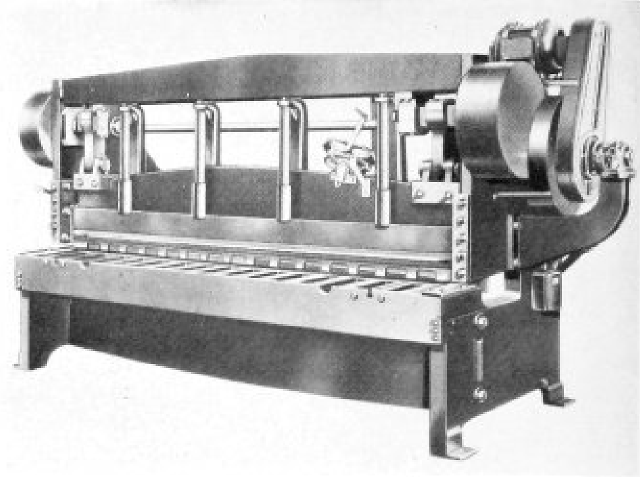
Just as it is impossible to produce the craftsman in the technical library, so it is impossible to produce the competent welding inspector unless he has had the opportunity of absorbing welding fundamentals by working alongside practical welders and seeing all kinds of welds produced, bad as well as good.

Steel Power Shear with Back Gage

The Dreis & Krump Manufacturing Company, Chicago, has recently placed on the market the new Chicago steel power shear with back gage, operated from the front of the machine. This is an entirely new development in shears, designed to meet the demand for high-speed cutting with greater accuracy.

The convenience of setting the new type back gage from the front of the machine results in considerable saving of time, as it does not require the operator to walk around to the back of the shear each time he wants to set the gage. The illustration shows the operating crank of the gage and the dial, which is graduated in inches and sixty-fourths of an inch. Dial graduations are double scale so that accurate reading may be easily and quickly made. Both screws are operated in unison, keeping the gage in perfect parallel alinement with the knife at any position. The gage automatically locks at any setting. Gage screws can be disconnected for taper cutting.

Other new features on this machine, which are claimed to insure accurate cutting, are low cutting angle of the



Dreis & Krump steel power shear

upper blade, high-pressure hold-down, and rigidity of construction. The one-piece hold-down straightens out any buckles or unevenness in the sheet before the shearing is started, thus adding to the accuracy of the cut. Users preferring individual hold-down fingers can have them as optional equipment if desired. This shear is of all-steel plate construction, which insures long life and freedom from danger of breaking any of the main members.

Employers to Post Code Regulations

Regulations requiring employers operating under approved Codes to post the labor provisions of those Codes conspicuously in their establishments were issued recently by National Recovery Administrator Hugh S. Johnson.

Under the regulations, issued in accordance with a recent Presidential Executive Order, official copies of the hour and wage provisions of the Code to which he is subject will be furnished to each employer. These official copies will include detailed directions for the proper filing of complaints of violations of the provisions.

"Such official copies," the regulations prescribe, "with such directions, shall be kept conspicuously posted at all times by such person in each shop, establishment or separate unit of his enterprise to the extent necessary to make them freely accessible to all employees."

Posting of the provisions is designed not only to acquaint employees with their rights under Codes but also to protect employers from complaints made in ignorance of Code provisions and to protect faithfully-complying employers from chiseling competitors.

The regulations provide for registration within 30 days by employers with their Code Authorities of the number and locations of their shops, establishments, or separate units. Thereafter the Code Authorities will furnish the required number of official copies (prepared by N. R. A.) of labor provisions for posting.

In cases where an employer is permitted by a modification, exemption or exception to pay lower wages or work employees longer hours than prescribed by the Code for his industry or trade, certified copies of the modification, exemption or exception will be furnished for posting with the official copies of the code provisions.

A Handy Plate for the Layerout

By I. J. Haddon

Procure a piece of plate about 18 inches long by 7 inches wide by 1.8 inch thick, and on one side of the plate draw the figure as shown in Fig. 1, viz.:

Draw *A-B-C-D*, say, *A-B* and *C-D* 11 inches, and *A-D* and *B-C* say 6 inches. This is a very convenient size.

On *A-D* and *B-C* draw semicircles, as shown. From *E* and *F* (about 1 inch from *A* and *C* respectively) draw lines *A-F* and *E-C*. Divide the semicircle on *A-D* in 14 equal parts, and divide the semicircle on *B-C* into 16 equal parts. From the points obtained, draw lines to meet the lines *A-F* and *E-C*, as shown. All the lines drawn should be done with a scriber, scratching deeply into the plate. Number each line, as shown. On the other side of the plate draw a similar figure, except that the semicircles on *A′-D′* are to be divided into 12 equal parts, and the semicircle on *B′-C′* into 10 equal parts. Drop the lines from the points obtained on to the lines *A′-F′* and *E′-C′*, as shown. Scratch all lines in as before very deeply with a scriber, and number each line, as shown.

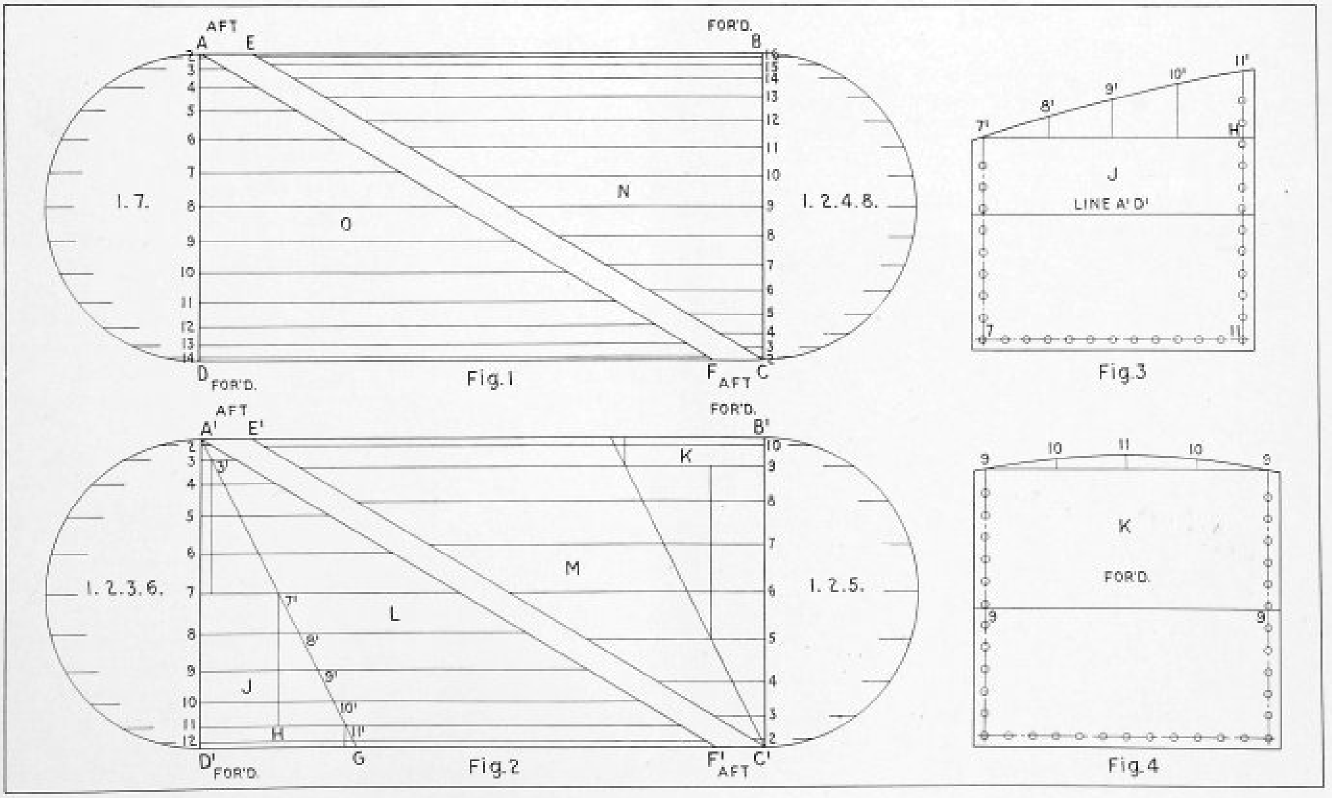
To use this plate: We will suppose you have an elbow to lay out in one plate, and the depth of the cut, or rake, is say 3 inches (the circumference of the pipe does not make any difference, as this will apply to any circumference). Measure along the line *D′-C′* from *D′*, 3 inches, thus obtaining the point *G;* draw *A′-G*. Now divide your plate into say 12 equal parts, then by using the lengths of lines drawn from *A′-3-5-7-9-11-D* respectively, the curve for the elbow may be obtained, or the whole number of lines may be drawn if desired, but I seldom find it necessary to use more than 12 on an elbow in one plate.

Now the particular use of this plate is when the whole pipe is made up of a number of plates in each ring, such as a main funnel (smokestack) for a steamship, and there has to be a rake in the bottom of the stack. The separate parts of the rake may be drawn on each plate without laying out the whole of the ring of plates. Now supposing the whole rake at the bottom of the stack, which is made up of say six plates in the circumference, is say *D′-G* equal to the depth of rake; draw lines from *11′*, *7′* and *3′* parallel to *A′-D′*, as shown in Fig. 2. Then the lines *3-3′*, *7-7′* and *11-11′* would represent the vertical seams, and there would be three lines on each plate besides those representing the vertical seams.

As a further explanation, we will develop a plate for a stack with six plates in the circumference, and one where there are five plates in the circumference.

Development of plate *J*, one of the six plates in the circumference: Let *7-11*, Fig. 3, equal one-sixth of the circumferential seam of the stack, and *7-7′*, *11-11′* equal the longitudinal seams. Draw the line *A′-D′* to represent the beginning of the whole rake, as *A′-D′* on Fig. 2.

Divide *7′-H* into four equal spaces and erect perpendiculars, as shown. Then take the respective dis-



Details of plate for use in layout work

tances from the line $7'$-H, Fig. 2, and cut those erected in $8'$-$9'$-$10'$ and $11'$. A curve drawn through these points will give the rake line on the plate J, as was required. Proceed in a similar manner to develop the plate K, as shown, in Fig. 4, viz.: one of the plates that has five plates in the circumference, only using the diagram marked M.

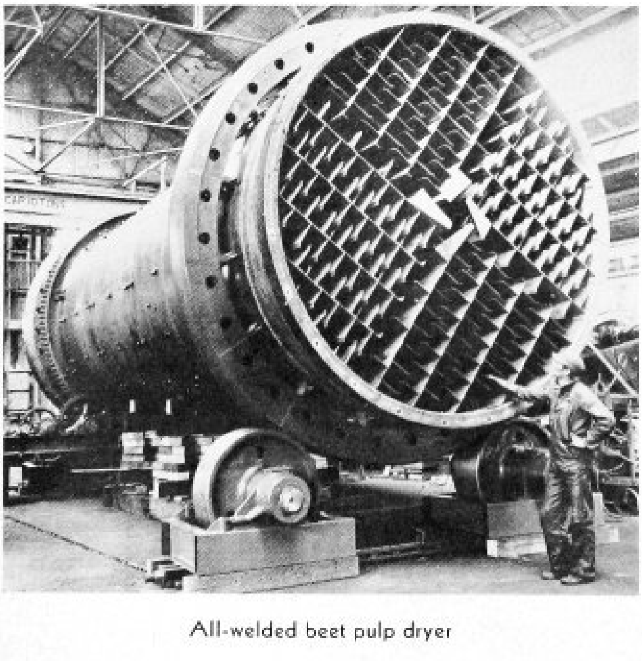
Note: The lines on the L part may be used conveniently for rakes when there are either one, two, three or six plates in the circumference. The lines on the part M may be used for rakes when there are one, two or five plates in the circumference. The lines on part N are suitable for rakes when there are one, two, four or eight plates in the circumference, and the lines on part O may be used when there are one or seven plates in the circumference. And it is, as well, for quick reference if those figures are stamped inside of the semicircles, as shown.

Welding and the Beet Sugar Industry

The Stearns-Roger Manufacturing Company, Denver, Col., in addition to building mining and oil refinery machinery, manufactures a great deal of equipment for the beet sugar industry. Recently, this concern completed the fabrication of a 75-ton beet pulp dryer, one of the largest ever built, and a large water separator for a western beet sugar company. Both of these equipments were constructed by means of electric arc welding with General Electric electrodes.

The beet pulp dryer, with auxiliary equipment, is capable of drying pulp from about 2000 tons of beets in 24 hours, evaporating approximately 430 tons of water in this time and consuming nearly one and one-half million cubic feet of natural gas. In this process, it produces approximately 2000 bags, weighing 100 pounds each, of dried beet pulp. The machine is 44 feet long and about 10 feet 6 inches in diameter. The shell is welded from ½-inch steel plate.

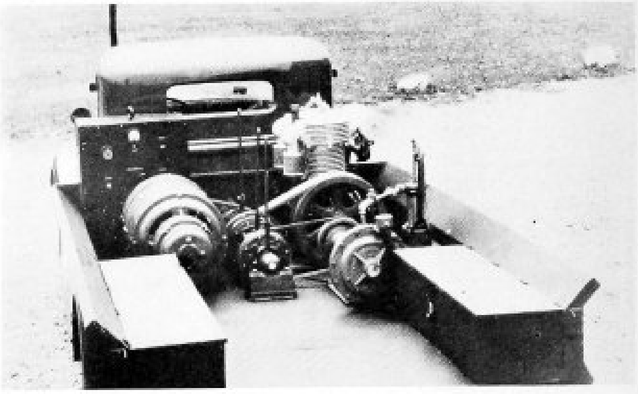
The water separator, which is used in conjunction with the pulp dryer, likewise can handle about 2000 tons of wet pulp per each 24 hours. This equipment is welded from ¼-inch steel plates.



All-welded beet pulp dryer

Universal Welders Now Truck Mounted

The Universal welder shunt inductor type mounted in a gasoline truck and driven by the truck engine gives the welding industry another easily portable working tool that has been developed through co-operation of



Universal truck mounted welder

Universal Power Corporation, 1719 Clarkstone Road, Cleveland, O., and the Ditwiler Manufacturing Company, Galion, O., on the Ditwiler Redi-Service Truck using Ditwiler power take-offs.

The illustration shows the useful combination of welder with an air compressor for chipping, cleaning and cold-working. The take-off is interlocked with the engine governor so that the welder operates at governed engine speed. The truck can be driven only after the power take-off is disengaged.

The Control of Industrial Research

Industrial research has been a major contributing factor in reducing the cost of production and in developing business through new or improved products, or through new uses for old products. If properly directed and controlled, according to a new report of the Policyholders Service Bureau, Metropolitan Life Insurance Company, New York, it is recognized as a sound investment for an industrial organization.

Following a discussion of the organization of a research department of this type, and of the origin and authorization of research projects, the report considers the question of cost estimates. Methods used by these 45 manufacturers in setting up the research budget are outlined in some detail. "The methods of budgeting in use," states the report, "show considerable variation. In some organizations the budget is prepared in great detail for each of the various projects to be undertaken. In other companies the budget is fixed as a lump sum to cover labor, materials and supply expenditures and is used primarily as a guide to assist in keeping expenses within bounds."

The other sections of the report consider standardized research procedure, cost keeping and control, and the review and reconsideration of research projects. A limited supply of copies of *"The Control of Industrial Research"* is available; copies may be secured by addressing the Policyholders Service Bureau, Metropolitan Life Insurance Company, 1 Madison Avenue, New York, N. Y.

LESSONS IN ARC WELDING

It is the object of these lessons to present in a concise manner certain fundamental facts of welding, the knowledge of which will enable the operator to use the welding process successfully and economically. These lessons are based on the course in arc welding given by Arthur Madson at the plant of the Lincoln Electric Company, Cleveland, O. The first lesson appeared on page 46 of the February issue.

Lesson 2

OBJECT: To strike an arc and run horizontal bead.
MATERIAL: Scrap steel plate, 5/32-inch Stable-Arc rod.
SET UP: Place plate on the bench and wire brush it to make sure it is clean.
PROCEDURE: The principal difficulty encountered in striking the arc, is freezing—that is, the electrode sticks or fuses to the work. This is caused by the electrode touching work on a small surface. High amperage or current flows as the electrode is practically short circuiting the welder. This heavy current melts the electrode and it sticks to the plate before it is withdrawn from contact. The high current will soon heat the electrode to red heat and then melt it, unless the circuit is broken by giving a rapid twist to the holder.

There are two general schemes of striking the arc although these are essentially the same. The first is to put the electrode on to the work, moving it down in a vertical direction and just as soon as it touches to withdraw it to the correct arc length, see Fig. 7. Sometimes this is rather difficult so the second method, which is a variation of the first, consists in moving the electrode at an angle to the plate, a sort of scratching the plate. The electrode will bump or rattle across the plate and form an arc, and when this happens the student withdraws the electrode to the proper arc length, Fig. 8. Practice this by using 125 to 140 amperes with the 5/32-inch electrode. Lesson No. 1 shows how to set the machine for this current and voltage.

Hold the electrode in a vertical position; bring it to a point on the plate where the weld is to be done and then hold it there without touching the plate until the hand shield is in front of your face. Touch the electrode very lightly and swiftly to the work by a motion of the wrist. The movement in touching to plate should be somewhat rapid, then after that more slowly; bring the electrode away from the plate about 1/8 inch, or a little less than the diameter of the electrode. Hold the arc for a few seconds and then break it.

If the electrode sticks or freezes give the holder a quick twist and this will generally free the electrode. If it doesn't, and the electrode becomes red hot then it is necessary to open the circuit by letting go of the electrode with the holder or stop the welder by pushing in the stop button.

Practice starting the arc and holding it, moving the electrode rather slowly over the plate until you are able to start the arc just as you desire. Move the electrode straight along so that there is no weaving or zig-zag motion of the holder but a straight bead is obtained.

In the other method; that is, scratching the electrode on the surface, much the same procedure is done. See

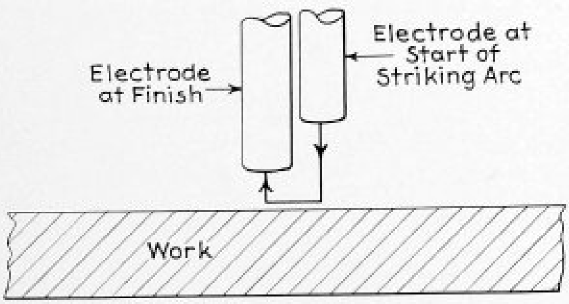


Fig. 7

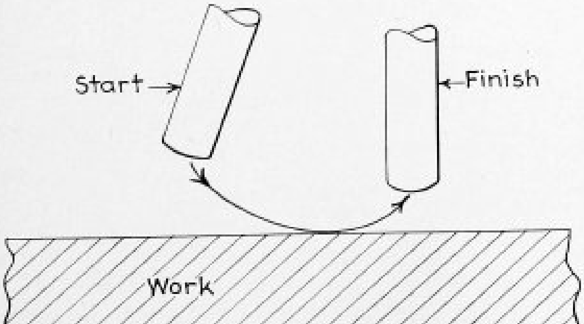


Fig. 8

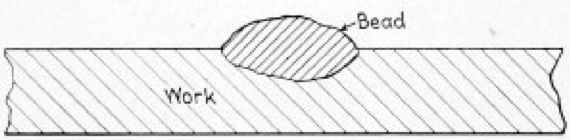


Fig. 9

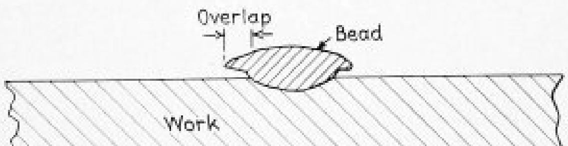


Fig. 10

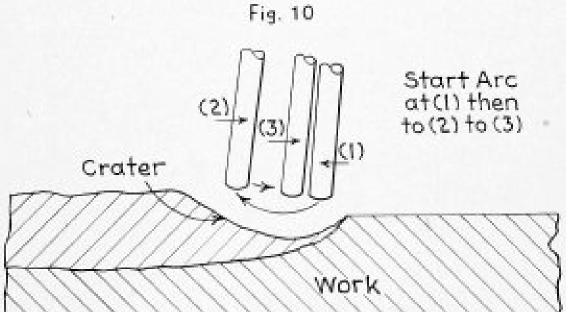


Fig. 11

Fig. 8. Be careful that you do not move the electrode too fast so that the deposited metal does not have time to penetrate into the parent metal. Keep the electrode just at the forward edge of the crater. The correct speed will be indicated by the bead being just the right size, not too thin and not built up too much, Fig. 9. Continue this until you are able to start the arc every time and stop it when you desire, start it when and where you desire. Try making some lines, letters, etc., but do not weave.

Examine the various beads and chip some of them off, look at them carefully. Keep this practice up until you can make the beads 3 or 4 or 5 inches long and of good appearance, even height, width, depth; no overlap but good penetration. See Fig. 10 for bead showing overlap.

When you stop the arc and then want to start again on the same bead, the arc should be started at the heel of the crater, Fig. 11. Do not leave this lesson until you are able to start and stop the arc at the time and place you desire.

Lesson 3

Object: To run a straight bead not less than 12 inches in length—uniform width and height. The arc must not go out during the time the bead is being run.
Material: Plate ¼ inch or heavier—$\frac{5}{32}$-inch Stable-Arc rod.
Set Up: Clean the plate so that sufficient space is available, so the arc may be struck as indicated in Lesson 2.
Procedure: Move the electrode slowly and steadily along the plate and away from the operator, proceeding

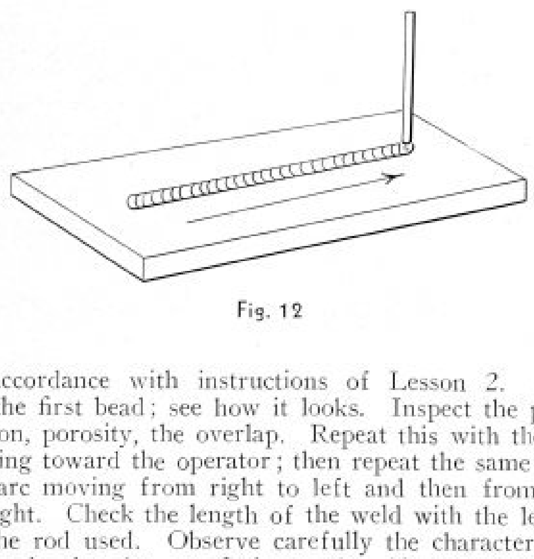


Fig. 12

in accordance with instructions of Lesson 2. Chip off the first bead; see how it looks. Inspect the penetration, porosity, the overlap. Repeat this with the arc moving toward the operator; then repeat the same with the arc moving from right to left and then from left to right. Check the length of the weld with the length of the rod used. Observe carefully the characteristics of the bead and try to find out what, if any, your difficulties are in making this, Fig. 12.

Lesson 4

Object: To study and learn several types of weaving or movement of electrodes.
Material: $\frac{5}{32}$-inch Stable-Arc rod, ¼-inch plate, or any flat pieces of scrap.
Set Up: Prepare the plates with a sufficiently clean surface so that the bead may be made several inches long. Place plate in horizontal position on bench.
Procedure: After you are able to strike an arc, hold a short arc and keep the arc at the advancing edge of

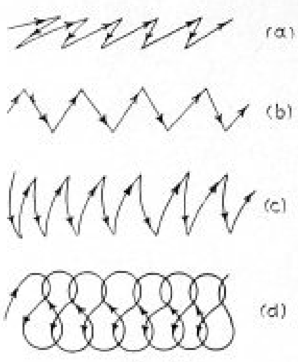


Fig. 13

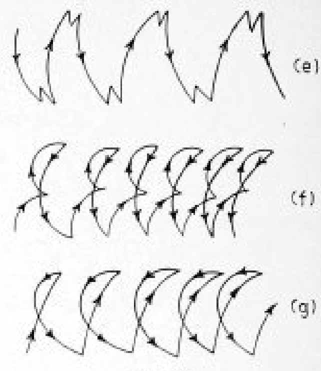


Fig. 14

the crater. You are then ready to proceed with the weaving motion. The first motion is to move the electrode which should be in a vertical position in a straight forward and backward manner, such as indicated on the sketch. (Fig. 13-a.) This will make a straight and smooth bead. This motion should be gradual, not jerky, smooth so the weld will have proper penetration and have regularly spaced ripples. The second motion (b)

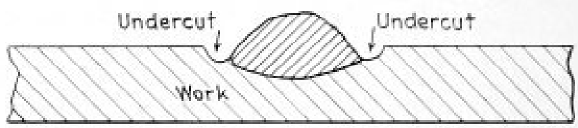


Fig. 15

is to move the electrode, advancing slowly from side to side in a zig-zag manner. This is shown in the sketch. The third (c) is moving the electrode in a half circle or half moon. The fourth motion (d) the electrode is moved in the same manner as a figure 8 backwards. This is indicated in the sketch (Fig 13.)

All of these must have smooth surfaces, each consisting of regularly spaced ripples without holes or spongy places, uniform width and height, proper penetration and no overlap or undercutting.

After these four have been mastered then proceed to do weaving as shown in Fig. 14. In some cases there is a tendency to undercut (see Fig. 15) caused by too high current for rod size being used and too high speed of travel of electrode across plate. Fig. 14 (e) or Fig. 13 (d) are helpful in this case. Where it is advisable to keep metal molten for a longer time than usual, Fig. 14 (f) and (g) may be used. This will help let out the gases as metal is molten longer and they can escape easily.

Lesson 5

Object: To study the effect of arc length, current and speed on bead.
Material: Pieces of scrap—clean plate about four inches by eight inches—$\frac{5}{32}$-inch Stable-Arc rod.
Set Up: See that the plate is clean and put aside until some practice has been obtained on each exercise. Set up some scrap pieces in convenient manner so surfaces are horizontal.
Procedure: Two students should do this. The first student doing the operating and the second student observing the meter and adjusting the machine. Using a $\frac{5}{32}$-inch rod, set the machine so that while welding 20 volts, 70 amperes are used. You will notice that this current is low. There are several things you must observe in each of these items. First, how the rods burn

off. Second, how metal piles up on the plate. Third, the character of the crater; then the bead, penetration and the sound. You will find in the case of this low current that the bead sticks on top of the plate and the sound is a rather weak, pulsating crackling sound, and that there is just a little bit of evidence of the crater.

Now, set it at 20 volts and 135 amperes. You will find that penetration is better; that the sound is a steady consistent crackling sound and you will have a normal bead.

The third one; set it at 20 volts, 225 amperes or more. You will find the penetration excessive, a lot of splatter. There will be a very energetic crackling sound and mixed in with this some explosions. Notice the character of the bead; the character of the crater; the metal. This gives you the three-current variations.

Now set for consideration of the voltage variations. Try a 10-volt arc if you can hold it, or just as short an arc as you can hold, at 135 amperes. Note this is a very steady sputtering or crackling sound. Note the bead piles up similar to that in the case of the low current but that the evidence of the crater is very much less. The character of the bead is very similar.

Then we will omit the normal bead and go to a very long arc; say a 28 or 30-volt arc and note the splattery effect—not the explosive action you got in the heavy current but a splatter. Most of the sound is rather a low whistle, mixed in with this being a few crackling sounds, or perhaps you might say explosions although they are not as vigorous as the heavy current ones. Note that the metal appears oxidized due to the fact that it had a long way to go and the air had a chance to act on it.

Now setting the welder for normal conditions, that is, 20 volts and 135 amperes, hold the speed of travel down just as slow as you can. Notice that the rod gets hot for a small ways up but it does not get hot all the way up as it does in the case of the heavy current. Notice also that the work is pretty hot and the bead piles up.

Then, the next one with the normal arc, voltage and current conditions; move the electrode as fast as you can over the plate. Notice how the bead is stringy. You do not get much penetration because you do not have enough energy to get it and in some cases you will even find that the metal is dragged out to such an extent that the bead is almost discontinued.

After this has been done, and it will take quite some time to do it, then the students are to change places and repeat.

Following this, one student then is to put down some beads and tell the other student just what he is doing, the second student checking this with the meter. For instance, he should say—"I am now holding a very short arc at normal current and the reading should be 10 or 12 volts at 135 amperes." Try a dozen or two of these and then change places and do it over again so that you know very clearly, definitely and positively just what you are doing.

This is one of the most important lessons in the course and you must keep at it until the student who is operating is able to tell the student who is on the switchboard just exactly what he is doing and the student at the switchboard is to check this before the lesson is considered as completed.

	Amperes	Volts	Speed	Polarity
1	70	20	Normal	Straight
2	135	20	Normal	Straight
3	225	20	Normal	Straight
4	135	12-15	Normal	Straight
5	135	28-30	Normal	Straight
6	135	20	Low	Straight
7	125	20	High	Straight

These lessons will be continued in the April issue.

Complete Protection for Workers

Protection for the worker, from the crown of his head to his toes—that is one of the projects of The Fifth Annual Greater New York Safety Conference, which met March 6 and 7 at the Pennsylvania Hotel.

"While Accidents are increasing in a definite ratio to recovery and re-employment," Julian H. Harvey, manager of the New York office of the National Safety Council, and in charge of the conference administration, says, "those who have planned the conference program wish not only to tell the worker and employer how to apply fundamental principles of accident prevention and care of the injured and how specific protection problems may be solved, but to show them how safety equipment may be employed. So there is a session devoted to safety equipment addresses and throughout the whole meeting period of two days, accident preventive and protective devices will be on exhibit."

In the Safety Equipment session, over which Henry J. Mineur, director of safety, The Bordon Company, New York, presided, the sight meter, a new aid to the conservation of eyesight, was described by H. E. D'Andrade, chairman, New York section of the Illuminating Engineering Society of New York City. This instrument is advanced as a new tool for use by non-technicians in determining the adequacy of illumination at given points.

Earl Blank, director of safety and welfare, Jones and Laughlin Steel Corporation, Pittsburgh, discussed the value of safety devices in preventing injuries, the need of quality control and the practical results to be obtained through their use. J. Walter Dietz, superintendent of industrial relations, Western Electric Company, Kearny, N. J., indicated how employee interests in first aid may be used as the basis of an aggressive program of safety education having the fullest co-operative interest of employees.

Specifications and standards essential to the securing of quality in eye protectors, and important requirements relative to the specifications for purchase and use of electric protective equipment, such as rubber gloves, blankets, line hose and hoods, were given in talks by W. P. Elstun, of the operating and engineering department, American Telegraph and Telephone Company, New York City; and R. O. Bentley, division superintendent, Public Service Electric and Gas Company, Newark, N. J., respectively.

Exhibits included fire extinguishers, first aid equipment, devices for protection against gas, minemen's safety equipment, personal safety equipment, safety billboards, antiseptics, safety operation codes for various industries and purposes, and literature on industrial, public and home safety.

Visitors to the exhibit booths found goggles adapted for individual kinds of work, those for steel workers, welders, foundrymen, etc.; those to protect from splashing of molten metal, those to shield the eyes from flying bits of steel and stone, etc. For the protection of feet, there were shown different types of shoes especially reinforced with steel and other material, devised to meet the needs of certain types of work. Hoods and helmets for work ranging from sand blasting to electrical were also represented.

Because of the growing interest in safety in the metropolitan district, the Safety Equipment Session was attended by nearly 700 this year.

What About Apprentices When Business Picks Up?*

The last time I visited the back shop, several years ago, it was teeming with activity. A trip through it always proved an inspiration, because of the progressive spirit of the management. You could always be sure of finding several new stunts to improve the quality of workmanship or to increase production.

And then there was the younger group—the apprentices and those more recently graduated. They were ever on the alert to promote worthwhile activities looking either to their own improvement, or for the benefit of the shop or the railroad as a whole. Back of this group, but studiously avoiding the spotlight, was the Apprentice Instructor. Unless you were fairly intimately acquainted with the organization, however, you would never suspect that he was the driving force behind the younger group.

* * *

Today, as I strolled through the plant with the Master Mechanic, the few men employed were already checking out, although it was early in the afternoon—a pathetic reversal from the former conditions.

"What has become of the Apprentice Instructor?" I queried.

"Because of the financial stringency we were forced to abolish the position," replied the M. M., "and we transferred him to an office job—not much of a job, but better than nothing. Some day we hope to put him back in his old position."

"But what about the apprentices?" I said.

"We haven't hired any new boys for a long time," was the reply, "but we still carry those that were with us when we began to slow down."

* * *

A little later I located the Apprentice Instructor. "Just what is happening to the apprentices?" I asked.

"Well," replied A. I., "they do have a few hours' work four days each week. Classroom instruction has been eliminated, but the foremen and lead workers see that the boys receive the necessary coaching on the job. Naturally they have a lot of spare time on their hands and most of them would probably be glad to attend study classes on their own time. Except for my own salary there would be little expense involved, since we have available the facilities and equipment for classroom work. With my demotion and the cuts applying to the lower rate of my present job, I am awfully hard hit. I have wondered, however, if I could get the management to revive the classroom apprentice training, with the boys and myself matching our spare time against the use of the facilities and the little expense required for materials."

"You still believe, then, in a good course of classroom training for railroad shop apprentices," I said.

"Unqualifiedly, yes," he replied, "and for three principal reasons. Look at the boys we have graduated in recent years. Most of them are still with the company and the type of training we have given them is reflected in the reliance we place on them. Several have advanced to minor supervisory positions, although our modern apprenticeship training has hardly been in effect for more than a decade.

"In the first place," continued A. I., "modern equipment and practices are becoming more and more complicated and we need a higher type of craftsmanship than was required even a few years ago. It looks very much now as if we would have to face even more radical changes in equipment and facilities within the next few years. If the mechanical department is to make good it must have available properly trained mechanics who can successfully tackle these new problems. It requires something more than manual training for the average mechanic to adapt himself to these new conditions. A certain amount of technical instruction is quite necessary."

"Upon just what basis do you make this assertion?"

"Several times in recent years," replied A. I., "when we have introduced new, complicated equipment, recent graduates of the apprentice department have been assigned to its care and maintenance. The older mechanics have not had sufficient technical training to understand the principles upon which the devices operated and were thus handicapped in understanding how properly to maintain and repair them."

"Aside from this," I asked, "what other desirable qualification has characterized the apprentice graduates of recent years?"

"They take a much keener interest in their work," replied A. I. "We have tried to show them just how mechanical department maintenance operations are important from the standpoint of the railroad as a whole, and also to give them a good idea of the more pressing railroad problems. As a result they not only co-operate more effectively in doing their own work, but they have been an important factor in helping to make friends for our road and to educate the public about the importance of and the needs of the carriers. As you know, they have put on several programs here in the community, which have been extremely helpful in cultivating a more friendly feeling on the part of the public."

"What other advantage do you claim for modern apprenticeship methods?"

"There is no question in my mind," replied A. I., "that with the growing complications in facilities and operations it is becoming increasingly important that we give more attention to that type of training which will assist in developing the best possible supervision. While our methods are primarily intended to make good mechanics, nevertheless, we can do much to stimulate the boy who has natural leadership qualifications. We have already seen enough evidences of this among our recent graduates to realize that apprentice training is invaluable in helping to develop men for supervisory positions. The same thing is true in even a more marked degree on the part of the few roads that seriously introduced modern apprenticeship methods almost a quarter of a century ago and have consistently followed them up, at least until the depression seriously upset mechanical department organizations."

"What is giving you the greatest concern at the present time?" I asked.

"Just this," replied A. I. "Apprenticeship instruction has been discontinued in the mechanical departments of most railroads. Nobody seems to be greatly concerned

* From an interview in mechanical department problems of a prominent railroad.

about it. I am afraid that when business starts to pick up, the officers of the mechanical departments will be so hard pushed that they will lose sight of apprenticeship and we will lose the effect of a movement which it took a quarter of a century to get well started. That is one of the reasons why I personally would be willing to make a considerable sacrifice of time and energy, if I could find some way of starting ahead on at least the temporary basis which I have suggested above. Surely the railroads cannot afford to drop a worthwhile effort which has so much promise for the future."

Discussion of Master Boiler Makers' Committee Reports

The two comments published below were submitted in connection with committee reports of the Master Boiler Makers' Association "Convention in Print" published in the October issue of The Boiler Maker.

Staybolt Thread Standards

We have read with much interest the report of Messrs. G. B. Usherwood, E. S. Fitzsimmons, and J. A. Graulty who comprise the Committee on "Better Methods Used in the Application and Threading of Staybolts, Iron, Nickel, and Special Alloyed Steel, Flexible, and Rigid, with Details and Tools Used," which appeared in the October, 1933, issue of The Boiler Maker. We believe that the efforts of this committee to have staybolt threads standardized, both as to form and tolerances, is worthy of support and we desire to add to their report from our experience as manufacturers of die heads and machines used in the threading of staybolts, not only by staybolt manufacturers but also by many roads.

Inasmuch as our experience has been limited largely to the threading of staybolts and not to tapping operations, we will endeavor to confine our discussion to thread forms, thread tolerances, and equipment and methods used in the manufacture of staybolts.

The V form of thread is still used by some roads although, as the committee reports, in recent years there has been a general change from the V form of thread to the U. S. form. This change is a very wise one, inasmuch as it is practically impossible to produce an actual V form of thread under the usual shop conditions. As a matter of fact, it is extremely difficult for manufacturers of threading tools to produce tools which will actually give a V form of thread which, of course, requires a sharp crest and sharp root on the thread. Wear on threading tools, both chasers and taps employing the V form of thread is very rapid, with the result that when the staybolts are screwed into the firebox, the threads will have contact only at the crest and root of the thread and not on the side angle.

Both from the tool manufacturer's and the user's standpoint, either the U. S. form of thread or the Whitworth form of thread is preferable to the V form. The U. S. form and Whitworth form are comparatively easy to manufacture and much simpler to maintain. It is true that a much greater output can be obtained per 0.001-inch wear on either taps or dies.

The Whitworth form of thread will give a somewhat better thread finish than the U. S. form of thread but, in our opinion, this advantage is more than offset by the fact that the U. S. form of thread lends itself more readily to checking for accuracy. Being a deeper thread, the U. S. form will give more bearing on the side angle of the thread form than the Whitworth thread.

It is interesting to note that in England, where the Whitworth thread form is used for staybolt thread, an 11 pitch Whitworth thread is employed instead of the 12 pitch thread which is universally used in the United States. The 11 pitch Whitworth thread is, of course, deeper than the 12 pitch Whitworth thread and without a doubt, this change in pitch was found necessary in order to give sufficient bearing between the mating parts.

In our opinion, so long as the 12 pitch thread is retained, the U. S. form of thread should also be retained as the standard thread form.

It is our feeling that thread tolerances should be considered as a single subject and not subdivided into "diameter tolerances" and "lead error tolerances." In other words, we feel that it is unwise to set a definite standard for diameter tolerances, and a separate definite standard for lead error tolerances. These tolerances should work together. It is, of course, necessary that a limit be placed on both tolerances but the limit should be set so that as pitch diameter errors increase, lead error tolerances will necessarily decrease and *vice versa*. This practice is in accordance with the Report of the National Screw Thread Commission.

Inasmuch as thread should fit on the side angle, it is absolutely necessary that the threads be measured for accuracy on the pitch diameter in order to insure a proper fit between the staybolt and the tapped hole in the firebox. The outside diameter of the staybolt could, of course, be checked also, but it should not be checked as a means of determining whether or not it will properly fit into a tapped hole.

The report of the National Screw Thread Commission (Revised 1933—Miscellaneous Publication No. 141, published by the U. S. Department of Commerce, Bureau of Standards) contains on page 73, Table No. 31, the limiting dimensions and tolerances, classes 2 and 3 Fits, American National 12 pitch thread series. We believe that these standards could be worked to in the threading of staybolts and in the tapping of fireboxes to excellent advantage. As will be noticed by reference to this table, the pitch diameter tolerance, class 2 Fit of all 12 pitch threads up to and including 1½-inch diameter is 0.0056 inch. The tolerance on Class 3 Fit threads on diameters up to 1½ inches is 0.0040 inch.

A copy of the report of the National Screw Thread Commission, Fourth Edition, Revised 1933, can be obtained from the Superintendent of Documents, Washington, D. C., at a price of fifteen cents per copy.

Whether or not the machine on which the staybolts are threaded should be equipped with a lead screw attachment will depend, first of all, upon the thread limits to be maintained and, next, upon the accuracy of the machine itself. In a number of cases, very satisfactory results are obtained without the aid of a lead screw attachment, but generally we believe that such an attachment should be employed.

It is absolutely essential that a lead screw attachment be employed in threading reduced body bolts, which are threaded on either end, when the two threads on the opposite ends are to be held in continuous lead. If the lead screw attachment is employed in conjunction with a timing attachment, which can be attached to the carriage of the machine, and which is used for positioning the bolt in the work grips, it is possible to thread the bolt on one end and then turn it end for end, using the timing attachment to locate properly the work in the vise grips. Upon engaging the lead screw attachment, the second thread to be cut will be in continuous lead with the first thread.

In threading the tapered end of tapered head crown bolts, it is very desirable that the die head have a taper attachment so designed as to cut the tapered threads from the large diameter of the taper to the small diameter. This is particularly important when the threads have an unusually deep taper. By using a reverse taper die head, the head closes down on diameter as the bolt enters the work. In this way, cutting strains are reduced to a minimum and since the thread is cut from the large diameter of the taper to the small diameter, there is no danger of the chasers nicking or marring the body of the bolt, as is frequently the case when threading the tapered end from the small diameter to the large diameter. Bolts of this type can also be threaded in continuous lead by using a lead screw attachment and timing attachment, as outlined above in the case of reduced body bolts.

Waynesboro, Pa.

G. M. STICKELL,
Assistant Sales Manager,
Landis Machine Company.

Master Boiler Makers Should Promote Interests of Association

I have read with much interest the Committee Reports that were published in our "Convention in Print," in the October, 1933, issue of THE BOILER MAKER, and while I would like to enter into the discussions on these papers, there is little I can offer that has not already been covered in the Committee Papers.

Since my retirement in September, 1929, rapid progress has been made in the construction and maintenance of locomotive boilers and tenders. It is evident therefore that everything possible should be done to hold together the railway mechanical associations, so that they may be able to meet again in convention, to carry on their research work as they have in the past. It is most interesting to read the committee reports that were published in the "Convention in Print" and compare them with the practice of several years ago.

It is a well known fact that the Master Boiler Makers' Association and its members have always been on the alert to improve conditions, and for these reasons we should all co-operate and carry on this work. The last ten years have been a "Real Decade of Progress" in railroad boiler making, and only intensive study and research guided by practical knowledge can bring results.

In judging the true value of an association, prime importance is placed on its research and development activities. If adequate, they signify capable association work. The Master Boiler Maker's Association can promote progress by adopting these principles, and promote adequate and co-ordinated research. The field is open, and our association members can demonstrate their interest by accepting the challenge, to demonstrate their progress by entering the discussions of the committee papers that were published in the "Convention in Print" October, 1933, issue of THE BOILER MAKER.

Topeka, Kans.

GEORGE AUSTIN,
Retired General Boiler Inspector,
Atchison, Topeka and Sante Fe R. R.

W. C. Connelly of Cleveland, former president of the American Boiler Manufacturers' Association has been appointed a member of the N. R. A. Code Authority for the Gray Iron Foundry Industry and the Metallic Wall Structure Industry.

Reader Service Bulletins

Many readers will find the information contained in the booklets listed of considerable value in their work. A request for them to the Editor of BOILER MAKER AND PLATE FABRICATOR, 30 Church Street, New York, will assure your receiving copies

Report on Extending Life of Smokestacks

In few cases does a smokestack last more than ten years and in the majority of cases less than half that time. This fact has proven of such great interest to a manufacturer of special plate particularly adapted for long life of smokestacks that an exhaustive study of the problem has been made by engineers of the company. The results of this study are now available to readers interested in the matter in a "Special Report on Flue Gas Conductors."

Users of flue gas conductors, such as stacks, breechings and smoke jacks, have found that the metals commonly used for this type of construction are rapidly affected by the corrosive conditions encountered. It has also been found that genuine wrought iron has the ability successfully to withstand the severe corrosive influences present in such installations.

The purpose of this report is to point out the principal causes of the severe corrosive conditions to which flue gas conductors are subjected and to suggest an economical means of increasing greatly the useful life of flue gas conductors. In order to do this in as clear and concise a manner as possible the report is divided into seven sections, which are outlined as follows: Smokestacks; boiler breechings; smoke jacks; service records of wrought iron installations; illustrations of recent wrought iron installations; specifications for wrought iron smokestacks; specifications for welded wrought iron smoke jacks, smoke pipe and smoke duct.

Information on Machine Gas Cutting

Machine gas cutting has been called the key to better design, faster production, and large economies in the manufacture of fabricated metal products of all kinds. With this thought in mind, a manufacturer of special equipment for all manner of cutting operations has prepared complete data on the subject in the book "Machine Gas Cutting."

The one major thing that machine gas cutting accomplishes is to enlarge immensely the scope of welded steel fabrication. It is claimed, in fact, that machine gas cutting has made welded fabrication practicable by providing a method for shaping parts of all sizes and contours from steel plate and slabs which brings the cost within reasonable bounds. These parts could be made by other methods but at a cost that would be prohibitive. So widely has this fact become known that machine gas cutting is generally thought of only in connection with welded construction. It is not so generally appreciated, however, that this method can be used to equal advantage for cutting out pieces of many shapes and dimensions for other than welded constructions.

The book covers in considerable detail gas cutting applications of all kinds, and the various types of machines developed for production operations are completely described and illustrated.

Boiler Maker and Plate Fabricator

VOLUME XXXIV 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.

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Society for Testing Materials Changes Headquarters

The American Society for Testing Materials, which has maintained headquarters in the Engineers Club Building, 1315 Spruce Street, Philadelphia, for the last fourteen years, has moved to the Atlantic Building, 260 South Broad Street, Philadelphia.

Supply Trade

William I. Howland, Jr., formerly assistant general manager of sales in charge of bar, strip and alloy steel, of the **Illinois Steel Company**, Chicago, Ill., has been appointed vice-president and general manager of sales of the company, succeeding **Edwin S. Mills**, who has retired on account of poor health.

E. E. Goodville has been appointed assistant to the vice-president in charge of sales of the **Bethlehem Steel Company**, Bethlehem, Pa.

W. A. Nugent, formerly district manager of the Chicago territory for the **Independent Pneumatic Tool Company**, Chicago, has been made sales manager of the company. He has been identified with the company for the past 19 years.

John J. Davis, until about 10 years ago superintendent of the **Interstate Iron & Steel Company**, East Chicago, Ind., now a part of the **Republic Steel Corporation,** recently died at Fort Benning near Columbus, Ga., at the age of 80.

B. F. Harris, president of the **Oil Well Supply Company,** was recently made president of the **National Tube Company,** succeeding **F. R. Waterman** who retired on January 1 under the pension plan of the **United States Steel Corporation.**

M. J. Czarniecki, general manager of sales of **A. M. Byers Company**, Pittsburgh, manufacturers of wrought iron products, recently announced the appointment of **J. B. Durkee**, as manager of the company's Houston office. Mr. Durkee succeeds H. B. Weathersby who died December 19, 1933.

Ralph G. Caulley has joined the Detroit District Sales Office of **Republic Steel Corporation**, according to announcement made by **N. J. Clarke**, vice-president in charge of sales. Mr. Caulley had been connected with **Wheeling Steel Corporation** for fourteen years, the last seven of which were spent in the Detroit district.

Frank G. Brinig, works manager of the **Erie City Iron Works**, Erie, Pa., has been appointed general manager of the company. Mr. Brinig has been identified with the Erie City Iron Works for the past 30 years.

Archibald Alston Stevenson, former vice-president of the **Standard Steel Works**, died at his home in Ardmore, Pa., recently. Mr. Stevenson was 71 years of age.

Frank L. Norton, vice-president of the **Scullin Steel Company,** died suddenly recently in his office in the Grand Central Terminal Building, New York. Mr. Norton lived in Larchmont, N. Y. He was 64 years of age.

Trade Publications

Ignitron Welding Timer.—An illustrated four page leaflet entitled, "Ignitron Welding Timer for Spot Welding," has recently been issued by the Westinghouse Electric and Manufacturing Company. This radically new and improved electronic controller is suitable for use in spot welding production work for joining all types and forms of materials. The distinctive features, construction, operation, and application are described. Copies may be obtained from the nearest district office or direct from the advertising department, East Pittsburgh, Pa.

Insulation of Industrial Furnaces.—This new 72-page book describes insulation methods which have proved most effective in improving performance and reducing operating costs on all types of industrial furnaces and ovens. The requirements for each particular type of heated equipment are analyzed and detailed recommendations made accordingly. The book is illustrated with scores of drawings and photographs. A section is also included on the insulation of boilers, piping and auxiliary power plant equipment with recommendations as to the proper type of insulating material and the most economical thickness to use as well as construction details on method of application. The book is available from Johns-Manville, New York.

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.

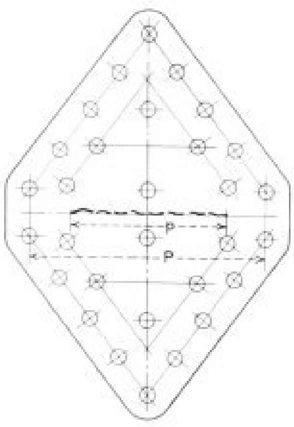
By George M. Davies

Design of Diamond Patches

Q.—Recently I came across a diamond patch put on a locomotive boiler with patch plugs. In designing this patch they evidently figured the stress in rivet shear by assuming the pitch to be the length of the crack in the shell sheet, and I would very much appreciate your advice as to whether this meets with the A. S. M. E. Code. Also, I would be pleased to receive a formula for figuring all the stresses in such a patch. W. B. G.

A.—The A. S. M. E. CODE Section III for locomotive boilers makes no specific mention of boiler patches.

Paragraph L-22 requires that the efficiency of a joint is the ratio which the strength of the joint bears to the strength of the solid plate. In the case of a riveted joint



Failure in diamond patch

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 of the section considered.

This paragraph could be applied to diagonal patches as follows: The efficiency would be the ratio which the strength of the patch bears to the strength of the solid plate, this is determined by calculating the breaking strength of the patch, 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 of the patch considered.

I see no objection to the method of computing the stress in rivet shear as outlined in the question. For example, assuming the patch shown in Fig. 1 and computing it for failure due to shear of rivets.

where:

P = pitch of rivets, inches (as shown in Fig. 1)
p = length of crack, inches
TS = tensile strength stamped on plate, pounds per square inch
t = thickness of plate, inches
a = cross-sectional area of rivet after driving, square inches
S = shearing strength of rivet in single shear, pounds per square inch
n = number of rivets in single shear.

In considering the patch for failure due to shear of rivets, it must be noted that in the distance P there is that part of the original plate $(P—p)$ to be considered, thus:

$$E = \frac{n \times s \times a + TS \times t \times (P - p)}{TS \times t \times P}$$

or,

$$E = \frac{n \times s \times a + TS \times t \times (P - p)}{TS \times t \times p + (P - p)}$$

or,

$$E = \frac{n \times s \times a + TS \times t \times (P - p)}{TS \times t \times p + TS \times t \times (P - p)}$$

cancelling, $TS \times t \times (P - p)$
we have,

$$E = \frac{n \times s \times a}{TS \times t \times p}$$

Patches should be calculated for each mode of failure in similar manner as illustrated for longitudinal seams. Figs. A-1 to A-7 of the appendix of the A. S. M. E. Code.

The formula for computing the efficiency along the diagonal seam was given in the February issue, page 58.

Allowable Working Pressure

Q.—Would you be so kind as to assist me in the interpretation of Par. p-193 of the A. S. M. E. Code for power boilers, or, in other words, solve what is a problem to me? The following is the question:

The steam drum of a watertube boiler is as follows: Diameter, 36 inches; plate thickness, $^{5}/_{16}$ inch; joint, 70 percent. One row of tube holes parallel to axis of drum. Diameter of holes, $2^{9}/_{16}$ inches; spaced $4\frac{3}{4}$ inches center to center; a reinforcing plate $\frac{3}{8}$-inch thick is placed on the inside and is secured by rivets ($^{13}/_{16}$ inch diameter after driving, as per Fig. 1). What would be the allowable working pressure with tensile strength of plate at 55,000 pounds per square inch and factor of safety of 5?—E. S. B.

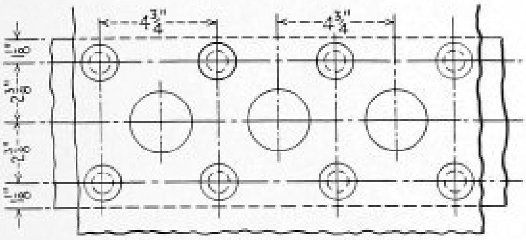
A.—The formula for computing the maximum allowable working pressure is as follows:

Maximum allowable working pressure, pounds per

$$\text{square inch} = \frac{TS \times t \times E}{R \times FS} \text{ where;}$$

TS = ultimate tensile strength stamped on shell plate, pounds per square inch
t = minimum thickness of shell plate in weakest course, inches
E = efficiency of longitudinal joint or ligaments between tube holes (whichever is the least)
R = inside radius of weakest course of shell or drum, inches
FS = factor of safety

The information given in the question includes all the necessary data for computing the maximum allowable working pressure except the efficiency through the tube holes.



Tubes expanded into inner and outer plates

Layout of tube holes and liner

Referring to Fig. 1, which illustrates the layout of tube holes and liner, it will be noted that the construction can fail in the following manner:

(1)—Tearing of shell plate through tube hole ligament and one rivet in single shear.

(2)—Tearing of shell plate through tube hole ligament and crushing of one rivet in liner.

The efficiency based on the above is determined as follows:

$$(1)\ E = \frac{(P - D) \times t \times TS + a \times s}{P \times TS \times t}$$

$$(2)\ E = \frac{(P - D) \times t \times TS + d \times b \times c}{P \times TS \times t}$$

where;

E = efficiency in percent
P = pitch of tubes, inches
D = diameter tube holes, inches
t = thickness of plate, inches
TS = tensile strength stamped on plate, pounds per square inch
a = cross-sectional area of rivet after driving, square inches
s = shearing strength of rivet in single shear, pounds per square inch
d = diameter of rivet after driving, inches = diameter rivet hole.
b = thickness of liner, inches
c = crushing strength of mild steel, pounds per square inch

Substituting values given in the question and assuming 44,000 pounds for the value of s and 95,000 pounds for the value of c, we have

$$(1)\ E = \frac{(4.75 - 2.5625) \times 0.3125 \times 55000 + 0.51849 \times 44000}{4.75 \times 55000 \times 0.3125} = 73.9 \text{ percent}$$

$$(2)\ E = \frac{(4.75 - 2.5625) \times 0.3125 \times 55000 + 0.8125 \times 0.375 \times 95000}{4.75 \times 55000 \times 0.3125} = 81.5 \text{ percent.}$$

The efficiency through the tube holes would therefore be = 73.9 percent.

The efficiency of the longitudinal joint is 70 percent and this being the least efficiency should be used in the formula for maximum allowable working pressure. Substituting in the formula, we have:

Maximum allowable working

$$\text{pressure} = \frac{55{,}000 \times 0.3125 \times 70}{18 \times 5} = 133.6 \text{ pounds per square inch.}$$

Size of Rivets—Correction

In the formulas for "factor of angularity" and "angular efficiency" given in the February issue, page 58, the l was a misprint and should have been "1".

The formulas should read as follows:

$$F = \frac{2}{\sqrt{3 \times sine\ B^2 + 1}}$$

$$Angular\ Efficiency = \frac{2\ (P\text{-}d)}{P\ \sqrt{3 \times sine\ B^2 + 1}}$$

Officers of Hydraulic Press Manufacturing Company

The board of directors of The Hydraulic Press Manufacturing Company, Mount Gilead, O., manufacturers of hydraulic presses and equipment, elected Frank B. MacMillin as president and general manager of the company, and Howard F. MacMillin as vice-president and assistant general manager at its annual meeting held recently in Columbus. Walter G. Tucker, son of the founder of the company, was advanced from the presidency to chairman of the board.

Frank B. MacMillin has been actively engaged in the management of the company for thirty-two years, most of this time in the capacity of executive vice-president.

Howard F. MacMillin, the newly elected vice-president and assistant general manager, joined the company in 1921. His previous responsibility was as vice-president in charge of sales. He is a graduate of the Massachusetts Institute of Technology. He has been instrumental in the progress made in recent years in establishing hydraulics on a higher plane.

Lukenweld Elects Chapman Vice-President

Everett Chapman, who joined Lukenweld, Inc., division of Lukens Steel Company, Coatesville, Pa., early in 1930 as director of engineering and research, has been elected vice-president. Lukenweld, Inc., is engaged in the design and manufacture of welded steel assemblies for machinery and equipment. After graduation in 1924 from the University of Michigan, with a Master's degree in physics, Mr. Chapman taught electrical engineering at Purdue University, leaving to serve the Lincoln Electric Company of Cleveland, on experimental research and development. Since joining Lukenweld, Inc., Mr. Chapman has been credited with responsibility for that organization's engineering achievements in the application of welded steel construction to Diesel engines, presses, planers, lathes, and other machinery and equipment.

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.

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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.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.

Executive Board — Charles J. Longacre, chairman, division boiler inspector, Pennsylvania Railroad, Baltimore, Md.

American Boiler Manufacturers' Association

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Vice-President—Owsley Brown, The Springfield Boiler Company, Springfield, O.

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

Executive Committee—(Three 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. (Two years)—J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.; M. E. Finck, Murray Iron Works, Burlington, Ia.; A. C. Weigel, Combustion Engineering Corporation, New York. (One year)—Homer Addams, Fitzgibbons Boiler Company, Inc., New York; George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn. (*Ex-Officio*)—H. H. Clemens, Erie City Iron Works, Erie, Pa.

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

Cities

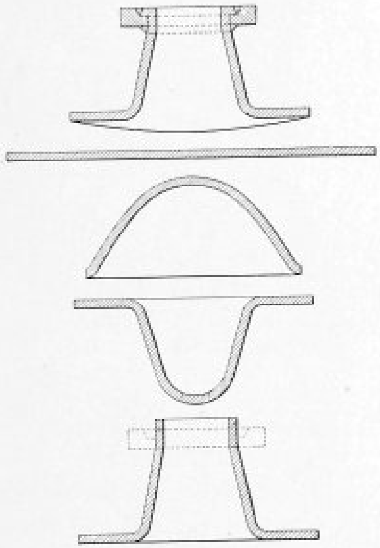
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,853,556. METHOD OF FORMING NOZZLES. CHARLES B. FAIRWEATHER, OF WEST CHESTER, PENNSYLVANIA.

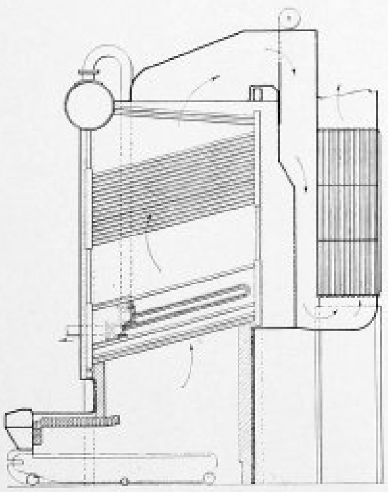
Claim.—The method of forming a nozzle from a sheet of ductile metal,



consisting of drawing the metal at the center of the sheet into bowl shape, forcing the bowl into reverse position, cutting an opening in the crown of said bowl, expanding the metal adjacent to said opening into a neck, and securing the end of said neck to a ring. Three claims.

1,832,029. STEAM BOILER. JAMES KEMNAL, OF LONDON, ENGLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

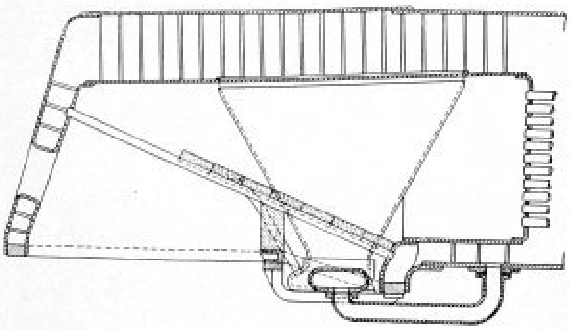
Claim.—A steam boiler having horizontally inclined water tubes, said tubes being divided into a lower bank extending across the boiler for the



full width thereof, a superheater in the lower bank, an upper bank at one side of the setting, a reheater above the lower bank and alongside the upper bank, a vertical dividing wall between the upper bank and the reheater and extending to the gas outlet of the boiler, a damper at the boiler gas outlet for the passage containing the reheater, and a damper at the boiler gas outlet for the passage containing the upper bank. Seven claims.

1,816,468. LOCOMOTIVE BOILER. ALFRED W. BRUCE, OF NEW YORK, N. Y.

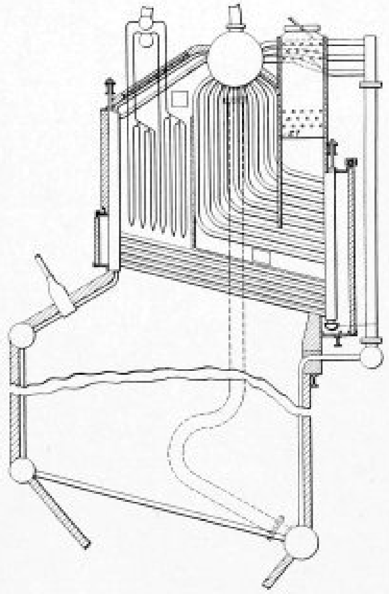
Claim.—In a steam boiler of the locomotive type, the combination of a crown sheet; a plurality of spaced substantially vertical water walls, having



open upper ends secured to upwardly projecting flanges on said crown sheet; a transversely extending header, rigidly connected to, and communicating with the lower ends of the water walls; arch tubes having their lower ends secured in said header; and a pipe leading from the waist of the boiler to the header. Eight claims.

1,829,919. BOILER. WILBUR H. ARMACOST, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

Claim.—In apparatus of the class described, the combination of vertical front and rear headers, a bank of horizontal water tubes connecting them,



a transverse steam and water drum some distance above the bank and approximately midway between the headers, a second bank of water tubes connected to one of the headers and extending toward the other header to a point under the drum and then upward toward the drum, a connection from the second header to the drum, a superheater in the angular space formed by the two banks, a housing enclosing the boiler and superheater, and a connection from the drum to the superheater. Seven claims.

Boiler Maker and Plate Fabricator

Steel Plate Fabricating Code Approved

The Code of Fair Competition for the steel plate fabricating industry was approved by National Recovery Administrator Hugh S. Johnson on April 7 to be effective April 16.

The code was approved subject to a possible further hearing on any provisions which may prove unsatisfactory to the administrator. It provides for a basic 40-hour week and fixed wage minima for factory and construction employees of 40 cents an hour in the North, 30 cents an hour in the South and 35 cents an hour in the states of Texas and Virginia. The industry at present has about 9700 employees, which is an increase of 45 percent over February of last year. The upturn in employment is due partially to large orders for oil storage tanks and partially to compliance with the NRA.

The code was not available for publication in this issue but will appear in the May issue.

The Boiler Maker Can Aid Recovery

There can be no doubt as to the importance of modernizing locomotive repair shops to keep pace with the improvement and modernization of motive power. The experience of the Canadian National Railways in this respect is outlined in an article in this issue.

Applying the principles of modernization cited to the boiler department, there is certainly a great deal that can be accomplished in the physical arrangement of the shop and machinery and in the relation it bears to other departments.

Modernization goes beyond physical equipment, however, and in these days of rebuilding organizations as rapidly as can be accomplished with recovering transportation demands, the attitude of each individual of the shop staff will play an important part in the approach to maintenance problems of the future. With the development of new types of power, with increased capacity of locomotives, with longer runs, and the myriad other maintenance problems which have been created under the changing system, nothing could be of greater importance than the modernizing of ideas to keep pace with physical improvements.

The boiler maker who, being aware of this condition, applies himself to the practical solution of these new maintenance problems will go far in his field. It is understood naturally that he can only work with what is provided in the way of shop equipment and is governed largely by rules laid down by the mechanical officials. Nevertheless there is a wide range within which the responsibility for doing any given job in the most practicable way is his alone. For example, as new power is brought to the shop for maintenance, his experience will largely govern the formulation of rules, and so he can aid immeasurably in working out the most efficient methods and in developing the most useful application of tools for specific work assigned to him.

The same principles apply equally to boiler makers in any other line of work where stationary or marine power boilers are produced, or where allied heavy plate products are fabricated.

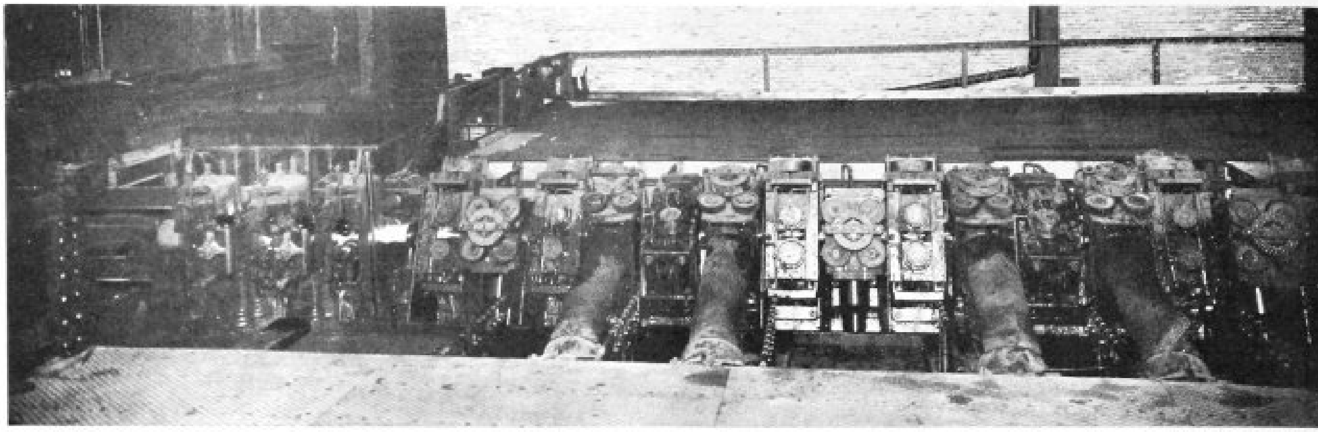
Boiler Repair Industry Being Organized Nationally

Recognizing the benefits that accrue from regulation within an industry, a group of boiler repair firms in the Metropolitan area of New York City has undertaken the work of organizing a national association in order that governmental support of its efforts in the direction of regulation may be obtained.

A fully representative organization of the industry is the first requirement in developing a program under the National Recovery Act. With the idea of enlisting the co-operation and active interest of the widely scattered members of the boiler repair industry, the officers of the National Boilermakers Repair Association have released a statement of their objectives as well as a proposed Code of Fair Competition, which are published in this issue. Just as soon as a sufficient number of individuals or firms have become actively interested in this work and have allied themselves with the association, the proposed code in a final form that meets with the approval of all will be submitted to the Administration for approval.

At the present time it is only necessary for such firms as are interested to communicate to officers of the association their willingness to support the movement, no expense being involved. As rapidly as possible the regional groups under which the code must be administered, because of conditions peculiar to far separated localities, will be organized. To this end the director of the association, L. L. Balleisen, secretary of the Industrial Division, Brooklyn Chamber of Commerce, has asked the co-operation of Chambers of Commerce throughout the country in reaching members of the boiler repair industry to inform them of the work of the National Boilermakers Repair Association.

Any interested reader who is a member of a firm engaged in the repair of steel boilers, pressure vessels, tanks, jacketed kettles, retorts and similar vessels has been invited by Mr. Balleisen to communicate either directly or through the Chamber of Commerce in his territory with the officers of the association, Room 2300, 66 Court Street, Brooklyn, N. Y.



Side view of Foren mill; note squeezer rolls at left

Foren process developed for rolling

SEAMLESS TUBES

The Globe Steel Tubes Company of Milwaukee, has recently developed, constructed and installed what is probably the fastest seamless tube-rolling mill in this country, if not in the entire world, only 20 seconds being required to convert a solid round billet two feet long into a seamless tube 30 feet long. This speed, however, according to P. A. Foren, engineer of the company, who conceived and invented the process, is merely incidental, because the primary aim of the new rolling method was to improve greatly the general quality of tubes for boilers, superheaters, heat exchangers and other varied purposes.

It is claimed that tubes rolled by the Foren process have a perfectly smooth inside surface, free from objectionable scores, scratches and plug marks so prevalent in seamless tubes produced by ordinary methods. Wall thicknesses are exceptionally uniform and accurate.

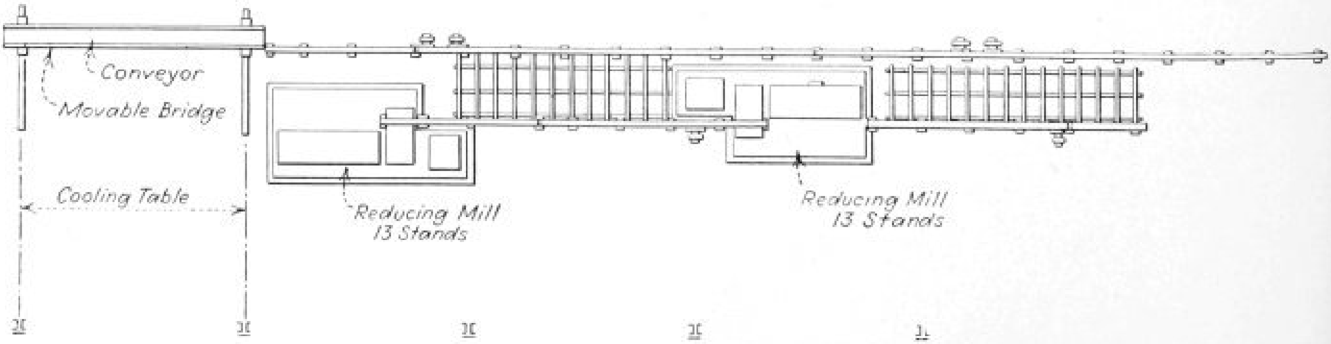
Each tube is rolled over a polished and lubricated mandrel bar which accompanies it through the entire mill. The action of the rolls is more a gentle kneading operation than rolling, and severe friction on the tubes, both longitudinally and transversely, is thereby eliminated. This makes it possible to work the metal under decreasing temperatures, refining the grain structure and greatly increasing the cold-working qualities of the tubes. In the common sizes of tubes the rolling operation is finished within the critical temperature range of the steel.

Other advantageous features claimed for the Foren process are the extremely long lengths readily obtainable and the ability to hot roll tubes of very thin wall thicknesses. Stainless steels, non-ferrous metals and various alloys can be worked to excellent advantage.

The operations in successive steps are shown in the accompanying illustrations and diagrams.

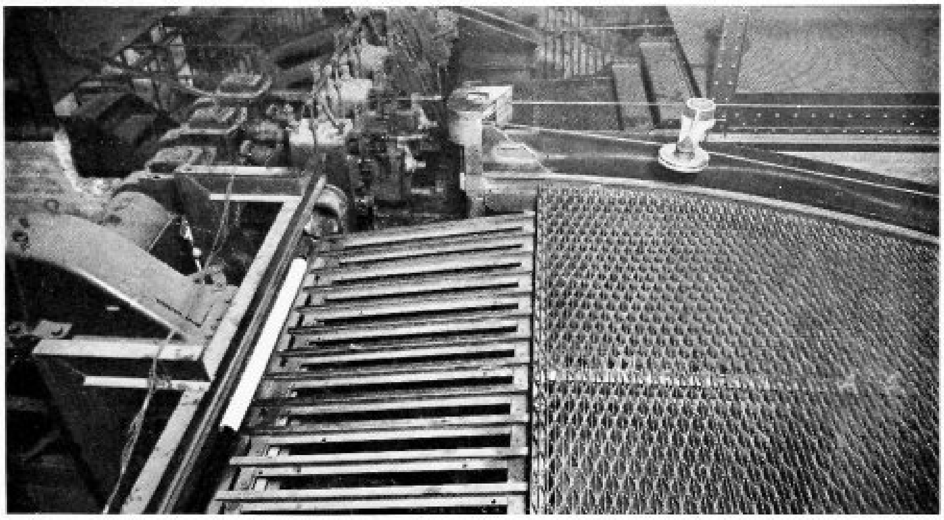
This particular mill has now been in operation more than two months and was designed for tubes ranging from one inch to four inches in diameter.

The furnace for heating the solid billets is elevated, the billets being charged into the furnace by means of an endless chain elevator. The furnace bottom is sloping, thereby permitting the billets to roll by gravity into and through the heating zone to the discharging trough. They are ejected from the furnace by a mechanically operated push bar, kicked out to a rollway and deposited in a trough in front of the piercing mill. A pusher

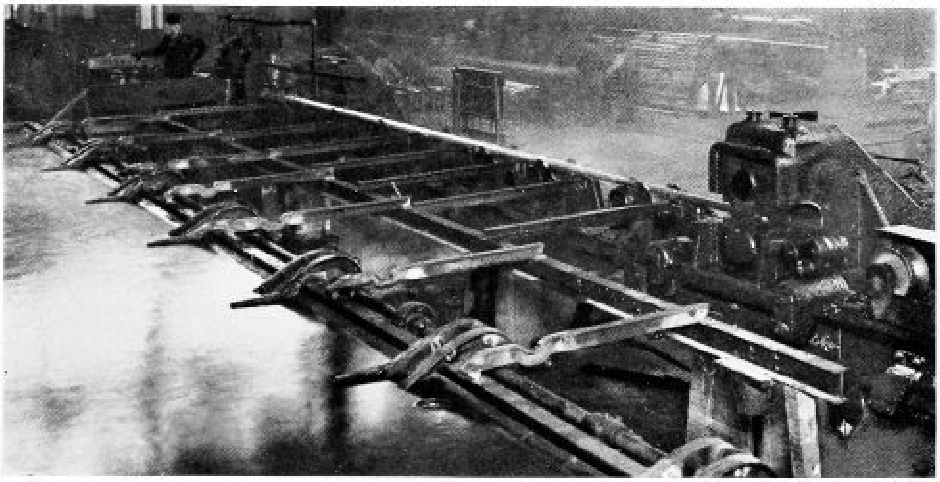


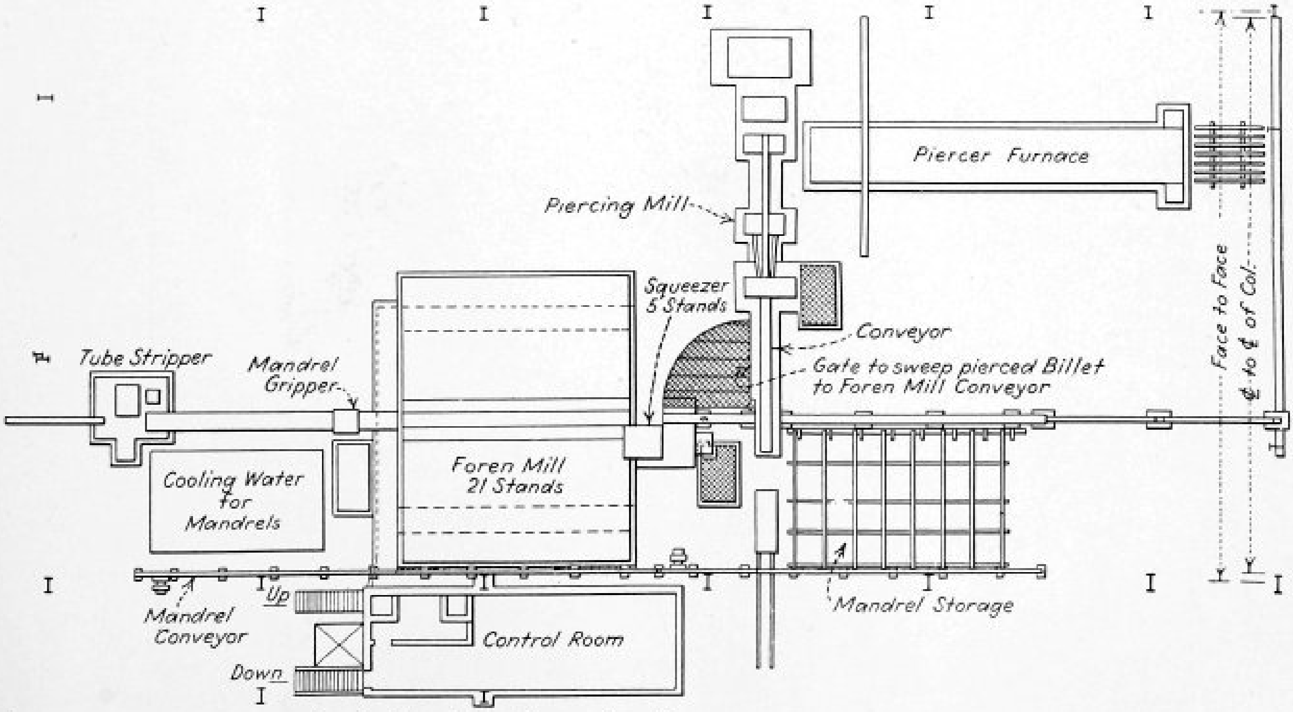
The process is one of straight-line production, at no point between the

Mandrel bar being inserted in pierced billet in front of squeezer rolls

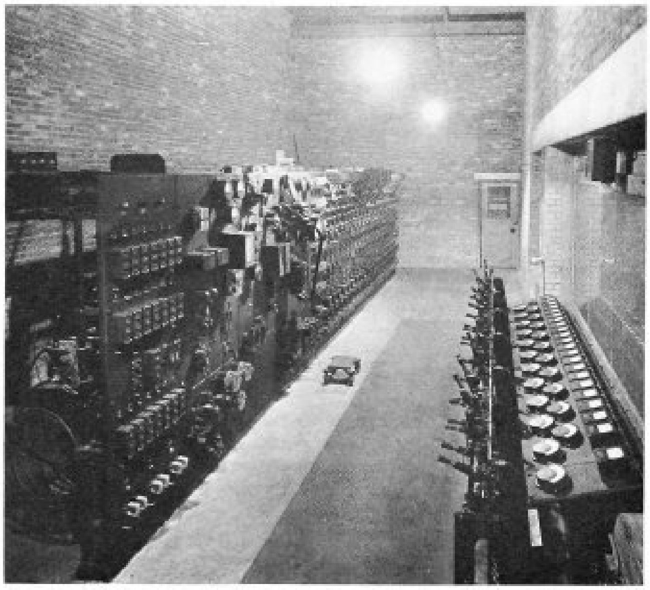


Mandrel gripper at right; note long mandrel. Stripping rolls at left. Mandrel cooling tank in foreground





billet heating furnace and the cooling bed does hot steel retrace its path



Foren mill electric control room

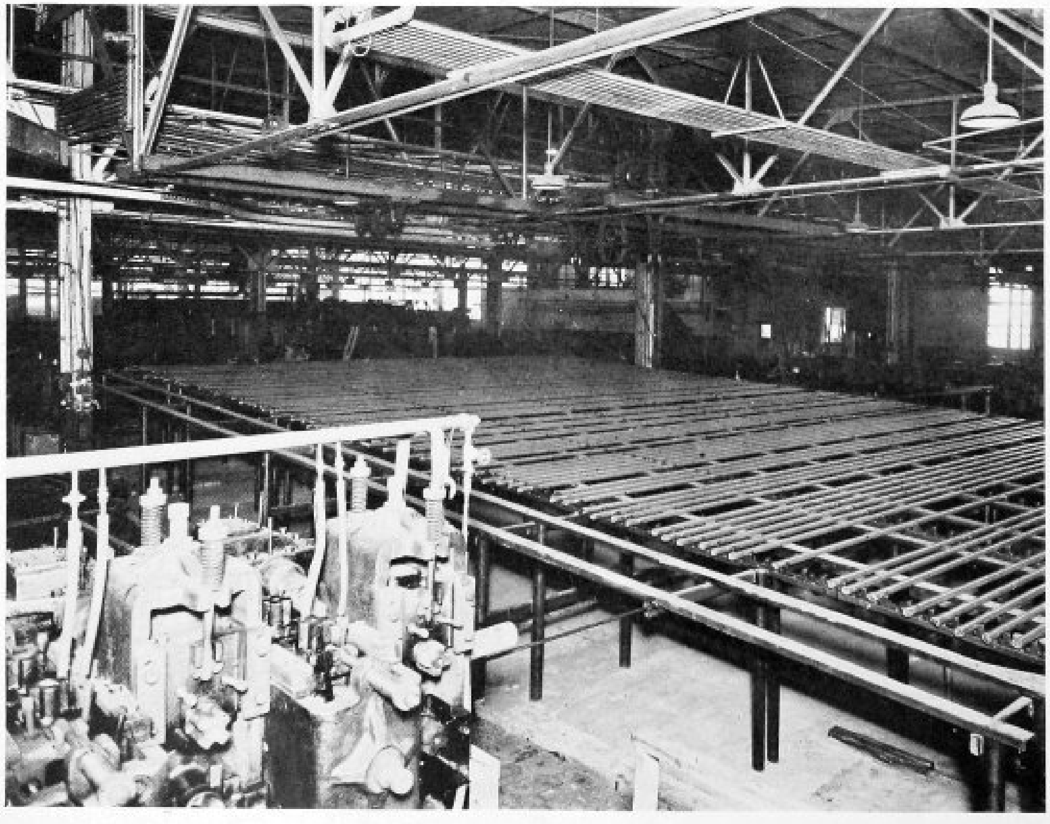
operated by compressed air forces the solid billet into the piercing mill. The piercing operation is performed in four to eight seconds, depending on the length of billet.

After being pierced, the billet is dropped to a steel grating, swept through an arc of 90 degrees by a gate pusher and deposited in the Foren mill inlet trough parallel with the center line of the Foren mill roll stands, thereby allowing the back end of the pierced billet to enter the Foren mill first. A carrier advances with the long mandrel bar and inserts it through the pierced billet till it projects several feet beyond the front end of the billet. A stop on the carrier moves the pierced billet and mandrel to squeezer rolls, of which there are five pairs, arranged at 90-degree angles with respect to each other. The squeezer rolls are directly in front of the Foren mill proper and serve to reduce the diameter of the pierced billet so it fits more snugly on the mandrel bar.

Upon leaving the last stand of squeezer rolls the billet, still over the mandrel, enters the Foren mill. This mill is made up of twenty-one closely assembled pairs of rolls or roll stands. The first roll stand is set at an angle of 22½ degrees from horizontal and the second stand at 90 degrees with relation to the first.

The first and second stands form the tube into elliptical shape, the second stand in an axis normal to the first. The third stand reforms the tube into circular shape to permit proper entry into the fourth and fifth stands which, while they are set at an angle of 90 degrees with relation to each other, are at angles of 45 degrees with relation to the first three stands. The sixth stand again reforms the tube into circular shape. Six stands of rolls arranged in the manner described constitute a working cycle.

In passing through this working cycle compression of the tube between the roll grooves and the mandrel bar occurs at eight arcs of the tube circumference, each arc being in excess of 45 degrees. Three such cycles are incorporated in the mill and account for eighteen roll stands. Three additional roll stands act as touching up and reforming passes with the result that the tubes leaving the Foren mill are circular in shape, inside and out, and entirely free from the mandrel bar. The mandrel bar, however, remains in the tube as it passes on a roll conveyor to the stripping rolls. Upon reaching that point an automatic clamp grips the trailing end of the mandrel bar and holds it stationary while the tube is stripped off the bar. The tube continues on



General view of the bed, where finished tubes are allowed to cool the conveyor to the reducing or sizing mill and from there to the cooling bed. The mandrel is kicked out to a multiple chain conveyor which carries it crosswise slowly through a cooling tank and drops it upon a roll conveyor which takes it back to the inlet end of the mill, ready to be used in another tube.

The Foren mill is equipped with twenty-one variable speed direct-current motors manufactured by Allis-Chalmers Manufacturing Company. Close speed regulation of these motors is very essential so that exact allowances can be made for the reduction in cross-sectional area and elongation of the tube as it passes through the twenty-one roll stands. Different relative speeds are naturally required for different sizes of tubes. No slack can be permitted between the closely coupled roll stands because of the mandrel in the tube.

Tachometers, ammeters, voltmeters, voltage regulators, rheostats, switches and other electrical control equipment are housed in a plate glass fronted room adjacent to the Foren mill. There the motor speeds are set by the operator from predetermined roll speed calculations. This room also houses the motor generator sets for changing alternating current to direct current.

Pierced billets can be handled by the Foren mill at the rate of six to seven per minute. The movement of the product is continuously forward, never backward. The human element has been eliminated to a marked degree as compared with the ordinary tube rolling process. Roll speed calculations, groove shapes and mill setting are all pre-arranged by highly trained technical experts. The operators merely handle levers and have no control whatsoever over quality or size. In that respect it appears to be practically fool-proof and imperfections or spoilage due to faulty judgment of the ordinary mill hand just does not exist. This naturally results in uniform tubes and puts the responsibility for quality upon engineers who are competent and capable of assuming it.

Patents on the Foren mill have been taken out by the Globe Steel Tubes Company in the United States and in a number of foreign countries.

Revisions and Addenda to the 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 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. 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-2*a*, P-2*b*, FIRST SENTENCE OF P-103, L-2, L-3, L-5, U-12, U-13 FIRST SECTION, FIRST SENTENCE OF U-71*a*, ADD THE FOLLOWING:

OR S-26 FOR HIGH TENSILE STRENGTH CARBON STEEL PLATES FOR PRESSURE VESSELS (PLATES 2 IN. AND UNDER IN THICKNESS), OR S-27 FOR HIGH TENSILE STRENGTH CARBON STEEL PLATES FOR WELDED PRESSURE VESSELS (PLATES OVER 2 IN. UP TO AND INCLUDING 4 IN. IN THICKNESS).

PARS. P-108 AND U-76. ADD THE FOLLOWING AS SECTION (*d*) OF THE THIRD SECTION OF PAR. P-108 AND AS SECTION (*d*) OF THE FIFTH SECTION OF PAR. U-76:

(*d*) NOZZLES OR WELDED ATTACHMENTS FOR WHICH STRESS RELIEF IS REQUIRED, MAY BE LOCALLY STRESS RELIEVED BY HEATING A CIRCULAR AREA AROUND THE NOZZLE OR ATTACHMENT, PROVIDED ANY PART OF THE WELDED EDGE THEREOF IS NOT LESS THAN $12t$ (t = THICKNESS OF PLATE) FROM THE NEAREST ADJACENT WELDED JOINT OR OTHER ELEMENT THAT WOULD TEND TO RESTRICT THE FREE EXPANSIVE MOVEMENT OF THE HEATED AREA. THE OUTSIDE DIMENSIONS OF THIS ANNULAR RING TO BE HEATED SHALL BE AT LEAST $6t$ AWAY FROM THE OUTERMOST WELD BUT NOT LESS THAN 5 IN., AND THE ENTIRE AREA SHALL BE HEATED SIMULTANEOUSLY.

PAR. P-277. REVISE SECOND SENTENCE TO READ:

Such intervening pipe or fitting [if used] shall not be longer than the face-to-face dimension of the corresponding TEE fitting of the same diameter and pressure under the CORRESPONDING American [Tentative] Standard AS GIVEN IN TABLES A-6, A-7 AND A-8 IN THE APPENDIX AND SHALL ALSO COMPLY WITH PARS. P-12*b* AND P-286.

PAR. P-286. REVISE SECOND SENTENCE TO READ:

The dimensions of flanges subjected to boiler pressure shall conform to the American [Tentative] Standard as given in Tables A-5, A-6, A-7, or A-8 IN [of] the Appendix SUBJECT TO THE RESTRICTIONS OF PAR. P-12*b* AND except that the face of a safety valve flange and the FACE OF THE nozzle OR FITTING to which it is attached may be flat and without the raised face for pressures not exceeding 250 lb. PER SQ. IN. BUT SHALL HAVE THE RAISED FACE FOR HIGHER PRESSURES.

PAR. P-289. REVISE FIRST SENTENCE TO READ:

Every safety valve used on a superheater discharging superheated steam AT A TEMPERATURE OVER 450 F. shall have a casing, including the base body, bonnet and spindle of steel, steel alloy, or equivalent heat-resisting material.

PAR. P-307. INSERT THE FOLLOWING AS THE FIRST SECTION:

A BLOW-OFF AS REQUIRED HEREIN IS DEFINED AS A PIPE CONNECTION PROVIDED WITH VALVES THROUGH WHICH THE WATER IN THE BOILER MAY BE BLOWN OUT UNDER PRESSURE, EXCEPTING DRAINS SUCH AS ARE USED ON WATER COLUMNS, GAGE GLASSES, OR PIPING TO FEEDWATER REGULATORS, ETC., USED FOR THE PURPOSE OF DETERMINING THE OPERATING CONDITION OF SUCH EQUIPMENT. PIPING CONNECTIONS USED PRIMARILY FOR CONTINUOUS OPERATION SUCH AS FOR DECONCENTRATORS OR CONTINUOUS BLOW-DOWN SYSTEMS, ARE NOT CLASSED AS BLOW-OFFS.

TABLE P-6. REVISE BY INSERTING VALUES FOR FACTOR S FOR THE TEMPERATURE OF 700 F. AS FOLLOWS:

	Spec. No.	700 F.
Seamless medium carbon steel	S-18	12,400
Seamless low-carbon steel	S-18 S-17	9,600
Fusion welded steel	S-1	9,900
Fusion welded steel, Grade B	S-2	9,000
Fusion welded steel, Grade A	S-2	8,100
Lap-welded steel	S-18	7,600
Butt-welded steel	S-18	5,400
Lap-welded wrought iron	S-19	5,700
Butt-welded wrought iron	S-19	4,900

TABLES A-6, A-7, AND A-8. ENLARGE THESE TABLES TO INCLUDE THE FACE-TO-FACE DIMENSIONS OF A TEE AND ALSO THE MINIMUM THICKNESS OF THE CASTING OR FORGING IN EACH CLASSIFICATION FROM A.S.A. STANDARDS B16e-1932, B16a-1928 AND B16b-1928.

FIG. P-6. To be altered to show a gradual reduction in thickness of one in four rather than the abrupt change in thickness now indicated. No special distance to be prescribed within which the tapering shall be done, a long gradual taper merely to be indicated.

FIGS. P-7 AND U-5. The present definition of *W* to be replaced by the following:

W = Minimum Width of Circumferential Band, IF USED, around the Drum or Shell for Stress Relieving. FOR ANNULAR STRESS RELIEVING, SEE PAR. P-108 (U-76).

SPECIFICATIONS S-5. REVISE PAR. 5*b* TO READ:

b The yield point shall be determined by the drop of the beam OR HALT IN THE GAGE of the testing machine.

SPECIFICATIONS S-8. Par. 9*b* to be revised to make these specifications identical with A.S.T.M. A 105-33 (except adjusted service pressure ratings).

SPECIFICATIONS S-9. Par. 10*b* to be revised to make these specifications identical with A.S.T.M. A 96-33.

SPECIFICATIONS S-10. Revise Par. 10*c* to read:

b The yield point shall be determined by the drop of the beam OR HALT IN THE GAGE of the testing machine.

SPECIFICATIONS S-12. Pars. 7*b* and 9 to be revised to make these specifications identical with A.S.T.M. A 95-33.

SPECIFICATIONS S-17. Change number of corresponding A.S.T.M. Specification to read "A 83-33." Par. 6*b* to be revised.

SPECIFICATIONS S-18. Pars. 2 and 5 to be revised to make these specifications identical with A.S.T.M. Specifications A 53-33.

SPECIFICATIONS S-19. Pars. 4 and 5 to be revised to make these specifications identical with A.S.T.M. Specifications A 72-33.

SPECIFICATIONS S-20. Par 3*b* to be revised to make these specifications identical with A.S.T.M. Specifications B 11-33.

SPECIFICATIONS S-21. Par 3*b* to be revised to make these specifications identical with A.S.T.M. Specifications B 12-33.

SPECIFICATIONS S-22. Par 3*b* to be revised to make these specifications identical with A.S.T.M. Specifications B 13-33.

SPECIFICATIONS S-23. Revise Pars. 3 and 12 to make these specifications identical with A.S.T.M. Specifications B 42-33.

SPECIFICATIONS S-24. Revise Pars. 4, 14, and 15 to make these specifications identical with A.S.T.M. Specifications B 43-33, for Muntz metal and high brass grades only.

PAR. U-13. ADD THE FOLLOWING AS SECTION (*c*):

c CAST STEEL MAY BE USED FOR SPECIALLY SHAPED PARTS OF VESSELS TO WHICH THE USE OF ROLLED PLATES ARE NOT ADAPTED. THE WORKING STRESS IN CAST STEEL SHALL NOT EXCEED 7000 LB. PER SQ. IN.

PAR. U-66. REVISE SECOND SENTENCE OF FIRST SECTION TO READ:

If the vessel is of fusion-welded construction OR IF IT HAS WELDED PRESSURE PARTS, it shall also be stamped to show the class of vessel.

PAR. U-72. REVISE SECOND SENTENCE OF SIXTH SECTION TO READ:

FILLET WELDED corner JOINTS [welds] shall NOT be USED [avoided] unless the plates forming the corner are properly supported independently of such welds.

Electric Welding of High Nickel Alloys

As a result of a thorough study of both wire and various flux materials extending over a period of years, the Development and Research Department of The International Nickel Company has developed new flux-coated welding wires for the electric welding of nickel, monel metal and other high nickel alloys. A very marked improvement is to be found in both the strength and appearance of welded joints made with these new wires.

Introduction of the new wires represents a development dating back to 1931. Prior to that time a fabricator desiring to electric weld these metals coated a suitable diameter of bare nickel or monel metal wire with a flux furnished by The International Nickel Company. This procedure could not be relied upon for results because of differences in technique, hurry, or sloppy application of the flux to the wire. Naturally, results made with improperly fluxed wire were apt to be unsatisfactory. For a time the company expended a great deal of effort in an endeavor to teach welders the proper way to flux-coat wire, but this was found too costly for the results obtained.

Because of this situation, the company began the production of its own welding wire at its plant in Bayonne, N. J., where the wire was properly fluxed under carefully controlled conditions. This brought immediate results in the form of better welded joints. But the study of fluxes was continued both in relation to nickel and monel metal and also to Inconel and nickel-clad steel, then in the process of development. This study was carried out in the company's laboratory, also in Bayonne, and involved the investigation of a wide range of flux combinations to determine that of the most satisfactory properties.

The new wires come as the result of these studies and of a series of practical tests in the field. They are available for the electric welding of nickel, monel metal, nickel-clad steel, and Inconel. Their introduction has brought immediate results and has eliminated difficulties previously encountered by fabricators. Where it previously was necessary to send a service man to demonstrate the proper use of the older wire and flux, it is now sufficient merely to send a sample of one of the new wires to the fabricator whose welder can, with a few minutes practice, make very satisfactory joints. With the new wire the arc is considerably more stable, making for easier working, while X-rays attest to the complete absence of porosity and cracking.

Further studies are going on to make even greater improvement and to develop new fluxes where they may be needed as, for example, in vertical welding. A wire for this purpose is now in the last stage of development and can be made available if the need arises for a special job. An electric welding wire also has been made available for joining monel metal to steel, or nickel to steel.

Locomotive Repair Shops and Modern Locomotives*

By John Roberts†

I feel sure that all mechanical officers will agree that, generally speaking, our present locomotive repair shops are not at all adequate to meet the needs of the power of today. The relation of the locomotive shop to the locomotive itself is too closely allied to be ignored any longer, if the railroad companies are to avail themselves of its maximum efficiency.

When we look around our many shops, one has to admit that the locomotive shop and shop practice have not kept pace with recent locomotive developments. Of course, there are various reasons for this condition—principally, I think most locomotive repair plants were built before the present-day power was developed—consequently, the larger locomotive finds itself in a place altogether too small and not adapted to its needs. Unfortunately, the mechanical department has too often been looked upon as a "spending department," and the mechanical officers find it difficult sometimes to get the necessary capital to keep their equipment up-to-date, with the result that a great many obsolete machine tools are still in operation at a loss to the company.

If we contrast this condition with the automobile industry, what do we find? No sooner does a machine or tool become obsolete than it is replaced with the most efficient tool on the market—a new engine is developed, immediately the entire plant is reorganized.

The railway mechanical officer has himself partly to blame for what is sometimes referred to as inefficiency—he has been too prone to say (perhaps under pressure) "Yes, we can get along for another year!"

I also want to say, even in the face of all we read in our trade journals and railway periodicals, that the machine tool builder is also partly to blame. They have not in the past kept pace with the requirements of the locomotive shops—perhaps because of the limited market for their product. I do not mean this to cover standard tools, such as lathes, milling machines, shapers, etc.—what I have in mind is special requirements to give better production, reduce cost and increase efficiency.

There are various types of locomotive shops in operation, but generally speaking, most plants are constructed either longitudinal type or transversal type. There may be advantages to both styles of shops, and sometimes the ground space available determines the layout. Recently, the longitudinal shop has come into favor with the introduction of the so-called spot system. In our study, however, we decided to go to the transversal type of shop—first because of the ground space available, and secondly because we thought we could develop a shop having the entire equipment under one roof, which has great advantages in a country where we get very cold weather during winter months. We also had in mind laying out a shop which would enable us to route materials from one department into another with the least possible travel.

I would like to tell you an interesting experience which was forced upon us when the railways now constituting the Canadian National were consolidated—and you may find this an interesting study if you go in for it. In this consolidation, we had practically five separate railroads—all furnished with their own rolling stock, their own shops in their respective territories, their own shop equipment and practices in operation. It certainly was a study. However, we decided to develop a set of standard maintenance regulations for the purpose of standardizing shop practices and also locomotives, and in doing so, we found that the shop methods of all our shops could be greatly improved—and do not forget that this consolidated railroad reaches from the Atlantic to the Pacific ocean, having a total mileage of 24,000 miles of railway, with a diversity of geographical and climatic conditions. However, the maintenance regulations were prepared and from this study, the new Point St. Charles shops were built to embrace the standards which had been adopted.

It was also felt that some standard measuring stick should be adopted for measuring shop production, particularly as some of our plants were working on a straight time basis, others were operating on a bonus system. To eliminate the bonus system was to remove the measuring stick in those shops. To introduce the bonus system in the other shops at that time was not desirable. It was then decided to develop some system which would enable the shop management to know what progress was being made. This was not an easy task. First, we tried to develop a measuring stick based on tractive effort, then on haulage capacity, and also on the potential horsepower basis, but none of these was practicable or sufficiently accurate to be of any value. It is also a well-known fact that the A. R. A. classification of repairs is of no value, because of the varied cost of reconditioning locomotives. Latterly, we adopted a unit measurement system based on the man-hour—this system has worked out very well and is sufficiently accurate to give us a close shop efficiency figure month by month for each locomotive and car repair shop.

Considering the large amount of money spent in labor and material per month in a large locomotive shop, it is not fair to the shop superintendent, unless you can give him some measuring stick by which he can tell what progress he is making.

Let me here again refer to the subject of shop practices. I might say that on our railroad, on account of the size of the railway, which necessarily employs a large number of men in the mechanical department—having quite a number of shops scattered from the Atlantic to the Pacific—we have found it necessary to establish a shop methods department which comes under the jurisdiction of the mechanical department. This department has been a valuable asset, particularly as the men employed in it are trained mechanics who are used for inspection purposes, conversant in the operation of the unit measurement system and also developing shop

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*Abstract of a paper presented before the New England Railroad Club at a meeting held in January.

† Chief of motive power and car equipment, Canadian National.

practices and methods, etc. It would be interesting perhaps to mention that when our maintenance regulations were first developed, a limit of wear was established for the various moving parts, also tolerances of fits covering the locomotive machinery, etc.

Ground journals—We have found that the ground journal on the axle was a step in advance of any previous practice, also that a closer and better fit of the axle box, brasses, should be accomplished. We have adopted steel liners on our driving wheels and have found that the best material for this purpose is standard boiler plate. When these liners are applied by the welding process, they practically last the life of the wheel. We then found that to make a good application of brass liners to boxes, it was advisable to use the electric welding process for fastening the brass liners to the boxes. This particularly applies to a floating bush type. This can best be done by changing the polarity of the electric welding generator and using a special electrode for the purpose.

Piston rod work—Another practice which I think would be of interest is the machining and fitting of piston rods to crossheads. We grind all piston rods within 0.002-inch tolerance, being very careful to see that all radii are properly rounded out without tool marks, and the piston rod is then fitted to the crosshead. Gages and reamers are used for machining the crosshead to a standard taper and fit, making sure that the fit is properly smoothed out without tool marks. The end of the piston rod is also machined to a gage and carefully fitted to the piston and pressed into position. We do not approve of the common practice of drawing the piston rod up with a temporary key, as from our experience, we have found more fractures starting at the piston rod keyway through the use of the temporary key than otherwise. The engine-houses were also notified to eliminate breaking the crosshead fit as much as possible.

Grinding of motion links, blocks, etc.—I might also mention that an interesting development has been made in the motion gang, where we adopted a link grinder and an internal grinder combined, thus enabling one machine to take care of all the grinding work necessary in the motion gang. This means that we can grind our motion links and link blocks, and swinging the pendulum out when not in use, the grinding head (being a No. 2 internal grinder) takes care of grinding the motion bushes.

Nickel cast iron cylinders—A few years ago, we were almost at the point of going to a cast-steel cylinder, but in recent years, we have developed a locomotive cylinder manufactured from nickel iron (60 percent steel and 1 percent nickel) having a tensile strength of 35,000—40,000 pounds per square inch. This metal has a Brinell hardness of from 207 to 230, which is easily machined, giving a good smooth finish and a good grain structure in heavy sections.

Electric flue welding—The adoption of electric flue welding has also greatly assisted in getting longer tube mileage. Our practice is to lightly bead the flues at the back end and then electric weld them to the tube sheet—the flue being prossered on the water side of the back tube sheet before the bead is formed. Instructions are also issued that at each washout period, the flues are given a light prossering, which means that they are constantly kept up against the back of the tube sheet, and that by the prossering process the scale is removed from the flue on the inside of the tube sheet.

Firebox application—I feel sure that you will all agree that the welding process has also changed the method of locomotive repairs, particularly the application of new fireboxes, one-half side and three-quarter side sheets. At one time it was necessary to take the boiler out of the frames and send it to the boiler shop for firebox renewal. Now, with the present practice, new fireboxes can be applied in the erecting shop in four or five pieces.

Double-gunning of staybolts—A very interesting development which has greatly reduced the possibility of staybolt leakage is that of double-gunning staybolts. This is a process in which we use Chicago Pneumatic No. 11 pneumatic hammers supported by a pneumatic holder-on—both guns working on the inside and outside of the staybolts at the same time with an especially developed tool manufactured to expand the staybolt from the inside, thus tightening up on the thread on the firebox sheet. Of course, it must be understood that we are using exclusively hollow staybolt steel for this purpose. A leaky staybolt on our railroad is a thing of the past. We find that by the double-gunning process, we save on an average about 25 percent over the old method of staybolt application. A fair average performance on a straight-away job on a side sheet is 50 to 55 staybolts per hour. At the same time this process removes the fatigue of the boiler maker, which makes it a preferable job from his point of view.

Heat treated tires—We are using heat treated tires. This necessarily caused us to develop a furnace with temperature control. Our Maintenance Regulations call for a maximum of 600 degrees F. for the application of tires, and prohibits any part of the tire being heated beyond 800 degrees F. It is necessary that this regulation be rigidly enforced in order that the temper of the heat treated tires which we use shall not be destroyed in the process of application. The electric tire heating furnace has an automatic pyrometer control, the power cutting out at 700 degrees F. and cutting in again when the temperature of the furnace drops to 650 degrees F. The capacity of the furnace is four tires per charge, and the tires remain in the furnace for about 90 minutes. The power is on for only about one-half this period, however, as the control cuts in and out as the temperature of the furnace rises and falls to the high and low limits. The load is approximately 90 kilowatts and, figuring on 1 cent per kilowatt hour for power, the cost of heating would be 17 cents per tire.

Quartering machine—We have a special quartering machine which was developed by one of the machine tool companies. The first machine built was installed at Point St. Charles shops, Montreal. With the introduction of this machine, we find that it is possible to quarter our crankpins accurately within 0.002 inch for a 14-inch throw and the alinement is perfect.

Shop facilities for auxiliary equipments—With the introduction of various auxiliary equipments to locomotives, such as boosters, feedwater heaters, superheaters, exhaust steam injectors, stokers, etc., it has become necessary that these equipments should be assigned to a definite department of the shop for reconditioning, just as we assign our air brake equipment.

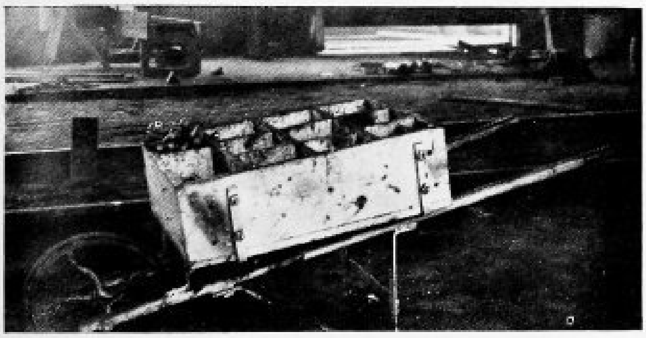
To my mind, the railway locomotive shops have been subjected to a good deal of undue criticism. Personally, I have often marveled at the splendid performance made in most of our large shops, considering the great disadvantage under which they are called upon to operate. I believe it is much simpler to build up an efficient organization in a manufacturing plant than in a railroad repair shop, particularly when one considers the diversity of operations that are necessary in reconditioning a locomotive—the many problems which the shop forces are faced with, on account of the condition of the locomotives when they arrive at the shops for repairs, also the many complications that enter into the problems on account of the location or the condition under which the locomotives have been operating. Some locomotives come from a bad water district, and you would naturally expect more boiler work than on locomotives coming from a good water district—the curvatures of the railroad, grade conditions, and many other conditions that enter into the wear and tear of the machine, confront the shop staff with problems which are not common to any other industry within my knowledge.

I believe that all railway mechanical officers should give most serious consideration to working to closer refinements in order to develop the best possible class of work known to us, so as to eliminate as much as possible unnecessary repairs at engine-houses.

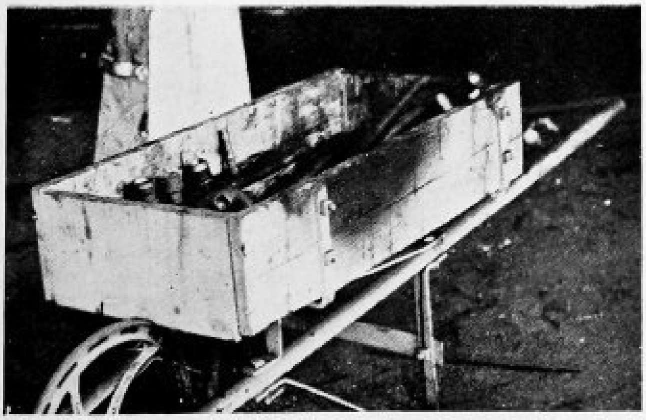
Much can be done to improve the class of work which shops are called upon to perform. At the same time, let me say that we should also give serious consideration to the many rules and regulations under which we are compelled to operate. It seems to me that some of these rules and regulations which are enforced upon the railway companies were quite right and proper when they were developed, but are now obsolete. Take for instance the developments in locomotive boiler maintenance. The high grade of material used and the class of work performed by the railroads make it possible for us to get from 200,000 to 300,000 miles between retubing. Why locomotives should be taken out of service at the end of five years for external examination, when it is a known fact that the boilers are in good condition, is something that I cannot understand.

Portable Tool and Rivet Containers

For the foreman who objects to seeing dolly bars, rivet sets and other tools lying around the ground in the shop and finds it inconvenient to have six or eight different containers sitting around each rivet forge, the two portable containers herein illustrated will be found of particular interest. One is a wheelbarrow container for dollies and the other a portable rivet container which is divided into a number of compartments.



A portable rivet container for the riveting gang



A tool wheelbarrow for the riveting gang

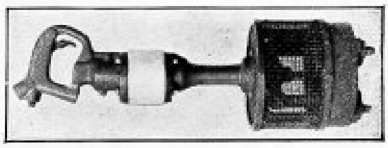
Each rivet container is divided into eleven compartments, the size of which is governed by the size and quantity of rivets used. The container eliminates the unsightly appearance of many special containers and reduces to a large degree the number of rivets left lying around on the ground.

A block attached to one side of the box of the tool wheelbarrow provides a place to insert the various sizes of rivet sets and drifting pins and the balance of the box has a flat bottom which permits the dolly bars to lie flat, making it possible to select the type of bar needed without disarranging the entire outfit.

The frame of each wheelbarrow is made from 1¼-inch pipe, at one end of which is attached a 12-inch wheel. The body of the tool container is made of 1-inch pine, 36 inches long, 18 inches wide and 7 inches deep. The body of the rivet container is made of the same material, 24 inches long by 18 inches wide and 9 inches deep.

External Tube-End Polisher

The Chicago Pneumatic Tool Company, New York, has developed a light-weight heavy-duty CP external tube-end polisher which, it is claimed, has many advantages over the hand method of filing boiler tubes and then polishing with emery cloth. The tool is entirely automatic in operation requiring no skill or physical strength to manipulate. Tube ends may be polished in stacks without moving the tubes, which eliminates danger of flat spots and tends to round the outside of the tube. This polisher is driven by a light-weight heavy-duty CP power vane rotary pneumatic motor. Pilots for the device are adjustable and bear on the outside diameter. Variation in the tube wall does not affect the finished job.



Tube-end polisher

In using the CP tube-end polisher it is advantageous to stack the tubes with about 3-inch space between them, which will allow the cleaner to be entered on the tubes and clean them without additional handling.

Substances such as linseed oil, grease, and the like, must first be removed from the surface to be cleaned. The machine will, however, remove all rust and scale very quickly. After oil and grease have been removed, the cleaner is entered at the back end of the tube and the motor started. It must be slowly moved back and forth to cover the entire surface to be cleaned.

The cleaner may be removed from the tube either while in motion or when stopped, but it is advisable to stop the motor before removing, as this prevents unnecessary strain on the stops. When the carborundum is worn to the holder the two bolts in the clamp must be loosened and the carborundum moved in towards the tube about ¼ inch. After the carborundum is worn to a size too small to be held by the clamp it must be replaced. The cleaner requires no other attention except the oiling of the motor. The oil chamber should be filled with light machine oil for every eight hours running. If the machine loses speed or power the rotor blades should be checked and, if necessary, replaced.

Boiler Repair Firms Organize to Improve Conditions in Industry

In October, 1933, a group of firms engaged in repairing steel boilers and in allied activities in the Metropolitan area of New York formed the National Boiler Makers Repair Association for the purpose of providing for the general welfare of the industry and for stimulating co-operative action under the National Recovery Act. After preliminary organization meetings it was decided that a code be developed which, after approval by the Administration in Washington, would aid in rehabilitating the industry by providing adequate governmental sanction to its conduct and further to eliminate unfair competitive practices. Through the administration of such a code it was felt that the fullest possible utilization of the present production capacities of this industry could be obtained and at the same time improve standards of labor and standards of the products of the industry.

The association is composed essentially of persons, groups of persons, firms, companies or corporations engaged in repairing steel vessels and parts used for the generation of steam, and repairing and welding steel tanks, jacketed kettles and other vessels utilized for pressure or storage and who have signed the National Boiler Makers Repair Association Code of Fair Competition. The constitution and by-laws have been drawn and agreed to by most of the firms in the New York Metropolitan area. The code which has been prepared also meets with the approval of these firms.

Because of the nature of the industry, which is made up of a great number of small firms scattered throughout the country, difficulty has arisen in developing a nation-wide organization, which is essential for recognition of a code of fair competition in Washington. The present purpose of this association is by the dissemination of information concerning its activities and objectives through Chambers of Commerce and other means to influence the widely separated units of the industry to ally themselves for a common purpose; namely code operation. There is no intention that representatives of any section of the industry dominate any other, the code being so set up and arranged that each local and regional area has complete jurisdiction over its own territory and can determine the wages and hours and other conditions of employment and fair trade practices, provided they do not conflict with the minimum and maximum provisions of the general code. The constitution provides that local areas shall elect their own local code authorities who in turn will elect regional code authorities. Finally the regional code authorities will elect representatives to the National Code Authority.

The proposed code, the enactment of which is the primary purpose of this organization, is published herewith in order that interest may be created throughout the country in the organization and to induce all firms engaged in this business to communicate with the officers of the association for further information. No expense is involved, the organization cost being borne by the Brooklyn Chamber of Commerce.

The office of the National Boiler Makers Repair Association is located in Room 2300, 66 Court Street, Brooklyn, N. Y. The temporary officers are: President, George Donohue, of Peter J. Donohue Sons, Inc., Brooklyn, N. Y.; vice-president, J. V. Bradley, of John Bradley Company, Newark, N. J.; secretary, George Burns, of the Fox Boiler Works, New York; treasurer, W. Elliot, Jr., of Leslie & Elliot, Paterson, N. J.; and director, L. L. Balleisen, secretary, Industrial Division, Brooklyn Chamber of Commerce, Brooklyn, N. Y.

The proposed code of fair competition, which is being published for comment and criticism, appears below. Any member of the industry desiring to become a member of the association, and who has suggestions to make, has been invited by L. L. Balleisen, director, to communicate with him at the above address.

Proposed Code of Fair Competition and Trade Practice for the Boiler Makers' Repair Industry

Article I

Purposes.—To effectuate the policies of Title I of the National Industrial Recovery Act, the following provisions are submitted as a Code of Fair Competition for the Boiler Makers Repair Industry, and, upon approval by the President, shall be the standard of fair competition for this industry.

Article II

Definitions.—The term, *industry*, as used herein is defined to mean the repairing, and selling of services in connection therewith, of steel vessels and parts thereof used for the generation of steam and the repairing and welding of steel tanks, jacketed kettles and kindred vessels used for pressure or storage.

The term, *member of the industry,* includes any person, group of persons, firm, company or corporation engaged in the repairing of steel vessels and parts thereof used for the generation of steam and the repairing and welding of steel tanks, jacketed kettles and kindred vessels used for pressure or storage, who shall be subject to this Code.

The term, *member of the Code,* includes any member of the industry who shall expressly signify assent to this Code.

The term, *employee,* as used herein includes any person engaged in the industry in any capacity, in the nature of employee, irrespective of the method of payment of his compensation.

The term, *employer,* as used herein means anyone for whose benefit such an employee is so engaged.

The term, *NBRA,* as used herein means the National Boilermakers Repair Association.

The terms, *President, Act* and *Administrator,* as used herein mean respectively President of the United States, National Industrial Recovery Act, and the Administrator of Title I of said Act.

The term, *expiration date,* as used herein means the expiration date of Title I of the Act.

The term, *Code Authority,* as used herein means the body constituted under Article VI hereof to co-operate with the Administrator in the administration of this Code.

Article III

Hours.—1. No employee engaged in any capacity whatsoever in the industry, except repair shop crews engaged in emergency repairs and supervisory staff, shall work or be permitted to work in excess of forty hours in any given week, nor more than eight consecutive hours in any given day.

2. The maximum hours fixed in the foregoing section shall not apply to employees engaged in an executive, managerial or supervisory capacity, who receives $35 per week or more; watchmen; employees engaged in plant protection and maintenance; and outside salespeople.

3. Overtime shall be permitted but all employees engaged in the fabrication, erection, repair or welding of any product of the industry shall be paid double time for all overtime; the normal working day shall consist of eight hours of work. Emergency, or overtime, work consists of all work done after eight hours of any regular working day or Saturdays, Sundays and holidays.

4. Provisions 1, 2 and 3 may be modified by any region with the consent of the National or Regional Code Authorities as set up in Article VI, but in no event shall these modifications increase the hours of employment beyond those stipulated in Provisions 1, 2 and 3.

5. No employee shall work or be permitted to work for a total number of hours in excess of the number of hours, prescribed for each week and day, whether employed by one or more employers.

6. A member of the industry who does not employ any help, shall be considered as an employee and shall not rent his equipment or offer his services in the industry in excess of the hours set forth herein.

Article IV

Wages.—The minimum wage that shall be paid by any employer to any employee in this industry, shall not be less than those agreed upon in each region, as described in Article VI. A typical form covering the classes of employees is shown for Region I, below:

Region I.—Minimum Wages

For boilermakers in shop	$	per hour
For boilermakers in field		per hour
For boilermakers' helpers		per hour
For clerical, office help and others		per week

The payment of all wages due shall be in lawful currency.

No one shall accept special rebates or free services or other gratuities from labor which shall have the effect of a reduction in wages.

The minimum wages to be paid in any region shall not be less than $15.00 per week, or less than 40c per hour on an hourly basis.

The minimum wages and the maximum hours stipulated in this Code shall be the criteria for any of the regions.

Article V

No person under eighteen years of age shall be employed in the industry.

Employees shall have the right to organize and bargain collectively through representatives of their own choosing, and shall be free from interference, restraint, or coercion of employers of labor, or their agents in the designation of such representatives or in self-organization or in other concerted activities for the purpose of collective bargaining or other mutual aid or protection.

No employee and no one seeking employment shall be required as a condition of employment to join any company union or to refrain from joining, organizing, or assisting a labor organization of his own choosing, and;

Employers shall comply with the maximum hours of labor, minimum rates of pay and other conditions of employment approved or prescribed by the President.

Within each state this Code shall not supersede any laws of such state imposing more stringent requirements on employers regulating the age of employees, wages, hours of work, or health, fire or general working conditions, than under this Code.

Employers shall not re-classify employees or duties of occupations performed by employees so as to defeat the purposes of the Act.

Each employer shall post in conspicuous places full copies of this Code.

This Code shall not supersede any former labor agreements where wages might be higher.

Each member of the industry shall provide for the safety and health of employees in full accord with all rules and regulations having jurisdiction in the location of his plant and/or work.

No employer shall knowingly employ an employee for any time which, when totaled with that of another employer in this industry exceeds the maximum hours herein prescribed.

Wages in the higher paid classes shall be equitably adjusted in accordance with the prescribed plan of the Code Authority.

Article VI

Administration.—1. To further effectuate the policies of the Act and for the purpose of administering this Code of Fair Competition for this industry, the United States shall be divided into regions as follows:

Region No. 1. Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

Region No. 2. Greater New York, Westchester County and Long Island, and that portion of New Jersey that is within a radius of 50 miles of City Hall, New York City.

Region No. 3. New York (except Region No. 2).

Region No. 4. Rest of New Jersey, Pennsylvania and Delaware (except Metropolitan District of Philadelphia).

Region No. 5. Metropolitan District of Philadelphia.

Region No. 6. Maryland, District of Columbia, Virginia and West Virginia.

Region No. 7. North Carolina, South Carolina, Georgia and Florida.

Region No. 8. Kentucky, Tennessee, Alabama, Mississippi.

Region No. 9. Ohio, Indiana, Michigan, Wisconsin (except City of Superior, Wisconsin), and Illinois (except the Metropolitan District of Chicago and Metropolitan District of St. Louis).

Region No. 10. Metropolitan District of Chicago.

Region No. 11. Minnesota, North Dakota, South Dakota and City of Superior, Wisconsin.

Region No. 12. Iowa, Missouri (except Metropolitan District of St. Louis), Kansas and Nebraska.

Region No. 13. Oklahoma, Texas, New Mexico, Arkansas and Louisiana.

Region No. 14. Wyoming, Montana, Colorado and Utah.

Region No. 15. Idaho, Washington and Oregon.

Region No. 16. Arizona, Nevada and California.

2. To further effectuate the policies of the Act, a Code Authority is hereby set up to co-operate with the Administrator in the administration of this Code.

3. The Code Authority shall be divided into Three divisions and shall be known as follows:

1. The National Code Authority.
2. The Regional Code Authority.
3. The Local Code Authority.

a. The National Code Authority shall consist of 18 members, 16 of whom shall be representatives of their respective regions and shall be elected by each region from among the Regional Code Authority, and 2 members of whom shall be representatives of the Administration, without vote, appointed by the President and who shall act in his behalf, without expense to the Association.

b. The Regional Code Authority shall consist of not less than 3 members nor more than 5 members, representing members of the Code. This Regional Code Authority shall have jurisdiction over its own region, but its rules, regulations and decisions shall be reviewed by the National Code Authority and the Administrator before becoming effective.

c. The Local Code Authority shall consist of not less than 3 members nor more than 5 members, representing members of the Code in that particular local area. Each Local Code Authority shall have the jurisdiction over its own local territory, but its rules, regulations and decisions shall be reviewed by the Regional Code Authority, the National Code Authority and the Administrator before becoming effective.

A typical example of a Local Code Authority and of a Regional Code Authority is furnished by the set-up in Region No. 2. The Regional Code Authority for Region No. 2 shall consist of one representative of the Boroughs of Manhattan, Bronx, Staten Island and the County of Westchester, one representative of the Boroughs of Brooklyn and Queens and the Counties on Long Island, one representative of that portion of New Jersey that is within a radius of 50 miles of City Hall of New York City. Each one of these divisions of Region No. 2 shall appoint its own Local Code Authority as follows:

For Local Region No. 1—One representative from the Boroughs of Manhattan and Staten Island, one representative from the Borough of the Bronx and one representative of Westchester County.

For Local Region No. 2—There shall be one representative from Brooklyn, one from the Borough of Queens, and one from the rest of Long Island.

d. Each region and local subdivision shall be independent and autonomous, except in matters involving more than one division. Each Code Authority shall adopt a method of providing necessary funds for the conduct of its affairs.

4. The Code Authorities shall have the following duties and powers to the extent permitted by this Act and subject to review by the Administrator; the policing, administering, enforcing and arbitrating of the provisions of the Code shall be vested in the Code Authorities.

5. In addition to any information required to be submitted under this Code, there shall be furnished to government agencies such statistical information as the Administrator may deem necessary for the purpose recited in Section 3 (a) of the Act.

6. Each member of the Code shall be entitled to participate in the activities of the Code Authority to the same extent as a member of NBRA. Each member of the industry shall contribute his proportionate share toward the cost of and administration of the Code and the cost of the maintenance of the Code Authorities and their activities, either by becoming a member of NBRA or by paying to the Code Authorities his equitable and proportionate share of the expense of administration as determined by the Code Authorities subject to the approval of the Administrator.

7. There shall be no future amendment of the Constitution and By-laws of the National Boilermakers Repair Association which will tend to make the Association not truly representative of and/or which shall impose any inequitable restriction on membership.

8. The Administrator shall have the power to call meetings of the Code Authorities in order to determine whether it is truly representative of the industry.

9. Any action of the Code Authorities shall be subject to review and disapproval by the Administrator.

Article VII

Trade Practices.—The Code Authorities shall study the following trade practice provisions, which are part of this Code, and the operation thereof and shall make any recommendations, from time to time, to the Administrator which is deemed desirable for modification or addition thereto, which, upon his approval, after such hearing as he may prescribe, shall become a part of this Code and have full force and effect as provisions hereof.

No member of the industry shall sell or offer to sell any product or service below the cost of such products or services.

For this purpose cost is defined as the cost of direct labor, plus the cost of his overhead, plus the cost of depreciation of his equipment, plus the cost of his materials consumed, as determined by cost accounting methods recognized in the industry (such cost accounting methods to be approved by the Code Authorities).

No member of the industry shall directly or indirectly give or permit to be given, or offer to give, money or anything of value to agents, employees or representatives of customers or prospective customers or competitors' prospective customers, with or without the knowledge of their employers or principals, as an inducement to influence their employers or principals to purchase or contract to purchase from the party offering such gifts, or to influence such employer or principal from contracting deals with competitors.

All products of the industry shall not be sold on any better terms than 2 percent cash discount when invoices are paid within ten days of date of invoice, 1 percent cash discount paid the tenth of the following month for goods delivered in preceding month and thereafter net. All invoices paid after thirty days must be paid with interest, provided, however, that in cases of pre-payments the average shall not exceed thirty days after date of invoice without interest.

When payments are to be made in notes, said notes shall not exceed 25 percent of the value of work done in any month and shall not be in excess of 90 days in duration and must be with interest of 6 percent.

No member of the industry shall give any guarantee against any decline in prices or allowances in any shape, form or manner.

Advertising or salesmanship effort either oral or written, printed or in the form of display or in any manner whatsoever, which misrepresents the quality, use of, or services of merchandise or any selling methods which mislead the consumers, shall be deemed acts of unfair competition.

No member of the industry shall accept contracts on a "fixed fee basis" or "cost plus basis" with an "upset price" protecting the purchaser against higher costs but not protecting the members against losses.

Members shall be free to advertise their own goods, their own services and their own prices but references to the goods, services or prices of competing dealers shall be regarded as an act of unfair competition.

No member of the industry shall undertake to complete a contract upon which another member has temporarily stopped work because of non-payment of amounts properly due the first member.

The maximum hours and minimum rates of wages shall apply with equal force to any member who works with his tools and he shall charge his time so occupied at said rate to each job, as though he were an employee.

Workmen's Compensation Insurance shall be carried in accordance with government requirements.

No member of the industry shall get information from competitors under false pretenses for the purpose of benefiting one's business and/or injuring the business of a competitor.

No member of the industry shall spread or cause to be spread reports concerning the policy, character or financial status of a competitor.

No member of the industry shall obtain business by threat, duress or coercion.

No one shall knowingly withhold from or insert in any quotation or invoice any statement that makes it inaccurate in any material particular.

A boiler maker's helper shall not be used on boiler work in the field.

A recognized member of the industry shall be one who has had a minimum of five years practical experience in a recognized boiler shop. No one other than a recognized member of the industry whose qualifications are as mentioned above shall be permitted to do any work in the field on a pressure vessel.

Article VIII

General.—This Code and all the provisions thereof are expressly made subject to the right of the President in accordance with the provision in Sub-section b of Section 10 of Title I of the National Industrial Recovery Act from time to time to cancel or modify any order, approval, license, rule or regulation issued under Title I of the National Industrial Recovery Act and specifically, but without limitation to the right of the President to cancel or modify his approval of this Code on conditions imposed by him upon his approval thereof.

This Code, except as to provisions required by the Act, may be modified on the basis upon application to the Administrator and such notice and hearing as he shall specify, and to become effective on approval of the President.

Such provisions of this Code as are not required to be included therein by the National Industrial Recovery Act, may, with the approval of the President, be modified or eliminated if it appears that the public needs are not being served thereby and as changes in circumstances or experience may indicate. It is contemplated that from time to time supplementary provisions of this Code or additional Codes will be submitted for approval of the President to prevent unfair competition in price and other unfair destructive competitive practices and to furthermore effectuate the policies of Title I of the National Industrial Recovery Act.

If any provision of this Code is declared invalid or unenforcible, the remaining provisions shall nevertheless continue in full force and effect, the same as if they had been separately presented for approval, and approved by the President.

Article IX

No provision of this Code shall be interpreted or applied in such manner as to promote or permit monopolies or monopolistic practices or to eliminate, oppress or discriminate against small enterprises.

Article X

This Code shall become effective on the 10th day after its approval by the President.

Orders Placed for Arc Welded Aluminum Tanks

Improvements in arc welding technique on aluminum have resulted in a substantial increase in the number of orders placed recently for welded aluminum tanks.

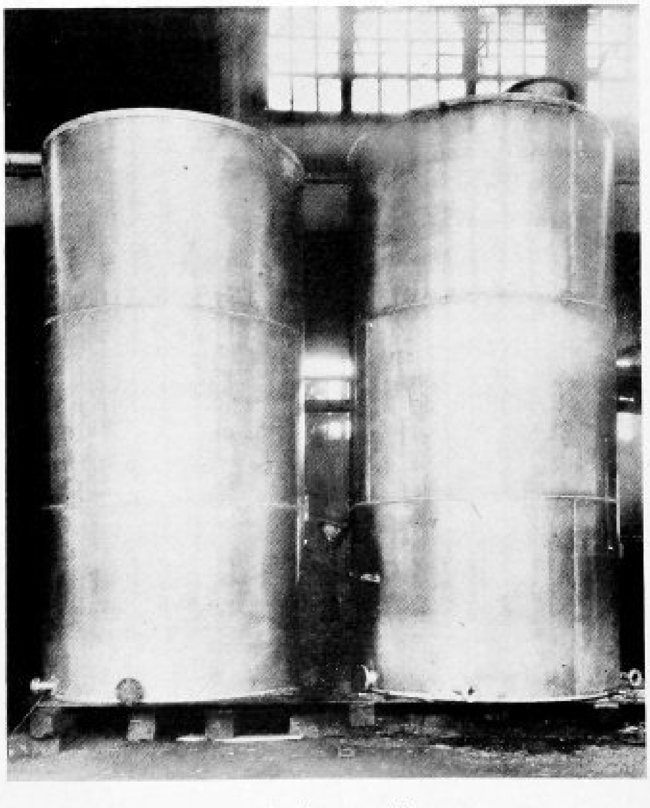
Construction of two aluminum storage tanks for a chemical plant proved a simple matter for The Thornton Company, sheet metal works, of Cleveland. The electric arc made the job a simple one. The tanks are 10 feet square and 7 feet high. The sheets are 3 S aluminum $\frac{3}{16}$ inch thick.

Butt welds, vertical welds and fillet welds were made in position, using the shielded-arc process with Aluminweld electrodes.

Two round aluminum tanks of unusual construction have just been completed by The James Russell Boiler Works, Boston, Mass., as shown in the accompanying illustration.

The tanks are 8 feet in diameter, 16 feet long and have a capacity of 6000 gallons. There is a steam coil in the bottom of each tank operating under a pressure of 10 to 15 pounds. The tanks themselves are made of $\frac{1}{4}$-inch aluminum plate. All welds were ground flush and polished on completion so that there would be no irregularities in the parent metal.

Welding was done with $\frac{3}{16}$-inch and $\frac{5}{32}$-inch electrodes. Altogether, there were more than 6000 feet of welding involved.



Aluminum tanks of 6000 gallons capacity

Significance Of Welding Tests*

***By Laurence R. Leveen*†**

Since the A.S.M.E. Boiler Code permitted fusion welding of pressure vessels in 1931, experience has shown that certain of the tests laid down in the code are more significant than others. At the same time there is still some misunderstanding of these tests so that the author will endeavor to clarify the meaning of them based on manufacturing experience in the past two years.

One of the problems facing manufacturers is the insistence of various customers on tests which really are not recognized. Regardless of what test is used, it is most important that everyone use a uniform test system in order that results may be comparable.

The welding tests outlined in the A.S.M.E. Boiler Construction Code for Power Boilers and Class 1 unfired pressure vessels, rated according to importance in the author's opinion, are as follows: The all-weld test, the free bend test, the non-destructive test, the specific gravity test, and the reduced section tension test.

The all-weld metal test is the most important because it gives the actual characteristics of the deposited weld metal which can be measured in terms of ultimate strength, yield point, and ductility measured in percent elongation in 2 inches. Without knowledge of what the weld metal would do under these conditions, no one would be able to state definitely whether or not the welded pressure vessel could be expected to stand up in service. The test not only shows the characteristics of the weld metal, when using a particular electrode, but also is a check of the ability of the manufacturer properly to use the electrode. There are many cases where an electrode will pass Class 1 requirements, yet certain manufacturers are unable to make the electrode do so because of improper procedure control and technique.

The free bend test is the next in importance because this is the only test given which really indicates the strength of the fusion zone in a joint. In the author's opinion this test tells a great deal more than the reduced section tension test. After a free bend test is made and a proper elongation is registered, one should not stop at this point but should carefully examine both fusion zones of the weld in particular because it is possible at times to get the proper ductility within the specified scribe marks, yet poor fusion will show up on the bend test either by small holes opening up on the outer surface or by cracks starting near the fusion zone. It is, therefore, important in making this test to give attention to both the characteristics of ductility and the surface appearance of the weld to really get the full benefits from this particular test.

The most practical non-destructive test today is the X-ray test, which permanently records with almost complete accuracy the condition of the weld metal, particularly as to porosity and lack of fusion. One has to watch on the X-ray test for occasional fine cracks which are parallel to the plane of the X-rays because a fine crack in this position will scarcely show on the film. This type of crack does not occur frequently, but it does occur often enough to make it necessary to examine radiograph films in conjunction with specimens welded.

The specific gravity test is another check on the soundness of the deposited metal. In some respects it covers some of the field of the non-destructive test but at the present time the author does not see where the specific gravity test could be eliminated. There has been some discussion and controversy over the method of taking this specific gravity test; that is, by the immersion method or the weight and measurement method. When these methods are both corrected to 4 degrees C., the point where one cubic centimeter of water weighs exactly 1 gram, the results are the same. The controversy arises because the code has not definitely specified conditions for taking measurements.

The reduced section tension test outlined in the code was originally designed as a joint test. The author does not believe this test indicates much because it is necessary to use heavily coated electrodes to meet Class 1 requirements and experience over a large number of tests has shown that failure always occurs in the plate. Naturally, where pressure vessels are built strictly according to code requirements, this test must be made. In other cases where Class 1 requirements are wanted but no regulatory body demands a test, we have been omitting this particular one because the other four, if satisfactory, tell the whole story.

We find that the Code for Unfired Pressure Vessels, Class 2 and Class 3 does not embrace all of the tests as outlined above but covers the free bend test, the nick break test, the reduced section tension test, and the full section tension test.

On these classes of welding the free bend test and the nick break test are the most important, because the bend test indicates the same characteristics of the joint as outlined earlier for the other free bend test, and the nick break test is used in lieu of the X-ray test in order to indicate soundness of the metal. It might be pointed out at this time that if one wishes to make a quick test of a joint to get a line on characteristics, these two tests are all that have to be run.

The reduced section tension test does not carry much significance because heavily coated electrodes generally must be used in order to meet Class 2 requirements. Bare electrodes seldom meet Class 2 requirements. Our experience is that welds generally break in the plate, having 0.25 carbon or less. Since a bare electrode which will pass Class 3 requirements generally breaks in the weld, it is more essential to run this test for Class 3 than Class 2.

The author sees even less necessity of a full section tension test than the reduced section. However, it must be borne in mind that on passing vessels for a regulatory body, it is necessary to meet the present code as is, regardless of opinions or experiences relating to these particular tests.

You will be interested in knowing from a manufacturing viewpoint that the use of the all-weld metal specimen for Class 2 work is growing because it really indicates more about the weld metal than the tension test, either full or reduced section. Based on our own experience, we prefer, for this type of work, a bend test, nick break and all-weld metal, when we wish to check a particular job.

* Paper presented at ninth annual meeting of National Board of Boiler and Pressure Vessel Inspectors.

† Engineer, Welding Engineering Department, General Electric Company.

The American Welding Society has issued a revised tentative "Specification for Filler Metal for use in Fusion Welding," and it is of particular interest to note that in its issue of June 1, 1933 it establishes specification numbers on electrodes. The primary specification numbers are E10, E20, and E30. In making the physical tests of the electrodes to qualify them in one of these groups, they are tested with all-weld metal specimens, free bend specimens, nick break specimens, density specimens, and reduced section tension specimens.

The E10 class has the same requirements as the power boiler and Class 1 Unfired Pressure Vessel sections of the A.S.M.E. Code with the exception that the non-destructive test is eliminated and the nick break test should be substituted. The A.W.S. Specification does not require nick break on E10 or E20, but the author believes this should be included.

Specification E20 covers electrodes which will meet Class 2 requirements and the tests here vary from the A.S.M.E. Code in that the full section tension specimen is eliminated and the all-weld metal and specific gravity specimens are added.

When one has to qualify a shop as to its ability to weld according to code requirements and at the same time may have to qualify a given electrode on the process, the specifications of the American Welding Society and the requirements of the A.S.M.E. Boiler Code are so arranged that one set of test specimens would do both things simultaneously.

Since the author does not rate the reduced section tension test very highly, it is in order to suggest another type of test which tells more. This test, known as the tension impact test, was developed at the Watertown Arsenal of the United States Army, which has the only machine in the United States which can make this type of test. This test takes a welded joint; that is, two pieces of parent plate welded together so that the combination of the three are tested at one time in a tension impact machine. This machine is similar to the standard Charpy impact machine, which can only test a small piece of parent stock or a small all-weld specimen.

The particular advantage of the tension impact test is that it actually gives the ability of the welded joint to withstand shock load in tension. In a series of tests recently run on plate not to exceed 0.25 carbon, it was noted that welds made with heavily coated electrode broke outside the weld, while welds made with bare electrode always broke in the weld.

Relative Value of Welding Tests*

By H. H. Mills†

Differences of opinions as to the relative values of the various prescribed tests do not preclude the fact that each test is necessary if a complete picture of the joint characteristics is to be obtained and for that reason it is rather difficult to make a positive determination without taking them all into account in their respective groups. This is particularly true of the test requirements as set forth in the code for Class 1 vessels.

The writer is inclined to differ somewhat with the author in the classification of value or merit and would designate their relative importance as follows: The free bend test, the non-destructive test, the all-weld metal test and the specific gravity test.

It is true, in the all-weld metal test, the quality of the weld metal is brought out, likewise, its physical properties can be determined accurately by no other test than the all-weld metal test, yet, the value of the joint as a whole can not be as completely determined as is possible with the free bend test.

First, in the free bend test, the sample is tested transverse to the weld which simulates the operating stresses and severely demonstrates what may be expected in service. It shows the ductility and when the test is carried further, discloses the density, visible imperfections and provides a check on the welder's knowledge and ability.

The non-destructive test provides a picture of the joints in their entirety, and in conjunction with the free bend test leaves little for conjecture as to what service the joints may afford. It shows what has been done, while the test samples show what can and probably is being done in fabrication.

The gravity test, it might be said, rounds out the all-weld metal test and was no doubt selected to support or complete this test. It also confirms the results of the bend and non-destructive tests.

These four tests, as earlier stated, are so co-related that at present they are all necessary if complete data of a weld are desired. Of the other tests, the writer agrees with the author as to their relative importance.

The welded joint and its accessories are at the present time undergoing the most intensive research, both practical and technical, but the writer knows of no recognized methods which can take the place of those now required.

The impact tension test, is, no doubt, valuable for many kinds of service, but the writer can not recall any type of pressure vessel whose service would simulate a test of this kind.

The writer is not familiar with the tension impact tester used by the Navy, but has some knowledge of the Charpy and Izod testers, and is of the opinion that the impact tension test is too severe to be practical except in research work.

* Comment on paper before National Board of Boiler and Pressure Vessel Inspectors.
†Chief safety engineer, Bureau of Safety Engineering, Detroit.

Stationary Cutting Machine

The Linde Air Products Company, New York, has recently introduced a new stationary cutting machine known as the Pantosec, which is especially designed for cutting dies, cams and other parts that must be smoothly and accurately cut. This machine has a cutting range of 44 inches longitudinally, and 20 inches laterally, and it permits of straight-line cutting, angle cutting, beveling, circular cutting and intricate shape cutting. The floor space required by the machine is 72 inches by 83 inches. The Pantosec may be operated from either the template end or the blowpipe end, as a hand-guided or machine-guided instrument.

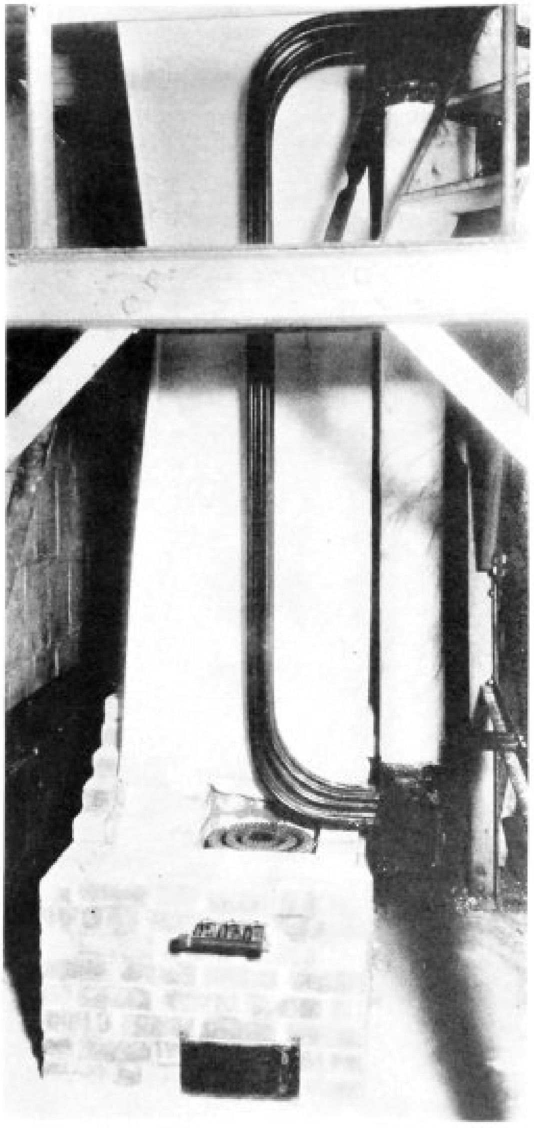
An extension so mounted as to be steady and secure makes it unnecessary for the operator to return to the back of the machine to start the profile cutting after the entry cut has been made.

The machine consists of a carriage mounted on three-point supports. The piping for the gases is all inclosed in the carriage and all drives are protected by dirt-proof casings. A motor for either 110- or 220-volt current may be specified. The wiring is concealed and switches and controls are labeled and easily accessible.

Boiler for Experimental Process Work

An interesting application of high-pressure steam to process, where a sustained high temperature is essential, is to be found in a small 1500-pound pressure boiler that a large manufacturer in one of the process industries is now installing for experimental purposes.

The idea underlying the use of saturated steam at this pressure was its ability to supply heat at a constant de-



High-pressure experimental boiler

livered temperature of 575 degrees F. to the particular process. Obviously, superheat and a lower steam pressure would not have provided a sustained temperature during process, for as heat was given up the superheat would drop. If the experiments with steam from this miniature boiler work out satisfactorily it is contemplated to install a full size unit to supply steam at this pressure for regular production. There are undoubtedly processes in other industries wherein this principle could be applied to advantage.

The experimental unit, which was built by Combustion Engineering Company, consists of a single row of tubes entering top and bottom headers which are connected by a single downcomer. The tubes are 1 inch outside diameter and the headers of forged steel, rectangular in section, placed 7 feet 2 inches between centers. The total heating surface is slightly over 9 square feet and the furnace will be a simple refractory lined chamber. The illustration shows the boiler before being bricked in. The boiler is gas fired, is of the single-pass type and will be hand controlled. Because of its size, experimental use and simple construction no attempt was made to attain a high efficiency in this unit.

Some Recent Boiler Explosions*

Two generations ago steam boiler explosions were considered by many to be "acts of God" and undoubtedly there were some folk in the back mountain country about 15 miles south of West Liberty, Kentucky, early in the year, who attributed a serious boiler explosion to this cause. Probably no exact knowledge of what caused the explosion will ever come to light, but the known results were the deaths of five men and injury of 12 others.

So remote was the location of this mill on Elk Fork creek that a man had to ride seven miles on horseback to get to a telephone to call a doctor. The doctor then traveled the 15 miles to do what he could.

One man was instantly killed, another died three hours later and three others were mangled when a boiler exploded on August 24, 1933, at a Texas cotton gin. According to newspaper accounts the explosion came while preparations were under way to gin the season's first bale of cotton.

Rupture of a steam line at the top of a boiler led to the death on November 13, 1933, of two men who were working above the boiler in a Lowell, Mass., building. The accident occurred a few minutes before one of the men was to go off duty. Both men were swept from the top of the boiler and died from scalds. Firemen had to wade through several feet of water to recover the bodies.

A ketchup canning factory at Front Royal, Va., was demolished, one employee killed and four others injured when a boiler exploded on October 28, 1933. One part of the boiler landed on the roof of a house two blocks away and cut through all of the floors to the basement. Another part landed in a yard about a block distant after having cut down a large shade tree.

A boiler explosion that was attributed to the failure of a welded repair wrecked a sawmill, killed one man and injured two others, at Powellsville, O. The boiler was of the locomotive type, 42 inches in diameter by 12 feet 6 inches in length. The repair had included the welding of a plate on the bottom of the firebox to join the wrapper and furnace sheet. The wrapper sheet was found two days later on the opposite side of a hill near which the mill stood. The barrel, ripped open longitudinally through the solid plate about 8 inches from the lap seam, landed in a creek about 180 feet away.

Grooving just below the longitudinal seam of the middle course of a locomotive type wet-bottom boiler, was blamed for its explosion in a Hohenwald, Tenn., sawmill on October 18, 1933. Employees of the mill reported that the steam gage showed a pressure of 140 pounds shortly before the explosion, although the safety valve was supposedly set to blow at 120 pounds. The accident caused the death of two men, one of whom was

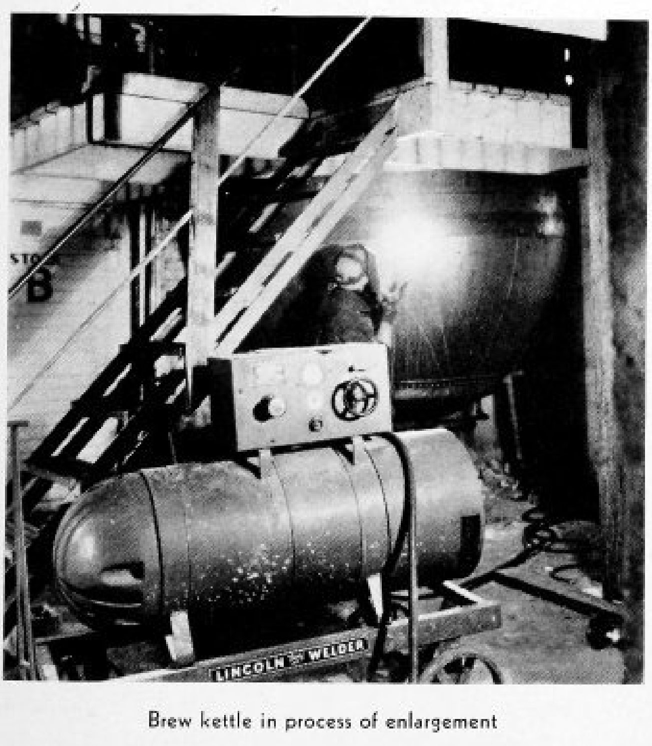
* Published through the courtesy of *The Locomotive*, Hartford Steam Boiler Inspection and Insurance Company.

hurled 400 feet and the other some 20 feet from the boiler room in which they were working. About half of the 150-foot mill shed was demolished. More persons would have been injured had not the mill run out of logs and the crew been dismissed for the day shortly before the accident. The boiler was torn into four pieces, the initial point of failure being along the inside lap of the longitudinal seam of the middle course.

The explosion of a horizontal tubular boiler in a stave factory at Camden, Tenn., caused the death of a machine operator, injured 8 other workmen, and wrecked the mill building. The accident was attributed to unbeaded and thin tube ends. The front tube sheet pulled loose from all of the tubes. The boiler was operating at a pressure of about 80 pounds at the time of the accident and the escaping steam was blown directly through the mill, scalding employees at work. The boiler itself skyrocketed 400 feet into a corn field.

Brew Kettle Stretched to Double Capacity

Stretching a brew kettle so as to more than double its capacity proved a simple operation for the Cream City Boiler Company, Milwaukee, Wis. Arc welding provided



Brew kettle in process of enlargement

the answer. A local brewery had a fifty barrel per day capacity brew kettle which was insufficient for requirements. An immediate increase of capacity was necessary to fulfill orders.

To accomplish this, the original spherical brew kettle was cut horizontally through the center. With the upper half elevated, four $\frac{3}{16}$ inch by 66 inch by 84 inch sheets were inserted and lap welded over the exterior of the original kettle and butt welded to each other. In this manner the capacity of the brew kettle was increased to 107 barrels per day. It is literally a case of "stretching" this brew kettle to more than double its capacity. The work was completed in two days.

The illustration shows the welder making the lap weld of the new sheets to the spherical bottom of the brew kettle. All welding was done by the shielded-arc process using Fleetweld electrodes and a welding machine manufactured by The Lincoln Electric Company, Cleveland.

Harnischfeger Wins Boulder Dam Crane Award

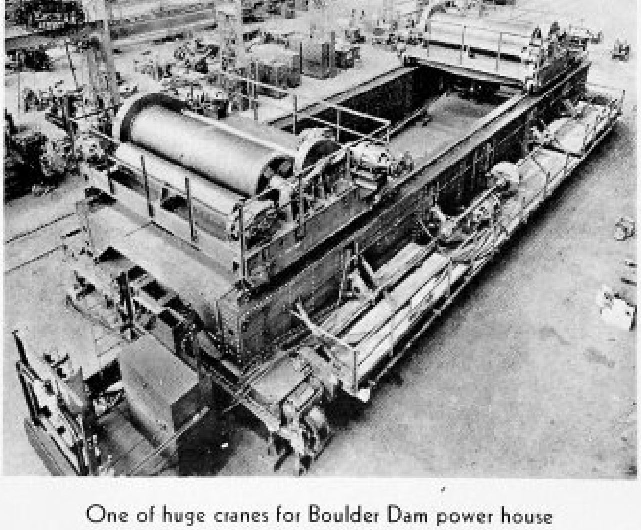
The largest award in the electric crane industry in the past five years has just been announced as the contract for five electric traveling cranes is confirmed to the Harnischfeger Corporation from the United States Reclamation Engineer's Office in Denver, Col. Total amount of the contract is approximately a quarter of a million dollars, involving construction of four 300-ton cranes and one 50-ton crane.

The four 300-ton units are equipped with two 30-ton auxiliary hoists. They are of the double trolley power house type, having a span of 64 feet and a lift of 70 feet. The eight electric motors employed in the bridge drive, the hoist and hoist propel mechanisms, are the Harnischfeger special crane type, having a combined output of 380 horsepower for each crane. The truck bodies and trolley frames are to be of welded construction.

After the cranes have been completely erected and tested in the Harnischfeger shops, they will be completely dismantled for shipment to Boulder Dam. A 150-ton cable-way which spans the Colorado Canyon will lower the huge units to the floor of the power house, approximately 600 feet below the brink of the canyon.

Two of the 300-ton units will be installed in each wing of the power house for the purpose of handling the huge generator motors, which have a diameter of 26 feet and weigh approximately 600 tons each. These huge motors are being supplied by General Electric, Westinghouse and Allis-Chalmers manufacturing companies. They are unquestionably the biggest generator motors ever built. Although only four of these huge generating motors are to be installed at the present time, the ultimate energy output of the power plant will exceed 115,000 horsepower.

The 50-ton crane to be installed in the Boulder Dam power house will be used for miscellaneous work in connection with fabricating structures that are too large to permit shipment and installation after being built up.



One of huge cranes for Boulder Dam power house

LESSONS IN ARC WELDING

It is the object of these lessons to present in a concise manner certain fundamental facts of welding, the knowledge of which will enable the operator to use the welding process successfully and economically. These lessons are based on the course in arc welding given by Arthur Madson at the plant of the Lincoln Electric Company, Cleveland, O. Preceding lessons were published on page 46 of the February issue, and page 77 of the March issue.

Lesson 6

OBJECT: To study effect of polarity.
MATERIAL: Scrap plate, 5/32-inch Stable-Arc rod, 1/4-inch carbon.
SET UP: Arrange this in any convenient fashion so that the beads may be easily observed and the operation carefully followed.
PROCEDURE: Polarity is an item concerning which there is a great deal of discussion. We speak of straight polarity and reverse polarity. By straight polarity, we mean that the negative side is the electrode and the work is the positive side. By reverse polarity we mean that the work is negative and the electrode positive.

It is well to know the meaning of these two terms. It is also well to recognize that for a given rod the best operation may be obtained with the rod positive or it may be obtained with the rod negative. In one case this is reverse and in the other case it is straight polarity. In the case of stable-arc, operation is on straight polarity, that is, with the work positive and if the polarity is reversed, it is the wrong polarity.

Often the question of polarity and how it is determined comes up and there is one very easy test which can be made. Place a small carbon electrode in the holder and make an arc on a piece of steel. If the carbon is positive, the arc will be difficult to maintain and will leave a black deposit on the steel. If the carbon is negative, the arc will be stable, and no black deposit will be left on the steel.

Look at the connections on the switchboard and check out the leads and make sure which is positive and which is negative, then connect it up and try it out with the carbon and determine for yourself what the characteristics are. Try both of these so that you know very definitely whether or not the arc is reversed. Then see if you can tell if somebody else operates the arc, whether or not it is reverse or whether it is the correct polarity.

Now, take a piece of stable-arc rod and operate it with the work positive and the rod negative and see what kind of performance you get. Now operate this stable-arc rod with the work negative and the rod positive and see what happens. You will find that with the wrong polarity, that is, with the rod positive you get all of the bad characteristics outlined in the previous lesson.

Listen to it carefully, watch how it performs, and get the characteristics so that you know and are sure what happens and can recognize wrong polarity without reference to connection, merely by looking at it.

Lesson 7

OBJECT: To study different sizes of electrodes.
MATERIAL: Some scrap pieces—Stable-Arc electrodes, 1/8-inch, 5/32-inch, 3/16-inch, 1/4-inch sizes.
SET UP: Set up on bench a piece of plate in horizontal position. Brush it clean. Select 5/32-inch rod. Set the welder in accordance with Lesson 1, to give 135 amperes, 18-20 volts while welding.
PROCEDURE: Strike arc and run bead as in Lesson 2. Now in accordance with general instructions of Lessons 2 and 3, use 1/8-inch, 5/32-inch, 3/16-inch and 1/4-inch rods. Setting welder for currents as follows:

Electrode	Amperes
1/8 inch	75
5/32 inch	135
3/16 inch	175
1/4 inch	225

Compare the rods as to length of bead deposited for given rod length. Note size of bead compared to rod. Note speed of deposit as compared to size of bead.

Note how much weld metal is deposited as compared to rod used. Some of the loss goes into vapor, some is splatter and some is the short ends, which cannot be used.

Next try some of the variations as given. Note carefully the results as different rod sizes are used.

Practice till a good bead is obtained on each size of electrode.

Lesson 8

OBJECT: The study of padding.
MATERIAL: Plates of suitable size, 5/32-inch Stable-Arc electrode.
SET UP: Place plate on bench, horizontal position. Brush clean.
PROCEDURE: This exercise is to show the proper method of building up several layers of weld material. The first exercise consists of running lines of beads (using the weaving motion) the beads being parallel to each other and fused together. In this way a complete welded area is formed, see Fig. 16.

After each bead is welded it is thoroughly brushed with a wire brush. After the first layer of bead has been deposited the oxide and scale must be removed from the surfaces, using a roughing tool or chisel and thoroughly brushed. The second layer should be welded in at right angles to the beads of the first layer. This is commonly called lacing and is illustrated in Fig. 16. This layer and all succeeding layers must be thoroughly cleaned as indicated for the first layer.

Build up a pad 4 inches long, 2 inches wide and 1 inch high using a 5/32-inch electrode. Then saw this pad through, grind off the cross section and then etch it with dilute sulphuric acid. You can then get a compari-

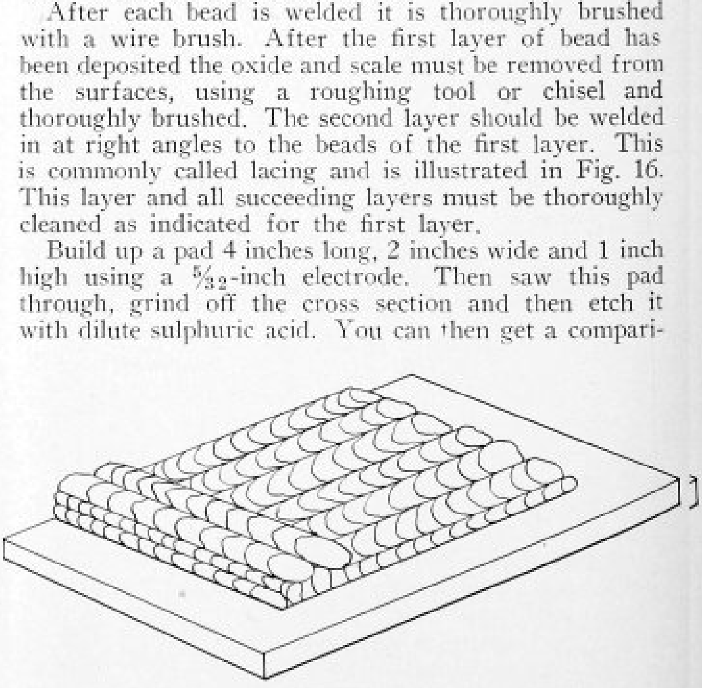


Fig. 16

son of the weld deposit with the parent metal. Observe carefully the lines of fusion between the beads, layers and the original plate. This must be a real line of fusion, no pin holes, porosity, etc.

Lesson 9

OBJECT: Building up a shaft.
MATERIAL: Scrap shaft, 5/32-inch Stable-Arc electrode.
SET UP: The shaft should be turned 1/32-inch to 1/16-inch undersize on the side, that is, 1/16 inch to 1/8 inch in diameter, see Fig. 17. Place in V blocks so it may be turned.
PROCEDURE: Weld parallel to the axis of the shaft,

Fig. 17

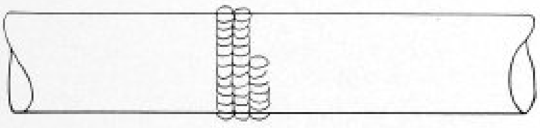


Fig. 18

placing one bead and turning the shaft 180 degrees to place the second, returning to the starting point and placing the third bead, and continuing so on. The object of this is to avoid warping the shaft.

If the place to be welded is distant from the end, see Fig. 18, it is advisable to weld around the shaft and continue turning the shaft so that the weld metal is always on an incline.

Before starting on the second bead on the shaft remove all scale and oxides and treat as in Lesson 8. Be sure each bead is properly fused together. Welding parallel to the axis will tend to avoid warping of the shaft.

Lesson 10

OBJECT: To weld two pieces together by butt weld. These joints are illustrated in Fig. 19.
MATERIAL: Plates of suitable thickness, 1/4 inch or 3/16 inch and 3/8 inch; 5/32-inch Stable-Arc electrode.
PROCEDURE: In general all plates above 1/4 inch should be beveled or scarfed. All plates over 1/2 inch should have a double bevel. This is shown in illustration Fig. 19; (a) being placed without beveling, (b) is a very poor type of joint due to the vertical side and the small included angle. An increase in the included angle makes a stronger weld possible, see Fig. 1 (c). An opening of 3/32 inch is left between the edges of the plates. This of course, is increased as the thickness of the plate is increased. This plate thickness also determines the size electrode to be used. Place plates on bench without backing. First bead rather small; put in without weaving; use 2 or 3 beads to complete the joint.

The motion used should be the half-circle motion (see Lesson 4), but with the ends longer and more in a horseshoe shape to allow the electrode properly to fuse into the bottom of the vee, see Fig. 19-d. Notice the other illustration (e). The penetration does not go to the bottom of the vee because not enough current is used or wrong size of rod, or both.

Sometimes because of this lack of penetration at the bottom of the vee there is what is known as a notch effect. This reduces very greatly the strength of the joint, due to the concentration of stress at that point.

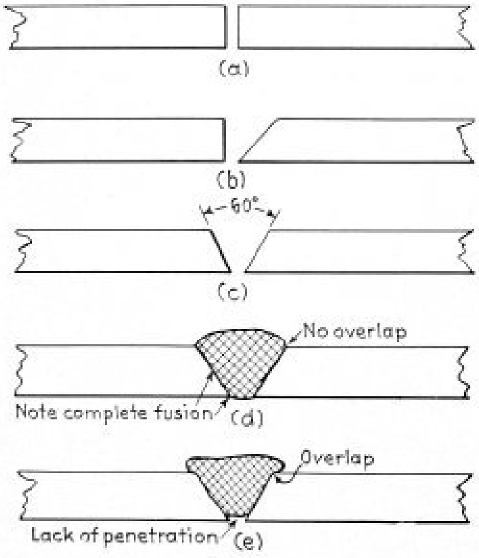


Fig. 19

It is just like nicking a bar; when that is done the bar breaks very easily.

Make up a joint as in (d), also as in (e). Use same size plate, current, rod in both cases, but be sure of good penetration at (d) and poor penetration at (e). Use fairly narrow plate.

Put in a vise and break by hitting sharp blow with hammer.

You will see the difference; very clearly and definitely will be shown the weakness of (e) and the strength of (d).

Lesson 11

OBJECT: Study of lap welding.
MATERIAL: Two pieces of boiler plate—1/4-inch—3/8-inch thick. 3/16-inch Stable-Arc electrode.
PROCEDURE: Place these two pieces of boiler plate so that they overlap about 2 inches and tack weld them together, then weld them using the back and forward motion with a slight curve as the electrode is brought back,

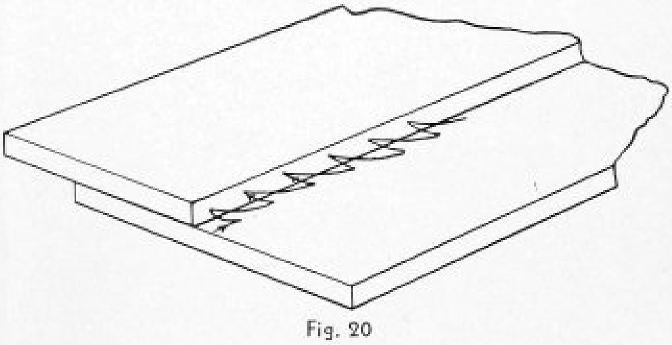


Fig. 20

illustrated in Fig. 20. Make the bead on 1/4-inch plate with one pass. Use two passes on the 3/8-inch plate.

In this case we are welding on the edge of one plate and in the middle part of the other. In order to get the proper penetration the arc must be held a longer time

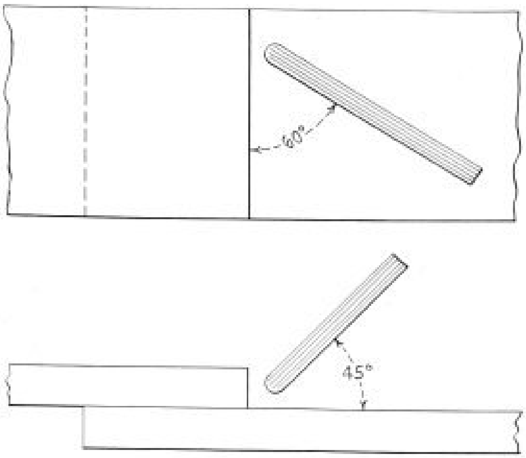


Fig. 21

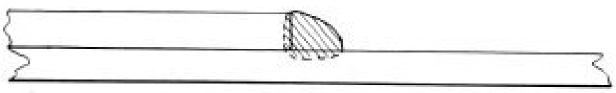


Fig. 22

on the horizontal plate; the electrode should be held on approximately a 45-degree angle, see Fig. 21. Weld on one side only so joint may be broken. Break the weld and inspect it carefully.

It is necessary that the weld be smooth in appearance and that penetration be complete. The bead must go into the corner, see Fig. 22. The metal should be a rather dull gray. No pronounced black spots, lines or holes. These indicate improper fusion and penetration. If they exist, repeat the lesson, using other ends of plates.

Lesson 12

OBJECT: To make a tee weld.
MATERIAL: Two pieces plate—1/4-inch or 5/16-inch thick. Any convenient size. 3/16-inch Stable-Arc electrodes.
PROCEDURE: Place one plate horizontal. In the middle of this tack weld the other vertically. It is evident that the heat from the bead will be conducted away in two horizontal directions and only one vertical direction. Use the same movement as given in Lesson 2. Remember that it is well to put in more heat on the horizontal plate than the vertical, therefore, a slower movement on the horizontal plate than on the vertical will be helpful.

After the movement of Lesson 2 has been practiced until you become proficient, use movement as shown in Fig. 23. Make the height of the bead the same as the plate thickness. Weld one side of plates only, and remember that a good weld means complete penetration into the corner. This requires attention, since the arc has a tendency to skip this corner. This required penetration means that the metal in the corner must be at the fusing point when the arc reaches it. To do this hold a short arc, and use motion as shown in Fig. 23. Do not advance the arc too rapidly. Particular attention should be paid to this point at the start of the weld, so that metal in corner will be heated. It this is not given proper attention and the corner metal is not heated sufficiently, then there will be lack of fusion in the corner. This precaution must be observed when the weld is started, whether it is on new bead or continuation of one previously deposited. This is very important, since lack of fusion at this point means a chance for a crack to start.

These lessons will be continued in May.

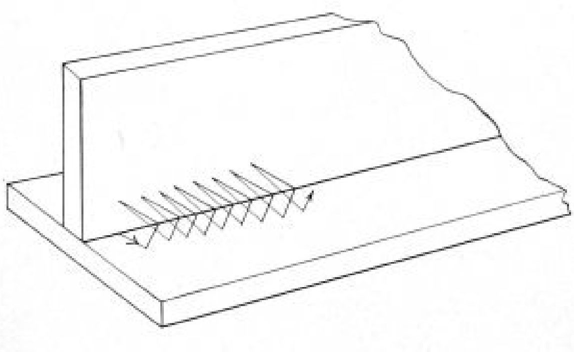
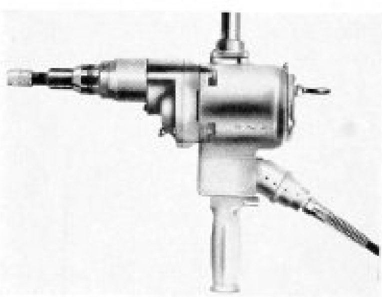


Fig. 23

New Shockless Nut Runner

A shockless high-frequency electric nut runner, with an adjustable releasing clutch, which tightens the nut without shock to the operator, is being introduced by The Buckeye Portable Tool Company, Dayton, O.



Electric nut runner

This clutch operates on a new principle. It is not a friction or jaw clutch, but has an adjustable releasing cam which trips open the clutch when the nut is tight.

The tool is made in a number of sizes, the specifications for the No. 30-N, illustrated, are: 3-phase, 180 cycles, 225 volts; speed 750 revolutions per minute; capacity—5/16-inch and light 3/8-inch nuts; length—14 inches; weight—16 1/2 pounds.

Boiler Repair Accident

A Federal report cited an injury where the boiler maker was attempting to stop a leak at a practically threadless bolt, the bolt also being badly fractured near the top end. While a mechanic was hammering the bolt the drawing effect of hammering parted the bolt at the fracture and the bolt came through the hole into the firebox. Steam filled the firebox and a man was injured. A shoulder on the bolt bearing against the top side of the crown sheet would have prevented this accident.

Milwaukee's Six-Million-Gallon

WELDED TANK

Construction of an all-welded 6,000,000-gal. steel water tank was completed some months ago by the city of Milwaukee, augmenting the storage and increasing the supply in the Menomenee Valley in the western part of the city. The tank is of the flat-bottom type and is said to be the largest welded tank yet built. The location is near the junction of a 30-inch and a 36-inch main having an outlet capacity of 100 m.g.d. The ultimate plan calls for another tank of the same capacity and a pumping station housing four 30-m.g.d. centrifugal booster pumps. The tanks will be filled at night, and the boosters will operate during the peak consumption period of the day.

The tank is 165 feet in diameter, 37½ feet high to the overflow line and is covered with 3/16-inch roof plates supported on structural-steel trusses and purlins. With the exception of the structural work, all steel was welded in the field by the electric-arc process. The total weight is 700 tons.

Support for the tank is a 12-inch slab deposited directly on the ground and pitched toward the center. The ⅜-inch steel bottom plates comprised the first shipment to the job and were laid on a ½-inch layer of sand and asphalt, spread over the concrete slab. They were butt-welded, 3-inch by ¼-inch chill strips being used under each joint. Inasmuch as some difficulty was experienced from buckling of the bottom due to exposure to the sun, its completion was finally deferred until the roof plates were in place. The buckled plates then were cut loose, straightened and rewelded.

Six courses varying in thickness from 1 3/16 inch to ⅜ inch make up the cylindrical section of the tank. Each course comprises thirteen plates, 4 feet wide, shaped to the diameter of the tank and placed in position by three crawler cranes. These cranes operated jaw grapples, which supported the plate while the initial welding was being done. The individual plates of the bottom course weigh 4 tons each. These were welded to the base plates with double fillet welds. No angle iron was used at this connection. The top and bottom edge of all plates were machined and beveled and joined to the next course above with double-bevel butt welds. All vertical seams used solid butt welds. An angle was welded to the top of the shell to act as a stiffener and as a support for the roof trusses.

During construction cage scaffolds for the welders were hung from the top edge of the plates by means of roller supports. This arrangement permitted the welder to move his cage around the tank as his work progressed. When a course was completed a crane lifted the cage to the next course.

Sixteen radial roof trusses are supported on a column at the center and the tank side. In addition, an intermediate column is placed at the mid-point of each truss. All columns have steel base plates welded directly to the floor plates. The 3/16-inch copper-bearing steel roof plates rest on purlins and rafters framed into the trusses.

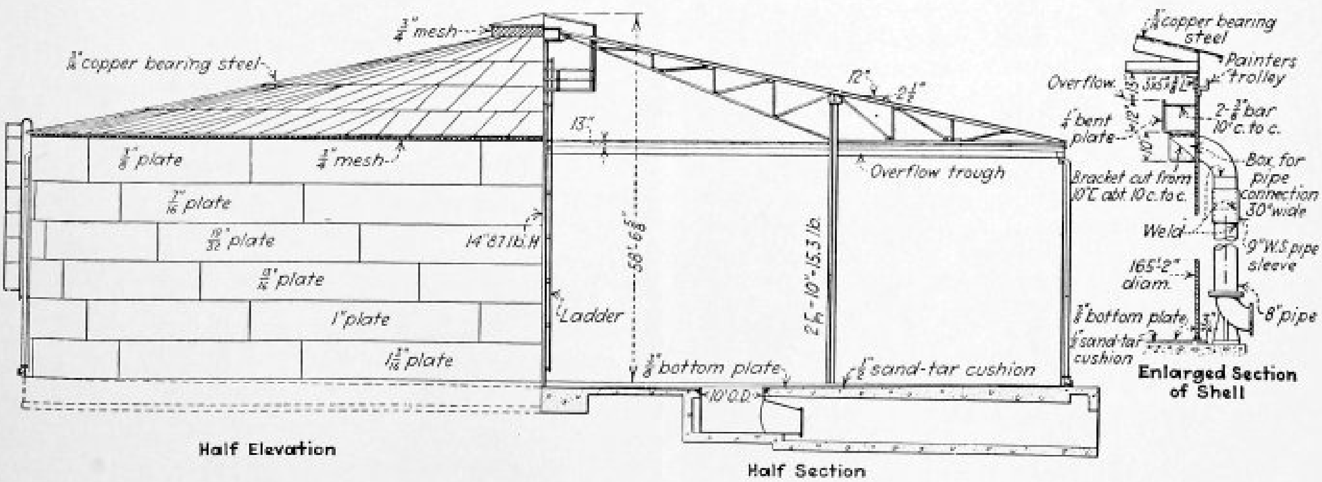
At the center of the roof is a pent-house, 16 feet in diameter and 2 feet high, designed to permit ventilation through a heavy wire mesh screen and to give the tank a finished appearance. Additional ventilation is provided by a screen 9 inches high tack-welded above the top of the side walls and covering the ends of the roof trusses.

In erecting the roof three sheets were welded together on the ground and then placed in position with a crawler crane equipped with an 80-foot boom and special grappler. They were then welded to the roof framing.

An overflow trough, 12 inches by 12 inches in cross-section, extends around the inside of the tank, with the lip 1 foot from the top of the top plate. It is supported on brackets cut from 10-inch channels and welded to the top plate at 10-foot intervals. Six 8-inch pipes lead the water from this overflow trough down the outside of the shell to a storm sewer.

The specifications called for the entire tank to be sandblasted and then given a prime coat of chromate of lead. The exterior then received two coats of aluminum paint, and the interior two additional coats of chromate of lead. Structural steel was not sandblasted but was given the prime coat of chromate of lead in the shop, followed by two field coats. The under side of the base plate was sandblasted, primed with one coat of chromate of lead

NOTE.—Information furnished by the *Engineering News Record*.



Welded storage tank of 6,000,000 gallons capacity; one of largest in the world and one heavy coat of asphalt paint before being laid. An outside painter's trolley track consists of a Z-bar welded to the tank side. An inside trolley will ride on the lip of the overflow trough.

Exclusive of the concrete foundation mat the work was carried out on a cost-plus basis by the A. O. Smith Corp., Milwaukee. Ten gasoline-powered arc-welders with crews were supplied by the Harnischfeger Corp., Milwaukee. The work was carried out under the general direction of J. C. Schwada, city engineer, with Herbert H. Brown, engineer, in direct charge of design and construction of pumping stations for the city of Milwaukee.

Welding Handbook Reissued in Enlarged Form By Lincoln

A revised and enlarged edition of "Procedure Handbook of Arc Welding Design and Practice" is announced by The Lincoln Electric Company, Cleveland. The book has been reissued because of the demand which exhausted the original issue published last Fall. Orders for the books have been received from some 25 foreign countries as well as from every state in the Union at the rate of more than a thousand a month.

The new volume is greatly enlarged and encyclopedic in scope and contents. It contains over 450 pages with several hundred illustrations. The eight principal sections deal with various phases of arc welding in a simple, concise manner, well illustrated with detailed drawings and photographs. Taken together, they cover practically every use and application of arc welding.

Among the many additional features which have been included in the new edition are the following: Weld inspection (visual, stethoscopic, electro-magnetic, X-ray and Gamma ray); study of stress distribution by means of polarized light; a simplified method for the design of arc welded machinery; procedure and speeds for arc welding aluminum; technique and speeds for welding of copper; construction of welded water lines, etc.

Aside from the value of the book as a practical guide to anyone interested in welding, it serves as handy reference work for estimators. Complete welding speed tables and information make it a simple matter to estimate welding costs.

The book is designed especially for the use of designers, engineers, welding operators, welding foremen, and for engineers responsible for the design of products which may be redesigned for welding construction.

Among the subjects treated in detail are, descriptions of various welding processes, definition of welding terms, classification of welds, strength of welded joints, methods of stress relieving, tabulations of speed of welding all types of joints in all positions, methods for estimating cost of weld production, structures and properties of weld metal, specifications for steels and alloys of good weldability, the welding of non-ferrous metals, comparison of limitations of rolled steel and cast iron in machine design, construction details of basic machine parts built by welding, treatise on fundamental advantages of arc welded and riveted steel structures, details of structural arc welding, welding of automotive parts, construction and repair of bridges, use of arc welding in cement plants, gas plants, machine shops, mines, refineries, pipe lines, railroad shops, steel mills, shipyards and hundreds of other interesting subjects.

To make the book convenient for both desk and shop use, it has been made 5¾ by 9 inches and bound in semi-flexible simulated leather embossed in gold. A comprehensive index has been included. Copies will be mailed postpaid in the United States by the publisher for $1.50 per copy; foreign postage 50 cents extra.

Service Bulletin

Many readers will find the information contained in the booklet listed of considerable value in their work. A request to the Editor of BOILER MAKER AND PLATE FABRICATOR, 30 Church Street, New York will assure your receiving a copy.

Manual of Arc Welding

A prominent manufacturer of arc welding equipment has published a new edition of a widely used service bulletin entitled "Manual of Simplified Arc Welding." The regular price of this book is $1 but copies will be supplied free to our readers.

This book has been compiled with the object of presenting such facts about the electric arc welding process as are essential for its successful application to practical work.

In recent years, in addition to the trained engineers already interested, the welding process has engaged the attention of a vast army of men with little or no technical training, who are interested only in practical accomplishments in a wide range of industries.

With this condition in mind, a special effort has been made to avoid highly technical and theoretical discussion and to confine the work to a manual of brief, logical, and non-technical arrangement, including only useful information and suggestions derived from a vast amount of practical experience.

The contents includes chapters on The Welding Arc, Welding Equipment, Types of Joints and Welds, Weldability of Metals, Choice of Electrodes, Using the Metallic Arc, Using the Carbon Arc, Operating Instructions for Simplified Welders, and Speed and Cost of Arc Welding.

Republic Steel Distributors

Appointment of Gate City Iron Works, Omaha, Nebr., as distributors of Toncan copper molybdenum iron, was recently announced by N. J. Clarke, vice-president in charge of sales, Republic Steel Corporation, Youngstown, O. A complete warehouse stock of Toncan iron sheets will be carried by the new distributors.

Barde Steel Company and Doran Company, both of Seattle, Washington, are newly appointed distributors of Enduro stainless steel. Enduro is produced by the Central Alloy Division of Republic, Massillon, O.

Cost Accounting Principles Approved for Boiler Industry

General Hugh S. Johnson, National Recovery Administrator, has approved, effective April 21, principles of cost accounting for the Boiler Manufacturing Industry.

The standard principles approved are those contained in "A Manual of the Standard Accounting and Cost System adopted by the Machinery Builders Society," a pamphlet of 75 printed pages.

Only the principles of the system need be followed, according to the Administrator's order approving the manual. That order approves "the principles of said Standard Accounting and Cost System, but without mandatory requirement for the use of specific systems."

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New York Labor Department Inaugurates Plan to Promote Safety

Industrial Commissioner Elmer F. Andrews of New York State has instituted a new plan in the Department of Labor whereby industrial and mercantile employers and workers may keep in closer touch with the Inspection Division of the Department of Labor. As the first step in carrying out this plan, Commissioner Andrews has announced that George C. Daniels, recently appointed assistant chief factory inspector in charge of inspection work in the up-State districts, will visit the principal industrial and mercantile centers monthly to confer with manufacturers, merchants and employees regarding administration of the sections of the Labor Law applying to industrial and mercantile plants.

The Department of Labor is charged with co-operating with employers and employees to hold down the accident rate, to maintain standards of industrial health and to improve them wherever possible as provided in the law. The present move is designed to develop such co-operation.

Industrial Radiography

Under the title "Industrial Radiography" John Wiley & Sons, Inc., New York, has published a book by Ancel St. John and Herbert R. Isenburger. The price of this book is $3.50. Engineers, metallurgists, salesmen and executives who have to do with developing, working, purchasing and selling materials will find this treatise on the practical applications of X-ray and radium inspection of value.

The theoretical part has been treated as briefly as possible; yet thoroughly enough to cover all that is necessary for a comprehensive study and successful operation. All the practical aspects of industrial radiography are presented in a form and language which can be easily understood by all those who desire to obtain some useful knowledge of the basic theories.

Industrial radiography applies radiant energy to non-destructive testing. Herein lies its importance, for when applicable it is able to assure the designer that the object examined is sound and satisfactory, or it supplies evidence as to the location and extent of any necessary reconditioning. The range and usefulness of industrial radiography will be extended as more designers and more users realize its great possibilities.

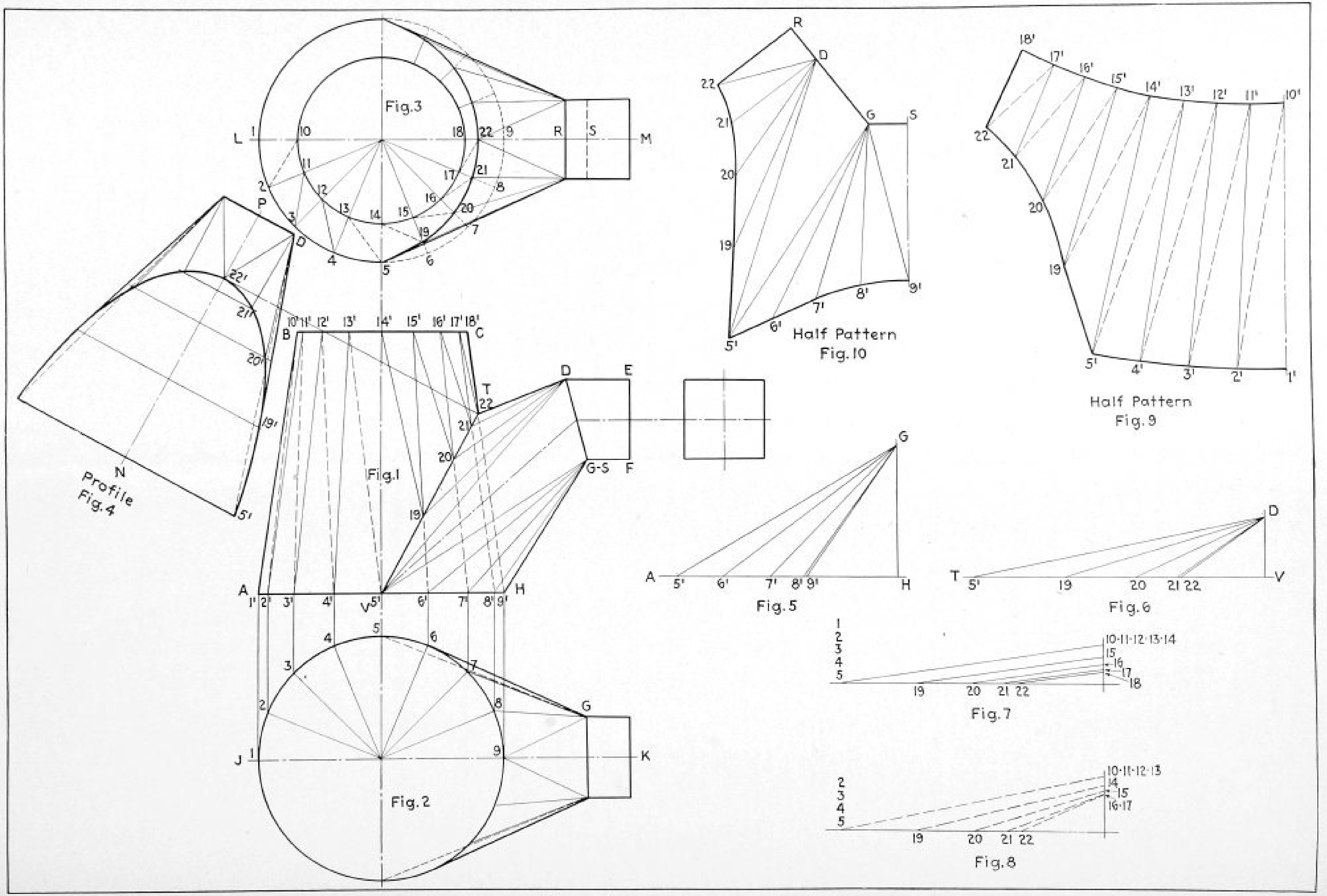
Trade Publications

Two-Stage Horizontal Compressors.—The Gardner-Denver Company, Quincy, Ill., has issued a new bulletin, HAC-36, illustrating and describing the duplex two-stage horizontal compressor produced by the company. Copies may be secured from the Quincy office or any of the company's branch offices.

Seamless Steel Fittings for Welding.—The Taylor Forge & Pipe Works, Chicago, has issued a 64-page catalogue covering Taylor forged welding fittings and flanges. This book is probably the most complete yet offered on the subject of welding fittings. In addition to the usual full line of Taylor forged standard material it includes engineering information and charts on the flexibility of welded piping design, describes and illustrates new types of welding fittings and new types of flanges.

Lukens Nickel-Clad Steel.—A new booklet on Lukens nickel-clad steel has recently been issued by Lukens Steel Company, Coatesville, Pa. Although this metal has been commercially available only for the comparatively short period of a year or two, its economy and corrosion-resistance efficiency have gained for it wide application in the process industries and many other fields. It combines the corrosion resistance of pure nickel with the economy of plain steel. It has been successfully used in evaporator bodies, heaters, mixers, tanks, digesters, reaction vessels, caustic equipment, troughs, tank cars and similar applications. Many examples of its application are illustrated. Its properties, tables of sheet size, and the like, are included.

Cutting Metals.—A folder describing the methods of cutting metals with the Wells band saw has been issued by the Wells Manufacturing Corporation, Three Rivers, Mich. The band saw principle is as applicable for cutting metals as for wood or other materials. Blades for this type saw can be purchased which are highly efficient in service. This saw produces maximum cutting speed for the reason that a continually running saw is always cutting. It can be operated at high speed without heating because excessive friction is eliminated. Details of the saw and an explanation of its uses are contained in the folder.



Elevation, top and bottom plan views of two-way transition branch piece

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

Development of Transition Branch

Q.—Please show the method of developing a two way transition branch with horizontal square and vertical round connection. G. M.

A.—Figs. 1, 2 and 3 illustrate the elevation, top and bottom plan views of a two way transition branch piece as outlined in the question.

Upon examining the plan view it is noted that the transition piece is symmetrical each side of the center line *L-M,* and therefore a development of one-half of the plan as shown would represent one-half of the complete pattern.

Divide the semicircles *1-9,* Fig. 2, and *10-18,* Fig. 3, into the same number of equal parts; any number of parts may be taken, the greater the number of parts taken the more accurate the final development. Number the divisions from *1* to *9* and from *10* to *18* as shown. Project these points to the base line *A-H* and the top line *B-C* of the elevation, numbering them from *1′* to *9′* and from *10′* to *18′* as shown.

Connect these points *1′-10′, 2′-11′, 3′-12′,* etc., of the elevation as shown, the line *6′-15′, 7′-16′, 8′-17′* cutting the miter line *T-V* at the points *19, 20* and *21.*

Next draw the full and dotted lines connecting the various points in the elevation and plan view as shown. These lines represent the surface lines of the object. Next project the profile of the miter line from the elevation and top plan as shown in Fig. 4. The next step is to construct a series of right angled triangles to obtain the true lengths of all the surface lines.

Fig. 7 shows the right triangles for determining the true lengths of the full surface lines of the vertical connection. The distances measured off on the base line are equal to the vertical heights of the various points from the line *B-C* in the elevation, and altitudes shown are taken equal to the length of the corresponding full lines as shown in the top plan view. The hypotenuses obtained are the true lengths of the full surface lines.

The true length of the dotted surface lines of the vertical connection are obtained in like manner as shown in Fig. 8.

The method of obtaining lengths of the surface lines for the horizontal connection is shown in Figs. 5 and 6.

In Fig. 5 the altitude of the triangles is taken as equal to the vertical distance between line *A-H* and the point *G* in the elevation, and the bases of the triangles are taken from the plan view, Fig. 2, as *G-9, G-8, G-7, G-6,* and *G-5.*

In Fig. 6, the altitude of the triangles is taken as equal to the vertical distance between the line *T-V* and the point *D* in the elevation, and the bases of the triangles are taken from profile, Fig. 4, as *D-22′, D-21′, D-20′, D-19′* and *D-5′.*

The pattern for the vertical transition piece is shown in Fig. 9. The distance *1′-10′,* Fig. 9, is taken equal to the distance *A-B* of the elevation. The divisions *10′* to *18′* are taken equal to the divisions *10* to *18* of the plan. The divisions *1′* to *5′* are taken equal to the divisions *1* to *5* of the plan and the divisions *5′-19, 19-20, 20-21, 21-22* are taken equal to the spaces *5′-19′, 19′-20′, 20′-21′, 21′-22′* respectively of the profile, Fig. 4. The lengths of the dotted and solid lines are taken from Figs. 7 and 8 for these corresponding numbers. Complete the pattern as shown.

The pattern for the horizontal transition piece is shown in Fig. 10. The distance *S-9′* is taken equal to the distance *S-H* in the elevation. *G-S* is taken equal to *G-S* in the plan, *G-D* is taken equal to *G-D* in the elevation and *D-R* is taken equal to *D-R* in the plan. The spaces *5′-6′, 6′-7′, 7′-8′* and *8′-9′* are taken equal to the spaces *5-6, 6-7, 7-8, 8-9* of the plan and the spaces *5′-19, 19-20, 20-21* and *21-22* are taken equal to the spaces *5′-19′, 19′-20′, 20′-21′, 21′-22′* of the profile, Fig. 4. The lengths of the full lines are taken from Figs. 5 and 6. Complete the pattern as shown.

Twelve-Ton Capacity Boom

Q.—I wish to build a boom 28 feet long for 12-ton capacity, the mast is 32 feet high. Will use angles, laced. Could you give some information or rules as to size of angles, size of lacing material and spacing of same? W. N. S.

A.—The stresses to be considered in the design of a steel lattice boom or derrick pole comprise the following:

(a) Direct compression due to load lifted, weight of

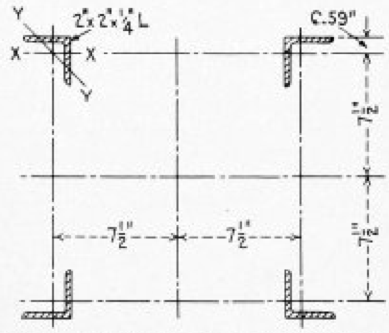


Fig. 1. Maximum cross section of boom

tackle and derrick and also thrust from the tensions in the guy ropes.

(b) Transverse or lateral stresses due to the bending movement from the weight of the derrick itself, overhang of load, and wind pressure.

(c) Stress due to starting and stopping, swaying or surging of the load which will depend upon the guy ropes and angle of rake of boom.

The derrick or boom should also have sufficient stiffness to resist stresses set up when slung for transit, or when raising to vertical position, this being important for long booms or derrick poles, and it is essential that the bracing bars be capable of acting as either struts or ties. Allowance should be made for possible unequal distribution of the load on the legs of the derrick when deciding upon the scantlings for these members, and several sets of diagonal bracing or stout diaphragm plates in a plane at right angles to the length of the pole should be inserted to prevent a tendency of the boom or pole to twist, and keep the framing from getting out of square. To facilitate handling, the boom or derrick pole should be of minimum weight consistent with a fair factor of safety, and the deatils arranged as simply as possible with view to easy riveting and painting.

The width of the boom or derrick pole at the center should be from 1/20 to 1/30 of the length, thus for the boom outlined in the question the width could be from:

$$\frac{28}{20} = 1.4 \text{ feet or 1 foot 5 inches}$$

$$\frac{28}{30} = 0.03 \text{ feet or 11 inches}$$

Make the width 1 foot 3 inches between the centroid lines of the angle legs, say 1 foot 4¼ inches overall which is practically 1/20 of the length. Design of legs; Fig. 1 shows maximum cross-section of the boom or derrick pole.

Assume 2-inch by 2-inch by ¼-inch angles. Area 0.94 square inches.

$Ixx = 0.34$; $rxx = 0.61$; $ryy = 0.39$; distance of center of gravity from heel of angle, 0.59 inch.

Moment of inertia $= I = 4\ (0.35 + 0.94 \times 7.5^2)$

$I = 4 \times 57.54 = 230.16$

$$\text{Radius of gyration} \quad R = \sqrt{\frac{I}{A}}$$

$$R = \sqrt{\frac{230.16}{3.76}} = \sqrt{61.2} = 7.82 \text{ inches}$$

$$\frac{l}{R} = \frac{28 \times 12}{7.82} = 43$$

Considering the boom or derrick as a strut with pin joint at each end and using the strut formula:

Allowable compressive stress in tons per square inch =

$$8\ (1 - 0.005 \frac{l}{R})$$
$$8\ (1 - 0.005 \times 43)$$
$$8\ (1 - 0.215)$$
$$= 8 - 1.72$$
$$= 6.28 \text{ tons}$$
$$6.28 \times 2200 = 13{,}816 \text{ pounds.}$$

Maximum allowable stress pounds per square inch = 15,400 pounds. Direct compression allowing 1 ton for weight of derrick and tackle. Load as specified in question—12 tons.

$$\frac{12 + 1}{4 \times 0.94} = \frac{13}{3.76} = 3.45 \text{ tons}$$
$$3.45 \times 2000 = 6900 \text{ pounds.}$$

Assuming the maximum overhang of the derrick head under full load to be 8 feet, the bending moment will be as follows:

(a) Due to own weight =

$$\frac{Wl}{8} = \frac{1 \times 8 \times 12}{8} = 12 \text{ inch-tons}$$
$$12 \times 2000 = 24{,}000 \text{ inch-pounds}$$
$$\text{Stress due to bending} = \frac{24{,}000 \times 8.09}{230.16} = 843 \text{ pounds.}$$

(b) Due to wind pressure (say 20 pounds per square foot); maximum under working conditions on 1½ exposed area of derrick:

Assume 0.75 square foot exposed area per foot of derrick:

$$28 \times 0.75 \times 1.5 \times 20 = 630 \text{ pounds}$$

Bending moment

$$\frac{Wl}{8} = \frac{630 \times 28 \times 12}{8} = 26{,}460 \text{ inch-pounds}$$
$$\text{Stress due to bending} = \frac{26{,}460 \times 8.09}{230.16} = 930 \text{ pounds.}$$

Maximum stress = 6900 + 843 + 930 = 8673 pounds.

Permissible stress with a factor of safety of 5 = 11,000 to 13,000 pounds.

Allowing 50 percent on direct compressive stress for surging, unequal distribution, etc., the maximum stress would be

$$6900 \times 1.5 + 843 + 930 = 12{,}123$$

and the factor of safety based on the minimum strength of structural steel

$$\frac{55{,}000}{12{,}123} = 4.53$$

so that 2-inch by 2-inch by ¼-inch angle section may be considered quite safe for the legs.

The maximum spacing of the bracing connections =

$$l = \frac{L \times r}{R}$$
$$\frac{28 \times 12 \times 0.39}{7.82} = 16.7 \text{ inches.}$$

Latticing.—Latticing of compression members to be proportional to resist a shearing stress equal to 2 percent of the direct stress. Minimum thickness of lattice bars to be for single lattice 1/40 and for double lattice 1/60 of the distance between the end rivets.

Minimum widths as follows for:

Built up sections with 3½-inch and 4-inch angles—2½ inches (⅞-inch rivets).

Built up sections with 3-inch angles—2¼ inches (¾-inch rivets).

Built up sections with 2½-inch angles—2 inches (⅝-inch rivets).

Built up section with 2-inch angles—1¾ inches (½-inch rivets).

Inclination of lattice bars with axis of member generally to be not less than 45 degrees. When distance between rivet lines in flanges is more than 15 inches; if a single rivet bar is used, lattice to be double. The pitch of the lattice connections along flange, divided by least radius of gyration of member between connections, to be less than the corresponding ratio of member as a whole.

Pins.—Pin holes to be reinforced by plates where necessary. At least one plate to be as wide as the projecting flanges will allow. Where angles are used; this plate to be on the same side as the angles. Plates to contain sufficient rivets to distribute their portion of the pin pressure to the full cross-section of the member.

Associations

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

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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

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.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.
Executive Board — Charles J. Longacre, chairman, division boiler inspector, Pennsylvania Railroad, Baltimore, Md.

American Boiler Manufacturers' Association

President—Charles E. Tudor, The Tudor Boiler Manufacturing Company, Cincinnati, O.
Vice-President—Owsley Brown, The Springfield Boiler Company, Springfield, O.
Secretary-Treasurer—A. C. Baker, 709 Rockefeller Building, Cleveland, O.
Executive Committee—(Three 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. (Two years)—J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.; M. E. Finck, Murray Iron Works, Burlington, Ia.; A. C. Weigel, Combustion Engineering Corporation, New York. (One year)—Homer Addams, Fitzgibbons Boiler Company, Inc., New York; George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn. (*Ex-Officio*)—H. H. Clemens, Erie City Iron Works, Erie, Pa.

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

Cities

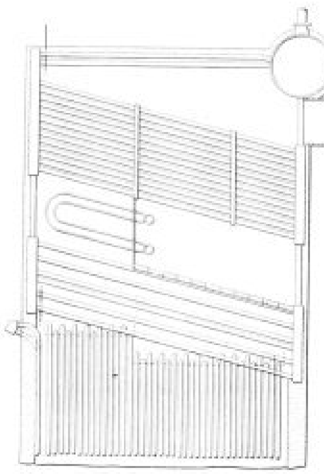
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,832,071. BOILER. ALBERT C. WEIGEL, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim.—In a boiler having a main section of boiler tubes and a drop-header section of boiler tubes, the combination of upper and lower rows



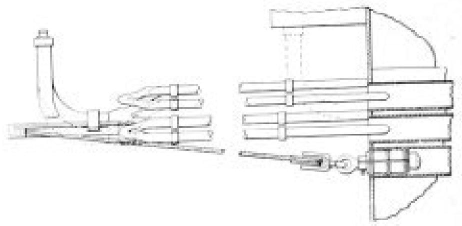
of spaced boiler tubes in the drop header section, the upper rows being spaced more widely apart than lower rows and the spacing of the tubes of the upper rows being greater than the spacing of the tubes of lower rows. Four claims.

1,776,839. REHEAT SUPERHEATER. WILLIAM S. MONROE AND HERMAN C. HEATON, OF CHICAGO, ILL., AND DAVID S. JACOBUS, OF MONTCLAIR, N. J., ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J.

Claim.—In a steam boiler, a first vertical flue disposed above the boiler heating surfaces and leading upward therefrom, a second vertical flue adjacent to the first flue and having its upper portion connected to the upper portion of the first flue with a gas exit at the bottom of the second flue, a wall dividing said flues, a support for said wall disposed above said surfaces, and a steam superheater having tubes extending across the second flue with the steam inlet at the bottom and the steam outlet at the top of the second flue. Twenty-four claims.

1,817,327. APPARATUS FOR INSTALLING SUPERHEATER TUBES IN BOILER FLUES. WILLIAM N. TATRO, OF WEST SPRINGFIELD, MASSACHUSETTS.

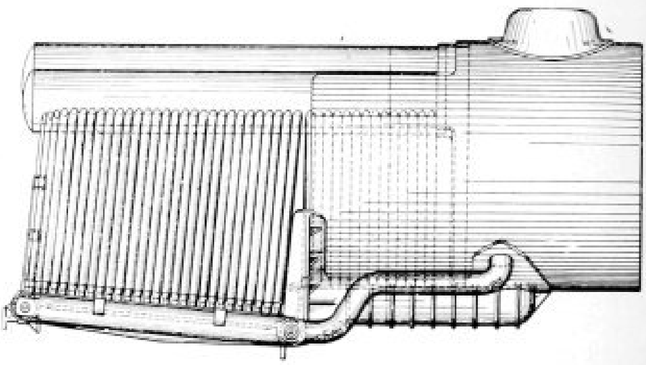
Claim.—An apparatus for the purpose described, comprising in combination, a motor, a windlass operated by the motor, a cable attached



to the windlass, a means insertable in the tubes of a boiler, sheave wheels attachable to the said means and over which the cable passes, a holder member to which the cable is attached whereby, when a superheater unit is placed on the holder, the tubes of the same may be inserted in some of the tubes of the boiler. Eight claims.

1,813,939. LOCOMOTIVE BOILER. CHARLES W. LESTER, OF SCHENECTADY, NEW YORK.

Claim.—A structure for locomotive boilers, comprising a mud ring embodying a water circulation passageway; a member extending for-



wardly of the mud ring and having a longitudinal groove communicating with the passageway in the mud ring; and a conduit disposed outside of the groove and connected at one end to the grooved member and at its other end to the mud ring.

Boiler Maker and Plate Fabricator

Boiler Industry Code Amendment

As a result of the extensive hearings since last December on amendments to the Code of Fair Competition for the boiler manufacturing industry covering trade practice, approval was finally given by the Administrator of the National Industrial Recovery Act on April 16 and signed by the President. The provisions included in the amendment are published in this issue. The articles cover administration of the code, selling practices, price lists, transactions between branches of the industry and affiliates, export sales and fair trade practices in general.

These provisions come as the result of specific experience in administration since the code was put in operation last October and are concerned mainly with business practices that have demanded attention over a long period, but with which the industry up to the time of code administration, has not been organized to deal.

Boiler Manufacturers' Annual Meeting

Since the annual meeting of the American Boiler Manufacturers' Association a year ago, at which time National Industrial Recovery Code operation of the industry was first considered and provided for, real progress has been made in improvement within the entire industry and among its affiliates. The forty-sixth annual meeting will be held at Skytop Lodge, Skytop, Pa., June 10 to 14.

The meeting will be held jointly by the American Boiler Manufacturers' Association and the boiler manufacturing and affiliated industries in general. The program arranged will include an executive committee meeting on June 10; the president's address and committee reports of the A. B. M. A., an address to the entire industry by J. W. Hook, Administration Member of the Code Authority, and a meeting of the Code Authority on June 11. The election of A. B. M. A. officers and their installation and a general session of the entire industry to discuss code matters will occur on June 12. The last two days of the meeting, June 13 and 14, will be devoted to sessions of the various divisions of the industry, including the Class One welding branch, the horizontal return tubular, the watertube, the pulverizer, the air preheater and economizer, the superheater and the stoker branches.

This is the first general meeting of the entire industry and one of the most important in the forty-six years of activity of the American Boiler Manufacturers' Association. The secretary of the association has communicated with the membership urging every firm in the industry to be represented and to make early reservations.

Boiler Repair Association Rapidly Organizing

The response to the announcement last month, that the National Boilermakers Repair Association had been organized in New York for the purpose of promulgating a Code of Fair Practice under the National Industrial Recovery Act, has met with widespread response from all parts of the country. The code proposed by this association was published in the April issue of Boiler Maker and Plate Fabricator.

All firms, companies, groups of persons or individuals engaged in repairing steel vessels and parts used for the generation of steam and repairing and welding steel tanks, jacketed kettles and other vessels utilized for pressure or storage are eligible to membership in the association. The only requirement for members is that they abide by the by-laws and sign the National Boilermakers Repair Association Code of Fair Practice.

Contact has been made throughout the country with individual repair companies through Chambers of Commerce and through the medium of this publication. The entire group of forty concerns engaged in this work in the Metropolitan Area of New York has become affiliated, as well as the Master Boiler Makers and Welders Organization of Chicago, comprising about thirty-five members. These and other firms which have joined the association have given unqualified approval to the proposed code as a means of eliminating many of the existing evils.

The Code Authority of the boiler manufacturing industry, including the American Boiler Manufacturers' Association, other members of this and affiliated industries, will shortly address its entire list of members informing them of the new association and its proposed code. It is likely, since most of the members of the boiler manufacturing industry are engaged in pressure vessel repair work, that many will enter the organization.

With the interest evidenced by the Code Authority of the well-organized boiler manufacturing industry and the practical experience gained by operation under a Code of Fair Competition, it is certain that when the code of the repair group is finally in form for hearings in Washington, it will have every chance of acceptance by the Administration.

The objects of this association are entirely worthy of widespread support and, when the machinery for this branch of the industry is finally set up, it should do much to aid conditions of employment as well as to eliminate practices in this highly competitive line that react against the welfare of firms engaged in the business.

L. L. Balleisen, director of the association and secretary of the Industrial Division, Brooklyn Chamber of Commerce, will be glad to supply information concerning the National Boilermakers Repair Association. Communications may be addressed to him at the headquarters of the association, Room 2300, 66 Court Street, Brooklyn.

Code of Fair Competition for

STEEL PLATE FABRICATORS

In his report on April 6 to the President, approving the Code of Fair Competition for the Steel Plate Fabricating Industry, General Hugh S. Johnson, Administrator of the National Recovery Act, outlined his findings on the Code as follows:

(a) Said Code is well designed to promote the policies and purposes of Title I of the National Industrial Recovery Act, including removal of obstructions to the free flow of interstate and foreign commerce which tend to diminish the amount thereof and will provide for the general welfare by promoting the organization of industry for the purpose of co-operative action among the trade groups, by inducing and maintaining united action of labor and management under adequate governmental sanctions and supervision, by eliminating unfair competitive practices, by promoting the fullest possible utilization of the present productive capacity of industries, by avoiding undue restrictions of production (except as may be temporarily required), by increasing the consumption of industrial and agricultural products through increasing purchasing power, by reducing and relieving unemployment, by improving standards of labor, and by otherwise rehabilitating industry.

(b) Said Industry normally employs not more than 50,000 employees; and is not classified by me as a major industry.

(c) The Code as approved complies in all respects with the pertinent provisions of said Title of said Act, including without limitation Subsection (a) of Section 3, Subsection (a) of Section 7, and Subsection (b) of Section 10 thereof; and that the applicant association is an industrial association truly representative of the aforesaid industry; and that said association imposes no inequitable restrictions on admission to membership therein.

(d) The Code is not designed to and will not permit monopolies or monopolistic practices.

(e) The Code is not designed to and will not eliminate or oppress small enterprises and will not operate to discriminate against them.

(f) Those engaged in other steps of the economic process have not been deprived of the right to be heard prior to approval of said Code.

For these reasons, therefore, I have approved this Code.

Code of Fair Competition for the Steel Plate Fabricating Industry

Article I—Purpose

To effectuate the policies of Title I of the National Industrial Recovery Act, the following provisions are established as a Code of Fair Competition for the Steel Plate Fabricating Industry, and shall be the standard of fair competition for such Industry and shall be binding upon every member thereof.

Article II—Definitions

The following words are used in this Code with the meanings respectively set forth:

1. The term "Steel Plate Fabricating Industry" or "the Industry" as used herein includes the fabricating and/or selling, and/or erecting in the United States of America, exclusive of Alaska, Hawaii, the Canal Zone and its other insular and maritime possessions, of:

(a) Field erected storage tanks for water, oil, etc.

(b) Shop built storage and pressure tanks (except refrigerant receptacles manufactured by a member of the Refrigerating Machinery Industry or a corporation affiliated therewith) for water, oil and other purposes except where standardized and shipped in finished conditions and/or sold from a published price list, and further excepting pressure and sump tanks for governing and control systems of water power plants when manufactured by a member of the Water Power Equipment Industry or a corporation affiliated therewith.

(c) Blast furnaces.

(d) Gas holders.

(e) Elevated steel tanks and supporting towers.

(f) Penstocks and pipe line construction and water pipe either riveted or welded, lock bar or seamless, either hot dipped vertically or specially coated, except feeder pipes and intake pipes, not exceeding thirty-five (35) feet in length, furnished with the turbine as part of a water power installation and manufactured by the manufacturer of such turbine or a corporation affiliated therewith.

(g) Steel stacks.

(h) Miscellaneous sheet, plate and kindred work, not provided for in other Codes, and branches or subdivisions thereof as may from time to time be included under the provisions of this Code.

2. The term "Association" as used herein shall mean "Steel Plate Fabricators' Association."

3. The term "employee" as used herein shall include any and all persons engaged in any phase of the Industry in any capacity however compensated, except a member of the Industry.

4. The term "employer" as used herein means any employer engaged in the Industry.

5. The term "Member of the Industry" as used herein includes any individual, partnership, association, corporation or other person or form of enterprise engaged in the Industry either as an employer or on his own behalf.

6. The term "Member of the Code" as used herein includes any member of the Industry who shall expressly signify assent to this Code.

7. The term "apprentice" as used herein means a person (usually a minor) bound by indenture to serve an employer for a term of years at a pre-determined wage for the period of indenture in order to learn a trade, art or profession.

8. The term "Act", "The President", and "Administrator" as used herein shall mean respectively Title I of the National Industrial Recovery Act, the President of the United States, and the Administrator for Industrial Recovery.

9. "Population" for the purposes of this Code shall be determined by reference to the latest Federal Census.

Article III—Hours

1. Factory and construction employees, mechanical

workers or artisans or other employees in the Industry, except as hereinafter provided, shall not be employed in excess of an average of forty (40) hours per week in any four (4) weeks period or more than forty-eight (48) hours or more than six (6) days in any one (1) week. For the purposes of this Article III the first four (4) weeks period for such employment shall begin April 1st, 1934. The foregoing limitations as to hours of labor shall not apply to persons in a managerial, an executive or a supervisory or technical capacity and their respective staffs; to commercial traveling salesmen or watchmen, nor to employees engaged in emergency maintenance or repair work; nor to very special cases where restrictions of hours of highly skilled workers on continuous processes would unavoidably reduce production. No watchman shall be permitted to work in excess of fifty-six (56) hours in any one week.

2. No employer shall work any accounting, clerical, or other office employees in the Industry more than forty (40) hours per week averaged over a period of five (5) weeks, nor more than forty-eight (48) hours in any one week, excluding the classes of employees referred to in the third sentence of paragraph 1 of this Article III.

3. No employer shall knowingly permit any employee to work for any time which when totaled with that already performed with another employer, or employers, exceeds the maximum permitted herein.

Article IV—Wages

1. The minimum wage that shall be paid by any employer to any factory, construction or other employee of this Industry in the labor operations directly incident thereto shall be not less than forty (40) cents per hour except that:

In the States of Louisiana, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Florida, and Mississippi the minimum rate for such workers shall be not less than thirty (30) cents per hour and in Texas and Virginia not less than thirty-five (35) cents per hour.

2. Accounting, clerical and other office employees, mentioned in paragraph 2 of Article III, shall be paid at not less than the following rates in cities of the sizes listed below and their immediate trade areas:

500,000 population and more, not less than $15.00 per week.

Between 250,000 and 500,000 population, not less than $14.50 per week.

Between 2500 and 250,000 population, not less than $14.00 per week.

In towns of less than 2500 population, all wages of such employees shall be increased by not less than twenty (20) percent provided that this shall not require wages in excess of $12.00 per week.

3. No employees of the classes mentioned in paragraph 2 of Article III now receiving compensation at a rate in excess of the minimum provided in paragraph 2 of this Article IV, next above, shall have their compensation reduced on account of any reduction in the weekly hours of employment to conform with the requirements of paragraph 2 of Article III.

4. The provisions in paragraphs 1 and 2 of this Article IV relating to rates of wages shall not apply to apprentices, office boys and girls or messengers, not exceeding five (5) percent in number of the employees of any employer.

5. The minimum wage that shall be paid to office boys and girls and messengers, shall be not less than eighty (80) percent of the minimum salary stipulated in paragraph 2 of this Article IV.

6. Where an employee's total earnings for the pay period, including any earnings from piecework, divided by the total number of hours worked during such period, produces a result under the hourly wage established by the employer for said employee, such earnings shall be adjusted to equal his established hourly wage, and in no case shall any employee engaged in piecework receive less than the minimum wage stipulated in paragraph 1 of Article IV.

7. The hourly wage rate or salary of all employees receiving more than the minimum rate or salary herein provided shall be equitably adjusted, if such adjustments have not already been made. All such adjustments shall be reported to the Code Authority.

8. Any system of contracting shop work by which an employee undertakes to do a piece of work at a specific price and engages other employees to work for him is prohibited by this Code.

9. No distinction in rates shall be made between male and female employees where substantially the same class of work is performed, regardless of whether compensation is calculated on an hourly, weekly, monthly, or piecework basis.

10. Nothing in this Article IV, except the limitations provided in Section 4 of this Article, shall apply to or affect any employee apprenticed to any employer by an indenture made in pursuance of the laws of any State of the United States, or by a written contract under any apprentice system established and maintained by such employer, and copies of any such contracts shall be filed with the Code Authority.

11. A person whose earning capacity is limited because of age or physical or mental handicap may be employed on light nonproductive work at a wage below the minimum established by this Code, but such wages shall not be less than eighty (80) percent of the minimum wage provided in paragraph 1 of this Article IV.

Article V—General Labor Provisions

1. No employer shall employ any person under the age of sixteen (16) years, or under the age of eighteen (18) years in any occupation hazardous in nature or dangerous to health.

2. Pursuant to subsection (a) of Section 7 of the Act, the following provisions are contained in this Code:

(a) Employees shall have the right to organize and bargain collectively, through representatives of their own choosing, and shall be free from interference, restraint, or coercion of employers of labor, or their agents, in the designation of such representatives or in self-organization or in other concerted activities for the purpose of collective bargaining or other mutual aid or protection.

(b) No employee and no one seeking employment shall be required as a condition of employment to join any company union or to refrain from joining, organizing, or assisting a labor organization of his own choosing.

(c) Employers shall comply with the maximum hours of labor, minimum rates of pay, and other conditions of employment approved or prescribed by the President.

3. No employer shall reclassify employees or duties of occupations performed or engage in any other subterfuge for the purpose of defeating the provisions of the Act or of this Code.

4. Every employer shall provide for the safety and health of employees during the hours and at the places of their employment. Standards for safety and health shall be submitted by the Code Authority to the Administrator within six months after the effective date of the Code.

5. No provisions in this Code shall supersede any State or Federal law which imposes more stringent re-

quirements on employers as to age of employees, wages, hours of work, or as to safety, health, sanitary or general working conditions, or insurance, or fire protection, than are imposed by this Code.

6. All employers shall post complete copies of this Code in conspicuous places accessible to employees.

Article VI—Organization

1. A Code Authority is hereby constituted to co-operate with the Administrator in the administration of this Code.

(a) The Code Authority shall consist of seven (7) members of the Association together with one or more, but not more than three (3) non-voting appointees of the Administrator who shall serve without expense to the industry. Members of the Association elected to the Code Authority shall be elected thereto, either prior to and in contemplation of the approval of this Code or subsequent to its approval, by the active members of the Association at a meeting of such members to be called for such purpose, each member of the Association to have only one vote at such meeting.

To the Code Authority as so constituted and established the members of the Industry who are non-members of the Association may thereafter, if they so desire, elect either prior to and in contemplation of the approval of this Code or subsequent to its approval, not more than two (2) members by a method of selection approved or prescribed by the Administrator.

(b) Each trade or industrial association directly or indirectly participating in the selection or activities of the Code Authority shall (1) impose no inequitable restrictions on membership, and (2) submit to the Administrator true copies of its articles of association, by-laws, regulations, and any amendments when made thereto, together with such other information as to membership, organization, and activities as the Administrator may deem necessary to effectuate the purposes of the Act.

(c) In order that the Code Authority shall at all times be truly representative of the Industry and in other respects comply with the provisions of the Act, the Administrator may provide such hearings as he may deem proper and thereafter if he shall find that the Code Authority is not truly representative or does not in other respects comply with the provisions of the Act, may require an appropriate modification in the method of selection of the Code Authority, or any sub-Code Authority.

(d) Nothing contained in this Code shall constitute the members of the Code Authority partners for any purpose. Nor shall any member of the Code Authority be liable in any manner to anyone for any act of any other member, officer, agent or employee of the Code Authority. Nor shall any member of the Code Authority exercising reasonable diligence in the conduct of his duties hereunder, be liable to anyone for any action or omission to act under the Code, except for his own willful misfeasance or nonfeasance.

POWERS AND DUTIES

2. The Code Authority shall have the following powers and duties in addition to those provided elsewhere in this Code, to the extent permitted by the Act:

(a) To adopt by-laws and rules and regulations for its procedure and for the administration and enforcement of the Code, in accordance with the powers herein granted, and to submit the same to the Administrator for his approval together with true copies of any amendments or additions when made thereto, minutes of meetings when held, and such other information as to its activities as the Administrator may deem necessary to effect the purposes of the Act.

(b) To obtain from members of the Industry for use of the Code Authority, for the Administrator in the administration and enforcement of the Code, and for the information of the President, reports based on periods of one month or multiples thereof, as soon as necessary readjustments within the Industry can be made and to give assistance to members of the Industry in improving methods, or in prescribing a uniform system of accounting and reporting. All individual reports shall be kept confidential as to members of the Industry and only general summaries thereof may be published.

(c) With the approval of the Administrator to receive complaints of violations of the Code, make investigations thereof, provide hearings thereon and adjust such complaints, and bring to the attention of the Administrator for prosecution, recommendations and information relative to unadjusted violations; but in no event shall the Code Authority instigate prosecution without notice to and approval by the Administrator.

(d) To use such trade associations and other agencies as it deems proper for the carrying out of any of its activities provided for herein and to pay such trade associations and agencies the cost thereof, provided that nothing herein shall relieve the Code Authority of its duties or responsibilities under the Code and that such trade associations and agencies shall at all times be subject to and comply with the provisions hereof.

(e) To co-ordinate the administration of this Code with such other codes, if any, as may be related to the Industry, or any subdivisions thereof, and to delegate to any other administrative authority, with the approval of the Administrator, such powers as will promote joint and harmonious action upon matters of common interest.

(f) To secure an equitable and proportionate payment of the expenses of maintaining the Code Authority and its activities from members of the Industry. The Code Authority may from time to time make such assessments on account of such expenses against the members of the Industry as it shall deem proper and such assessments shall be payable as such Code Authority shall specify. The part of such expenses which shall be assessed against each member of the Industry shall be based on the proportion which the value of shipments of the products of the Industry of such member bears to the total value of shipments of the products of the Industry of all members of the Industry in the same current accounting period as determined by the Code Authority.

(g) To co-operate with the Administrator in regulating the use of the N.R.A. Code Insignia solely by those employers who have assented to, and are complying with, this Code.

(h) To initiate, consider and make recommendations for the modification or amendment of this Code.

(i) In addition to the information required to be submitted to the Code Authority as set forth in this Article there shall be furnished to government agencies such statistical information as the Administrator may deem necessary for the purposes recited in Section 3 (a) of the National Industrial Recovery Act.

(j) An appeal from any action by the Code Authority affecting the rights of any employer or employee in the Industry may be taken to the Administrator.

(k) If the Administrator shall determine that any action of a code authority or any agency thereof may be unfair or unjust or contrary to the public interest, the Administrator may require that such action be suspended to afford an opportunity for investigation of the

(Continued on page 132)

Federal Co-ordinator of Transportation's Organization Reports on Locomotives

Co-ordinator Eastman on April 24 addressed personal letters to the presidents of the Class I railroads enclosing a series of statements relating to steam locomotives, based in part on the returns to a questionnaire addressed to them on November 8, including a report by the Section of Car Pooling in which is summarized the first section of its study of the returns, dealing with description, condition, potential capacity, and programs for repair and retirement. The second section, devoted to a study of repair costs with relation to the age and size of locomotives, will follow in the near future. These studies, Mr. Eastman said, are believed to constitute the most complete summarization of steam locomotive data ever undertaken.

An accompanying memorandum by O. C. Castle, director of the Section of Car Pooling, said that from the facts it is apparent that there is ample power if adequately maintained to protect any probable increase in traffic in the near future but that this does not imply that it may not be economical or desirable to purchase new power. Calculated on a tractive power basis, the remaining mileage for all locomotives is placed at the equivalent of 34.8 percent of the total estimated potential, and the difference between such ratio and 50 percent, the accepted normal, is said to represent the extent of deferred maintenance. In commenting on the statements Mr. Eastman said in part:

The value of the information developed obviously depends upon the use which is made of it. Means for applying the general data to the situation on an individual railroad, as more clearly presenting essential facts, will suggest themselves to executives.

The calculations in the attached statement were produced with the aid of tabulating machines. The punched cards used in the process are available for use in further general studies, or may be availed of by individual railroads desiring to analyze their reports on Form CP-2 and Form CP-3. My Section of Car Pooling will undertake to supervise such individual studies, providing the railroads desiring them will assume the cost of the tabulation and the extra clerical work involved. The cost of such a study should be nominal.

Respecting the results of the general study, it seems in order to comment upon a few of the interesting and important items, and to suggest some of the features which should prove of practical value at this time.

In submitting the questionnaire form, I requested those addressed to indicate their preferences or to give expression to their personal views on several subjects directly related to locomotive efficiency and operating economy. The replies are summarized. Unfortunately the value of this summary is lessened by the failure of many of those addressed to reply to the questions.

One of these questions was with respect to the most reliable unit for comparing locomotive repair costs. The statistical data on this feature of the study will appear in section two of the report, and the significance of the replies will be discussed in that section.

Another question dealt with the extent to which recent studies have been made for the purpose of determining the relative economic value of certain types of locomotives. Only six of the 146 railroads addressed advised that such studies have been made within the past five years. Possibly this apparent lack of interest in a factor of such vital moment in the operation of a railroad, may throw some light upon the startling variations which appear in the depreciation calculations.

There may be good reasons for such a wide spread in the life expectancy; for example, as between the 2-10-0 type, with 28 years, and the 4-4-0 type with 54. There may be a satisfactory explanation for the fact that Southern railroads base their calculations upon a life of 98 years for the same type of locomotive which is expected to reach its limit at 47 and 48 years in the Eastern and Western districts. Such reasons and explanations are not likely to be developed, however, without a more scientific study of locomotive efficiency and obsolescence than has heretofore been devoted to the subject, if we are to rely upon the replies so far submitted. Probably one answer is that the reporting railroads do not expect to secure any such length of service as the calculations show, and that the exaggerations are due largely to the fact that depreciation charges in these cases are inadequate.

As I have previously pointed out, there is little temporary and no permanent advantage in understating depreciation, and to the extent that the practice is continued, it affects the solvency of a concern and presents a misleading picture to the security holders and the public. It is encouraging that a large proportion of the roads replying have indicated their desire to adjust these undercharges by writing off the deficiency as a charge to profit and loss. Such action should have a beneficial effect by expediting the retirement of those units which, through obsolescence or excessive maintenance costs, cannot be economically retained in service.

In the light of the progress made in recent years in locomotive design and in the use of mechanical power in transportation, the fact that more than half of the steam locomotives now in service are over twenty years old is worthy of serious consideration.

The two items of operating expense which are most directly affected by the age and design of motive power, locomotive repairs and fuel, together constitute a substantial proportion of the total cost of operation. I am sure that you appreciate the opportunity for economies which lies in this field of research and hope that you may find the results of our locomotive studies helpful in the analysis of your own situation.

Mr. Castle's summary follows:

The total number of steam locomotives owned by Class I Railroads, as reflected by their reports, is 51,425, averaging 20.7 years of age.

The oldest unit reported was built in 1865. The owner of this locomotive schedules it for class repairs in 1938 when it will be 73 years old.

More than 53 percent of all locomotives, or 27,598, are 21 years or more of age. Of this number 6696, or about one-fourth, are scheduled for retirement by the end of 1938.

On the basis of wheel arrangement there are forty-six types of locomotives, of which forty are road and six are switch types.

Seven types include 84.7 percent of all road locomotives, and 97.9 percent of the switch units fall under two types.

The ledger value averaged $33,402 per unit, and varied by types from $2,806 to $172,031.

The average cost per tractive-power pound is seventy cents, the variation in this cost as between districts being but 3.3 percent.

The accrued depreciation averaged $15,136 per locomotive, equivalent to an annual rate of 2.19 percent. Applying this rate to the average ledger value, we find the projected life of existing locomotives averages 46 years. There are wide variations in the life expectancy, indicated by the depreciation rate, as between roads and as between types. The most hardy type appears to be an 0-16-0, with a projected life of 1,111 years. Other unusual cases are 286, 167, and 100 years respectively.

During the year ending September 30, 1933, there were 10,120 steam locomotives which made no mileage. These units constitute 19.7 percent of the total.

In a general way, the variations in the ratio of idle to total locomotives by types give some indication of degrees of obsolescence or surplus. For example, the types showing ratios of idle units substantially above the average were, 4-4-0 (American), 42.9 percent; 2-6-6-2 (Articulated) 33.7 percent; 2-6-2 (Prairie) 33.1 percent; 2-6-0 (Mogul) 30.6 percent; 4-4-2 (Atlantic) 30 percent.

Included in the idle locomotives were 2110 units held for sale or scrap. The time these locomotives were so held averages 27.2 months. The district averages are, Eastern 22.9, Southern 28, Western 30.4. One railroad with an ownership of about 200 locomotives reported 35 percent of its ownership stored an average of 51.6 months. The trackage occupied by these 64 locomotives set aside for more than four years is located in a large industrial center.

Using the actual locomotive mileage made during August and September, 1933, as a basis, the railroads estimate that with an adequate preliminary repair program, they could, under conditions of peak demand, increase the total locomotive miles per day with the engines in service 39.7 percent, and obtain from them as a maximum 122.7 miles per locomotive-day. From 5393 locomotives to be withdrawn from storage, additional mileage equal to 20.6 percent of the August-September actual could be secured. From the shop out-turn, the estimated mileage equals an additional 37.3 percent, making all told, a possible increase in total locomotive-miles per day of 97.6 percent.

The average miles per locomotive-day under the assumed conditions is, for those in service, 122.7; withdrawn from storage, 110.6; and all locomotives, 116.1.

The actual freight and passenger locomotive miles made during the peak month of October, 1929, was 3,495,188 per day. The carriers now estimate they could, under the assumed conditions, produce 5,016,807 locomotive-miles per day with road power. That is to say, they now have power sufficient to make, for a 60-day period, 43.5 percent more locomotive-miles per day than during the peak month, October, 1929.

From these facts it is apparent that there is ample power if adequately maintained to protect any probable increase in traffic in the near future. This does not imply that it may not be economical or desirable to purchase new power. There are other factors to be reckoned with in determining this question. It is hoped that our study of Form CP-3, which will shortly be released, will have data which may be helpful in aiding the railroads to determine the economic life of motive power from the standpoint of cost of repairs.

The estimated mileage which can be secured from power when new, or between shoppings for general repairs, averages 86,380 per locomotive. By districts the averages are, Eastern 68,158; Southern 86,835; Western 105,423.

Analysis of the reports develops that on October 1, 1933, the mileage remaining in locomotives was 33.7 percent of the estimated potential. The district averages were, Eastern 37.9 percent; Southern 32.1 percent; Western 31.5 percent. Calculated on a tractive power basis, the remaining mileage for all locomotives is equivalent to 34.8 percent of the total estimated potential. The difference between these ratios and 50 percent, the accepted normal, represents the extent of deferred maintenance.

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 given records of the interpretations of this committee in Cases Nos. 763 and 767 as formulated at the meeting of February 16, 1934, they having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

Case No. 763—*Inquiry:* Is it the intent of Pars. P-295 or H-63 and/or H-116 of the code to permit the introduction of feed water into a boiler through the water column or its pipe connections?

Reply: It is the opinion of the committee that Pars. P-295 or H-63 and/or H-116 do not sanction the connection of any device that will permit the introduction of feed water into a boiler through the water column or its pipe connections (see Pars. H-38 and/or H-91 for the introduction of feed water into the boiler).

Case No. 767: (In the hands of the Committee)

Westinghouse Constructs New Boiler House

The Westinghouse Electric and Manufacturing Company has started construction on a new boiler house for plant process and heating purposes at the East Pittsburgh Works.

Work on the new plant was started, the company said, realizing the timeliness of proceeding with rehabilitation work while the upturn of business is in evidence and feeling that such procedure will add weight to the general recovery and increase employment.

The present plans provide for the erection of a building having five of an ultimate of eleven bays and the installation of one boiler at a total cost of about $400,000. This first installation, which replaces six boilers of the present plant, is one of the four new boilers which will ultimately replace the twenty-four units now in use.

The new boiler, rated at 1,600 horsepower, will produce 150,000 pounds of steam an hour and is capable of operation at pressures up to 600 pounds.

Amendment to Code of Fair Competition Boiler Manufacturing Industry

The following constitutes the official approval of General Hugh S. Johnson, Administrator for Industrial Recovery, given on April 16, to Amendment to the Code of Fair Competition for the Boiler Manufacturing Industry. The order approving the amendment is as follows:

An application having been duly made pursuant to and in full compliance with the provisions of Title I of the National Industrial Recovery Act, approved June 16, 1933, for approval of a Supplement "A" to the Code of Fair Competition for the Boiler Manufacturing Industry, approved October 3, 1933, and hearings having been duly held thereon and the findings with respect thereto having been made and directed to the President:

Now, therefore, on behalf of the President of the United States, I, Hugh S. Johnson, Administrator for Industrial Recovery, pursuant to authority vested in me by Executive Orders of the President, including Executive Order No. 6543-A, dated December 30, 1933, and otherwise; do hereby incorporate by reference said annexed report and do find that said Supplement "A" of said Code complies in all respects with the pertinent provisions and will promote the policy and purposes of said Title of said Act; and do hereby order that said Supplement "A" to said Code of Fair Competition be and it is hereby approved; provided, however, that the provisions of Article V, Section 1 (d), in so far as they prescribe a waiting period between the filing with the Code Authority and the effective date of revised price lists or revised terms and conditions of sale be, and they are hereby, stayed pending my further Order either within a period of sixty days from the effective date of this Code or after the completion of a study of open price associations now being conducted by the National Recovery Administration.

Report to the President

The President,

The White House.

Sir: This is a report on the Supplement "A" to the Code of Fair Competition for the Boiler Manufacturing Industry, approved October 3, 1933, as revised after a Public Hearing held in Washington on the 27th day of December, 1933, in accordance with the provisions of the National Industrial Recovery Act.

Findings

I find that:

(a) Said Supplement to said Code is well designed to promote the policies and purposes of Title I of the National Industrial Recovery Act, including removal of obstructions to the free flow of interstate and foreign commerce which tend to diminish the amount thereof and will provide for the general welfare by promoting the organization of industry for the purpose of co-operative action among the trade groups, by inducing and maintaining united action of labor and management under adequate governmental sanctions and supervision, by eliminating unfair competitive practices, by promoting the fullest possible utilization of the present productive capacity of industries, by avoiding undue restrictions of production (except as may be temporarily required), by increasing the consumption of industrial and agricultural products through increasing purchasing power, by reducing and relieving unemployment, by improving standards of labor, and by otherwise rehabilitating industry.

(b) Said Industry normally employs not more than 50,000 employees; and is not classified by me as a major industry.

(c) The Supplement and the Code as approved complies in all respects with the pertinent provisions of said Title of said Act, including without limitation Subsection (a) of Section 3, Subsection (a) of Section 7, and Subsection (b) of Section 10 thereof; and that the applicant, the Code Authority of the Boiler Manufacturing Industry, constituted by Article IX of the Code, and approved by Administrative Order, dated February 1st, 1934, is truly representative of the aforesaid Industry.

(d) The Supplement and the Code is not designed to and will not permit monopolies or monopolistic practices.

(e) The Supplement and the Code is not designed to and will not eliminate or oppress small enterprises and will not operate to discriminate against them.

(f) Those engaged in other steps of the economic process have not been deprived of the right to be heard prior to approval of said Supplement of said Code.

For these reasons, this Supplement to said Code has been approved by me.

Respectfully,

Hugh S. Johnson,
Administrator.

Amendment to Code of Fair Competition for the Boiler Manufacturing Industry

Article I—Purposes

Pursuant to Article XIII of the Code of Fair Competition for the Boiler Manufacturing Industry, duly approved by the President on October 3, 1933, and further to effectuate the policies of Title I of the National Industrial Recovery Act, the following provisions are submitted as a supplement to said Code of Fair Competition, and, upon approval by the President, shall be binding upon every member of the Boiler Manufacturing Industry.

Article II—Definitions

(1) The term "the Code", as used herein, shall mean the Code of Fair Competition for the Boiler Manufacturing Industry, duly approved by the President on October 3, 1933.

(2) The term "Boiler Manufacturing Industry", or "Industry", as used herein, shall mean the Boiler Manufacturing Industry as defined in Article II of the Code.

(3) The term "Branches of the Industry", as used herein, shall mean those groups of members of the Industry who manufacture specific classes of products of the Industry, such as water tube boilers, fire tube boilers, air preheaters, economizers, superheaters, stokers, pulverized fuel equipment, Class I welded pressure vessels and such other specific classes of products of the Industry as defined from time to time by the Code Authority.

(4) The term "Code Authority", as used herein, shall mean the Planning and Fair Practice Agency constituted by Article IX of the Code and approved by the Administrative order dated February 1, 1934, and variously

referred to in the Code as the A. B. M. A. Committee of Industrial Recovery or the Committee.

(5) The term "Manager", as used herein, shall mean the Manager (or his Deputy), appointed as provided in Article IX of the Code.

(6) The term "Member of the Industry", as used herein, shall include but without limitation, any individual, person, partnership, association, corporation or other form of enterprise engaged in the manufacture or sale of the products of the Industry either as an employer or on his or its own behalf.

(7) The term "ultimate consumer", as used herein, shall mean one who purchases the products of the Industry from a member of the Industry for use and not for resale.

(8) The terms "employer" and "employee", as used herein, shall have the meaning as set forth in Article II of the Code.

(9) The provisions of this Supplement shall become effective immediately upon approval by the President.

Article III—Administration

Section 1. The Code Authority may, subject to the approval of a majority of the members of each of the several branches of the Industry, as defined in Article II, appoint a Supervisory Committee, for each of such branches, which shall among other duties co-operate with the Manager as Trade Practice Compliance Boards for the several branches of the Industry; provided, however, that nothing herein contained shall relieve the Code Authority of any of its duties and responsibilities under the Code or under any Supplement thereto; and provided, further, that the Administration representatives on the Code Authority may act in the same capacity on these Supervisory Committees.

Section 2. Nothing contained in the Code or in this Supplement shall constitute the members of the Code Authority partners for any purpose. Nor shall the Code or this Supplement be construed to render any member of the Code Authority or of any Supervisory Committee liable in any manner to any one for any act of any other member, officer, agent or employee of such Code Authority or Supervisory Committee. Nor shall this Code be construed to render any member of the Code Authority or of any Supervisory Committee, exercising reasonable diligence in the conduct of his duties hereunder, liable to any one for any action or omission to act under this Code except for his own wilful misfeasance or nonfeasance.

Section 3. If the Administrator shall at any time determine that any action of the Code Authority or any Supervisory Committee or any agency thereof may be unfair or unjust or contrary to the public interest, the Administrator may require that such action be suspended to afford an opportunity for investigation of the merits of such action, and further consideration by such Code Authority or Supervisory Committee or agency thereof pending final action which shall not be effective unless the Administrator approves the same or unless he shall fail to disapprove the same after thirty (30) days' notice to him of intention to proceed with such action in its original or modified form.

Article IV—Sales Below Cost

Section 1. Upon approval by a majority of the members of any branch and due notice of such approval to the Administrator the following provision shall become effective as to such branch, not less than five (5) days after the filing of such notice to the Administrator. It shall be a violation of the Code to sell, or offer to sell, directly or indirectly by any means whatsoever, any product of such branch of the Industry, any product purchased for resale in connection with the installation of products of such branch of the Industry, service, and/or erection, at a net realized price less than the members individual cost determined as prescribed in Article X, Section 1 of the Code, with such modifications as may be (a) required by the conditions affecting such member (such as abnormal volume of business, etc.,) and (b) approved by the Supervisory Committee of the branch involved, all subject to the approval of the Code Authority and the Administrator; provided, however, that nothing in this Section shall prevent a member from quoting a price lower than his individual cost determined as herein provided to meet the price of a competitor, who is not violating any provisions of the Code or any Supplement thereto, for products of equivalent type, quality, specification and/or performance; provided, further, that nothing herein shall limit the effect of Article VIII, Section 2 of this Supplement.

Section 2. Obsolete or discontinued lines of products, or distress merchandise, may be disposed of, at a net realized price less than cost, by any member, if such member has at least ten (10) days prior to the date of such sale filed with the Manager a list of such items.

Article V—Price Lists

Section 1. (a) Upon approval by a majority of the members of any branch and due notice of such approval to the Administrator the following provisions shall become effective as to such branch, not less than five (5) days after the filing of such notice to the Administrator. The Supervisory Committee of such branch shall require the members of said branch to prepare and file with the Manager, within thirty (30) days, price schedules which may be in the form of net prices or prices with discounts, for such of his products as are sufficiently standard to permit of such pricing.

(b) The price schedules prepared and filed as provided in Section 1 above, shall become effective on filing and shall be the prices which he will quote to all ultimate consumers.

(c) Upon receipt of the above described price schedules the Manager shall at once distribute copies of same to all members of the branch effected.

(d) None of the price schedules so filed shall be changed by a member of the Industry except by filing with the Manager new price schedules setting forth such change or changes to become effective on the tenth day after the date on which such new price schedules shall have been received by the Manager who shall immediately notify the member filing such revised price schedule of the effective date resulting from the date of receipt. Copies of such revised price schedules, either increases or decreases, together with notice of the effective date thereof shall be immediately sent by the Manager to all other members of the branch of the Industry affected, who thereupon may file similar revisions. Such similar revisions if filed prior to the effective date of the revised schedules first filed shall take effect upon that date, except when the revised price first filed constitutes a decrease, and such similar revision is more favorable to the purchaser than such revised price first filed, in which case such similar revision shall not take effect until ten (10) days after the date when the same shall have been received by the Manager.

(e) All current price schedules on file shall be open to inspection by any customer or prospective customer or other interested party at all reasonable times.

Section 2. Each member of the Industry who makes products of special design that do not lend themselves to standard prices shall not sell such products at a price less than the sum of the filed prices on standard products, used in such products of special design, and the cost (determined as provided in Article IV, of this Supplement) of all additional products, or parts of products that enter into the construction of such complete products of special design.

Article VI—Intra Industry Transactions

All members of the Industry do not manufacture all of the products of the Industry. Many sales involve a combination of products, some of which some members do not manufacture. To enable all members, who desire, to compete on an equitable basis for such sales, all members shall publish to the Industry the discount which they will allow when and if selling products or parts of products to other members for incorporation in or assembly with products of the Industry of the purchasing member's own manufacture and shall agree to take no unfair advantage through the use of such a discount when competing for such sales of a combination of products. The provisions of Article IV and Article V of this Supplement shall not prevent or restrict the allowance of such a discount.

Article VII—Export Sales

Section 1. As trade practices in foreign countries are governed by foreign laws and as foreign manufacturers are not subject to the Code, it is understood the provisions of this Supplement "A" do not apply to export trade; provided, however, that should the total export business of the Industry in any three (3) months period exceed five (5) percent of the total domestic business of the Industry for the same period, it is expressly understood that the Administrator may require the modification of this Section 1 in such manner as may be calculated to effectuate the purposes of the Act.

Section 2. The term "export" is defined as shipments to all countries of the world except the United States of America, or any territory or possession thereof.

Article VIII—Fair Trade Practices

Section 1. Each member of the Industry shall send to the Manager (who shall hold same in strict confidence) immediate notice of each inquiry received on which he proposes to quote, a copy of each letter of proposal and estimate sheet made, and a copy of each order received, including prices and terms; provided, however, that such reports need not be made in connection with repair or renewal parts or such other products as may be excepted by the Code Authority, upon request of the majority of the members of the branch affected and with the approval of the Administrator.

Section 2. No member of the Industry shall change any quotation submitted unless a change is made in the specifications, and, in the event of such change in any specifications, the price and terms of the new quotation shall be determined in the same manner as in the original quotation. Where the original quotation has been reported, the revised quotation, with changes noted, and the reasons therefore indicated, shall at once be reported to the Manager.

Section 3. No member of the Industry shall accept secondhand or used equipment of any kind whatsoever as part payment towards the purchase of new equipment.

Section 4. No member of the Industry shall accept an order or contract for the products of this Industry, except Class I welded pressure vessels, which includes the construction of foundations, structures other than those necessary for the support of the equipment, or the removal of old equipment or structures, except in the case of repair or renewal of parts, unless the order or contract is so written that that part covering the products of this Industry and subject to the provisions of the Code and this Supplement is definitely segregated.

Article IX—General

The provisions of the Code are hereby specifically recognized to be applicable to this Supplement.

Exposition of Power and Mechanical Engineering

The Eleventh National Exposition of Power and Mechanical Engineering will be held this year. The last exposition was held in 1932. Grand Central Palace, New York, will again be the location, and the dates selected are December 3 to December 8, inclusive. Coming during the first week of December, 1934, the exposition will adhere to its usual convention and will take place during the same week that the American Society of Mechanical Engineers holds its annual meeting, in New York. Concurrence, in time and city, of these events is a matter of important convenience to thousands from all over the United States.

Responsive to the new trends in expositions the Eleventh National Exposition of Power and Mechanical Engineering will feature dynamic and graphic display. He who runs may not only read, but may learn through seeing mechanisms in operation. Thus certain technical advantages can best be demonstrated. This is responsive, or reciprocal, to experience of the past year which has revealed a great increase of interest in industrial expositions. There is active interest on the part of the natural audience. On the other hand, the depression-developed keen sight of some new exhibitors, now leads them to analyze and properly to relate the salient features of their subject in a manner technically concise, but dramatically interesting.

The time of the exposition is particularly appropriate. Following years of reduced production and accompanying machine obsolescence, present stimulated production compels equipment replacement and new installations.

Power generation and distribution, engines and auxiliaries, electrical equipment and elevators, boilers, pumps, air compressors, refrigeration equipment—in every class, exhibits are being built to show the most valuable and the newest improvements. Exhibitors have now more in mind the viewpoint of engineers who attend the exposition, critically evaluating process design, to decide upon equipment specifications. Presented, in addition to every phase of power generation and mechanical engineering machinery, there will be innumerable auxiliary subjects of interest. Among these, to name only a few, are piping and valves, instruments of precision, material handling machinery, fire protection equipment, metals and metallurgy, and ceramic materials including fire brick and cements.

Republic Galvannealed Sheets.—A folder on this subject has just been issued by Republic Steel Corporation, Youngstown, O. The folder explains the metallurgical reasons for the superior adherence of the zinc coating on Republic Galvannealed sheets and details a number of the desirable characteristics of these sheets. A large number of recommended applications are listed and several are illustrated. In addition a table is given of the gages and sizes in which Republic Galvannealed sheets are furnished. Tables on size extras and gage differentials are also included.

CERTIFICATION OF WELDERS*

By C. D. Thomas†

The question of repair work by welding has held the attention of the field inspector for some time past. This question has bobbed up at the annual meetings of the boiler inspectors in the State of Oregon for the past several years. Insurance inspectors as well as state inspectors have asked that some regulations be made whereby irresponsible welders will be prevented from doing repair work, because of many defective welds. Sometimes repairs of such a nature have been made that proved costly and often resulted in the ruination of the boiler itself.

Our department has hesitated about issuing any instructions regarding the matter as it was felt that to have any effect, some force would have to be behind the movement to make it effective. If a law were passed or a safety order issued, specific requirements would have to be made and these requirements changed from time to time in order to keep pace with progress in the art. Also a law or order for welding repair work would mean a certificate or license would have to be issued to the successful welder. This would be objectionable to the manufacturers of Class 2 and 3 Unfired Pressure Vessels for the reason that licensed welders for repair work might attempt to do work which belonged to the manufacturing class, while their welders would still be unlicensed and prohibited from doing repair work.

Also many of the manufacturers do a considerable amount of pipe work, hydraulic and so forth, which at the present time requires no special test as to procedure except such tests as are required by the purchaser. As a consequence the licensed welder would bid for this trade.

It was therefore felt by our department that an injustice would be done the manufacturers of pressure vessels if welders were certified or licensed for boiler repair work. The pressure was so great, however, due to irresponsible repair work that two years ago the writer decided to draft a set of rules, which would enable the inspector to determine that the welder was able to produce safe welds.

While these rules were being formulated, the executive committee of the National Board also drew up a set of rules for the same purpose, a copy of which was sent to the writer. Since the rules formulated by the National Board Committee were along the same lines as outlined by the writer, it was evident that we were on a safe road to a solution of the problem. Therefore after a few minor changes were made these rules were submitted to the members of the Oregon inspectors at our last annual meeting in December, 1932, and were adopted without a dissenting vote. These rules were therefore adopted subject to revision and change as progress is made. Copies of the requirements necessary to qualify to do boiler repair work by welding were sent to all boiler repair and welding shops in the state. Inspectors agreed to accept no work unless such work was done by a welder who had qualified under these rules. The result of this action is now just becoming effective.

There is at least one qualified welder in most of the important towns in the state. Reports of all tests as witnessed by the inspector in that territory must be filed with our department and we in turn keep the inspectors informed as to who is qualified for this work. The procedure followed in making these tests need not be discussed here as that does not concern the subject. I have only outlined how and why the method was introduced in Oregon. We issue no certificates or license to the successful welder. He is merely informed that he is qualified to do such work but that no repairs by welding may be done unless such work is authorized by the inspector who regularly inspects the boiler. Should a welder's work at any time prove unsatisfactory he is informed that another test is required before he can do any more work. If he fails in the test or if he does not try again, his name is struck from the roll and all inspectors are informed to that effect. We believe this system will be successful, at least we intend to follow it until a better method is devised.

Where no certificate is issued the welder will not feel at liberty to do work unless such work is authorized by an inspector. Should he attempt to do work not authorized his name is struck from the roll and all inspectors are so advised and they will not accept any more of his work. This is more effective than having to revoke a commission once issued, for in that case the welder could appeal, while in this case an appeal would be useless.

There is in my opinion another objection to issuing a certificate or license. Welding is a trade in mechanical lines, the same as a machinist or boiler maker and there is no more need to license a welder than there is to license those trades.

Inspectors recommend boiler makers of known experience to do boiler repair work and will recommend no others. It should be the same with welders. It may be that the system outlined here would not be practical in the central and eastern states, which are more industrial than agricultural, where well equipped shops are conveniently placed throughout the states. In such places the expense of going to and from a repair job is not excessive; but with us it is different. Many small plants are from fifty to one hundred miles from where a competent workman may be had, and in some cases in my state it is more than that. The cost of sending to Portland in order to have a small repair job done when the plant is in the southeastern part of the state is prohibitive. It is therefore necessary to have some simple method of procedure whereby small industries may have a chance. We believe we have solved the problem by giving welders in such places a chance to qualify and authorize them to do such work only so long as their work is satisfactory. From the little experience we have had we have found that the welder is ready to do his part.

There is also considerable expense involved where shops are not prepared to make extensive tests, and with the small amount of repair work to be done in some localities, this expense is not justified. Therefore a simple but conclusive test need only be made in

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* Abstract of paper presented at ninth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

† Chief boiler inspector, Bureau of Labor, State of Oregon.

such cases as will prove the welder is competent to perform the work. A license is a permit by law and can only be revoked by law which sometimes is complicated, whereas permission to do such work can be annulled at once.

Qualifications for Welders Doing Repairs*

By E. R. Fish†

So far as I am aware, Oregon is the first state which has formally set up requirements for welders to demonstrate their ability to do good welding in connection with repair work on boilers or pressure vessels. It is very gratifying to note that the required tests are only for the purpose of proving that each individual welder can do the kind of work which should be done in connection with the repairing of vessels, and that there is no attempt to set up machinery for real certification.

The State of California early this year issued requirements for the qualification of welders to safe end tubes for use in fire-tube boilers, but so far as I am aware has not extended these qualifications to include any other repairs by welding. Nor has California, apparently, attempted to give the welders any certificates of any kind. It does, however, require the qualification test to be made in the presence of a certified inspector. The Oregon rules, apparently, do not require the test plates to be made in the presence of a qualified inspector, but do require that the samples so made shall be tested in the presence of such an inspector. The welding should really be done in the presence of an inspector also. It is a great temptation for a man to let some accommodating friend who is a good welder make the test plates for him. This has been done, and can be prevented only by an inspector actually witnessing the making of the specimens. Witnessing the qualification tests in the well-run larger shops is not necessarily important but in the case of individuals it is very desirable.

The State of Ohio has set up requirements for welders on pipe work, but does not deal with those doing work on boilers or pressure vessels other than is required by the Boiler Code.

With these exceptions, so far as I know, no other states or municipalities have attempted to set up any formal requirements of any kind for welders doing work on pressure vessels. In my opinion, welders should be required to demonstrate their ability to do proper work before being permitted to do any welding on vessels where the safety of the vessel is involved. The step taken by Oregon is most commendable, although possibly still lacking in some details.

Sufficient provision seems to have been made to make certain that all qualified inspectors will be kept posted as to the names of the welders who have qualified and who may, therefore, be permitted to do repair work by welding.

Since the methods and materials of fusion welding have not yet been standardized, the welding technique of each shop differs to a greater or lesser extent from that of any other shop. It follows, therefore, that men who do satisfactory work for one employer may not necessarily be able to do equally satisfactory work in another place. Under present conditions, it would be exceedingly dangerous to set up a system of certification for welders, whereby the men are given some evidence purporting to give assurance of their ability to weld anywhere for anybody and under any conditions.

The Boilermakers' Union, now known as the International Union of Boilermakers, Helpers and Welders of America, has taken some steps in an endeavor to provide its members who do welding with some evidence of their qualification. That organization would, undoubtedly, welcome some official action on the part of the Boiler Code Committee or states to issue some tangible evidence of welding ability of individuals as it would be a great help to them.

Several educational institutions have considered setting up courses in welding and giving certificates of some kind to those taking the course. While there is no objection to teaching men to weld, there are objections to the certificates and the schools have been discouraged from so doing. I do not know of any that are certifying their graduates in this way.

The procedure established by Mr. Thomas to meet the situation in his state seems to me to be very commendable and one that might well serve as a guide for others. However, there are some details connected with the kind of test and the way in which the test plate should be made that might well be modified, but that is a question for discussion under some other head. No doubt, also, in the more thickly settled communities, the details would have to be considerably modified and adapted to the local needs. However, I want to emphasize further the desirability of permitting welded repairs to be made only by welders who are known through positive demonstration to have the necessary skill and ability to do dependable work.

* Discussion of C. D. Thomas paper before ninth annual meeting of National Board of Boiler and Pressure Vessel Inspectors.
† Chief engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company.

New Hard Surfacing Electrode Announced

"Wearweld," a new shielded-arc electrode for building up steel surfaces to resist shock and abrasion, is announced by The Lincoln Electric Company, Cleveland.

Deposits made with this electrode are air hardening alloy steel with an unusual combination of hardness and toughness, according to the manufacturer. Wearweld can be used to build up all steels other than those of the austenitic type. It is said to be particularly valuable for facing parts subjected to rolling or sliding abrasion, batter, sand abrasion and repeated impact.

The deposited metal has exceptional hardness, depending to some extent upon the composition of the base metal. A single layer on mild steel has a hardness of 40 to 45 Rockwell C. Additional layers will have a hardness of 48 to 52 Rockwell C, it is claimed. On 0.70 carbon steel, a single layer will have a hardness of 50 to 55 Rockwell C.

The heavy coating of this electrode provides a shielded arc allowing the transfer of molten metal to take place under non-oxidizing conditions. It also provides a layer of slag which further protects the metal from the harmful effects of the air and causes the weld metal to solidify in a smooth uniform bead.

Good deposits may be made in very thin layers if required. If shaping is necessary, the deposit may be ground to size.

Wearweld electrode is manufactured in two sizes—$\frac{1}{4}$ and $\frac{3}{16}$-inch diameter, and 18-inch lengths. It is packed in 50-pound steel containers.

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 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. 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-9. REVISE SECOND SECTION TO READ:

[The] Pipes [and fittings] used on boilers up to the required valve or valves on ALL [steam] outlets, INCLUDING STEAM LINES, feed lines, blow-off lines and DRAINS shall conform to the specifications for pipes or tubes, OR THEY MAY BE MADE OF FERROUS OR NON-FERROUS MATERIALS HAVING PHYSICAL CHARACTERISTICS WHICH ARE NOT LESS THAN THOSE REQUIRED FOR WELDED AND SEAMLESS STEEL PIPES AND WHOSE STRENGTH IS NOT IMPAIRED BY THE TEMPERATURES TO WHICH THEY MAY BE SUBJECTED (SEE ALSO PAR. P-25).

IN NO CASE SHALL PIPE OR TUBES BE USED OF A THICKNESS LESS THAN "STANDARD" AS GIVEN IN SPECIFICATIONS S-18, S-19, S-23 AND S-24 FOR THE MATERIAL USED.

PAR. P-24. REVISE TO READ:

P-24. *Feedwater Piping.* Feedwater piping SHALL CONFORM TO THE REQUIREMENTS OF PARS. P-9 AND P-300 [may be of welded or seamless pipe of wrought iron, steel, brass, or copper]. The maximum allowable working pressure for feedwater piping and/OR water piping BELOW THE WATER LINE shall be taken as 80 per cent of that for steam piping of the corresponding sizes as given by the rules in Par. P-23.

PAR. P-25. REVISE TO READ:

P-25. *Blow-Off Piping.* THE blow-off piping shall CONFORM TO THE REQUIREMENTS OF PAR. P-9, EXCEPT THAT GALVANIZED [be of black] wrought iron or [black] steel, [not galvanized] BRASS OR COPPER PIPE SHALL NOT BE USED.

THE PIPE [and] shall be AT LEAST AS THICK as [heavy as] required for the feed pipe BY PAR. P-24, EXCEPT THAT FOR PRESSURES OVER 100 LB. PER SQ. IN., THE THICKNESS SHALL NOT BE [and in no case] less than THAT GIVEN FOR "extra-strong" [pipe size] IN TABLE 2 OF SPECIFICATIONS S-18 AND S-19, AND SHALL ALSO CONFORM TO THE REQUIREMENTS OF PAR. P-300.

PARS. P-105*d* AND U-73*f*:

FLAT HEADS MAY BE WELDED INTO ANY PRESSURE VESSEL UNDER THE RULES GIVEN IN PAR. P-198*a* (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. P-198 AND U-39. REPLACE BY THE FOLLOWING:

P-198 (U-39). *a Flat Heads.* The minimum required thickness of unstayed flat heads, cover plates, blind flanges, etc., shall be calculated by the following formula:[1]

$$t = d\sqrt{\frac{C \times P}{S}}$$

where t = minimum required thickness of plate, in.,

d = diameter, or shortest span, measured as indicated in Fig. P-14½ (U-1-1/2), in.,

P = maximum allowable working pressure, lb. per sq. in.,

S = maximum allowable unit working stress, as given in Table P-14½ (U-3), lb. per sq. in.,

C = 0.162 for plates rigidly riveted or bolted to shells, flanges, or side plates, as shown in Fig. P-14½A (U-1-1/2A); and for integral flat heads as shown in Fig. P-14½B (U1-1/2B) where the diameter does not exceed 24 in. and the ratio of thickness of the head to the diameter 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 Figs. P-14½ D and E (U-11/2D and E) 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. P-14½ C (U-1-1/2C) and where the corner radius on the inside is not less than 3 times the thickness of the flange immediately adjacent thereto.

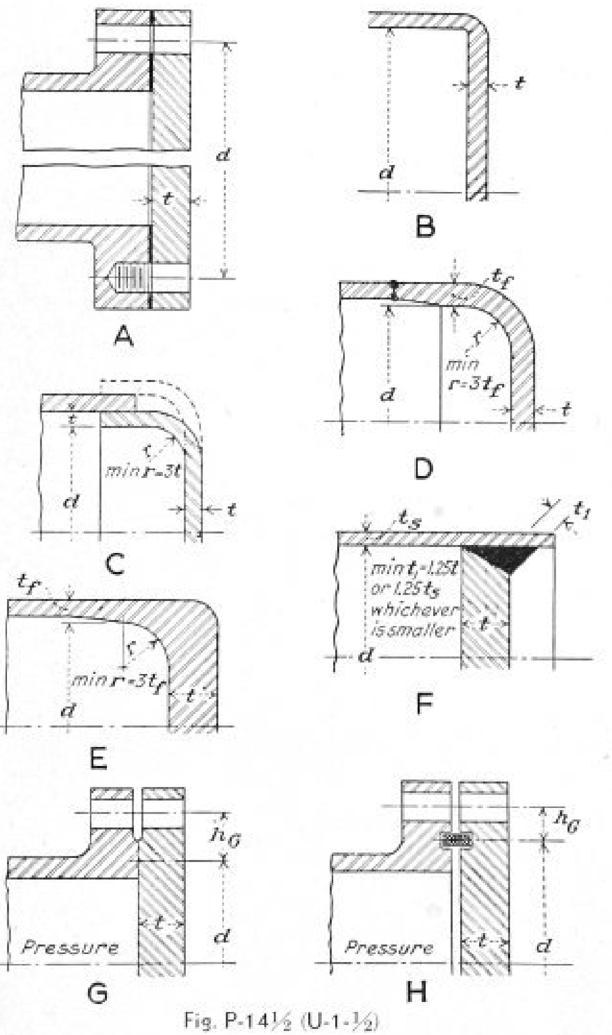


Fig. P-14½ (U-1-½)

[1] This formula is designed to give safe results in so far as stress conditions are concerned. Greater thicknesses than indicated by this formula may be necessary in certain special cases. For example, in a bolted cover plate as shown in Fig. P-14½ F or G (U-1-1/2F or G), the deflection of the plate under pressure may relieve the pressure on the gasket sufficiently to result in leakage. A further tightening of the bolts will tend to correct this condition. Another example is that of a cover plate, as shown in Fig. P-14½ F or G (U-1-1/2F or G), bolted to the channel casting of a multiple-pass heat exchanger, where the cover plate makes the seal with the partitions in the channel casting separating the different passes. The deflection of the plate under bolt tension and/or pressure may be sufficient to break its contact with the partitions and short-circuit the various passes. A further tightening of the bolts will tend to aggravate this condition.

$C = 0.50$ for plates fusion welded to the inside of vessels and otherwise meeting the requirements for the respective classes of fusion welded vessel, including stress-relieving when required for the vessel but omitting radiograph examination, and where the plate is welded for its entire thickness as shown in Fig. P-14½F (U-1-1/2F) with a fillet weld having a throat not less than 1.25 times the thickness of shell or flat head, whichever is 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. P-14½ G and H (U1-1/2G and H)

where W = total bolt load, lb.

h = radial distance from the bolt circle diameter to the diameter d, in.

H = total hydrostatic and force on area bounded by the outside diameter of the gasket or contact surface, lb.

d = as defined above.

b Openings. Unreinforced openings in unstayed flat heads shall be designed in accordance with the rules given in Par. P-268*a* (U-59*a*) where $D = d$ and K = (thickness required by formula given above in (*a*) ÷ (actual thickness of flat plate).

Reinforced openings in unstayed flat heads where the maximum diameter of the opening does not exceed 50 percent of dimension d shall be designed as though the heads were a spherical head dished to a radius equal to the inside diameter of the vessel and the reinforcement calculated in accordance with the rules in Par. P-268*b* (U-59*b*).

Where the maximum diameter of an opening exceeds 50 percent of dimension d, the flat plate shall be designed as a flange in accordance with the rules for bolted flanged connections given in Pars. U-1001 to U-1007, inclusive.

Unreinforced and reinforced openings in unstayed dished plates as described in (*b*) shall be governed by the same rules as given for openings in dished heads in Par. P-195 (U-36).

PAR. P-264. REVISE FIRST SENTENCE TO READ:

All boilers OR PARTS THEREOF must be provided with suitable manhole or handhole openings FOR EXAMINATION OR CLEANING, except special types where they are manifestly not needed.

PAR. P-286. MODIFY PROPOSED REVISION OF SECOND SENTENCE TO READ:

The dimensions of flanges subjected to boiler pressure shall conform to the American Standards as given in Tables A-5, A-6, A-7 and A-8 in the Appendix, subject to the restrictions of Par. P-12*b*, except that the face of a safety valve flange and the face of a nozzle OR FITTING to which it is attached, may be flat without the raised face for pressures not exceeding 250 lb. per sq. in., [shall have the raised face] for higher pressures SHALL HAVE FACINGS SIMILAR TO THOSE SHOWN IN FIG. A-9 AND OF DIMENSIONS GIVEN IN TABLE A-12[2] IN THE APPENDIX.

PAR. P-299. REVISED:

P-299. *Fittings.* The flanges of ALL VALVES AND pipe fittings shall conform to the American [Tentative] Standards given in TABLES A-5, A-6, A-7 AND A-8 IN the Appendix FOR THE MAXIMUM ALLOWABLE WORKING PRESSURE AND TEMPERATURE AND SUBJECT TO THE REQUIREMENTS OF PAR. P-12.

THE THICKNESS OF ALL FITTINGS OR VALVE BODIES SUBJECT TO PRESSURE SHALL NOT BE LESS THAN THAT REQUIRED BY THE AMERICAN STANDARD FOR THE CORRESPONDING MAXIMUM ALLOWABLE WORKING PRESSURE, TEMPERATURE, AND THE MATERIAL USED.

ALL VALVES AND FITTINGS SHALL BE EQUAL AT LEAST TO THE REQUIREMENTS OF THE AMERICAN STANDARD FOR 125 LB. PER SQ. IN., EXCEPT WHERE A HIGHER PRESSURE OR STEEL CONSTRUCTION IS SPECIFICALLY REQUIRED.

ALL VALVES AND [If the] fittings ON WATER LINES [are] below the water line [they] shall be EQUAL AT LEAST TO THE REQUIREMENTS OF THE AMERICAN STANDARDS FOR A PRESSURE 20 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 STANDARDS FOR 250 LB. PER SQ. IN. [extra heavy]. (See table top of next column.)

IN ALL CASES THE SCHEDULED WORKING PRESSURE FOR STEEL FITTINGS MAY BE ADJUSTED TO THE ACTUAL MAXIMUM ALLOWABLE WORKING PRESSURE ACCORDING TO TABLE A-10 GIVEN IN THE APPENDIX.

[The face of the flange of a safety valve, as well as that of a safety valve nozzle, may be flat and without the raised face for pressures not exceeding 250 lb. but shall have the raised face for higher pressures.]

[2] This table will be identical with Table 5 of A.S.A. Standard B-16e—1932.

TABLE A-10 PRESSURE-TEMPERATURE RATINGS FOR STEEL FLANGED FITTINGS AND COMPANION FLANGES

Service Temperatures	Pressures Given in American Standards for 750 F: 100	300	400	600	900	1500
F	Service Pressures at Temperatures From 100 to 850 F					
100	230	500	670	1000	1500	2500
150	220	480	640	960	1440	2400
200	210	465	620	930	1395	2325
250	200	450	600	900	1350	2250
300	190	435	580	870	1305	2175
350	180	420	560	840	1260	2100
400	170	405	540	810	1215	2025
450	160	390	520	780	1170	1950
500	150	375	500	750	1125	1875
550	140	360	480	720	1060	1800
600	130	345	460	690	1035	1725
650	120	330	440	660	990	1650
700	110	315	420	630	945	1575
750	100	300	400	600	900	1500
800	85	250	325	500	750	1250
850	70	200	270	400	600	1000

All pressures are in pounds per square inch (gage).

Tables A-5, A-6, A-7, and A-8 do not apply to the flanges on the boiler side of steam nozzles, or to fittings designed as part of the boiler. The terminating flanges, however, shall be in accordance with THESE Tables [A-5, A-6, A-7, and A-8] EXCEPT THAT the number of bolts in a flange may be increased provided they are located on the standard bolt circle AND SYMMETRICALLY ARRANGED.

SCREWED FITTINGS OF CAST IRON OR MALLEABLE IRON CONFORMING TO THE REQUIREMENTS OF THE AMERICAN STANDARDS FOR 125, 150, AND 250 LB. PRESSURE AS GIVEN IN TABLE A-11 IN THE APPENDIX MAY BE USED EXCEPT WHERE OTHERWISE SPECIFICALLY PROHIBITED OR WHERE FLANGED FITTINGS ARE SPECIFICALLY REQUIRED.

CAST OR FORGED STEEL SCREWED FITTINGS OR VALVES THAT ARE AT LEAST EQUAL TO THE STRENGTH REQUIREMENTS OF THE AMERICAN STANDARD FITTINGS WHICH WOULD OTHERWISE BE REQUIRED, MAY BE USED IN ALL CASES EXCEPT WHERE FLANGED FITTINGS ARE SPECIFICALLY REQUIRED.

COPPER OR BRASS, SCREWED OR FLANGED-TYPE FITTINGS OR VALVES MAY BE USED PROVIDED THEY ARE AT LEAST EQUAL TO THE STRENGTH REQUIREMENTS OF THE AMERICAN STANDARD CAST IRON FITTINGS, WHICH WOULD OTHERWISE BE REQUIRED. THEY SHALL NOT BE USED FOR TEMPERATURES OVER 406 F. OR WHERE STEEL OR OTHER MATERIAL IS SPECIFICALLY REQUIRED. SCREWED TYPE FITTINGS SHALL NOT BE USED WHERE FLANGED TYPE ARE SPECIFIED.

TABLE A-11 MINIMUM METAL THICKNESS OF BODIES OF CAST IRON AND MALLEABLE IRON SCREWED FITTINGS

(The following Table is taken from Tentative American Standards B-16d—1927 and B-16c—1927)

Nominal Pipe Size In.	Metal Thickness, In.: Cast Iron Screwed Fittings 125 Lb.	Cast Iron Screwed Fittings 250 Lb.	Malleable Iron Screwed Fittings 150 Lb.
⅛	...	..	0.090
¼	0.110	0.18	0.095
⅜	0.120	0.18	0.100
½	0.130	1.20	0.105
¾	0.155	0.23	0.120
1	0.170	0.28	0.134
1¼	0.185	0.33	0.145
1½	0.200	0.35	0.155
2	0.220	0.39	0.173
2½	0.240	0.43	0.210
3	0.260	0.48	0.231
3½	0.280	0.52	0.248
4	0.310	0.56	0.265
5	0.380	0.66	0.300
6	0.430	0.74	0.336
8	0.550	0.90	0.403
10	0.690	1.08	...
12	0.800	1.24	...
14 O. D.	0.880	1.33	...
16 O. D.	1.000	1.50	...

All pressures are in pounds per square inch (gage).

PROPOSED RULES FOR BOLTED FLANGED CONNECTIONS

U-1001. *Scope* (1) Bolted flanged connections having the dimensions given in Tables A-5 and A-6 for the working pressures and temperatures designated therein should be used for connections to external piping and may be used for other flanged connections. Connections of sizes and/or working pressures within the range of Tables A-5 and A-6 may be designed by interpolation.

(2) Bolted flanged connections having dimensions other than those given in Tables A-5 and A-6, or interpolated therefrom, shall be designed in accordance with the rules given in Pars. U-1002 to U-1007, inclusive. These rules may be applied to flanges of any diameter and for any working pressure.

U-1002. *Materials.* (1) Alloy-steel bolting material shall be made in accordance with Specifications S-9 for Alloy-Steel Bolting Material for High-Temperature Service, of Section II of the Code.

(2) Carbon steel bolts shall be of material made in accordance with standard commercial practise. They may be used provided the working pressure does not exceed 160 lb. per sq. in., and/or the working temperature does not exceed 450 F.

(3) Bolts and studs shall be equipped with semi-finished nuts of at least American Standard heavy dimensions chamfered and trimmed as given in Table UA-1. If washers are used under nuts, they shall be of forged or rolled steel.

(4) All bolts and studs shall have American National Standard coarse screw threads, provided that bolts and studs 1⅛ in. in diameter and larger shall have eight threads per inch. A stronger form of thread may be used.

(5) Bolts less than ½ in. in diameter shall not be used.

Flange Material. (6) Flanges that are to be fusion welded shall be of good weldable quality and the carbon content of such material shall not exceed 0.35 percent.

(7) Rolled or forged-steel flanges shall be of material made in accordance with Specifications S-8 for Forged or Rolled-Steel Pipe Flanges for High-Temperature Service, of Section II of the Code.

(8) Cast-steel flanges may be used provided the thickness does not exceed 4¼ in., and shall be of material made in accordance with Specifications S-12 for Carbon-Steel Castings for Valves, Flanges and Fittings for High-Temperature Service, of Section II of the Code.

(9) Flanges fabricated by welding, as shown in Fig. U-101D, shall be of material made in accordance with Specifications S-1 for Steel Boiler Plate, S-2 for Steel Plates of Flange and Firebox Qualities for Forge Welding, S-8 for Forged and Rolled-Steel Pipe Flanges, S-12 for Carbon-Steel Castings, S-25 for Open-Hearth Iron Plates of Flange Quality, of Section II of the Code.

U-1003. *Working Stresses.* The design working stresses in a bolted flanged connection shall not exceed the values given in Table U-1½. Bolt stresses shall be calculated on the area at the root of the thread.

TABLE U-1½ MAXIMUM ALLOWABLE DESIGN WORKING STRESSES FOR BOLTED FLANGED CONNECTIONS AT VARIOUS TEMPERATURES, IN LB. PER SQ. IN.

Maximum Tempera-ture F	Flange Material: Minimum of specified range of the tensile strength of the material, lb. per sq. in.					Alloy Bolting Material[1]
	45,000	50,000	55,000	60,000	70,000	
700	10,650	11,850	13,050	14,200	16,600	14,200
750	9,450	10,500	11,550	12,600	14,700	12,600
800	8,100	9,000	9,900	10,800	12,600	10,800
850	6,750	7,500	8,250	9,000	10,500	9,000
900	5,400	6,000	6,600	7,200	8,400	7,200
950	4,050	4,500	4,950	5,400	6,300	5,400

This table applies to all plain carbon steel flange materials and alloy steel bolting materials for which specifications are given in the Code. Where the minimum tensile strength of the specified range or the temperature differs from those for which values are given in the table, the values of maximum allowable design working stress may be determined by interpolation.

[1] Carbon steel bolts may be used provided the working pressure does not exceed 160 lb. per sq. in. and/or the working temperature does not exceed 450 F, and provided the design working stress does not exceed 11,000 lb. per sq. in. (see Par. U-1002).

U-1004 (1) The bolting shall be designed to resist the hydrostatic end force and to maintain a predetermined compression on the contact surface of the joint.

(2) The hydrostatic end force H in pounds is the total force exerted by the working pressure upon the area bounded by the outside diameter of the contact surface.

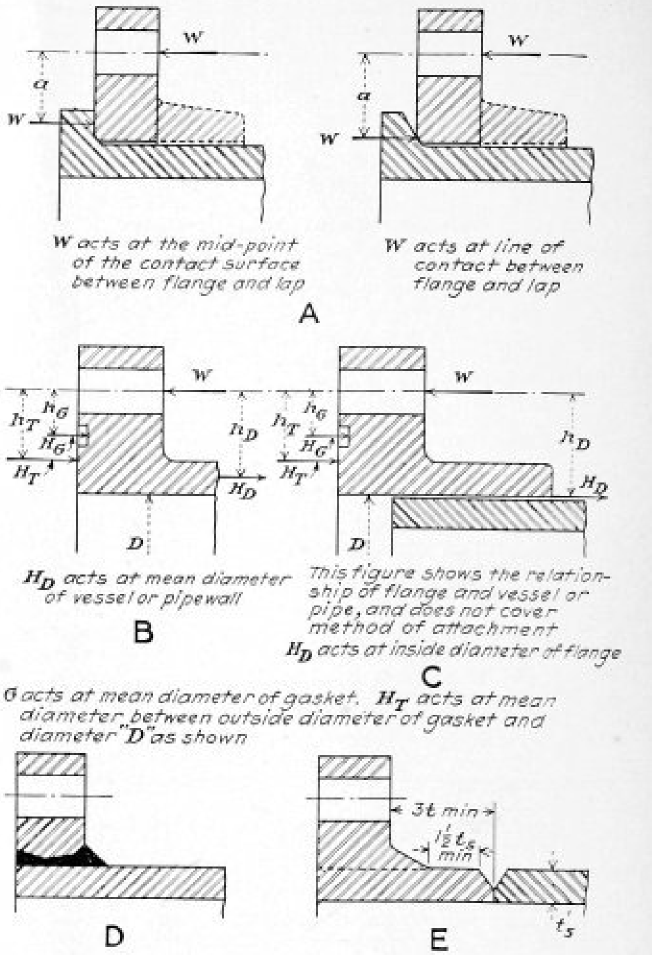


Fig. U-101

(3) The force H_G in pounds to maintain the predetermined compression on the contact surface is the total force exerted by the required unit compression acting upon the area of the annular cross section of the contact surface.

(4) The unit compression on the contact surface will be some multiple of the working pressure such as experience has shown will be sufficient to maintain a tight joint.[3]

U-1005 (1) For loose flanges, either with or without hubs, the lever arm a of the bolt loading shall be the radial distance from the bolt circle diameter to the line of pressure of the opposing force, as shown in Fig. U-101A.

(2) For flanges integral with the vessel or pipe, including those fabricated by fusion welding, of the type shown in Fig. U-101B and for flanges riveted, fusion-lapwelded or screwed to the vessel or pipe of the type shown in Fig. U-101C, the lever arm a shall be calculated by means of the following formula:

$$a = \frac{(H_D \times h_D) + (H_T \times h_T) + (H_G \times h_G)}{W}$$

where

H_D = end force due to hydrostatic pressure on area bounded by inside diameter D shown in Fig. U-101B and U-101C, lb.

h_D = radial distance from the bolt circle diameter to the line of pressure of force H_D, in.

H_T = $(H - H_D)$, lb.

H = total hydrostatic end force as defined above in Par U-1004, lb.

h_T = radial distance from the bolt circle diameter to the line of pressure of force H_T, in.

H_G = total gasket or contact load, lb.

h_G = radial distance from the bolt circle diameter to the line of pressure of force H_G, in.

W = $(H_D + H_T + H_G)$ = total bolt load, lb.

(3) No consideration shall be given to any possible reduction in the lever arm a either due to cupping of the flanges or due to inward shifting of the line of action of the bolts as a result thereof.

[3] The ratio of the unit compression on the contact surface to the working pressure (known as the contact-pressure ratio) depends upon the material and shape of gasket or ground face, the form of raised face or gasket groove, the nature of the confined fluid, and other similar considerations.

U-1006 (1) The working stress in a flange, with or without hub, either loose, screwed, or attached to the vessel or pipe, or integral with the vessel or pipe, shall be determined by the following formula:[4] [5]

$$S = \frac{0.955 \times W \times a \times (K+1)}{t^2 \times B \times (K-1)} \left[\frac{N}{\frac{10K}{K-1} + (B^2 \times t^3 \times e)} \right]^6$$

where

S = unit working stress, lb. per sq. in.
W = total bolt load, lb.
a = lever arm distance, as defined in Par. U-1005, in.
t = flange thickness, in.
K = ratio A/B
A = outside diameter of flange, in.
B = inside diameter of flange, in.

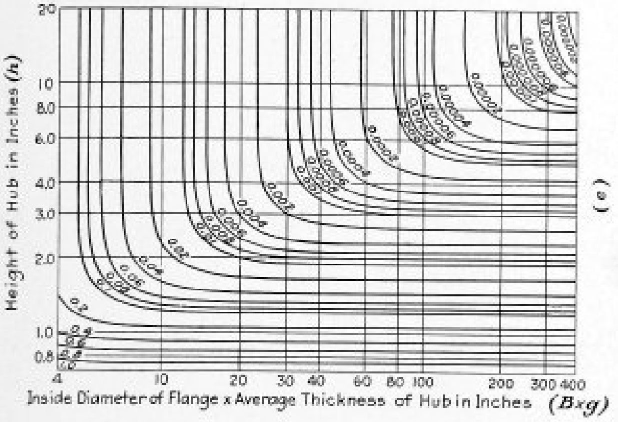


Fig. U-102

e = value obtained from chart in Fig. U-102
g = average thickness of hub, in.
h = distance from back of flange to end of hub (height of hub), in.

$N = 3 + (B^2 \times t^3 \times e)$ or $N = \frac{10t^2}{g^2}$ — whichever is greater

(2) Flange thicknesses as used in the above formulas are to be the minimum thicknesses. Raised faces, grooves, or recesses, when required, shall be furnished as follows:

(*a*) No metal shall be cut from minimum flange thickness;

(*b*) The minimum flange thickness shall be first provided and then at least sufficient metal added thereto for the male or female, tongue or groove, raised face or recess;

(*c*) In Van Stone or lap joints, where the flanges have been recessed to receive the lap, the minimum flange thickness shall be measured from the thinnest portion of the flange.

(3) For hubbed flanges, the corner formed by the back of the flange and the hub shall be provided with a fillet, the radius of which in no case shall be less than one-fourth of the average thickness g of the hub, nor less than 3/16 in.

U-1007 (1) Hubbed flanges may be attached to the ends of pressure vessel shells or nozzle necks by any of the methods permitted for circumferential joints in pressure vessels, and when so attached the attachment shall conform to the requirements for circumferential joints of the type employed.

(2) Ring flanges may be fusion welded to a cylindrical shell or nozzle neck as shown in Fig. U-101D provided that (1) the full depth of the flange is welded to the shell or neck, (2) for Class 1 vessels the welding meets the requirements for this class of vessel, with the exception of the radiograph examination, (3) for all other vessels the welding is stress relieved and meets the requirements for Class 2 vessels, and (4) the throat of the fillet back of the flange is not less than three-fourths of the thicknesses of the shell or nozzle neck.

[4] For loose flanges without hubs, the entire quantity within the brackets is equal to unity, and may be disregarded.

[5] The formula given in Par. U-1006 is an approximation of the Taylor-Waters formula and is deemed sufficiently accurate.

[6] Another simplified form of the Taylor-Waters formula is under consideration and may be obtained upon application.

(3) Flanges may be screwed or similarly attached to pressure vessels provided the attachment is sufficiently strong to resist the hydrostatic end force H_D with a factor of safety of 5.

(4) Hubbed flanges may be butt-welded to the end of a vessel or pipe provided that:

(*a*) The distance from the back of the flange to the center line of the weld is at least 3 times the thickness of the shell or pipe and not less than 1 in.;

(*b*) The hub of the flange at the beginning of chamfer shall have the same outside diameter and thickness as the shell or pipe to which it is to be butt-welded. The outside of the hub shall either be straight (parallel to the inside diameter), or tapered at not more than 6 deg. for a distance at least 1½ times the thickness of the shell measured from the beginning of chamfer.

TABLE UA-1 AMERICAN STANDARD HEAVY NUTS
(Semi-Finished and Hexagon)

Diameter of Bolt D		Width Across Flats Maximum (Basic)		Width Across Flats Min.	Width Across Corners Min. Hex.	Thickness Heavy Nut Nom.	Thickness Heavy Nut Max.	Thickness Heavy Nut Min.
1/2	0.5000	7/8	0.8750	0.850	0.969	31/64	0.504	0.464
9/16	0.5625	15/16	0.9375	0.906	1.033	35/64	0.568	0.526
5/8	0.6250	1 1/16	1.0625	1.031	1.175	39/64	0.631	0.587
3/4	0.7500	1 1/4	1.2500	1.213	1.383	47/64	0.758	0.710
7/8	0.8750	1 7/16	1.4375	1.394	1.589	55/64	0.885	0.833
1	1.0000	1 5/8	1.6250	1.575	1.796	63/64	1.012	0.956
1 1/8	1.1250	1 13/16	1.8125	1.756	2.002	1 7/64	1.139	1.079
1 1/4	1.2500	2	2.0000	1.938	2.209	1 3/16	1.220	1.156
1 3/8	1.3750	2 3/16	2.1875	2.119	2.416	1 5/16	1.347	1.279
1 1/2	1.5000	2 3/8	2.3750	2.300	2.622	1 7/16	1.474	1.402
1 5/8	1.6250	2 9/16	2.5625	2.481	2.828	1 9/16	1.601	1.525
1 3/4	1.7500	2 3/4	2.7500	2.663	3.036	1 11/16	1.728	1.648
1 7/8	1.8750	2 15/16	2.9375	2.844	3.242	1 13/16	1.855	1.771
2	2.0000	3 1/8	3.1250	3.025	3.449	1 15/16	1.984	1.894
2 1/4	2.2500	3 1/2	3.5000	3.388	3.862	2 3/16	2.236	2.140
2 1/2	2.5000	3 7/8	3.8750	3.750	4.275	2 13/32	2.458	2.354
2 3/4	2.7500	4 1/4	4.2500	4.113	4.689	2 21/32	2.712	2.600
3	3.0000	4 5/8	4.6250	4.475	5.102	2 29/32	2.966	2.846
3 1/4	3.2500	5	5.0000	4.838	5.515	3 5/32	3.220	3.092
3 1/2	3.5000	5 3/8	5.3750	5.200	5.928	3 13/32	3.474	3.338
3 3/4	3.7500	5 3/4	5.7500	5.563	6.342	3 21/32	3.728	3.584
4	4.0000	6 1/8	6.1250	5.925	6.755	3 29/32	3.982	3.830

All dimensions given in inches.

Boiler Plant in Operation in Record Time

What probably constitutes a record in the speed of designing and constructing a large boiler plant is the installation at the Newcastle, Indiana, works of the Chrysler Corporation. Faced with the necessity of adequate and economical steam production to meet the Spring demand for cars, the company, early in October decided that it would be necessary to install a new boiler plant of two steam generating units with their appurtenances.

On October 21, 1933, the consulting engineers, Thomas E. Murray, Inc., were told to proceed with the necessary plans and specifications for both building and equipment. On October 23, the specifications for the boilers, furnaces, fuel-burning equipment and air heaters were sent out for bids. On October 28, this contract was let to Combustion Engineering Company. On November 11, the steel contract was let, the first shipment arriving about the middle of December. The first boiler was shipped on December 12, and was supplying steam on February 28, exactly four months from the letting of the contract. The second unit was ready about two weeks later.

The new boiler plant consists of two 140,000 pounds per hour bent-tube boilers, having fin-tube water walls and direct fired with impact type mills. A vacuum system of ash removal, full combustion control and a feed-water treatment system are part of the installation. The entire plant is housed in a new building, 110 feet long, 70 feet wide and 60 feet high, surmounted by an 80-foot steel stack.

This remarkable achievement emphasizes what can be accomplished by well co-ordinated effort on the part of all concerned toward meeting recovery demands in one important industry.

Steel Plate Fabricators' Code

(Continued from page 120)

merits of such action and further consideration by such code authority or agency pending final action which shall not be effective unless the Administrator approves or unless he shall fail to disapprove after thirty days' notice to him of intention to proceed with such action in its original or modified form.

Article VII—Unfair Practices

On and after the effective date of this Code, the following practices are hereby declared to be unfair methods of competition and violations of this Code:

1. To sell any product (s) or service (s) below the seller's cost of such product (s) or service (s).

The Code Authority shall as soon as reasonably convenient determine a uniform method of cost accounting to be used in estimating costs for the purpose of this paragraph (1), upon the approval of such method by the Administrator.

2. No member of the Industry shall secretly offer or make any payment or allowance of a rebate, refund, commission, credit, unearned discount or excess allowance, whether in the form of money or otherwise, for the purpose of influencing a sale.

3. For any member of the Industry, which is a subsidiary or branch of a company engaged in the operation of rolling mills, to use, in the preparation of its estimate of cost, a lower basic price for the steel entering into said cost than the said rolling mill company would at the same time quote other members of the Industry.

4. Making or causing or knowingly permitting to be made or published any false, materially inaccurate, or deceptive statement by way of advertisement or otherwise, whether concerning the grade, quality, quantity, substance, character, nature, origin, size, finish, or preparation of any product of the Industry, or the credit terms, values, policies, or services of any member of the Industry, or otherwise having the tendency or capacity to mislead or deceive customers or prospective customers shall be an unfair method of competition.

5. The specific mention of any particular unethical or unfair practice in this Article shall not be construed to prohibit the application of any of the general prohibitions of unethical practices included in this Code.

Article VIII—Monopolies

No provision of this Code shall be so applied as to permit monopolies or monopolistic practices, or to eliminate, oppress, or discriminate against small enterprises.

Article IX—Modification

1. This Code and all the provisions thereof are expressly made subject to the right of the President, in accordance with the provisions of sub-section (b) of Section 10 of the National Industrial Recovery Act, from time to time to cancel or modify any order, approval, license, rule, or regulation issued under Title I of said Act and modify his approval of this Code or any conditions imposed by him upon his approval thereof.

2. This Code, except as to provisions required by the Act, may be modified on the basis of experience or changes in circumstances, such modifications to be based upon application to the Administrator and such notice and hearings as he shall specify, and to become effective upon his approval.

Article X—Effective Date

This Code shall become effective on the second Monday after its approval by the President.

Article XI—Expiration Date

This Code shall cease to be in effect at the expiration of two years after the date of enactment of the Act, or sooner if the President shall by proclamation or the Congress shall by joint resolution declare that the emergency recognized by the Act has ended.

New Machine Cuts Steel Plates and Slabs

The Air Reduction Sales Company, New York, has recently added to its line of pantograph-type flame cutting machines, a new unit designated as the Travograph. The mechanism consists essentially of a carriage that supports a pantograph assembly, in addition to suitable driving and control mechanism, a tracing bar carrying a tracing device, and machine cutting torch. All are mounted on a stationary track. The base as well as the arms travel.

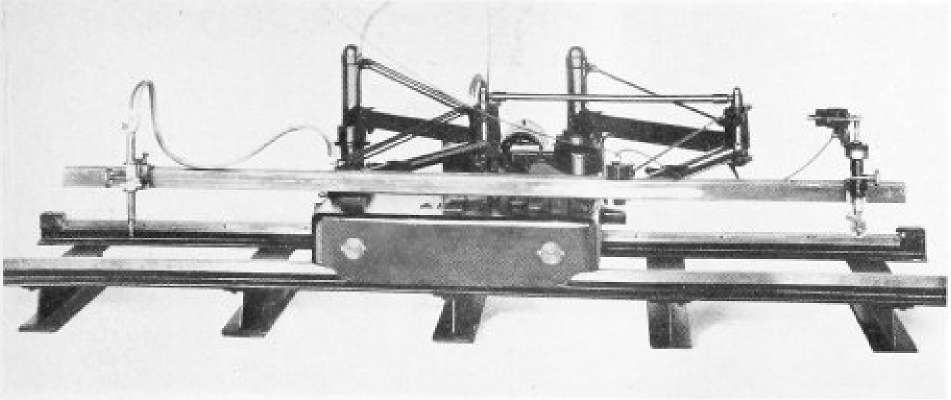
The No. 1 Travograph is fitted with a long tracer bar, attached to the outer ends of the pantograph arms. The tracer mechanism and cutting torch holders are mounted on this bar and may be moved to any position along the bar and secured in place by set screws. As many as six cutting torches may be mounted on the bar for multiple cutting. Being mounted on the same bar, the cutting torches conform closely to the movement of the tracer.

This machine can also be operated with either manually-controlled or magnetic tracer. The cams used with the latter are mounted on the tracing table of this machine.

The manually controlled tracer is standard equipment furnished with this machine. It consists of a tracer wheel driven through worm gearing by a variable-speed motor. The entire mechanism forms a unit that is mounted on the tracer bar, the bar on which the cutting torch is also mounted.

In operation, the pantograph assembly is first swung by hand, to bring the tracer wheel and torch to the starting point of the cut, the tracer is lowered until its full weight rests on the table, the torch is adjusted to the proper height above the work, and then the driving motor is started. The operator then guides the tracer along the lines of the drawing until the cut is completed.

A feature of the operation is the automatic control of the carrier driving motor by the movement of the pantograph arms. As these arms reach certain limiting positions in their swing in either direction, they operate switches located at the point where the arm turns about the right vertical post. This actuates the magnetic reversing starter of the carrier motor. In this way the carrier is automatically positioned, so that the pantograph arms are at all times in the most desirable working position in relation to the tracing point. The position of the tracing device, its speed and direction of travel



Pantograph-type flame cutting machine, designated as the Travograph for cutting shapes in steel plate, slabs, billets and forgings

automatically determine and control the direction and extent of travel of the carrier.

The cutting torch, rigidly mounted on the same bar with the tracer, conforms to the movement of the latter and cuts a faithful reproduction of the path over which it travels.

For quantity reproduction from cam or template, the magnetic tracer can be used in place of the manually controlled tracer. Operation with the magnetic tracer is the same as just described except for the operation of the tracer itself. Both the manually controlled and magnetic tracers are equipped with variable speed motors. Cutting speed is controlled by regulating the speed of these motors which is done by adjusting the speed governor on each motor.

With arms of rugged proportions, the machine is adequately braced for maximum strength and rigidity under load. The bearings and all hinged joints are equipped with large diameter ball bearings, assuring smooth, almost frictionless operation.

The carrier is also precision built, and has large wheels with ball-bearing axles for smooth, easy running. The electrical circuit provides for giving the carrier driving motor a slow starting speed and smooth pick-up thus eliminating any jarring of the tracer bar.

The rails on which the carrier runs are specially rolled tie sections, 16 feet long, with tops or treads accurately machined. They are bolted to five large H-beam sections which serve as ties and supports for the machine. Additional 16-foot lengths may be added if required.

Straight lines, circles and regular and irregular shapes are cut in steel plate, slabs, billets and forgings. The cutting area or range is a rectangle 4½ feet in width and 11 feet in length with one 16-foot section, or any length desired with additional rail sections.

Calcium Sulphate Scale in Boilers

The results of an investigation conducted to determine the cause and means of prevention of embrittlement in steam boilers emphasized the importance of maintaining a definite sulphate concentration in the boiler water. The Boiler Code Committee of the A.S.M.E. has recommended the maintaining in the boiler water ratios of sodium sulphate to total sodium hydroxide and sodium carbonate alkalinity calculated to equivalent sodium carbonate of from 1:1 for pressures up to 150 pounds per square inch to 3:1 for pressures over 250 pounds per square inch.

Within recent years there has been much discussion as to the possibility of maintaining the desired sulphate ratios without causing calcium sulphate scale formation, especially at the higher steam pressures. If the A.S.M.E. recommendations for the prevention of embrittlement are followed the amount of sulphate becomes too high for the carbonate, and the formation of scale would normally be predicted. However, in many instances sulphate-carbonate ratios of over 3 are being maintained in boilers operating at high pressures, calcium is entering by the feed water in various amounts, phosphate is not being added, the amount of CO_3 is decidedly low, and yet scale is not a problem, although, according to existing theories, these plants should experience scale troubles.

These discrepancies between theory and actual operating conditions may readily be explained on the basis that there are not sufficient data available to formulate theories which hold at the higher pressures.

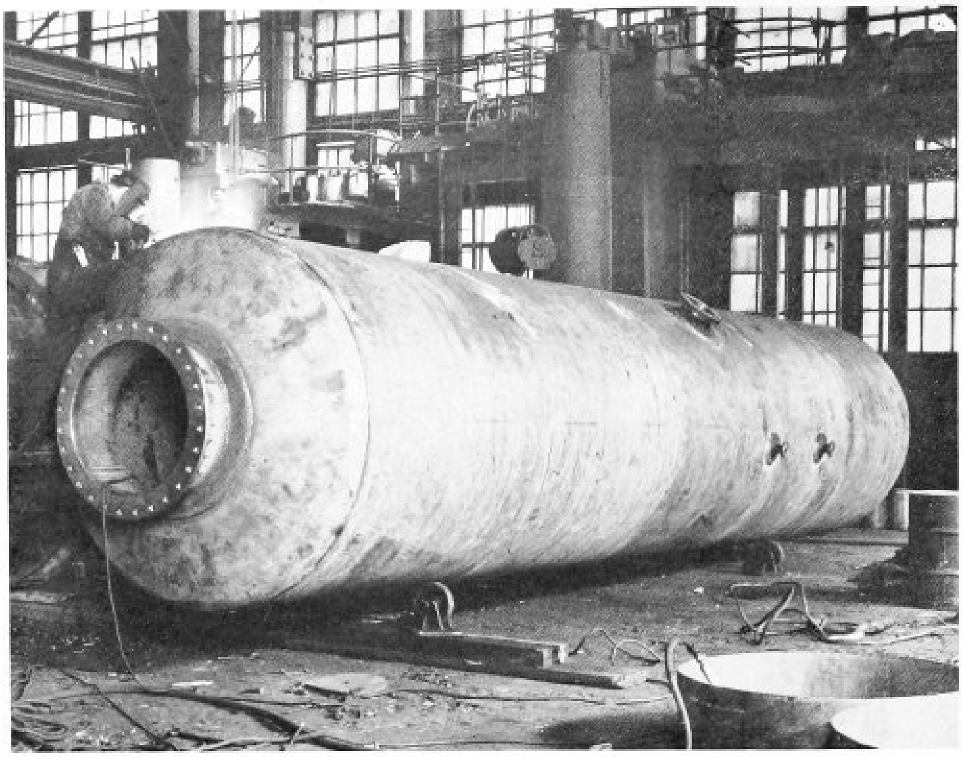
The investigation described in Bulletin No. 261 of the Engineering Experiment Station of the University of Illinois "The Cause and Prevention of Calcium Sulphate Scale in Steam Boilers," by F. G. Straub, was entered into by the Station in co-operation with The Utilities Research Commission, Inc., for the purpose of obtaining data with regard to the solubility of calcium salts alone, and in the presence of positive and negative ions, over the entire pressure range of boiler operation, as well as data with regard to the behavior of these chemicals under conditions simulating those of actual operation, with the object of formulating a fundamental theory of scale formation and prevention.

Among the conclusions arrived at with regard to the formation and prevention of calcium sulphate scale are the following:

(a) The rate of calcium sulphate scale formation is almost constant at 150, 250, and 500 pounds per square inch pressure; at 1000 pounds pressure scale forms about one-third as fast as it does at 150 pounds pressure (for a constant rate of heat transfer); and at 2000 pounds pressure it forms only about one-tenth as fast as at 150 pounds pressure.

(b) The presence of more than 30 parts per million (1.7 grains per gallon) of sodium carbonate in the boiler water will prevent the formation of calcium sulphate scale at pressures up to 2000 pounds per square inch.

For a limited time copies of Bulletin No. 261 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Illinois.



Fractionating tower built by Foster Wheeler Corporation. The tower is 59 feet 6 inches high and 6 feet 6 inches in diameter. It was built in two sections and arc welded

Stainless Steel Fractionating Tower

One of the first large pressure vessels ever built of arc-welded stainless steel has been completed by The Foster Wheeler Corporation at its Cleveland shops. This is a fractionating tower constructed for the distillation of fatty acid.

The tower is 59 feet 6 inches high and 6 feet 6 inches in diameter. Eighteen-eight stainless steel was used for the entire structure including the 29 bubble trays. Shell plates are $\frac{3}{8}$ inch thick. Horizontal welds were made with a double vee.

The tower was built in two sections, a butt strap being welded on the ends of the section for connection on erection. The bubble trays were also fabricated entirely by welding. These trays rest on 2-inch by 2-inch by $\frac{3}{16}$-inch angles welded to the inside of the vessel.

All welding was done by the shielded-arc process using Stainweld A electrodes manufactured by The Lincoln Electric Company, Cleveland.

On completion, the tower was tested with 25 pounds of air pressure after filling one-third full with water. Approximate weight of the tower is 20 tons.

Remarkable German Rotating Boiler

By G. P. Blackall

The remarkable new prime mover evolved by Herr Fritz Huettner for his novel steam airplane has recently been the subject of a description in the *Deutsche Allgemeine Zeitung*. While being curiously reminiscent of the Heron turbine, the ancestor of steam engines, the new unit embodies all that is most modern in current practice, and it is claimed to be the most completely automatic of prime movers.

Chief novelty attaches to the boiler which, instead of resting upon its foundations, has been made rotatable, the steam-generating system turning round its axis at the rate of several thousand revolutions per minute. The boiler comprises a series of small U-shaped copper tubes, each of which is a steam generator on its own. The whole set is arranged around a rotor and communicates with a circular water tank fed from outside.

The boiler is started either by hand, in the case of small engines, or by an electric motor or other suitable engine where any larger units are concerned. As the boiler with its set of U-tubes is thus rotating around its axis, water will flow into the tubes, passing by the burners and being converted into steam which, as it escapes through two nozzles, sets the boiler system rotating by reaction. Again, the steam jets issuing from the nozzles strike the blades of the turbine rotor, setting this in rotation at a rate three or four times that of the rotating boiler and in a reverse direction. After performing useful work, the steam is condensed on the walls of the housing, through the openings of which it reverts to the water tank, to start on another cycle. The boiler pressure is produced by the centrifugal force resulting from the rotation of the steam-generating system.

A miniature engine which Herr Huettner has just completed comprises a rotary boiler operating at a speed of 4500 revolutions per minute and supplying a steam pressure of 70 pounds per square inch in excess of atmospheric. Despite its small dimensions, it has been found to yield as much as 34.5 pounds of steam per hour per square foot of heating surface. Although the efficiency is moderate in the case of small outputs, Herr Huettner claims that it will increase rapidly as the capacity of the engine increases. In the case of another unit, designed for an output of 30 horsepower, the specific weight was only 11 pounds per horsepower. This figure, it is expected, will be reduced to under 3.3 pounds in the case of 2000 horsepower units.

LESSONS IN ARC WELDING

It is the object of these lessons to present in a concise manner certain fundamental facts of welding, the knowledge of which will enable the operator to use the welding process successfully and economically. These lessons are based on the course in arc welding given by Arthur Madson at the plant of the Lincoln Electric Company, Cleveland, O. Preceding lessons were published on page 46 of the February issue, page 77 of the March issue and page 106 of the April issue.

Lesson 13

OBJECT: Study of vertical beads on flat plate.
MATERIAL: Suitable plate—$\frac{3}{16}$-inch Stable Arc electrode.
PROCEDURE: Set up the plate vertically and firmly tack or otherwise hold in position.* Then refer to Lesson 3. Strike an arc at the bottom of the plate and weld upward. Hold a short arc. Examine carefully the first

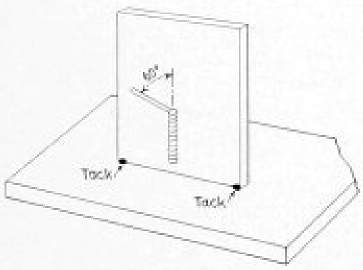


Fig 24

bead. Chip it off if its appearance is not acceptable, see Fig. 24.

When a smooth bead can be run, then try some of the weaving motions as specified in Lesson 4. Notice how the arc length affects the bead. A short arc is necessary to get good results.

Be careful to get good fusion at start of bead, particularly when starting at end of bead previously deposited.

Lesson 14

OBJECT: To make lap, tee and butt welds in vertical position.

MATERIAL: $\frac{1}{4}$-inch plates of suitable size—$\frac{5}{32}$-inch Stable Arc electrode.
PROCEDURE: First refer to Lessons 11, 12 and 13. Place plates vertically on bench so lap weld may be made. See that plates are firmly held together. Weld, starting at bottom, with a short arc, so as to have accurate control of the deposit, Fig. 25. Upon completion of

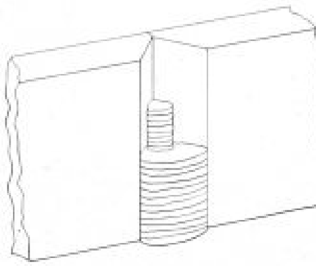


Fig. 27

weld, examine it, then break it open and examine the bead in accordance with Lesson 2.

Using the same pieces, set them upon bench, as a tee weld, and proceed as before. Weld on one side only so weld may be broken and examined. Be sure to use a short arc. Watch metal carefully, Fig. 26. After the weld has been made, break it by bending pieces together toward weld. Examine fusion, penetration, as given in previous lessons.

For butt welds follow same procedure; it being necessary, however, to run in a small bead first in the bottom of V, when plates are scarfed, Fig. 27.

Lesson 15

OBJECT: Study of horizontal welds.
MATERIAL: $\frac{1}{4}$-inch plate—$\frac{5}{32}$-inch Stable Arc electrode.
PROCEDURE: Set the plate on the bench in the vertical position. Then weld a bead horizontally on this vertical

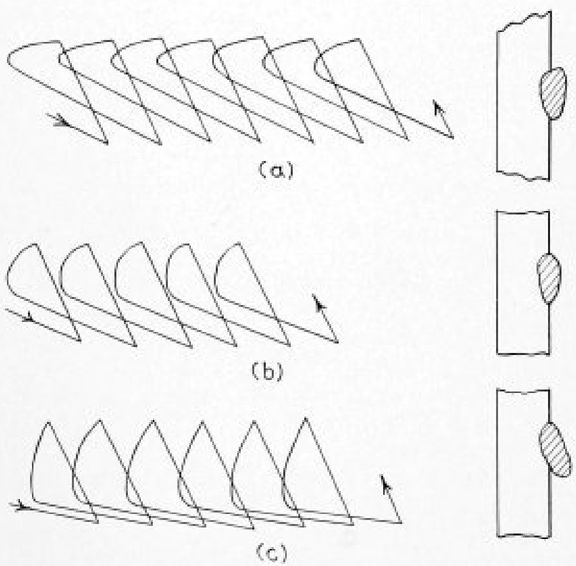


Fig. 28

* Note: This lesson is to run a vertical bead on a vertical plate as preparation for making a vertical joint.

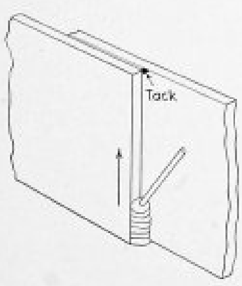


Fig. 25

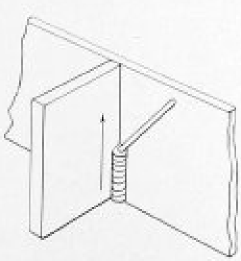


Fig. 26

plate. This is not the same as the vertical bead, as in Lesson 13, but is entirely different because the travel is horizontal and therefore more opportunities exist for the metal to be improperly placed. Use a short arc and a steady arc. Great care is necessary to obtain an even layer of deposited metal.

To start, practice making weaving motions, as shown in Fig. 28-a. You should be able to deposit a bead as shown in cross section, Fig. 28-a. That is due to the greater time the electrode is at top of bead and a greater amount of metal is deposited.

By cutting down or reducing the amount of travel or movement at the top of the bead, this excess metal may be reduced and a bead as shown in Fig. 28-b is made.

Further reduction of travel at top of bead and increase of travel at bottom will give a bead which droops or overlaps such as shown in Fig. 28-c. The travel or weaving motion and resultant beads are shown in Figs. 28-a, b and c. Practice these until you have control of the deposited metal.

Lesson 16

OBJECT: Study of horizontal, butt, lap and tee welds.
MATERIAL: 1/4-inch plates—5/32-inch Stable Arc electrode.
PROCEDURE: Horizontal butt weld may be of two general types: those where the plate edges are not scarfed or machined and those where the plate edges are machined.

In the first case the method outlined in Lessons 15 and 10 may be followed.

In the second case, when the edges are scarfed, a combination method is used (Lessons 11 and 15). One method is to scarf one plate only, see Fig. 29.

Use a small rod to put in the first bead, unless it can be done in one pass, then care must be taken to have complete fusion in the corner. The method used is similar to lap weld plus the horizontal weld. An inside bead may be used in accordance with Lesson 15 where such a bead is necessary.

Fig. 29

Another method of scarfing is the usual double scarf. In this it is necessary to follow Lesson 15 as there is no shoulder to weld on.

Set up two plates, one scarfed—the other not. Tack plates into position and place so joint is horizontal. Lay in a small bead to start. This will be very nearly like a lap weld. Then finish with a bead such as outlined in Lesson 15.

Proceed the same, only using plates, both of them scarfed.

Lap welds, horizontal, are practically the same as in Lesson 11. Take care, however, that the edge of the plate on which the weld metal is being deposited is not undercut.

Tee welds are covered in Lesson 12.

Lesson 17

OBJECT: Study of overhead welding.
MATERIAL: 5/32-inch Stable Arc electrode—1/4-inch plate.
PROCEDURE: Fasten the plate firmly in a horizontal position so that the under side may be easily reached with the electrode, and so you can take an easy, comfortable position for welding. Hold electrode at nearly right angles to the plate—grasp holder so knuckles of hand are up—palm down—so drops of metal will roll off glove and not be caught.

Then practice striking an arc (see Lesson 2). Try this as many times as necessary for you to strike and maintain the arc. Then, holding a very short arc, and moving the electrode at a steady rate, put on a bead on the under side of the plate.

There is, of course, a tendency for the metal to run down and form drops. A very short arc will stop this. You can melt this drop by using a long arc and when drop is molten quickly shorten the arc.

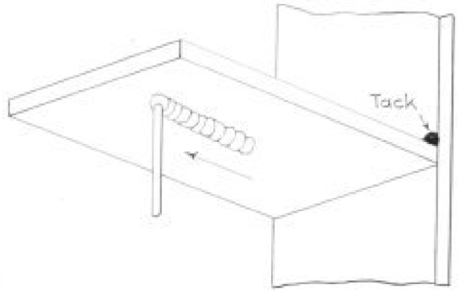


Fig. 30

This lesson will require a great deal of practice. Try a very short arc, short arc, long arc, and very long arc, and observe performance of arc and appearance of bead. Practice until bead looks reasonably good then inspect it, by chipping or filing so that penetration and fusion may be observed. Do not be satisfied with anything but the best bead. It can be done.

Lesson 18

OBJECT: Study of butt, lap, and tee overhead welds.
MATERIAL: 5/32-inch Stable Arc electrode—1/4-inch plates.
PROCEDURE: After Lesson 17 has been mastered, make a butt weld. Place two plates with edges together in a horizontal position, so the under side may be easily reached with the electrode. Weld according to Lesson 17. Do this from one side only, so weld may be broken and inspected. When a satisfactory weld can be made, then make a butt weld using two scarfed plates. Be careful the weld metal goes to bottom of the scarf with good penetration and fusion. This type of bead is an application of Lesson 17.

Lap and tee welds are very similar. They are both a combination of pure overhead and horizontal welds (Lessons 17, 16 and 15).

Considerable care must be exercised to get good fusion in the corner. Use enough heat to do this but not too much so as to cause undercutting or allow metal to flow down. Where more than one pass is needed, the instructions of Lesson 17 must be followed.

Set up a lap weld by tacking two plates together and placing in a horizontal position so under side may be easily reached by electrode. Weld a single small bead in corner. Then break weld and inspect for quality of weld metal, fusion into corner, penetration, porosity.

When a satisfactory job can be done, make a full size joint and inspect it.

Watch out for undercut or flow of metal on edge of plate.

These lessons will be continued in June.

Sales Manager Appointed for Combustion Engineering Company

The appointment of H. S. Colby as General Sales Manager of Combustion Engineering Company has been announced by R. M. Gates, vice-president of that company. Mr. Colby, until recently, was president of the Air Preheater Corporation. His technical education was acquired at Cooper Union and Columbia University and for the past twenty years he has been engaged in the design, production and sales of steam generating equipment involving boilers, stokers, pulverizers, economizers and air preheaters. This background of experience and an extensive acquaintance in the field of steam generation, eminently fit him for his new duties, which include direct charge of district office activities.

Engineering Data Required for Foreign Construction Project

Charles R. Swinford, engineer, of Brenneman & Swinford, 3607 Chestnut Street, Philadelphia, Pa., has announced that his firm, only recently organized, has been commissioned by heavily financed interests in one of the larger foreign countries to take charge of a huge development of modernization and natural resources. The project at present includes the design and construction of plants for many purposes, such as canning industries for fruit, meats, etc., driers, bottling works, a complete unit for utilizing all the by-products of coal, power plants, dams, bridges and roads; also city buildings, such as hospitals, banks, beauty parlors, hotels, the development of passenger bus lines using buses of bullet proof material, etc.

Catalogues and complete data are desired from manufacturers of equipment for above types of service in the shortest time possible. Headquarters for the project, which is expected to extend over a period of many years, will be established this summer. Manufacturers desiring further information should communicate with Mr. Swinford.

New Hartford Chief Inspector at Seattle

William J. Smith, an inspector with the Hartford Steam Boiler Inspection and Insurance Company, in Oregon and Washington since November 1, 1909, was appointed chief inspector for the Seattle department on March 1, 1934. The appointment permits a broadening of the scope of the Seattle department where E. G. Watson has been both manager and chief inspector. Mr. Smith had been acting as assistant to Mr. Watson on inspection matters. His thorough familiarity with the engineering problems on the Pacific Coast and the ability he has demonstrated as an inspector fit him well for the responsibilities incident to his promotion.

Hartford Chief Inspectors Hold Discussion Sessions

In the interest of still better service to Hartford Steam Boiler Inspection and Insurance Company assured the Company's chief inspectors from the sixteen department offices met in convention at Hartford from January 29 to February 3, 1934. They were joined in their discussion by the men in charge of engineering and inspection work for the Boiler Inspection and Insurance Company of Canada. The convention was under the direction of Dale F. Reese, vice-president in charge of engineering.

Among the subjects discussed were: Developments in boilers and pressure vessels, turbines and internal combustion engines; cast iron boiler problems, fusion welding with special field surveys of modern welding practice, inspection of electrical equipment, turbine construction and hazards and a variety of kindred subjects with respect to modern boiler and machinery practice.

By means of such meetings and in many other ways the company maintains what amounts to a continuous training course for its field inspectors. The convention permitted rapid exchange of experience with respect to current inspection problems, and the findings of the meeting were transmitted quickly to the inspectors. Thus a nation-wide field force is kept constantly advised of anything which will contribute to greater safety in boiler or machinery operation.

While Hartford Steam Boiler inspectors are so stationed as to give prompt service even to the most remote plants, the field men are never out of close touch with their chief inspectors or with the Company's engineering department at Hartford.

Trade Publications

STOKERS.—Link-Belt Company, Chicago, has just published an interesting book, "Firing Method Modernized for Profit," giving a comparison of hand firing and controlled automatic underfeed firing of boilers from 10 to 250 brake horsepower. This book illustrates in graphic and pictorial form such features as smoke elimination, uniform temperatures and pressures, coal savings, firing efficiency, etc., etc.

GRAIN SIZE IN CARBURIZING AND FORGING STEELS.—This was the title of an address given by Harry W. McQuaid, Republic Steel Corporation, Youngstown, O., before a dinner meeting of the Cincinnati, Dayton and Columbus Chapters of the American Society for Metals, on April 24, at Columbus, O. Mr. McQuaid, who devotes his time with Republic to research and development work, is nationally known as an authority on carburizing steels. He is also a pioneer in grain size control and collaborated in the development of the McQuaid-Ehn test which bears his name.

ENDURO 18-8 STAINLESS STEEL.—Republic Steel Corporation, Massillon, O., has issued a 16-page brochure containing up-to-the-minute data on Enduro 18-8 stainless steel as well as several of the more important variations which make up the Enduro 18-8 series of types. These include Enduro 18-8-S, 18-8-STi, 18-8-SMO and 18-8-FM. Authentic metallurgical and fabrication data are given. An important feature of the booklet is a Table of Laboratory Corrosion Data listing the degree of corrosion-resistance of Enduro 18-8 stainless steel, Enduro AA and Enduro S to each of more than three hundred chemical reagents, solutions and products under varying conditions of temperature and concentration.

HIGH TEMPERATURE INSULATION.—This is the title of a lecture prepared by the Johns-Manville Engineering Department, New York, and used each year by schools of mechanical, chemical, metallurgical and ceramic engineering throughout the country. This lecture comprises a short review of the principles of heat transfer; a discussion of the theory and practice of conductivity values of insulation and refractories; insulation in boilers, kilns, oil stills, furnaces, regenerators and other typical industrial equipment operated at high temperatures. A standard formula for heat transfer by conduction and description of a method for determining heat flow through furnace walls are also included. Reprints in the form of 32-page pamphlets are available for those interested in the subject.

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

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Communications

An Unusual Boiler Failure

TO THE EDITOR:

A few days ago, the manager of a local hotel phoned our plant to send a boiler maker to repair a boiler in their establishment. Upon investigating, we found it to be a 24-inch diameter by 48-inch length, vertical fire-tube boiler built in 1930, used only for heating the water for dish-washing. We were informed it had been inspected a week previous and found to be in good working order.

Our man stripped the boiler, and, it being so easy to handle, we brought it to the shop, which was a short hauling distance away. On a close inspection the tubes showed evidence of leaks at the firebox end, and one tube appeared to have a crack the length of it. Upon checking further, the cause of the apparent leak was located. The apparently cracked tube was an extra heavy tube with a fusible plug from which the soft metal had been melted out. The crack was a line of deposit from the defective plug. The plug was replaced with a new one, and after a very thorough cleaning, with sufficient water pressure to remove all scale, the boiler tested to 150 pounds per square inch hydrostatic pressure and was found to be all right.

The owner was notified to renew the fusible plug at least once a year and, when the boiler was open, to scrape and clean the fusible metal to prevent any recurrence of this trouble in the future.

Oswego, N. Y. JOHN A. SHANNON.

How Many Square Feet In Any Boiler?

TO THE EDITOR:

Here is a chart that quickly gives the total number of square feet in any cylindrical boiler of any diameter up to 18 feet and of any length. The chart automatically adds the two flat ends and the cylindrical surface without any long-hand figuring whatever.

For example, if the diameter of a Scotch boiler is 10 feet and the length is 6 feet, how many square feet of metal are in the boiler?

The dotted line drawn across the chart shows how easily it is done. The line passes through the 10, in the

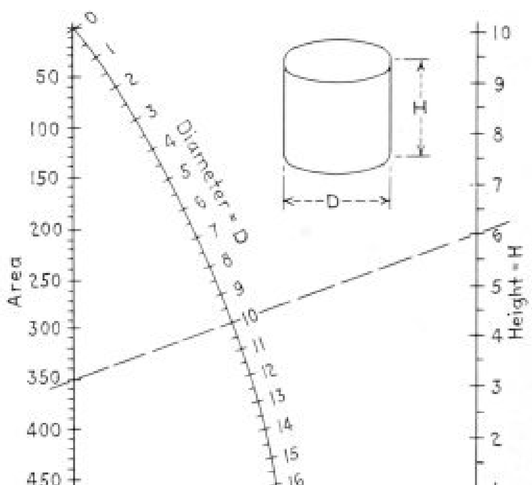


Chart giving total square feet in boiler

curved column *B*, and through the 6, column *C*. The intersection with column *A* shows that the area is 350 square feet.

Of course any unit of measurement may be used Thus if the diameter and length are in yards the area will be in square yards.

In the event that the length or height of the boiler should be greater than given in column *C*, simply add the necessary length to column *C* and then proceed as above. Thus if the length is 20 feet and the diameter 5 feet, double the length of column *C*. Running a line through the 20, column *C*, and the 5, column *B*, it will be found that the area is 350 square feet.

Newark, N. J. W. F. SCHAPHORST.

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

Smokestack Breeching Layout

Q.—Will you at an early date furnish me drawing in the BOILER MAKER AND PLATE FABRICATOR of a smokestack breeching in a correct and simple method. J. L. T.

A.—The shape of the smokestack breeching submitted in the question is shown in Fig. 1. It tapers from a round section where it joins the breeching to a wash-boiler section at the connection to the stack.

Due to the fact that the diameter of the connection to the breeching is the same as for the semicircular ends of the wash-boiler section at the connection to the stack, the parallel line method of development may be used, when these diameters are different this method of developing cannot be used and such a breeching should be laid out by the triangulation method.

Lay out the elevation and plan view as shown in Fig. 1.

Divide the semicircular end of the plan into any number of equal parts, eight being taken in this case and number same from *1* to *5* and *5* to *1* as shown.

Erect perpendiculars to the line *G-H* through points *1* to *5* extending the perpendiculars to the line *A-B* of the elevation locating the points *1'*, *2'*, *3'*, *4'*, *5'*.

Parallel to the line *B-D* draw lines through the

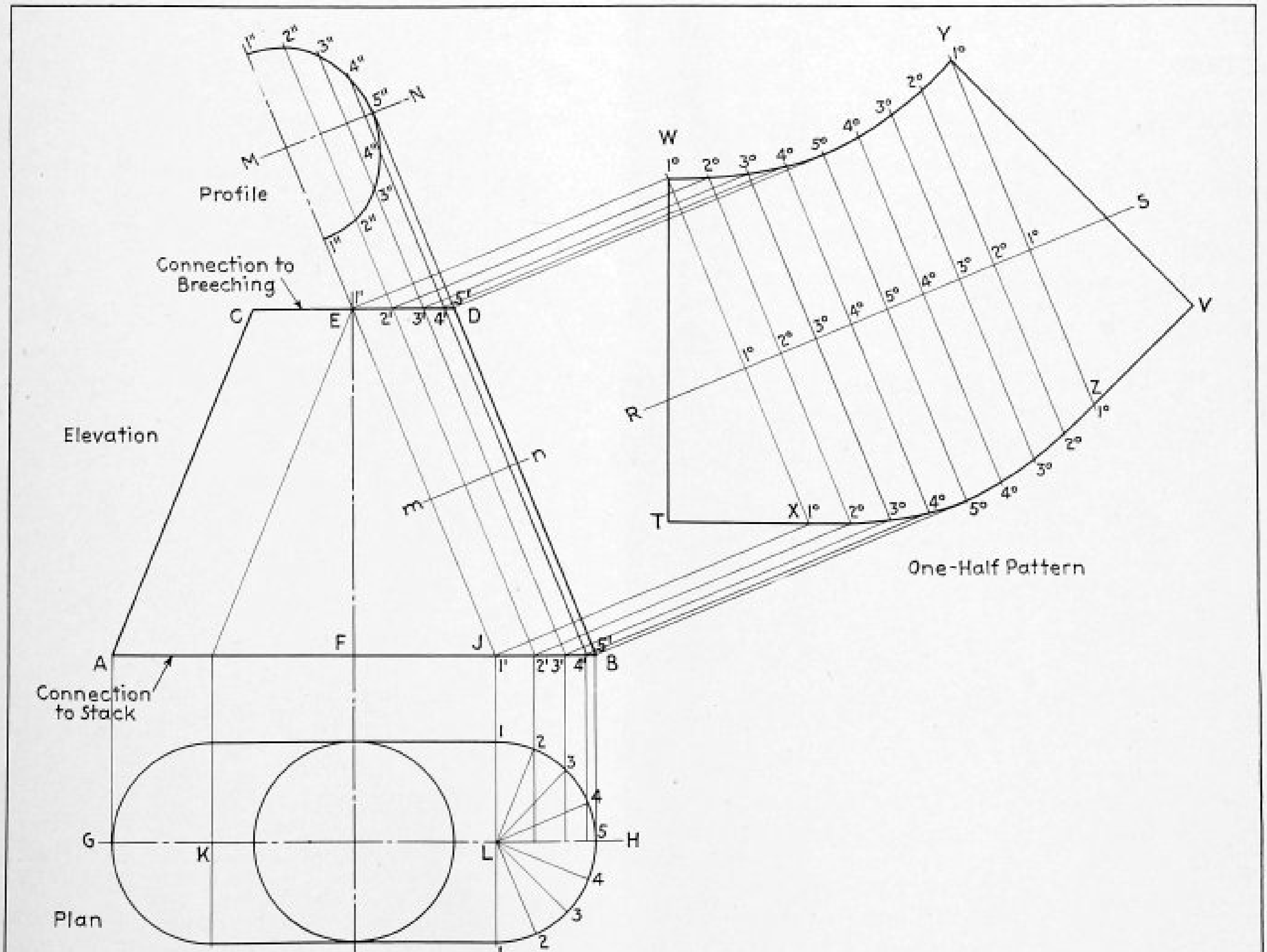


Fig. 1

Details of smokestack breeching layout

points 1', 2', 3', 4', 5', cutting *C-D* locating the points 1', 2', 3', 4', 5' on the line *C-D*.

The next step is to construct the profile of the circular breeching connection, this profile to be taken along the line *m-n* which is drawn perpendicular to the line *B-D*.

Erect *M-N* perpendicular to the line 1'-1' which has been extended, extend the lines 2'-2', 3'-3', 4'-4', 5'-5' of the elevation through the line *M-N*.

Each side of *M-N* on the line 1'-1' step off a distance equal to the vertical distance between the line *L-H* and the point *1* of the plan, locating the points 1"-1" in the profile, in similar manner each side of *M-N* on the line 2'-2' step off a distance equal to the vertical distance between the line *L-H* and the point *2* locating the points 2"-2" in the profile, continue in this manner until the points 3"-3", 4"-4" and 5" are obtained. Connect these points as shown completing the profile.

The next step is to construct the pattern. Before constructing the pattern it will be noted that the breeching is symmetrical about the line *E-F* and therefore a development of one half of the breeching can be made, and a duplicate of same would give a complete pattern.

Erect *R-S* perpendicular to *B-D* of the elevation. Divide the line *R-S* into a number of parts making 1°-2° equal to 1"-2" of the profile, 2°-3°, to 2"-3", 3°-4° to 3"-4" and 4°-5° of the profile.

Erect a series of perpendiculars to the line *R-S* through the points 1°, 2°, 3°, 4°, 5°, etc. extending same both sides of the line *R-S*.

Next parallel to the line *R-S* draw lines through the points 1', 2', 3', 4', 5', on the lines *E-D* and *F-B* of the elevation extending same into the pattern cutting their corresponding lines in the pattern as shown, completing that portion of the pattern shown by *W, X, Z, Y*. Make *W-T* and *Y-V* equal to *E-F* of the elevation, make *X-T* and *Z-V* equal to *F-J* of the elevation completing the half pattern as shown.

Areas and Self-Supporting Stack

Q.—Referring to your book "Laying Out for Boiler Makers" under chapter 9, page 186, you state that the area 7½ square feet corresponds to a diameter of 9 feet 8 inches. Now the area of a 9-foot 8-inch diameter is equal to 73.39 square feet. Isn't this an error? or am I mistaken?

On page 200 of the above book; for base of self-supporting stack you assume the height of the base to be 15 feet. I would like very much to have the formula to find the correct height of the base. A. R. H.

A.—The part of Chapter IX in Laying Out for Boiler Makers referred to in the question is as follows:

In order to make the calculations which are necessary in the layout of a particular stack, assume that is required to build a stack for boilers which have a total horsepower of 285 and a total grate area of about 60 square feet. The effective area of the stack should be about one-eighth the total grate area, or about 7½ square feet. The diameter corresponding to this area would be about 9 feet 8 inches; the actual diameter of the stack, however, according to the assumptions which were made, should be 4 inches greater than this, or about 10 feet. Using the equation:

$$\text{Horsepower} = 3.33\,(A - 0.6 \times \sqrt{A})\,\sqrt{H}$$

and substituting 285 as the value of the horsepower and 10×0.7854 as the value for *A*, the height of the stack may be determined:

$$285 = 3.33\,(7.854 - 0.6\,\sqrt{7.854})\,\sqrt{H}$$

$$\sqrt{H} = 13.8$$

$$H = 191$$

Therefore, the required dimensions of the stack are: Height, 191 feet, diameter, 10 feet.

This paragraph is evidently in error—

Using the height of the stack obtained, 191 feet and substituting in the formula:

$$HP = 3.33\,(A - 0.6 \times \sqrt{A})\,\sqrt{H}$$

and solving for horsepower we would have

$$A = 10^2 \times 0.7854 = 78.54 \text{ square feet.}$$

$$HP = 3.33\,(78.54 - 0.6\,\sqrt{78.54})\,\sqrt{191}$$

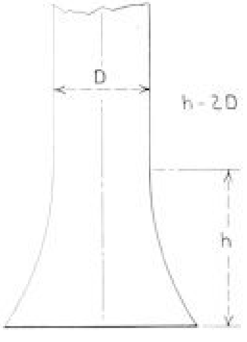
$$HP = (3.33 \times 73.26) \times 13.8$$

$$HP = 3367$$

Interpolating in the Table given on page 183 for 120-inch diameter stack, 191 feet high, we find the horsepower to be *3367*, which checks the formula.

The paragraph should read:

In order to make the calculations which are necessary in the layout of a particular stack, assume that it is required to build a stack for boilers which have a total horsepower of *3367* and a total grate area of about 600 square feet. The effective area of the stack should be



Bell shape stack base

about one-eighth the total grate area, or about 75 square feet. The diameter corresponding to this area would be about 9 feet 8 inches; the actual diameter of the stack, however, according to the assumptions which were made, should be 4 inches greater than this, or about 10 feet. Using the equation:

$$\text{Horsepower} = 3.33\,(A - 0.6 \times \sqrt{A})\,\sqrt{H}$$

and substituting 3367 the value of the horsepower and $(10)^2 \times 0.7854$ as the value for *A*, the height of the stack may be determined:

$$3367 = 3.33\,(78.54 - 0.6\,\sqrt{78.54})\,\sqrt{H}$$

$$\sqrt{H} = 13.8$$

$$H = 191$$

Therefore, the required dimensions of the stack are, Height 191 feet, diameter, 10 feet.

I do not have any formula for determining the height of the bell shaped base for a self supporting steel stack. Christie's "Chimney Design and Theory" gives the height of the bell base as twice the diameter of the stack, as shown in the sketch.

Cross-Sectional Area of Pitted Sheet

Q.—How is the cross-sectional area of a pitted sheet obtained in order to determine if same should be renewed or patched? E. R.

A.—There are various methods used in determining the cross-sectional area of a pitted sheet.

The Master Boiler Makers Association Proceedings gives the following method:

In Fig. 1 is illustrated the cross-section of a barrel course along the belly of the boiler; surface *C* denoting the extent of deterioration. A board the length of the course is laid on edge and to the face of which a piece of paper is placed and secured thereto. Several rivets in the girth seam are removed in order to obtain the exact position of line *A-A*, on paper shown by line *B-B*.

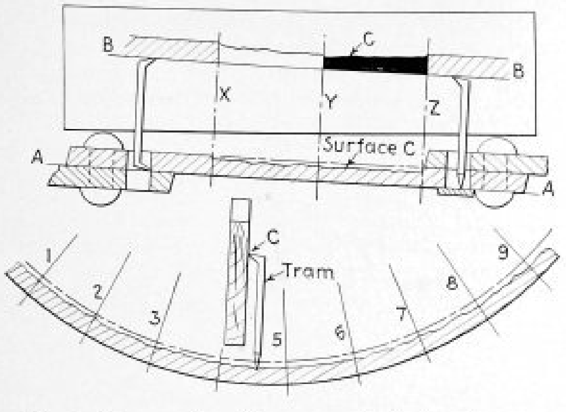


Fig. 1—Cross section of locomotive boiler barrel course

Then the tram is taken and run carefully along surface *C* so an exact reproduction of the plate cross-section is transferred to the paper at *C*.

It is suggested that in making calculations, sections longitudinally represented by lines *X*, *Y* and *Z* and circumferentially by lines *1* to *9* inclusive be taken at *8*-inch intervals. The purpose of this is to have each unit, each comprising an area of 64 square inches treated separately as you should not consider section *X-Y* (unshaded) if stronger than section *Y-Z* (full shaded) as adding any strength in the support of section *Y-Z*. That is, section *X-Z* may give you a factor of safety of four, where as section *X-Y* will be over four and section *Y-Z* below four. The latter is therefore weak and calls for a patch which patch should be extended longitudinally sufficiently to include all the weak sections. The width of the patch depends upon the strength of the longitudinal sections taken at intervals circumferentially in the centers of sections *1-2*, *2-3*, *3-4*, etc. Therefore, if section *Y-Z* figures weak through the five sections *2* to *7* inclusive, the patch should be extended around the belly to take in these given sections or the area of *320* square inches.

It will be understood that if the pitting extends the full length of the course to the extent that the greater part of the plate gives a factor below four a new portion of plate should be applied, but when following this method there is no guesswork, and the reason for doing the work is easily explained.

If this method is followed carefully it will save considerable expense, either in the application of new shell plates or in determining the size of patches to be applied. Many shell plates have been removed and patches applied on the mere judgment and order of the foreman boiler maker, without proper calculation being made to determine the actual strength of the plate under consideration.

Plug in Boiler Seam

Q.—What is the purpose of the ⅞-inch plug shown on the attached locomotive boiler seam? Is it satisfactory to weld the seam at this point in place of the plug? D. G.

A.—The purpose of the ⅞-inch plug between the outside butt strap and the shell course as shown in Fig. 1 is to secure a tight seam.

The joint of the shell course to which the seam is attached is along the line *A-A*. Due to the fact that the edges of the inside welt strap are not calked, the tightness of the seam is dependent upon the calking of the outside butt strap.

The calking of the outside butt strap causes the seam to be tight at all points except the short space between the end of the butt strap and the shell plate of the adjacent course. This space is provided between the end

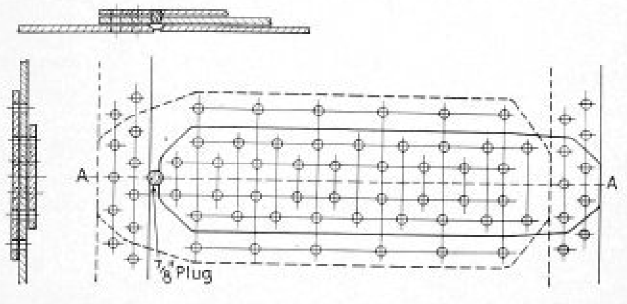


Fig. 1—Use of plug between butt strap and steel course

of the outside butt strap and the adjacent shell course to allow room for calking both the end of the outside butt strap and also the adjacent shell course at this point.

In order to secure a tight seam at this point a screwed

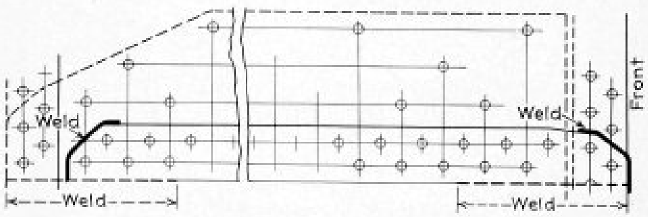


Fig. 2—Welding seams for tightness

plug is inserted between the end of the outside butt strap and the adjacent shell course. The diameter of the plug is to be large enough entirely to fill this gap. The threaded plug produces a tight seam at this point.

While welding the ends of seams for tightness as shown in Fig. 2, is being used, and is no doubt satisfactory, eliminating the necessity of the plug and also calking the butt strap between the end of the butt strap and the adjacent course. The objection is to having weld on a portion of the boiler that is not supported by other construction.

Plate Fabricators' Code of Practice

The long awaited Code of Fair Competition for the Steel Plate Fabricating Industry under the National Recovery Act was finally approved on April 6 and is now in effect. Provisions of the code are published in this issue. In the period of delay caused by hearings, the industry has had an excellent opportunity to organize under the leadership of the Steel Plate Fabricators' Association. Since the measure of success of future operation under the code depends on co-operative action between all members of the industry, it is important that any firm which is not yet a member of the association become affiliated without further delay.

Locomotive Industry's Code Approved

National Administrator Hugh S. Johnson on April 30 approved the code of fair competition for the locomotive manufacturing industry. This industry, which suffered a 95.8 percent reduction in production, a 72.6 reduction in employment and a 90 percent reduction in payrolls between 1929 and 1933, expects a marked increase for 1934.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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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.

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.

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

Cities

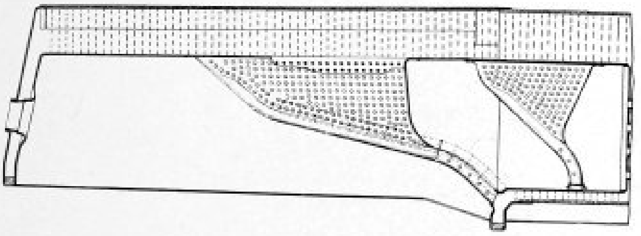
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,852,122. THERMIC SIPHON. BERT E. LARSON, OF PARK RIDGE, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

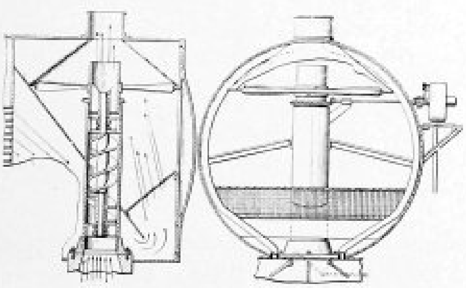
Claim.—A siphon of the kind described embodying therein a flat hollow body having a closed bottom and a closed end disposed at an angle with respect to said bottom and connected thereto by a corner portion of sub-



stantial curvature, said corner portion having a cross sectional width greater than that of said body. A siphon of the kind described embodying therein a flat hollow body having a closed bulged bottom and a closed rear end disposed at an angle with respect to said bottom and connected thereto by a bull nose like corner portion, said corner portion also being bulged with a cross-sectional width greater than that of said body and substantially equal to that of the bulged bottom of the body. Two claims.

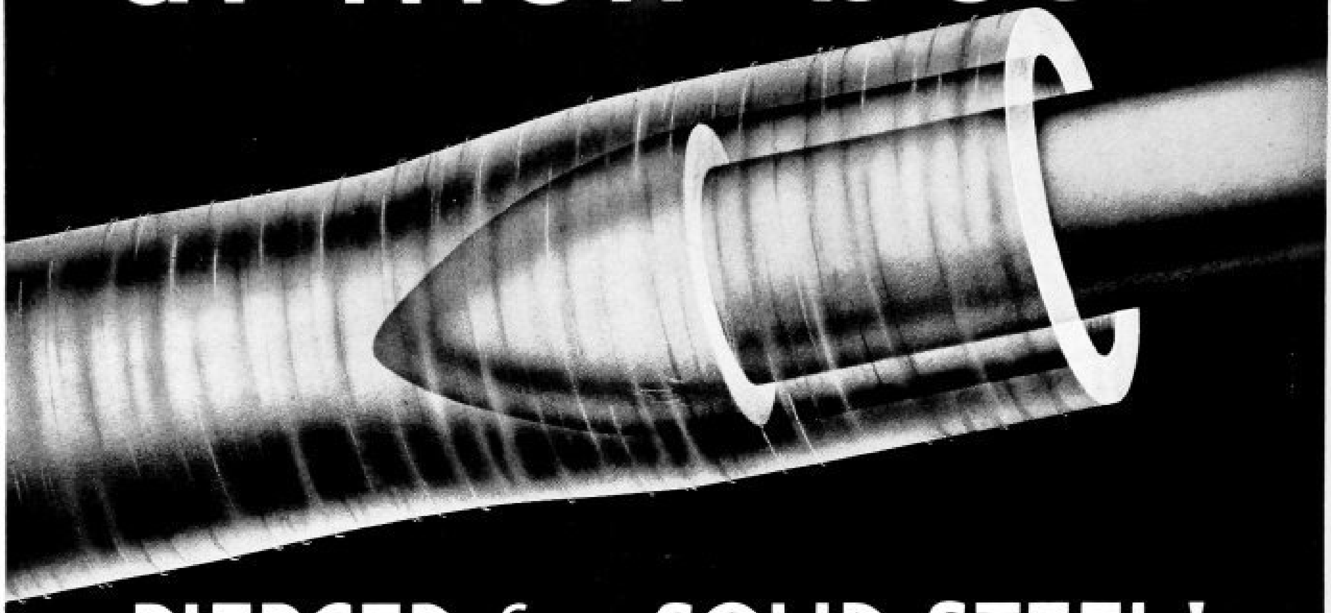
1,844,439. LOCOMOTIVE DRAFT APPLIANCE. HUGH ROONEY AND HUGH K. ROONEY, OF MUSKOKEE, OKLAHOMA.

Claim.—A locomotive draft appliance comprising in combination with a smoke box having a nozzle for admitting exhaust steam in its bottom, a smoke outlet in its top alined with said nozzle and a straight cylindrical pipe connected at its lower end to said nozzle and having its upper end disposed under and alined with the smoke outlet, a shaft disposed axially

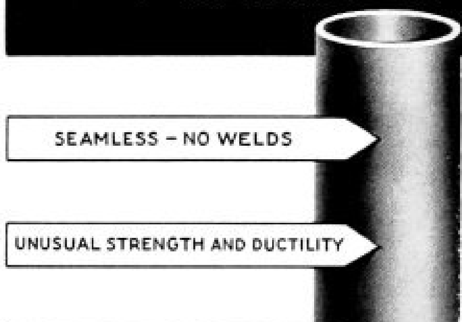


within said pipe, a spiral blade on said shaft extending longitudinally thereof and fitting close to the wall of the pipe, bearings for said shaft within said pipe and near the ends thereof, the blade extending between and terminating near said bearings whereby to present an extended surface to the action of the steam entering through the nozzle, a spider fixed to the upper end of the shaft, a sleeve fixed about the spider and fitting in and projecting upwardly from the upper end of the pipe toward the smoke outlet and terminating near said outlet, and a fan having a hub encircling and secured to said sleeve above the upper end of the cylindrical pipe.

BOILER TUBES at their best



PIERCED *from* SOLID STEEL!



There is no weld

No weld—no long line of possible weakness. No chance, no dependence on the human element, no uncertainty of any kind need be allowed for, as affecting the uniform wall strength of a NATIONAL Seamless Boiler Tube. One continuous hollow cylinder, pierced from a solid billet, expanded and rolled at proper and definitely controlled temperatures to produce grain refinement and uniform transverse and longitudinal strength A balanced, homogeneous unit—unsurpassed from a manufacturing standpoint.

Likewise, from a service standpoint NATIONAL Seamless Boiler Tubes represent the ultimate of security. In countless railway, marine, and stationary boiler installations, they have proved reliable in every way under the most trying conditions. To get the advantage of the highest quality seamless boiler tubes, specify NATIONAL-SHELBY—

America's Preferred Boiler Tubes

NATIONAL TUBE COMPANY • Pittsburgh, Pa.

Subsidiary of United States Steel Corporation

NATIONAL SEAMLESS

BOILER TUBES—SAFE ENDS—SUPERHEATER TUBES—CONDENSER TUBING—ARCH TUBES—SUPERHEATER PIPES—STAY-BOLT MATERIAL

Boiler Maker and Plate Fabricator

NRA U.S. CODE GRAPHIC ARTS INDUSTRY

Orders for Locomotives

Shipments of railroad locomotives from the principal manufacturing plants in the United States, outside of railroad shops, as reported to the Bureau of Census, total 34 in May as compared with none in April, one in May, 1933, and 15 in May, 1932. Unfilled orders at the end of May totaled 136, as compared with 146 at the end of April, 70 at the end of May, 1933, and 146 at the end of May, 1932.

Boiler Industry Well Organized for Future

With the experience gained from having one of the early codes under the National Industrial Recovery Act approved, the boiler manufacturing industry faces its second year of code operation with confidence in the ability of its members to work in harmony and with the prospect of profitable enterprise. The American Boiler Manufacturers' Association, which has just completed its forty-sixth annual meeting, served as the prime mover in organizing the industry last year and setting up the machinery by which it is now operating smoothly.

As a result of the activities of the Industrial Recovery Committee of the association practically the entire industry is now coming under the influence and subscribing to the code. The problems that developed through the first few months after adoption of the code were rectified by approval of amendments which were placed in effect on April 16. These amendments, which were published in the May issue, concern trade practices largely and are designed to eliminate many of the difficulties of the first few months of operation.

The machinery exists for administering the code efficiently and co-operation between companies and groups within the industry is the only other requisite for the conduct of successful business. This matter of co-operation was stressed throughout the meeting at Sky Top and is the one factor that has been more or less absent at times in the past in this as in many other industries.

Improvement in production has already been sustained over a period of months and prospects for still better business are bright. Because the orders placed can now be contracted for on a profitable basis, it remains solely within the power of the members of the industry to speed their own recovery by complete conformance to the requirements of the Code Authority.

The consensus of opinion is that within the next year or two, a considerable number of orders for equipment to modernize large power plants operated by the utility companies will be placed, in order that the high efficiency of such plants can be maintained, after a long period of failure to carry out improvements. Such programs of modernizing will require new steam generating equipment of all kinds. Municipal power plants have been proposed by a number of localities, and at least a fair percentage of the projects will materialize.

It is in the industrial field, however, that the greatest volume of orders for power plant modernization will probably develop. An increasing volume of such orders has been forthcoming in recent months and with the prospects of savings made possible by the use of high-efficiency steam generators, the boiler manufacturing industry contemplates an increasing number of contracts from this field.

The possibility of new plant construction with a return of business has been largely discounted but continued recovery will eventually require expansion in certain industries that will unquestionably develop boiler orders.

A Practical Course in Laying Out

In order to stimulate study in the art of boiler construction and plate fabrication among those who would equip themselves for the future in these industries, a practical series of articles on the subject of laying out has been commenced in this issue. George M. Davies, editor of the Questions and Answers Department of this publication, is the author.

The work is being prepared along the simplest possible lines, with geometric construction as the basis from which the greatest accuracy in laying out may be obtained. This series is the result of long study on the part of the author to present the subject in the most logical and comprehensive manner, and in such a way that the underlying principles once mastered will make possible a rapid advance in understanding the many complicated forms required in industrial work of all kinds.

The articles should be of value both to the beginner and in later instalments to those already engaged in laying out work. To the latter they will be useful as a review of principle as well as to suggest variations in method and a check.

It is possible that some readers will wish further explanations of the principles discussed as the series progresses. The suggestion is made at the outset that where a complete understanding of any step is not gained by careful study, the reader should communicate with the author, addressed to the Editorial Department, in order that his difficulties may be straightened out.

The whole intent of the series on laying out is to benefit our readers. Unless questions are raised and explanations given our readers to clear up all problems in connection with the work, the greatest value cannot be obtained. All such questions and their explanation will be published as a supplement to each instalment.

A supply of reprints of each instalment of the series will be maintained so that new subscribers may obtain the lessons from the beginning.

ELEMENTARY PLATE LAYOUT—I

By George M. Davies

The basic principles of the various methods of plate development are derived from geometry. Geometry is the science which investigates and demonstrates the properties of lines on surfaces and solids, and a good working knowledge of the various geometric theorems is a sound foundation for all plate development work.

The layerout will find a practical use for many of these problems in most every development to be made and by using the methods outlined in the following geometric problems, greater accuracy will be obtained in making the development.

Making use of the methods outlined in the following problems in every-day work is just as important as a knowledge of them.

PROBLEM 1

Given: The straight line *X-Y* in Fig. 1.

Problem: To bisect or divide the straight line *X-Y*, into two equal parts.

Method: With the ends of the straight line *X* and *Y* as centers and with a radius greater than one-half of the line *X-Y*, draw circular arcs intersecting each other above and below the line *X-Y* at *M* and *N*. Draw the line *M-N*. The line *M-N* divides *X-Y* into two equal parts as *X-Z* and *Z-Y*.

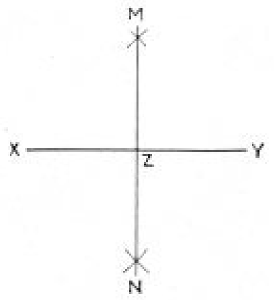


Fig. 1

PROBLEM 2

Given: A straight line *X-Y* with any point on the straight line as *M*, Fig. 2.

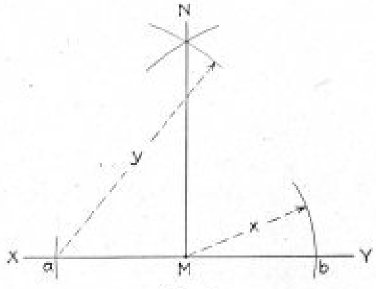


Fig. 2

Problem: To erect a perpendicular to line *X-Y* at the point *M*.

Method: With *M* as a center and with any radius as *x*, draw circular arcs intersecting the given line *X-Y* at *a* and *b*. Then with *a* and *b* as centers and with *y*, taken greater than *x*, as a radius, scribe arcs intersecting at *N*. Connect *M-N*. *M-N* is perpendicular to *X-Y* at *M*.

PROBLEM 3

Given: The line *X-Y*, Fig. 3.

Problem: To erect a perpendicular to the line *X-Y* at *X*.

Method: With any point *M*, outside the line *X-Y* as a center and with *M-X* as a radius, draw a circular arc intersecting *X-Y* at *N*. Draw a line through *M* and *N* intersecting the arc just drawn at *P*. Connect *X-P*. *X-P* is perpendicular to *X-Y* at *X*.

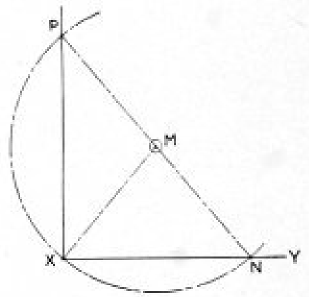


Fig. 3

PROBLEM 4

Given: The line *X-Y* and any point *M* at a distance from it, as in Fig. 4.

Problem: To erect a perpendicular to the line *X-Y* from the point *M*.

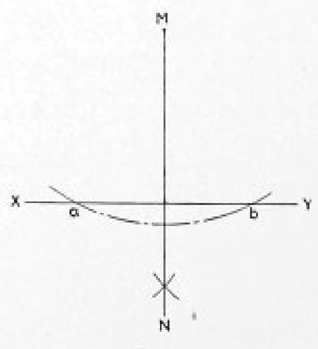


Fig. 4

Method: With M as a center, draw a circular arc cutting the line X-Y at a and b. With a and b as centers, draw circular arcs, with a radius greater than one-half the distance a-b. The arcs intersect at N. Connect M-N. M-N is perpendicular to X-Y and passes through M.

PROBLEM 5

Given: The line X-Y, Fig. 5.

Problem: To draw a straight line parallel to the given line X-Y at a given distance a away from X-Y.

Method: From any two points on the line X-Y as m and n describe a circular arc with a radius equal to

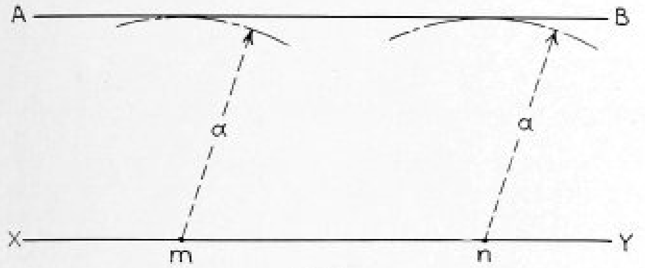


Fig. 5

the distance a. Draw a line tangent to the arcs first drawn as A-B. A-B is parallel to X-Y at the distance a away from X-Y.

PROBLEM 6

Given: A straight line X-Y, Fig. 6.

Problem: To divide the straight line X-Y into any number of equal parts (eight in this case).

Method: From X draw a straight line X-Z forming any angle with X-Y. Set off on X-Y eight equal parts

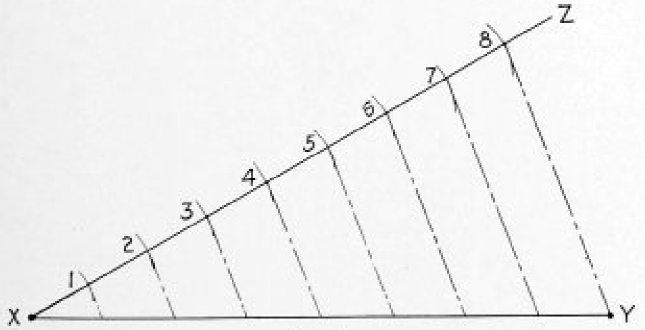


Fig. 6

of any length. Join the point 8 to Y and parallel to this line from the points $1, 2, 3, 4, 5, 6,$ and 7. Draw lines cutting the line X-Y as shown, which will divide the line X-Y into the desired number of parts.

PROBLEM 7

Given: The angle X-Y-Z, Fig. 7.

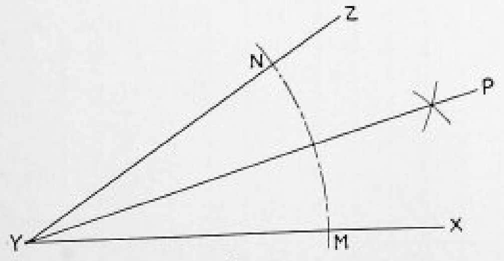


Fig. 7

Problem: To bisect or divide the angle X-Y-Z into two equal parts.

Method: With Y as a center, and with any radius describe, a circular arc cutting X-Y at M and Y-Z at N. With M and N as centers and with a radius greater than one-half M-N draw circular arcs intersecting at P. Draw Y-P. The line Y-P bisects or divides the angle X-Y-Z into two equal parts.

PROBLEM 8

Given: An angle X-Y-Z and a straight line M-N, Fig. 8.

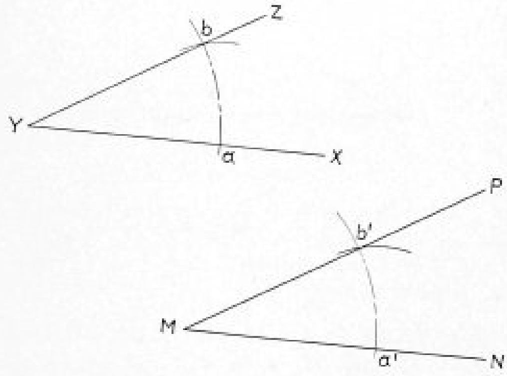


Fig. 8

Problem: To transfer the angle X-Y-Z on the straight line M-N.

Method: With Y as a center and with any radius scribe a circular arc, cutting X-Y at a and Y-Z at b. Using the same radius and with M as a center scribe a circular arc cutting the line M-N at a'. Then take the distance from a to b and set off as shown from a' to b'. Draw a line from M through b' as M-P. Angle N-M-P is a reproduction of angle X-Y-Z.

PROBLEM 9

Given: The line X-Y, Fig. 9.

Problem: To draw a 45-degree angle.

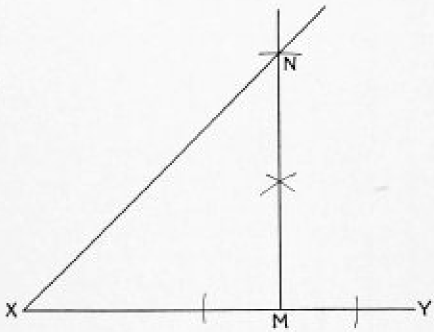


Fig. 9

Method: From point X on line X-Y set off a distance X-M. Draw a perpendicular to X-Y at M (as shown in Problem 2). Set off the distance M-N equal to X-M. Draw X-N. M-X-N is a 45-degree angle.

PROBLEM 10

Given: The right angle, X-Y-Z, Fig. 10.

Problem: To trisect or divide the right angle X-Y-Z into three equal parts.

Method: With Y as a center, and with any radius, describe a circular arc, cutting *X-Y* at *M* and *Y-Z* at *N*. Then with the same radius and with *M* as a center, describe a circular arc cutting the arc *M-N* at *P*. Then

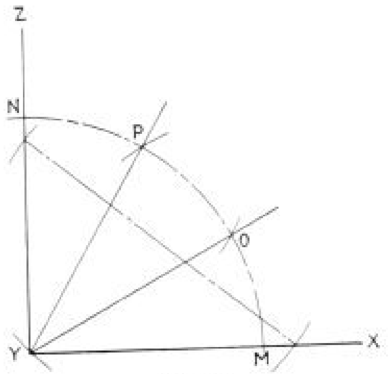


Fig. 10

with the same radius and with *N* as a center describe a circular arc cutting the arc *M-N* at *O*. Draw *Y-P* and *Y-O* and the right angle *X-Y-Z* will be trisected or divided into three equal parts.

Examples of Geometric Construction

In order to illustrate how the methods of geometric construction can be adopted for use in every-day development work, the two piece 90-degree elbow illustrated in Fig. 11 is constructed as follows:

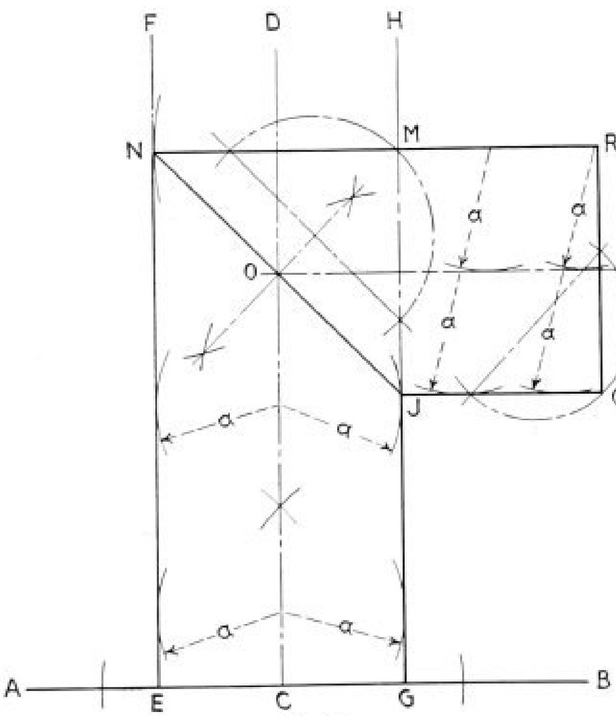


Fig. 11

Draw the line *A-B*, Fig. 11 and at any point *C* erect a perpendicular to the line *A-B* as *C-D*. (Use method illustrated in Problem 2).

Parallel to *C-D* draw the lines *E-F* and *G-H*. (Use method illustrated in Problem 5). Make *a* equal to one-half the required diameter of the pipe.

At *J*, any point on *G-H* construct a 45-degree angle as *J-M-N*, making *J-M* and *M-N* equal to the required diameter of the pipe. (Use method illustrated in Problem 9). Make the miter line *J-N*. Bisect *N-J*. (Use method illustrated in Problem 1). As a check, the bisected point *O* should fall on the line *C-D*.

Extend *N-M* and draw *O-P* and *J-Q* parallel to *M-N*. (Use method illustrated in Problem 5). Make *a* equal to one-half the required diameter of the pipe. As a check these lines should pass through points *J* and *O* already located.

At *Q* erect a perpendicular to *J-Q*. (Use method illustrated in Problem 3). This perpendicular *Q-R* completes the elevation.

Fig. 11 not only serves to illustrate how the various geometric problems can be applied to laying out but also a more important function, that of being the means of giving a quick check where a development has been laid out with the use of the straight edge and the square.

We will now consider the simplest form of plate development generally known as *Parallel Line Construction.*

Parallel line forms may be considered objects whose profiles are uniform throughout the object. This method of development is particularly suited to the treatment of patterns for pipe work, where the diameter of the pipe is, in all cases, uniform throughout.

The first development to be considered is a two-piece 90-degree elbow, as shown in Fig. 12.

Two-Piece 90-Degree Elbow

For a two-piece elbow the miter line *N-J* is at 45 degrees with both arms of the elbow, and both arms as

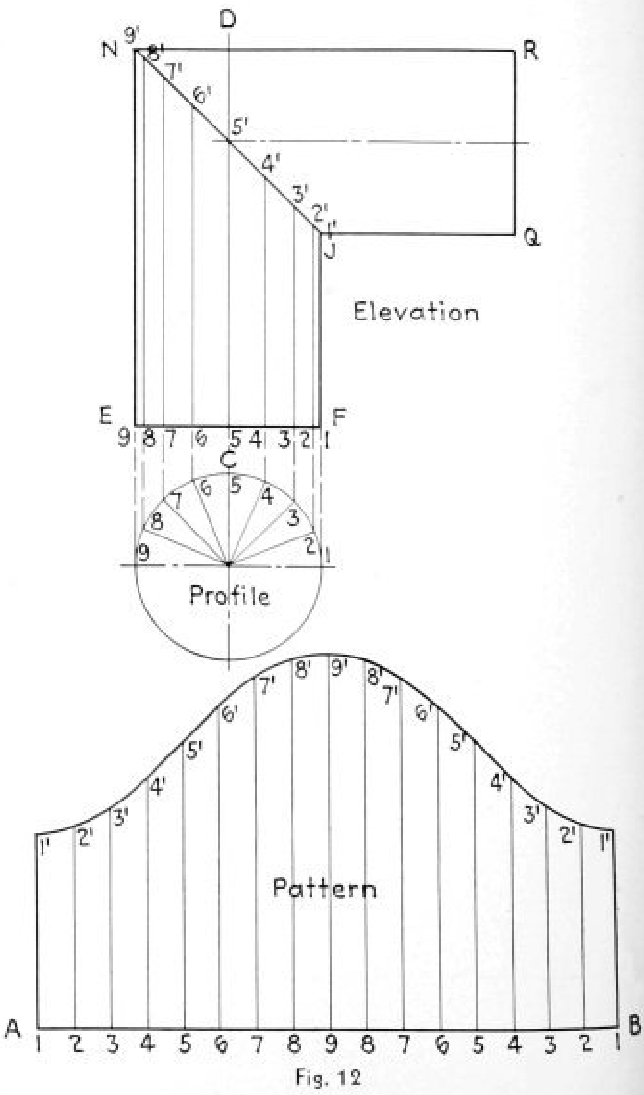


Fig. 12

F-E-N-J and *Q-R-N-J* are similar, therefore a development of one arm will be satisfactory for the other.

Extend the center line *C-D* and draw the profile as shown. Divide one-half the profile into any number of equal parts, as eight in this case, the greater the number of parts taken the more accurate the final development. Number the divisions from 1 to 9 as shown. Erect perpendiculars from these points, extending same into the elevation cutting the base line *E-F* and the miter line *N-J* as shown. Number the points to correspond with those taken in the profile, from *1* to *9* on *E-F* and from *1′* to *9′* on the miter line *N-J*. Connect the points shown.

To construct the pattern; draw the line *A-B*. The distance *A-B* is to be equal to the circumference of the profile. Divide *A-B* into sixteen equal spaces numbering same from *1* to *9* to *1* as shown. Erect perpendiculars to these points. On the perpendicular at *1*, mark off the distance *1-1′* equal to *1-1′* of the elevation; on the perpendicular at *2* mark off the distance *2-2′* equal to *2-2′* of the elevation. Continue in this manner until all the points of the pattern are located. Connect the points *1′-9′-1′* of the pattern with a curved line, completing the development.

Four-Piece 90-Degree Elbow

The next development to be considered is a four-piece 90-degree elbow, as shown in Fig. 13. It will be noted that the elbow consists of two full sections and two half sections.

First draw the line *A-B* and at *B* erect *B-C* perpendicular to *A-B*. Then with *B* as a center and with the trammels set to a radius equal to the inside radius of the elbow, draw the quarter circle *D-E*. With the same center and with the trammels set to a radius equal to the outside radius of the elbow, draw the quarter circle *F-G*. Divide the quarter circles *D-E* and F-G, respectively, into six equal parts, number same from *1* to *5* on the inside radius and from *1′* to *5′* on the outside radius as shown.

Draw lines from *3* to *5*, *3′* to *B* and *5′* to *B*; also draw the line *4′-B*. Where the line *3-5* intersects *4′-B* at *H*, lay off from *H* on the line *4′-B*, a distance equal to the diameter of the elbow as *H-J* which is equal to *E-G*. Draw *L-K* through the point *J* parallel to *C-D*. For convenience the point *3* is marked *M* and point *5* is marked *N*.

The course *K-L-M-N* is all that is required for the pattern. Therefore transfer *K-L-M-N* from the elevation to *K″-L″-M″-N″* in Fig 13(a). Describe the semicircle *G″-E″*, which is a half profile of the course *K″-L″-M″-N″*. Divide the semicircle *G″-E″* into eight equal parts. Number same from *1* to *9* as shown. Draw horizontal lines from the points *1, 2, 3, 4, 5, 6, 7, 8* and *9* of the half profile, extending them until they intersect the line *K″-N″*, Fig. 13(a). Number the intersection on line *L″-M″* from *1″* to *9″*, and on line *J″-H″* from *1* to *9*, and on line *K″-N″* from *1′-9′* as shown.

To construct the pattern, draw the line *J′-H′*, Fig. 13 (b), equal in length to the circumference of the elbow, having a diameter as *J-H* in the elevation.

Divide *J′-H′* into sixteen equal parts. Draw lines through these points of the division at right angles to *J′-H′*. Mark these lines with the same numbers as were used for the corresponding points in Fig. 13(a). Measure the distance from *1 to 1″*, Fig. 13(a), and transfer it to *1-1″*, Fig. 13(b). In like manner transfer the distances *2-2″*, *3-3″*, *4-4″*, etc. to Fig 13(b). Having completed the pattern on one side of *J′-H′*, transfer the distances *1-1′*, *2-2′*, *3-3′*, *4-4′*, etc., to the corresponding lines in Fig. 13(b), thus completing the pattern.

(To be continued)

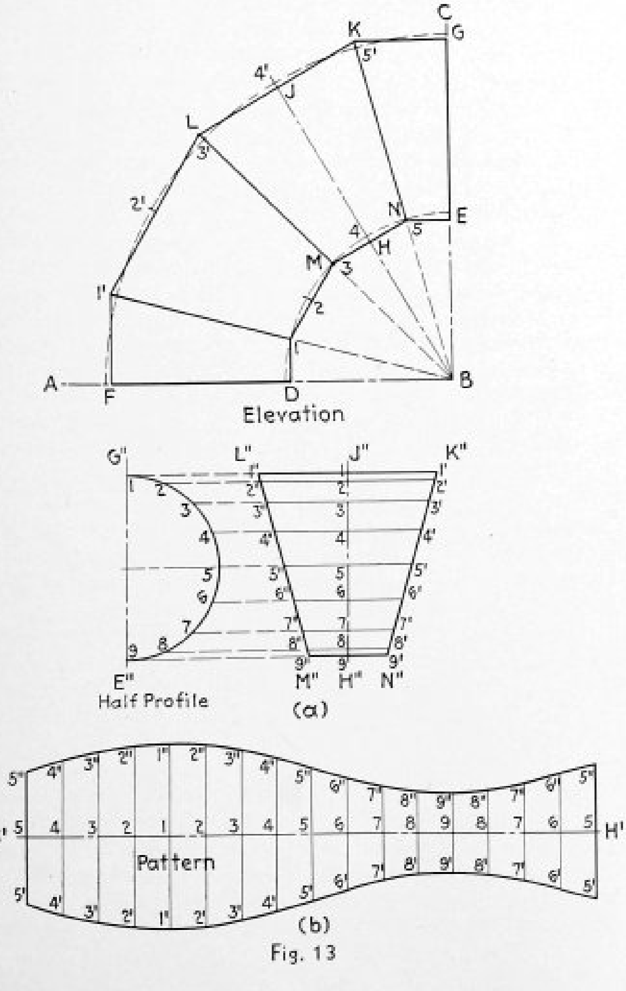


Fig. 13

Terms of Sale for Steel Tubular and Firebox Boiler Industry Approved

National Recovery Administrator Hugh S. Johnson has approved the terms of sale for the steel tubular and firebox boiler industry as submitted by the executive committee of the Steel Heating Boiler Institute, the industry's code authority. The terms specified are:

"Net cash thirty days or five percent discount for cash within fifteen days from date of invoice. The net amount of the invoice is to be determined by deducting all freight allowances from the net quoted prices. On all past due accounts legal rate of interest."

Simplification of Steel Heating Boilers

A general conference of all interests to discuss the simplification of steel horizontal firebox heating boilers was held under the auspices of the Division of Simplified Practice, of the National Bureau of Standards, in the Cleveland Hotel, Cleveland, on June 5.

A proposed recommendation covering these boilers, prepared by the Simplified Practice Committee of the industry, served as a basis for discussion. More complete details of the conference will be available shortly.

Boiler Manufacturers' Association Holds Joint Meeting With Associated Industries

The forty-sixth general meeting of the American Boiler Manufacturers' Association, held at Sky Top Lodge, Sky Top, Pa., June 11 to 14, was notable in that it represented the first joint meeting with the entire boiler manufacturing industry, as well as the industries such as the stoker and pulverized coal industry closely affiliated with it. Because of the broad character of the program a four-day session was required to transact necessary business, which is now involved with operation under the NRA Code for the industry.

About fifty members were present at the opening session on Monday, June 11, which was exclusively a meeting of the association proper. Charles E. Tudor, president, officiated. Routine committee reports occupied the first part of the session, followed by the president's annual address, an abstract of which follows:

President's Address

The American Boiler Manufacturers' Association has always welcomed and sponsored progressive moves. For some time prior to our annual meeting in 1932 there had been considerable discussion as to the advisability of attempting a merger between ourselves and our allied industries. While some doubts were expressed on the subject by representatives of all the organizations considered, the subject grew to be one of decided interest and importance. After an exchange of views and many suggestions on the part of all who were mutually interested, the merger was completed at our annual meeting in 1933 and from that time on we have been known as, and operating under, the title of the American Boiler Manufacturers' Association and Affiliated Industries.

I want to impress upon the minds of the old as well as the new members of our organization the fact that the American Boiler Manufacturers' Association and Affiliated Industries is a parent association and has under its wing the various divisions or branches, namely: Watertube branch, H.R.T. branch, pulverizer branch, stoker branch, air preheater and economizer branch, and class one welding branch. All of these branches are working individually with their peculiar problems with the desire and aim for unification and betterment of all those interested. After all, we are reaching out to a common end. Unity in action spells success and this unity of thought and action is possible only by personal contact and by being brought together under one head, which makes it absolutely necessary to have a parent organization through which the various activities can be directed. Every person present has a real obligation to support such an enterprise, and I commend you most highly for your wonderful and logical co-operation this past year.

I feel sure that as time brings about normal conditions we can build up, strengthen and broaden our mutual interests to a decided advantage and to the satisfaction of all.

At our annual meeting last year, our industry was at a low ebb. While manufacturers in all lines of endeavor reported deplorable conditions, there was none that had sunk any deeper into the mire than the boiler industry. At that time we seemed to have lost faith in our industry, in ourselves, and in each other. Hopefulness apparently was in the same category as any one of the lost arts. During the months of April and May of 1933 we were receiving information through confidential sources as well as through the press, clearly indicating that our Government at Washington proposed to take drastic measures to stem the tide of destructive competition, to bolster up industry, encouraging manufacturers to move as quickly as possible in the construction and adaption of practical codes, mutually agreeable to the officials at Washington. Through this assurance we looked forward with renewed hopes for a better day not far distant.

I am firmly convinced that we are beginning to see a lighted path ahead leading us out of our major difficulties. Business has fought its way through the storms, has experienced severe earth shocks, as it were, and now is coming through the choppy seas as well as can be expected under the circumstances.

The business world undoubtedly is in better condition today than it was one year ago. So, as we look back over the discouraging months of the past few years, let us again take a stronger grip and with renewed hope rise up Phoenix-like from the ashes of the gloomy past in an effort to rebuild ourselves on a firm and lasting foundation.

At our annual meeting on June 5, 1933, Mr. Owsley Brown offered a resolution, one paragraph of which called upon the President of the A. B. M. A. to appoint a committee of six members of this association and the president *ex-officio* to formulate a code of rules under which the industry was to be conducted, all in conformance with the National Industrial Recovery Act which had just recently come into being. The resolution was unanimously adopted, and the president later appointed the following gentlemen to serve as members of the A. B. M. A. Industrial Recovery Committee until the annual meeting in 1934 or until their successors were appointed: Owsley Brown, Springfield Boiler Company, chairman; A. G. Pratt, The Babcock & Wilcox Company; A. C. Weigel, Combustion Engineering Corporation; W. F. Keenan, Foster Wheeler Corporation: Starr H. Barnum, The Bigelow Company; A. W. Strong, Strong-Scott Manufacturing Company; H. H. Clemens, Erie City Iron Works; R. B. Mildon, Westinghouse Electric & Manufacturing Company; C. E. Tudor, Tudor Boiler Manufacturing Company, *ex-officio*.

The committee organized and had their first meeting at Sky Top Lodge, Pa. They made preliminary plans and swung into action without delay. On July 17, 1933, just one month after the enactment of the law, they prepared and submitted a code for approval. At that time the N.R.A. was unorganized and devoted its efforts to organization, and the drafting and approval of codes for the major industries.

Policies were still in the making, therefore action was slow and uncertain; nevertheless, the committee succeeded in securing the approval of our code as number 38, but 28 other codes had been approved prior to the date that our code was placed on the President's desk.

The committee drew up a code in accordance with all available information and had every reason to assume that it would be approved as written, but soon discovered that securing approval was a much more difficult task than they had anticipated. The code was re-written five times before it was granted a public hearing which took place on August 31, 1933. During this period three different assistant deputy administrators were assigned and had to be familiarized with the code as well as with their duties in general, as they were all new men in the Administration.

After the public hearing the real work of securing approval began. By this time five Advisory Boards had been set up and all five had to be satisfied individually before the Code could be approved, and still another assistant deputy was assigned to the Code and had to be familiarized with all that had proceeded. The result was that several more re-drafts were made before the Code was finally approved on October 3, 1933, with many important trade practice provisions omitted at the request of the Administrator and with the understanding that they could be secured later simply by application to the Administrator.

Within a few days after the approval of the Code, representatives of the committee went to Washington and consulted the deputy and advisors of the various boards interested to determine what was required to secure what they considered to be the necessary trade practice provisions. They returned with information supposedly sufficient to enable them to write a supplement acceptable to both the administrator and the industry.

This supplement was written, and after approval by the committee was presented to the administrator for approval on November 2, 1933. Much to the committee's surprise serious opposition developed at once and the supplement had to be re-drafted several times before it even reached a public hearing on December 27, 1933. During the discussion of the basic Code, the Committee had been given to understand that no public hearing would be necessary. At this public hearing a new set of representatives of various boards appeared with a new set of objections and the work of revision started all over again and continued until the supplement was finally approved on April 16, 1934.

During the entire period from July 17, 1933, to April 16, 1934, the committee devoted a large proportion of its time to this work with a corresponding loss of time for attention to the affairs of their own companies and were called upon not only to secure the best possible code provisions for this industry but to defend the industry from attempted encroachment by several other industry code committees.

On February 1, 1934, by administrative order, the committee was approved as the Code Authority for the Boiler Manufacturing and Affiliated Industries—and thus became an adjunct of the National Recovery Administration and ceased to be a committee of the American Boiler Manufacturers' Association so far as its relations with the N. R. A. were concerned.

No matter what comes about you have made substantial progress in constructing your code which eventually will bring about a better understanding, a better feeling among competitors. It will raise the industry to a higher plane. It will mean better working conditions for your men. It will result in satisfactory returns on your investment and our slogan should be "hold fast that which is good."

And now a word about your association. You have been functioning for forty-six consecutive years. In the early years the problems of the firetube and watertube boiler advocates were much the same. The manufacturing difficulties were similar and as the years passed on our association recognized these facts. We, therefore, worked out many of these problems, covering detail construction but leaving the design to the individual builder.

Uniform boiler laws were advocated and recommended. Unfair trade practices were frowned upon. The unscrupulous dealer, the habitual bankrupt imposing upon the manufacturers were subjects discussed and acted upon in the early days. I could go on indefinitely covering many details which the association has brought to the surface for cleansing and for the protection of its members.

Our association is a permanent body capable of advising and guiding its membership through the pitfalls, of unscrupulous acts on the part of purchasers and users of our products, for the dissemination of knowledge and a broader understanding of the industry in general. In view of the fact that there is a possibility of the N.R.A. being definitely limited by law, we must be on the alert, prepared to make such moves that may be found necessary to protect our code and our association.

Consideration was given by the association to become members of the Exhibitors Advisory Council, a body designed to protect the interests of companies exhibiting their products at power and other shows held throughout the country. On this subject a special sub-committee of the A. B. M. A. presented a comprehensive report, referring particularly to the New York Power Show to be held in December. In this report E. R. Fish, chief engineer, Boiler Division, Hartford Steam Boiler Inspection & Insurance Company, took occasion to review the prospects for business as follows:

Business Outlook

My opinion is that public utilities generally have ample capacity for some time to come and that there will not be any boilers purchased by them to any great extent for a year or two at least. Most industries have power plants in excess of their present requirements or any demands that may be made in the near future.

There will be some business in the way of replacing incapacitated equipment, but I believe that the time has come when the operators of many industrial power plants can be shown that, by installing modern economical equipment, their power can be produced at a very greatly lessened cost. This, of course, is not a new idea, as it has been discussed for several years, but now would seem to be a very propititious time for a concerted effort to be made to enlighten power plant operators of the possibilities. The Power Show is one of the means by which such advantageous propaganda can be spread among those interested in power plants and power plant equipment.

As an illustration of this general principle may be cited the revolutionary high-speed streamlined trains with which the railroads are now experimenting and which offer great encouragement in the way of regaining passenger traffic and handling it at a substantial profit. This, together with the very wide-spread practice of air conditioning railroad cars, is evidence of the railroads getting out of a rut by adopting new ideas that contribute to reduced cost of operation.

In short, the prospect of any considerable amount of new business lies in the rehabilitation of old plants rather than the building of new plants or extensions of old ones.

Discussion was next entertained of proposed new by-laws of the association which were adopted. Under the by-laws, the objects of the association, as set forth in its certificate of incorporation, include, among other things, provisions to (1) establish such standards for material and workmanship as will result in uniform excellence of construction of all American boilers and auxiliary equipment and to procure the enactment and enforcement of laws pertaining thereto: (2) to promote

(Continued on page 160)

Blast furnace uptakes under erection

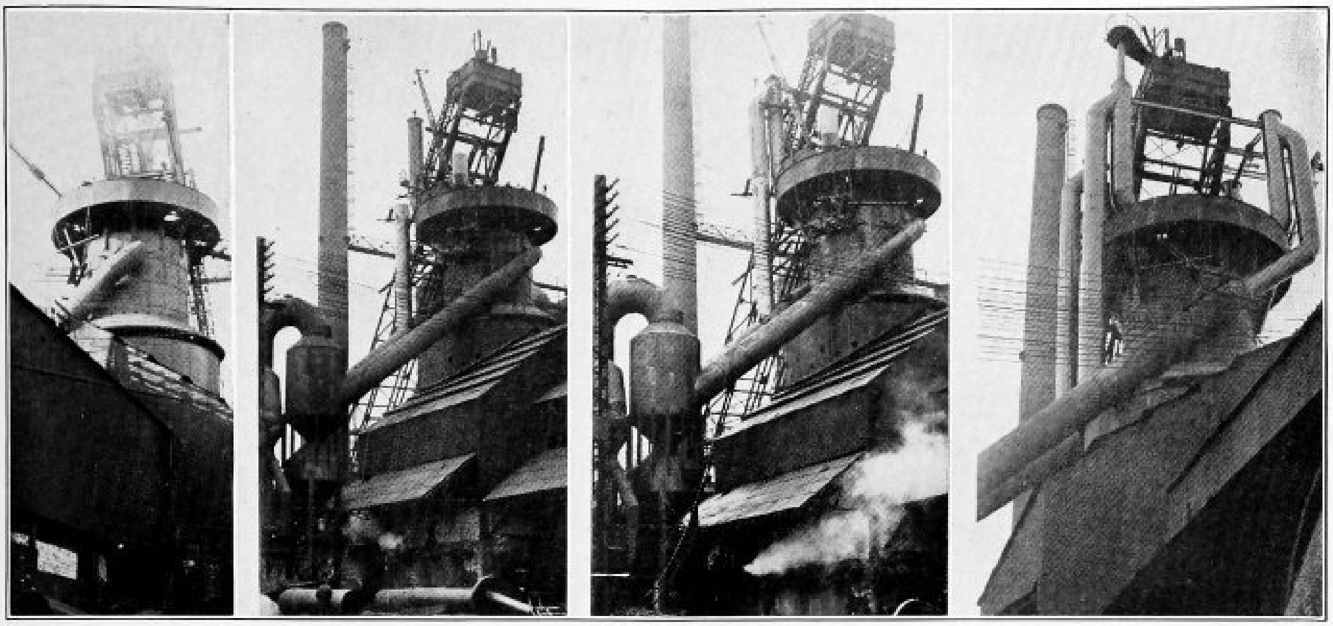
Welding used in

MODERNIZING A BLAST FURNACE*

The first time welding has been applied to the fabrication and erection of blast furnace uptakes and downcomers was in a recent remodeling job on a blast furnace at the plant of the Alan Wood Steel Co., Conshohocken, Pa. These all-welded gas outlets replaced the old style of outlet and were constructed by H. A. Brassert & Co., of Chicago. Supporting brackets and other construction pertaining to the same job were also welded.

It was decided to use welding for this job solely for reasons of design and economy, and, as matters turned out, this type of construction was a boon for the erectors, since it permitted needed alterations on the job at small additional expense and little outlay of time. Such alterations were made necessary by the impracticability of obtaining field measurements of the existing blast furnace and the unreliability of old blueprints showing the original construction. Moreover, the blast furnace structure is subjected more or less to warpage, which further complicated the problem of making a design that would fit the existing structure.

* From material supplied by *The Welding Engineer.*

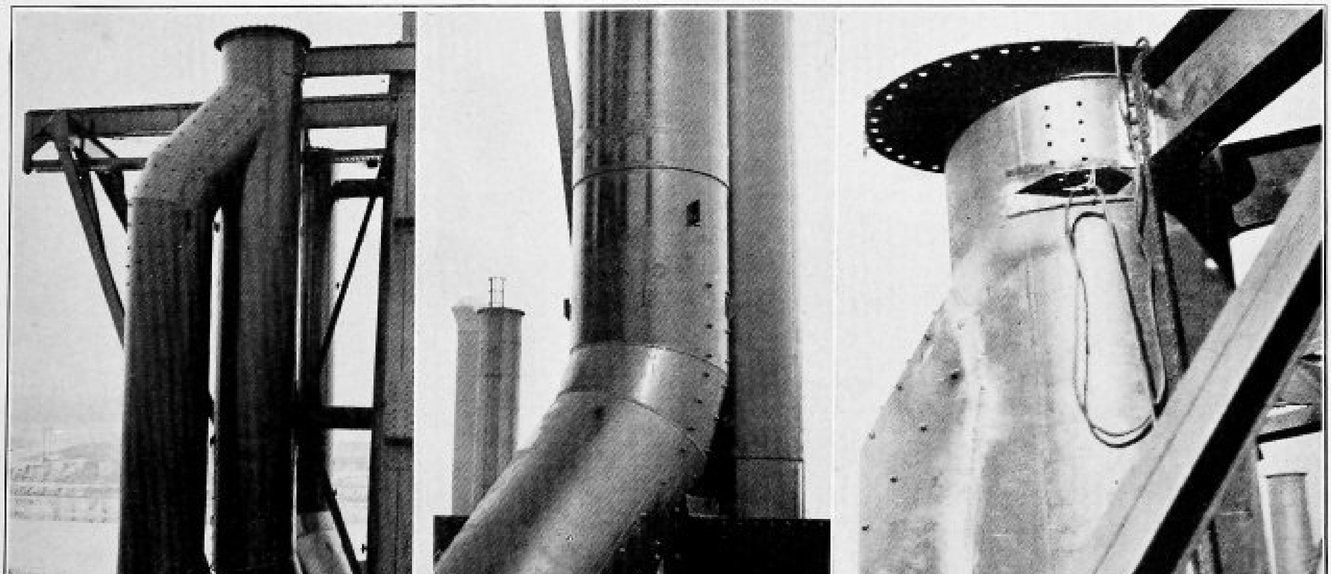


Progress views of the erection of uptakes

This furnace formerly had six short gas outlets leading from the top down to the two downcomers, which are the two slanting pipes, 5 feet 9 inches inside diameter, of riveted construction, shown in the accompanying illustration. With the completion of the four all-welded uptakes and connections to the downcomers, the original six outlets have been eliminated. The new design has the advantage that coke, ore and other materials blown out of the top of the furnace are deflected at the end of the uptakes and fall back into the furnace instead of being carried over with the gas into the dust catcher.

The gas at times travels at very high velocity, with the result that small particles carried with it have a serious eroding action against the outside wall at each elbow of the pipe or wherever the direction of movement of the gas is changed. At these points of wear, wearing plates are inserted inside the pipe and held in place with bolts, as the illustrations show. To replace these wearing plates, it is only necessary to burn off the ends of the bolts from the outside of the pipe and drive out the bolts, thus releasing the plate.

The welded uptakes and connections to the downcomers are made from ⅜-inch steel plates, formed and welded to make a pipe 4 feet in diameter. Though each



Details of all-welded uptakes and downcomers uptake and the vertical pipe connecting it to the downcomer form a complete structural unit, the uptake as well as the connecting pipe is welded to make two sections in the fabricating shop, necessitating five field welds, as follows: Lower section of the uptake welded to the blast-furnace shell; lower section of the connection pipe welded to the downcomer; each of the two upper sections welded to their respective lower sections; and both upper sections welded together.

Other field welding was required on the brackets, made of angles and plates, which support the uptakes and are welded to the uptakes and blast-furnace shell. Welding was also used to fasten a beam to the skip truss for anchoring the A-frame for hoisting the furnace bell and hopper; riveting the beam was out of the question here since the details of the truss were not known. Field welding also saved labor and expense in relocating one of the struts connecting the tops of two of the uptakes; rivet holes and angles had been provided for making the connections, but stairs were in the way, making it necessary to move the beam, which was readily accomplished by welding the ends in place and plugging up the rivet holes in the uptakes with weld metal.

The field joint in each of the four connection pipes between the uptakes and the downcomers was designed as a slip joint, the upper section fitting over the lower section and allowing a maximum of 12 inches of vertical movement to compensate for errors in the location of the downcomer. This field joint was welded both inside and out. Where the pipe was to enter the downcomer, a hole was marked out and cut, through which the bottom of the pipe was inserted. Then a flange, made of plate formed to an angle section, was fitted closely around the joint and welded in place, after which a cutter inside the downcomer cut off the end of the pipe flush with the inside wall of the downcomer.

Extending upward from the top of one of the uptakes is a 20-inch bleeder pipe, also of all-welded construction, as one of the illustrations shows.

A difficulty encountered in a job of this nature, where erection bolts are out of the question, is the fact that each welded section of pipe must be absolutely in plumb before tack welds are made. In this case, small erection lugs were welded to the pipe to provide places for anchoring tackle, hanging scaffolds, etc., thus facilitating handling of the welded sections after they arrived from the fabricating shop. As it was not necessary to remove these lugs, many of them were left on after completion of the work; these will be of material aid from time to time in supporting scaffolding, etc., for painting, for replacing wearing plates, or for other repair work.

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. 755, 767, 768, 770 and 771, as formulated at the meeting of March 23, 1934, they having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 755 (Reopened).—*Inquiry:* Will it be permissible to connect an automatic low-water fuel cut-off and/or water-feeding control device to the ½-inch water-glass connection of a low-pressure heating boiler, provided there is no external use therein of steam or water from the boiler?

Reply: 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 nonferrous tees or Y's not less than ½-inch pipe size inserted between the boiler and the water glass so that the water glass is attached directly and as close as possible to the boiler; the straight-way tapping of the Y or tee to take the water-glass fitting, the side outlet to take the fuel cut-off or water-feeding device. The ends of all nipples where used shall be reamed to full-size diameter.

CASE NO. 767.—*Inquiry:* Par. P-288*a* calls for every attached superheater to have one or more safety valves near the outlet. Is it permissible to have a safety valve at either end of an outlet superheater header to which steam is delivered from the boiler drum through a plurality of tubes spaced at practically equal intervals throughout the length of the header to provide a uniform flow of steam through the tubes?

Reply: It is the opinion of the Committee that if the superheater outlet header as described has a full free steam passage from end to end, a safety valve or valves located anywhere in the length of the header may be considered as fulfilling the requirements of Par. P-288*a*.

CASE NO. 768.—(In the hands of the Committee.)

CASE NO. 769.—*Inquiry:* Will boilers and pressure vessels of riveted construction meet the Code provisions if fabricated of an alloy steel plate material conforming to Specifications for CMS (Chrome-Manganese-Silicon) Alloy Steel Boiler Plate which will be designated in the Code as Specifications S-28, having the following chemical and physical properties:

Carbon, maximum, percent	0.25
Chromium, percent	0.30–0.60
Manganese, percent	1.05–1.40
Silicon, percent	0.60–0.90
Phosphorus, max., percent	0.035
Sulphur, max., percent	0.04
Tensile strength, lb. per sq. in.	85,000–100,000
Yield point, lb. per sq. in.	0.55 tens. str.
Elongation in 8 in., min., percent	1,600,000 / tens. str.

The rivet material to be used for fabrication may be of the same analysis except that the carbon shall not exceed 0.17 percent, which corresponds to a tensile range of 75,000 to 90,000 pounds per square inch.

Reply: It is the opinion of the Committee that alloy steel plate and rivets having the chemical and physical properties specified and otherwise conforming to Specifications S-28, may be used in the riveted construction of boilers and pressure vessels under Code requirements.

CASE No. 770.—*Inquiry:* In Fig. MA-2 of the Code, the definition of W is given as "approximately $1\frac{1}{2}t$," whereas in Fig. MA-3 it is given as "approximately 1½-in." Should these definitions not be the same and made to read "approximately 1½-in." to conform with the corresponding definitions in the Power Boiler and Unfired Pressure Vessel Codes?

Reply: The expression "approximately $1\frac{1}{2}t$" which appears in the definition of W in Fig. MA-2 is a typographical error and should read "approximately 1½-in." This illustration will be corrected accordingly.

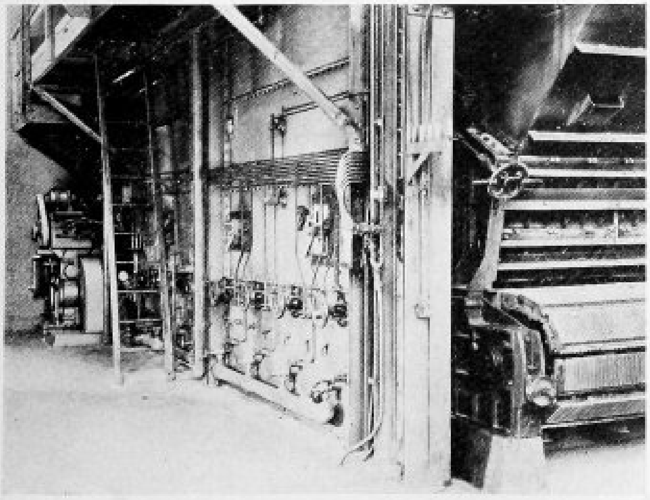
CASE No. 771.—*Inquiry:* What are the pressure and temperature limits for bronze safety valves under the requirements of the Code?

Reply: Although the Code contains no direct reference to or specifications for bronze, it is the opinion of the Committee that if non-ferrous fittings or valves are made of a bronze corresponding to A.S.T.M. Specifications B 10-18, or B 61-28, they may be used for temperatures not in excess of 450 degrees F. and for any pressure within the temperature limitation.

Coxe Traveling Grate Stoker

To adapt the well-known Coxe Stoker to wider furnaces, hence larger capacities in the burning of small sized anthracite, coke breeze, lignite and certain non-caking bituminous coals, under forced draft, Combustion Engineering Company, New York, has brought out what is designated as the CD design. This employs two or more carrier bars placed end to end instead of a single bar across the stoker as in the older design where the length of the bar was necessarily limited in order to avoid warping. These bars carry cast-iron keys the overlapping construction of which prevents ash being carried back to the front of the stoker.

The stoker body is built up of structural steel cross members which, in turn, support the skids and grate surface. This is in contrast to the smaller Coxe stokers in which the skids are supported on the box structure comprising the several air compartments. These compartments are formed by plates attached to the cross members so as to form a trough and steam or air jet blowers are placed at the sides to blow siftings into the longitudinal trough. Air is distributed to the compartments from air chambers beneath the side walls and the use of ducts is therefore avoided. Handwheels at one or both sides of the setting permit individual air control to each compartment. Preheated air may be employed.



Installation of Coxe stoker

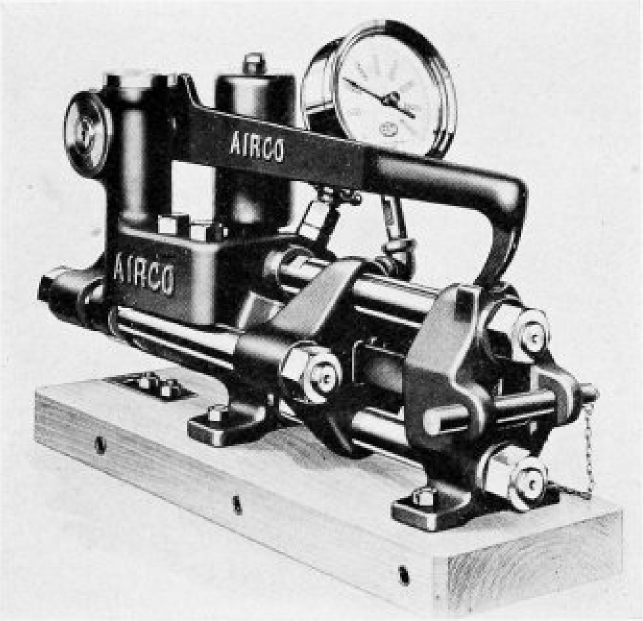
As in the smaller design the stoker is driven from the rear shaft with the take-up for the driving chains located at the front.

The new design applies to furnace widths of 12 to 24 feet whereas the older type, with the single-bar design was limited to 11 feet 8⅝ inches.

Portable Testing Machine for Welding Work

The growing demand for accurate knowledge of weld strength is the natural result of great developments in welding. In fabrication and in pipe line work, engineers now consider it essential to know with close exactitude the actual strength of welds as they are made. Also knowledge that the welds are as strong as the plate being welded is frequently desired.

The delay and complexity of shipping weld specimens to testing laboratories have brought about a strong demand for a compact, accurate and portable testing machine for use right on the job. In answer to this demand the Air Reduction Sales Company has developed the Airco portable tensile and bend testing machine, which is a compact, comparatively light machine that can be carried to the welding job so that welded specimens can be tested on the spot, rapidly and easily.



Entire tester weighs but 200 pounds

The machine consists essentially of an oil pump, a hydraulically actuated piston or ram, two heads—one fixed and one movable—for gripping the test specimens, and four symmetrically located steel shafts, two of which transmit the piston motion and load to the movable head. The other two shafts maintain the alinement of the two heads, and prevent the introduction of bending stresses in the tensile test specimen.

By means of a long lever attached to the pump, and the ratio between the areas of pump plunger and hydraulic ram, the downward force on the pump lever is magnified four hundred times in the load applied to the test specimen. This magnification of the force applied to the pump lever, together with the large piston displacement of the oil pump, enables specimens to be tested rapidly and with a minimum of effort.

The load on the test specimen is indicated on a 6-inch pressure gage of special construction, carefully calibrated against a standard dead weight tester. The gage is designed to maintain its accuracy under the strains of usage and shipping.

The machine is calibrated, using clean lubricating oils covering the range of viscosities sufficient to assure that the viscosity of the oil does not materially affect the accuracy of the machine. Any good light crank case oil can be used. The oil chamber is provided with a filter to prevent any dust particles which may drop into it from entering the oil passages.

With a few strokes of the operating lever, after the specimen is set up, the operator of the Airco testing machine can apply a direct load up to 40,000 pounds to specimens from 9½ inches to 10 inches long, up to ½ inch thick, and up to 1½ inches wide. Then, by using specimens of smaller cross-sectional areas than the maximum 1½ inches by ½ inch, loads equivalent to 150,000 pounds per square inch or higher can be applied. With these reduced size specimens the whole range of various types of steel can be tested by this quick and easy method. The stroke of the movable head is up to 2¾ inches, more than ample for practically any of the ferrous or non-ferrous metals. The operation of the machine requires but little effort. It is rapid, simple, and sure, and readings are accurate to plus or minus 2 percent.

For the bend test, the machine is provided with an anvil which fits into the movable head, and which bends the specimen against a pair of supports set 3 inches apart and cast integral with the body of the machine.

An important feature of this testing outfit is its easy portability. A solid hardwood base upon which the machine is permanently mounted forms part of the packing case. Sides and top of the case are assembled with screws. A few minutes with a screw driver frees the machine for immediate use, or packs it for shipment to another job. A separate box contains the gage, carefully packed to protect it in transit. The entire unit, machine and case, weighs only a little more than 200 pounds and can be handled freely without damage to the machine.

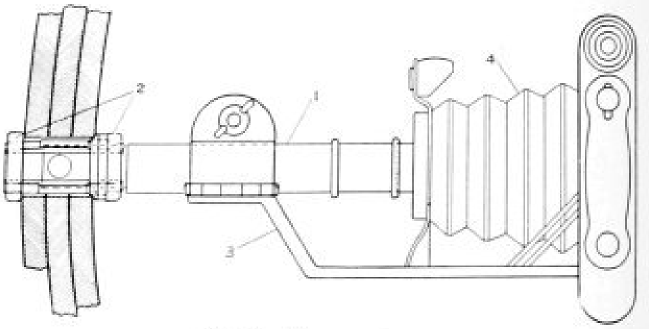
Hartford Magniscope Granted Letters Patent

The Hartford Magniscope, a magnifying periscope with a camera attachment used to photograph the walls of rivet holes in caustic embrittlement investigations, has been patented for the Hartford Steam Boiler Inspection and Insurance Company by Jared P. Morrison, assistant chief engineer of the boiler division. The patent was granted February 20, 1934, seven claims being allowed.

The patent papers describe the magniscope as "an instrument for inspecting and recording the condition of walls of openings in metal plates." It comprises a "rigid tubular casing (see illustration, 1) containing magnifying lenses and a reflector for directing light rays upon the lenses, said reflector (prism) adapted to be inserted into and moved longitudinally and rotatorily in the opening to be inspected; means (2) adjacent to the reflector for firmly clamping said casing to the walls about the opening . . . and means (3) for the attachment of photographing apparatus (4) in front of the lenses."

The claims have to do with an "adjustable eye lens at one end and an object lens at the other" connected as explained above to the rest of the apparatus. The lenses are "adjustable with relation to each other" and with relation to the reflector, and the light rays are directed from one side to the lenses by means of the reflecting prism. An opening receives and directs the light rays. The patent also admits the claim for use of the microscope, reflectors, etc., in conjunction with the photographing apparatus detachably mounted in front of the eye lens.

Use of the magniscope is general among Hartford Steam Boiler inspectors. Its development has been the result of more than 20 years of painstaking research into the subject of caustic embrittlement, particularly as it affects the safety of large pressure vessels. This work was pioneered in the field by Hartford inspectors directed by Mr. Morrison. The magniscope has been available for general industrial use since patents were first applied for. The government's allowance of patent claims definitely recognizes the contribution to industry made possible through the development of this instrument for discovering and recording embrittlement defects in metal plates.



Details of the magniscope

Caustic embrittlement, the prevention and control of which led to the perfection of the magniscope, is an insidious boiler disease which manifests itself in pressure vessels by the presence of microscopic cracks in the plate adjacent to rivet holes. Because these cracks are hidden within a seam of the boiler, it is practically impossible to discover them in their early stages without some means of magnification applied to the wall of the rivet hole. Thus, a trained observer working with the magniscope, designed specifically for examining the walls of rivet holes, may locate the presence of caustic embrittlement in time to permit remedial measures. Caustic embrittlement defects in their advanced stages weaken the seam to the point of failure, and threaten the safety of all property and persons in the vicinity of the boiler.

The theory which is most widely accepted as to the cause of caustic embrittlement is that there occurs in the boiler a combination of stress and chemical attack, the former inherent in the operation of the vessel and the latter the result of sodium hydroxide in the boiler water. These conditions bring about a breaking down of the cement between the crystals of steel and cause a gradually developing network of minute cracks. Prevention has to do with feed water treatment, but once the disease has been started, reconstruction or at least repair of the affected seam is necessary to save the boiler. The magniscope has proved of most value to industry in making possible the discovery of microscopic cracks in slightly affected plate and in giving the signal that immediate remedial measures are necessary to save the boiler.

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 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. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communication 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-102*i* and U-68*i*. Revise First Sections to Read:

P-102*i*. *Non-Destructive Tests.* [For wall thicknesses of 4¼ in. and less every portion of] All longitudinal and circumferential welded joints of the structure shall be examined THROUGHOUT THEIR ENTIRE LENGTH by X-ray or gamma-ray method of radiography. [Drums or shells of a] IN CASE THE wall thickness EXCEEDS [over] 4¼ in. [need not be subjected to radiographic examination] AND until such a time as evidence is submitted to the Boiler Code Committee that greater thicknesses can be commercially examined, THE JOINTS SHALL BE RADIOGRAPHED WHEN THE THICKNESS OF THE METAL DEPOSITED IN THE WELD IS AT LEAST 3½ IN. [In order to be permitted to construct boiler drums or shells with a wall thickness over 4¼ in. without radiographic examination, a manufacturer shall have demonstrated his ability to produce sound welds in boiler drums or shells of a thickness not less than 3½ in., the joints of which have been examined by X-ray or gamma-ray methods.]

U-68*i*. *Non-Destructive Tests.* [For wall thicknesses of 4¼ in. and less, every portion of] All longitudinal and CIRCUMFERENTIAL welded joints of the structure [including the intersections with girth joints], shall be examined THROUGHOUT THEIR ENTIRE LENGTH by X-ray or gamma-ray method of radiography. [At least 25 per cent of the length of each welded circumferential joint equally divided between not less than four uniformly spaced intervals around the circumference, shall be radiographed. Where any one radiograph fails to comply with these requirements, all parts of the circumferential seam represented by that radiograph shall be radiographed. Vessels of a] IN CASE THE wall thickness EXCEEDS [of over] 4¼ in. [need not be subjected to radiographic examination] AND until such a time as evidence is submitted to the Boiler Code Committee that greater thicknesses can be commercially examined, THE JOINTS SHALL BE RADIOGRAPHED WHEN THE THICKNESS OF THE METAL DEPOSITED IN THE WELD IS AT LEAST 3½ IN. [In order to be permitted to construct vessels with a wall thickness of over 4¼ in. without radiographic examination, a manufacturer shall have demonstrated his ability to produce sound welds in vessels of a thickness not less than 3½ in., the joints of which have been examined by X-ray or gamma-ray methods.]

Revise Second Sentences of Third Sections to Read:

To determine whether the radiographic technique employed is detecting defects of a thickness equal to and greater than 2 per cent of the thickness of the BASE METAL [weld,] suitable thickness gages or penetrameters shall be used in the following manner:

In Items (1) Under Third Sections, Revise Second Sentences to Read:

Two ranges of universal thickness gages shall be available; these shall be stepped as follows: .005 in. to .04 in. for PLATE thicknesses up to 2 in., and .04 in. to .09 in. for PLATE thicknesses from 2 in. to 4¼ in., as shown in Fig. P-5A (U-11½A).

In Items (2) Under Third Sections, Revise Fourth Sentences to Read:

When necessary, steel strips ⅝-in. wide shall be placed below the penetrameter, the thickness of the strip used being sufficient to make the total thickness of penetrameter, strip and plate equal TO THE AVERAGE thickness of weld, as shown in Fig. P-5B (U-11½B.)

In Items (2) Under Third Sections Add the Following Sentence:

IN EVERY CASE THE THICKNESS GAGES OR PENETRAMETERS SHOULD BE SO PLACED THAT THE THIN EDGE OF THE GAGE OR THE SHALLOW GROOVE OF THE PENETRAMETER WILL BE ADJACENT TO THE END OF THE EXPOSED SECTION OF THE WELD.

Add the Following Sentence to the Fourth Sections:

THERE SHOULD ALSO BE A PLAIN INDICATION ON EACH FILM SHOWING THE JOB NUMBER, THE DRUM, AND SEAM, AS WELL AS THE MANUFACTURER'S IDENTIFICATION, SYMBOL, OR NAME.

Add the Following as Item (4) of the Ninth Sections:

(4) A COMPLETE SET OF RADIOGRAPHS FOR EACH JOB SHALL BE RETAINED BY THE MANUFACTURER AND KEPT ON FILE FOR A PERIOD OF AT LEAST TEN YEARS.

Figs. P-5 and U-11½. The illustration of the lower thickness gage in *A* will be moved to the left-hand end of the weld so that the thinnest part of the gage may come to the end of the weld as in the upper portion of the figure. Similarly, in *B* the lower penetrameter will be moved to the left-hand end of the weld so that the shallowest groove will come at the end of the weld.

Par. P-258. Revise Last Sentence to Read:

A handhole opening in A [the] shell of a boiler [or] drum IN WHICH THE DIMENSION IN THE LONGITUDINAL DIRECTION EXCEEDS THE ALLOWABLE SIZE OF AN UNREINFORCED OPENING GIVEN IN PAR. P-268A OR IN WHICH the greatest dimension [of which] exceeds 6 in., shall be reinforced in accordance with the rules IN PAR. P-268B [for manholes].

Par. P-270. Revised:

P-270. The safety valve capacity for each boiler shall be such that the safety valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 6 per cent above the maximum allowable working pressure [or more than 6 per cent above the highest pressure to which the valve is set].

IF THE HIGHEST PRESSURE AT WHICH ANY VALVE IS SET IS LESS THAN THE MAXIMUM ALLOWABLE WORKING PRESSURE, THE SAFETY VALVE CAPACITY SHALL BE SUCH THAT THE PRESSURE CANNOT INCREASE MORE THAN 6 PER CENT ABOVE THIS HIGHEST SET PRESSURE.

Par. P-302 Revised:

P-302. ALL [The main] stop valves AND THE FITTINGS BETWEEN THEM AND THE [of] boiler[s] shall be EQUAL at least TO THE REQUIREMENTS OF THE AMERICAN STANDARDS GIVEN IN TABLES A-6, A-7, A-8, AND A-11 IN THE APPENDIX FOR [extra heavy when] the maximum allowable working pressure AND THE TEMPERATURE IN SERVICE AND MATERIAL USED, SUBJECT TO PARS. P-12 AND P-299, AND EXCEPT WHERE HEAVIER CONSTRUCTION IS SPECIFICALLY REQUIRED [exceeds 125 lb per sq in. The fittings between the boiler and such valve or valves shall be at least extra heavy as specified in Tables A-5, A-6, and A-8 of the Appendix.]

IN ALL CASES THE VALVES AND FITTINGS SHALL BE EQUAL AT LEAST TO THE AMERICAN STANDARD FOR 125 LB PER SQ IN.

Par. P-304. Add the Following Sentence:

ALL DRAIN LINES, INCLUDING PIPE, FITTINGS, AND VALVES, SHALL COMPLY WITH THE REQUIREMENTS FOR STEAM PIPING OR WATER PIPING ACCORDING TO THE SERVICE.

Par. P-310 Revised:

P-310. [The blow-off piping and any piping or fittings connecting them to the boiler, shall be of black wrought iron or black steel (not galvanized) and shall be as heavy as required for the feed pipe and in no case less than extra strong pipe size and shall conform to the requirements of Par. P-300.] The blow-off valve OR VALVES AND THE PIPE BETWEEN THEM AND THE BOILER shall be OF the [full] SAME size EXCEPT WHERE A LARGER PIPE FOR THE RETURN OF CONDENSATION IS USED, AS PROVIDED IN PAR. P-308 [of the blow-off pipes].

All fittings between the boiler and valves shall be of steel FOR PRESSURES OVER 100 LB PER SQ IN.

IN ALL CASES THE VALVES AND FITTINGS SHALL BE EQUAL AT LEAST TO THE REQUIREMENTS OF THE AMERICAN STANDARDS GIVEN IN TABLES A-5, A-6, A-7, A-8, AND A-11 IN THE APPENDIX FOR A PRESSURE 20 PER CENT GREATER THAN THE MAXIMUM ALLOWABLE WORKING PRESSURE, EXCEPT THAT FOR PRESSURES NOT 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-7 AND A-11 IN THE APPENDIX FOR 125 LB PER SQ IN.

FOR PRESSURE 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.

For pressures over 250 lb per sq in., the valve or cocks shall be of steel construction EQUAL AT LEAST TO THE REQUIREMENTS OF THE AMERICAN STANDARD FOR 300 LB PER SQ IN. GIVEN IN TABLE A-6 IN THE APPENDIX.

PAR. P.-311. REVISE FIRST SENTENCE OF SECTION (*a*) TO READ:

On all boilers except those used for traction and/or portable purposes, when the maximum allowable working pressure exceeds 100 [125] lb per sq in., each bottom blow-off pipe shall have two slow-opening valves, or one slow-opening valve and a cock, COMPLYING WITH THE REQUIREMENTS OF PAR. P-310 [and such valves or valve and cock shall be at least extra heavy construction]. BY SLOW-OPENING VALVE IS MEANT ONE WHICH REQUIRES AT LEAST FIVE 360 DEG TURNS OF THE OPERATING MEANS TO CHANGE FROM FULL CLOSED TO FULL OPENING AND VICE VERSA.

REVISE SECTION *b* TO READ:

b THE BOTTOM BLOW-OFF PIPES OF every traction and/OR portable boiler shall have AT LEAST ONE [a bottom] blow-off valve, CONFORMING TO THE REQUIREMENTS OF PAR. P-310. [when the maximum allowable working pressure exceeds 125 lb per sq in., the blow-off valve shall be at least extra heavy]

PAR. P-321. REVISE TO READ:

P-321. THE DESIGN AND MATERIAL OF A WATER COLUMN SHALL COMPLY WITH THE REQUIREMENTS OF PAR. P-299.

THE STEAM CONNECTIONS TO A WATER COLUMN, INCLUDING PIPE, FITTINGS, AND VALVES, IF ANY, SHALL COMPLY WITH THE REQUIREMENTS OF PARS. P-9, P-23, AND P-300.

The water connections to a water column AND DRAINS FROM THE WATER COLUMN AND WATER GAGE GLASS, INCLUDING PIPE, FITTINGS AND VALVES, IF ANY, SHALL COMPLY WITH THE REQUIREMENTS OF PARS. P-9, P-24, AND P-300 [of a boiler]. When practicable THESE CONNECTIONS shall be provided with a cross at each right angle turn to facilitate cleaning. The water column shall be fitted with a drain cock or drain valve with a suitable connection to the ashpit, or other safe point of waste, and if the water connection thereto has a rising bend or pocket, which cannot be drained by means of the water column drain, an additional drain shall be placed on this connection in order that it may be blown off to clear any sediment from the pipe. The water column blow-off pipe shall be at least ¾ in. pipe size. [For steam pressures over 250 lb, the connections shall be of steel pipe or tubing, wrought iron pipe or of other material capable of safely withstanding the temperatures corresponding to the maximum allowable working pressure.]

SPECIFICATIONS S-16.

PAR. 3. REVISE PHYSICAL PROPERTIES FOR EXTRA-REFINED BAR IRON TO READ:

	Extra-Refined Bar Iron
Tensile strength, lb per sq in........	48,000—53,000 [54,000]
Yield point, lb per sq in..............	no change
Elongation in 8 in., min...............	no change
Reduction of area, min................	35 [37]

INSERT THE FOLLOWING AS SECTION *b*;

b FLAT BARS HAVING A THICKNESS 9/16-IN. OR LESS SHALL CONFORM TO THE FOLLOWING MINIMUM REQUIREMENTS AS TO TENSILE PROPERTIES:

TENSILE STRENGTH, LB PER SQ IN..........	47,000
YIELD POINT, LB PER SQ IN................	0.6 TENS. STR.
ELONGATION IN 8 IN., PER CENT............	22
REDUCTION OF AREA, PER CENT..............	30

REVISE FIRST SENTENCE OF SECTION *b* TO READ, RELETTERING SECTION *b* AS *c*;

c[*b*] The yield point shall be determined by the drop of the beam OR HALT IN THE GAGE of the testing machine.

PAR. 9. REVISE TO READ:

Test specimens shall be of the full section of the material as rolled; OTHERWISE THE SPECIMEN SHALL BE MACHINED FROM THE MATERIAL AS ROLLED.

SPECIFICATIONS S-28 FOR CMS (CHROME-MANGANESE-SILICON) ALLOY STEEL BOILER PLATE: These will be additional specifications to be included in the Code, copies of which are obtainable upon application.

PAR. H-28. ADD THE FOLLOWING SECTION:

THE MINIMUM SIZE OF FIRE-DOOR OPENING IN AN INTERNALLY FIRED BOILER IN WHICH THE MINIMUM FURNACE DIMENSION IS 24 IN. OR OVER SHALL NOT BE LESS THAN 11 IN. BY 15 IN., OR 10 IN. BY 16 IN. SIZE. A CIRCULAR OPENING SHALL NOT BE LESS THAN 15 IN. IN DIAMETER.

PAR. H-36. REVISED:

H-36. The minimum size of [at least one fire or other] access door used in a boiler [or] setting [for boilers 30 in. and over in diameter or width] shall be 12 in. by 16 in. or equivalent area, the least dimension being 11 in.

PARS. H-50 AND H-103. REVISED:

H-50 (H-103). Each diaphragm-TYPE water-relief valve ½ in. or over, used on a hot-water boiler shall have a substantial lifting device by which the valve DISK MAY [can] be POSITIVELY LIFTED [raised] from its seat AT LEAST 1/16 IN. WHEN THERE IS NO PRESSURE ON THE BOILER.

PAR. MA.-1. REVISE SECOND SECTION TO READ:

The tests of a welder shall be effective for a period of six months only, at the end of which time a repetition of the tests shall be made by the manufacturer. EXCEPTION TO THIS IS ALLOWABLE WHEN THE WELDER IS REGULARLY EMPLOYED ON PRODUCTION WORK EMBRACING THE SAME PROCESS AND TYPE OF WELDING, IN WHICH CASE THE TESTS MAY BE EFFECTIVE FOR A PERIOD OF ONE YEAR. The tests conducted by one manufacturer shall not qualify a welder to do work for any other manufacturer.

FIG. MA-2. REVISE THE DEFINITION FOR *W* TO READ:

Approximately 1½ IN. [*t*]

PAR. U-11. REVISED:

U-11. All pressure vessels which are to contain substances having a corrosive action upon the metal of which the vessel is constructed OR THOSE SUBJECTED TO EROSION OR MECHANICAL ABRASION, shall be designed for the pressure they are to carry, and the thickness of all parts subject to corrosion, EROSION OR ABRASION should be increased by a uniform amount to safeguard against early rejection.

PAR. U-31. REVISED ITEM (3):

(3) Tell-tale holes [⅛ in. to ¼ in. in diameter shall] MAY be drilled AS PROVIDED FOR IN PAR. U-62*b* [to a depth at least 60 per cent of the required plate thickness in those surfaces opposite the surfaces subjected to wear or other deterioration, with the spacing of the tell-tale holes not over 2 ft. apart].

PAR. U-36. REVISE FIRST SENTENCE OF EIGHTH SECTION TO READ:

A blank DISHED head of semi-ellipsoidal form, etc.

PAR. U-59*b*. Fusion Welded Connections. REVISE FOURTH SECTION TO READ:

WHEN [On Class 1] vessels ARE BUILT IN ACCORDANCE WITH PAR. U-68 all connections after being attached by fusion welding shall be stress relieved.

REVISE FIFTH SECTION TO READ:

WHEN [On Class 2] vessels ARE BUILT IN ACCORDANCE WITH PAR. U-69 AND ARE REQUIRED TO BE [requiring] stress RELIEVED [relief], all connections after being attached by fusion welding shall also be stress relieved.

REVISE SIXTH SECTION TO READ:

WHEN [On Class 2] vessels ARE BUILT IN ACCORDANCE WITH PAR. U-69 AND ARE [which do] not requireD to be stress relieved, all connections, etc.

REVISE SEVENTH SECTION TO READ:

WHEN [On Class 3] vessels ARE BUILT IN ACCORDANCE WITH PAR. U-70 connections, etc.

In the eighth section of this paragraph for the words "Class 2 Vessels" substitute the words "Vessels built in accordance with Par. U-69," and for the words "Class 1 fusion welding," substitute the words "As provided for in Par. U-68."

PAR. U-62. INSERT THE FOLLOWING AS SECTION *b*:

b IT IS RECOMMENDED THAT WHEN THE THICKNESS OF THE PLATE IS INCREASED AS PROVIDED FOR IN PAR. U-11, TELL-TALE HOLES BE DRILLED TO PROVIDE SOME POSITIVE INDICATION WHEN THE THICKNESS HAS BEEN REDUCED TO A DANGEROUS DEGREE. IN CASES WHERE TELL-TALE HOLES ARE DRILLED, THEY SHALL BE ⅛ IN. TO ¼ IN. IN DIAMETER, AND SHALL BE DRILLED TO A DEPTH OF NOT LESS THAN 60 PER CENT OF THE THICKNESS REQUIRED FOR A SEAMLESS SHELL OF LIKE DIMENSIONS. THESE HOLES SHALL BE DRILLED IN THE SURFACE OF THE PLATE OPPOSITE TO THAT SUBJECTED TO SUCH DETERIORATION, THE SPACING OF THE HOLES TO BE NOT OVER 2 FT APART.

PAR. U-66. REVISE THE SECOND SENTENCE OF THIS PARAGRAPH TO READ:

If the vessel is of fusion-welded construction it shall also be stamped WITH THE NUMBER OF THE PARAGRAPH UNDER WHICH IT WAS MADE [to show the class of vessel].

PAR. U-67. REVISE FIRST SECTION TO READ:

Pressure vessels may be fabricated by means of fusion welding provided the construction is in accordance with the requirements for material and design OF THE RULES FOR [and the] fusion welding [process used conforms to the specifications for each class of vessel] as required in this Code.

PAR. U-68. REVISE FIRST THREE SECTIONS TO READ:

[Class 1, All] Vessels covered by this Code [constructed in accordance with the rules herein given,] may be used for any purpose WHEN CONSTRUCTED IN ACCORDANCE WITH THE RULES GIVEN IN THIS PARAGRAPH.

The joint efficiency E [for this class] to be used in applying the rules in Par. U-20 shall be taken as 90 per cent.

THE welding [for this class] shall meet the following test requirements:

Add the following sections:

j ALL VESSELS CONSTRUCTED UNDER THE REQUIREMENTS OF THIS PARAGRAPH SHALL BE STRESS RELIEVED IN ACCORDANCE WITH PAR. U-76.

k VESSELS CONSTRUCTED IN ACCORDANCE WITH THIS PARAGRAPH SHALL BE STAMPED "U-68" AS REQUIRED BY PAR. U-66.

PAR. U-69. REVISE THE FIRST THREE SECTIONS TO READ:

[Class 2.] All vessels covered by this Code WHEN CONSTRUCTED IN ACCORDANCE WITH THE RULES OF THIS PARAGRAPH may be [included in this class] USED FOR ANY PURPOSE except for containing lethal gases or [lethal] liquids and/or [those containing] liquids operating at a temperature in excess of 300 F, PROVIDING the plate thickness [as required by the permissible stress allowance shall] DOES not exceed 1½ in. AND the maximum pressure [at which any vessel in this class may be operated is] DOES NOT EXCEED 400 lb per sq in., NOR AT A [the maximum] temperature IN EXCESS OF [is] 700 F. This pressure limitation does not apply to vessels operated under hydraulic pressure at atmospheric temperature.

The joint efficiency E [for this class] to be used in applying the rules in Par. U-20 shall be taken as 80 per cent.

Welding [for this class] shall meet the following test requirements.

ADD THE FOLLOWING SECTION:

(*c*) VESSELS CONSTRUCTED IN ACCORDANCE WITH THE REQUIREMENTS OF THIS PARAGRAPH SHALL BE STAMPED "U-69" AS REQUIRED BY PAR. U-66.

PAR. U-70. REVISE THE FIRST SENTENCE OF FIRST SECTION TO READ:

[Class 3] All vessels covered by this Code, WHEN CONSTRUCTED IN ACCORDANCE WITH THE RULES OF THIS PARAGRAPH [not exceeding ⅝ in. plate thickness and] 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 F [may be included in this Class excepting those containing lethal gases or liquids]. PLATE THICKNESS SHALL BE LIMITED TO ⅝ IN.

REVISE THE FOURTH SECTION TO READ:

Welding [for this class] shall meet the following test requirements.

PAR. U-73*a*. REVISE THE FIRST PART OF THE FIRST SENTENCE TO READ:

Longitudinal joints on [Classes 1 and 2] vessels COVERED BY PARS. U-68 AND U-69 shall be of the double-welded butt type, etc.

REVISE THE FIRST PART OF THE SECOND SECTION TO READ:

The longitudinal joints of [Class 3] vessels COVERED BY PAR. U-70 may be of the [double welded] butt weld type, etc.

REVISE SECTION *c* TO READ:

Circumferential joints on [Class 1] vessels COVERED BY PAR. U-68 shall be of the double-welded butt type. Circumferential joints on [Class 2] vessels COVERED BY PAR. U-69 shall be of the double-welded butt type except for thicknesses of ⅝ in. or less, in which case they may be of the single-welded butt type. Circumferential joints on [Class 3] vessels COVERED BY PAR. U-70 may be of the butt or lap type. The details of all of these joints shall conform to the requirements for longitudinal joints given in (*a*).

REVISE THE FIRST TWO LINES OF SECTION *d* TO READ:

Dished heads concave to the pressure when used on [Class 3] vessels COVERED BY PAR. U-70 may be inserted with a driving fit and fillet.

PAR. U-76. REVISE THE FIRST SECTION TO READ:

All [Class 1] fusion-welded vessels CONSTRUCTED IN ACCORDANCE WITH PAR. U-68 shall be stress relieved.

REVISE THE FIRST LINE OF SECOND SECTION TO READ:

[Class 2 fusion welded] Vessels CONSTRUCTED IN ACCORDANCE WITH PAR. U-69 shall be stress relieved where

PAR. U-78. For the words "Class 1 vessel" in the first section substitute the words: "Vessel built in accordance with Par. U-68."

For the words: "Class 2 vessels" in the second section substitute the words: "Vessels built in accordance with Par. U-69."

For the words "Class 3 vessels" in the fourth section substitute the words "Vessels built in accordance with Par. U-70."

Change the heading of the form following Par. U-79 to read as follows: "Manufacturer's Data Report for VESSELS CONSTRUCTED IN ACCORDANCE WITH PARS. U-69 AND U-70" [Classes 2 and 3 Test Requirements].

FIG. U-7. For the words "Class of vessel" substitute the words "Welded according to Par. U-. . . ."

New Electrode for Class I Welds

A general-purpose welding electrode, designated as the Type W-22, has been added to the General Electric line of arc-welding electrodes. The new electrode is of the heavily coated or shielded-arc type and produces welds of the quality required for Class I pressure vessels according to the A.S.M.E. Boiler Construction Code. Its distinctive feature is that it may be used in any position, i.e., for flat, vertical, or overhead welding, and at the same time has deep penetrating properties. It is therefore equally suitable for butt and fillet welds.

Tests on all-weld-metal specimens made from Type W-22 electrode show the following average results, which more than meet the rigid Class I requirements:

Tensile strength,
65,000 to 75,000 pounds per square inch.
Elongation. . . . . .20 to 30 percent in 2 inches.
Impact resistance. . 30 to 45 foot-pounds (Charpy).

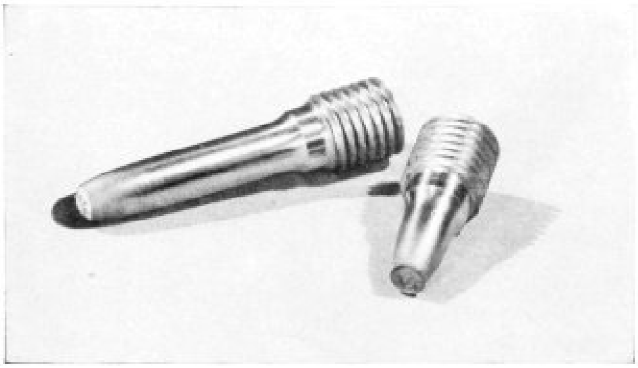
In addition, welded joints average 35 to 60 percent elongation when tested by the free bend method and X-ray, Class I.

Because these physical properties are obtained without regard to the position in which the welds are made, there is no necessity for moving the work so that welding may be done in a down-hand position. Heretofore, position welds of Class I quality were not generally obtainable.

The W-22 electrode has a wide field of application in the fabrication of large structures, such as ships and locomotives, where it is impossible or impracticable to move the work into a special welding position—and in the welding of such fittings as nozzles and flanges to pressure vessels, where handling costs are less if positioning of the work is unnecessary.

Coated Welding Electrodes for High-Strength Steels

Difficulty in arc welding steels containing more than 0.20 percent Carbon is overcome by a new heavy coated electrode, known as "Murex Special A", it is announced by the Metal & Thermit Corporation, 120 Broadway, New York. The new electrode, an improvement of a previous design, hinders the migration of carbon from the parent metal to the deposited metal when welding and assures a more ductile deposit. Sound, dense, X-ray-clean welds, having excellent penetration, can be made in high-carbon steels with perfect ease with this new addition to the Murex line, it is claimed. The deposit, containing a small quantity of nickel, has unusually good physical properties and stress-relieved, all weld metal specimens invariably show clean full-cupped fractures under test. The tensile strength of these deposits is 73,000 pounds per square inch; the yield point 59,000



Full-cupped fracture of test specimen

pounds per square inch; the elongation in 2 inches is 31 percent, and the reduction in area is 63.5 percent.

Other recently developed Murex electrodes, designed for use with the latest high-strength steels now make it possible to obtain welds with tensile strengths of 85,000 to 100,000 pounds per square inch. Such high strengths are obtained by including nickel or molybdenum, or a combination of these elements in the deposited metal. For example, one of the new electrodes, depositing 2½ percent nickel, is being used extensively in the welding of steels of this same analysis for low-temperature work where welds must show Charpy impact resistance of 10 to 24 foot-pounds at the extremely low temperature of —75 degrees F. The physical properties of this weld metal are also, it is said, extraordinary. Tensile strengths average 86,000 and yield points 72,000 pounds per square inch. The elongation in 2 inches is 25.5 percent. The reduction in area is 64 percent, and, almost without exception, test specimens show clean, fully cupped fractures.

Boiler Manufacturers' Annual Meeting

(Continued from page 151)

foster and further the improvement of the industry; (3) to formulate and adopt engineering standards for the industry; (4) to formulate and adopt standard commercial practices for the industry; (5) to study and develop methods for trade extension; (6) to procure and furnish to its members statistics of the trade; and (7) to co-operate with other organizations related to the industry.

Active membership under the new by-laws is open to any person, firm, association or corporation engaged in the manufacture of boilers, stokers, pulverized fuel equipment, superheaters or such auxiliary apparatus as may comprise a major part of a steam generating unit. Associate membership is open to any person, firm, association or corporation interested, directly or indirectly, in the boiler industry.

New Officers Elected

As a result of a vote taken on the nominations submitted by a special committee, the following officers were elected:

President, Owsley Brown, Springfield Boiler Company, Springfield, Ill.

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

Executive Committee (3 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.

Executive Committee (1 year): A. C. Weigel, Combustion Engineering Corporation, New York; Walter F. Keenan, Jr., Foster Wheeler Company, New York.

A number of older members of the association and representatives of special groups addressed the meeting, discussing current problems raised by operation of the industry under the code. Co-operation and conformance to the standards set up by the Code Authority for the industry are essential to successful business. The opportunity exists for the conduct of profitable enterprises, if these rules are followed. No attempt at this first session was made, however, to go into the working of the code, the program, which continued until Thursday, June 14, being devoted to general sessions of the entire industry at which all matters pertaining to the code were delt with.

The complete program of business sessions follows. Because of the impossibility of reporting other than the opening session in this issue, a more complete account will appear next month.

Program of the Meeting

Monday, June 11

9:00 A.M. Registration.

9:30 A.M. A.B.M.A. President's Address.

10:00 A.M. A.B.M.A. Committee reports, etc.

8:00 P.M. Address to entire industry: J. W. Hook, Administration member of Code Authority and vice-chairman of Durable Goods Industries Committee.

Informal discussion.

9:30 P.M. Meeting of Code Authority (A.B.M.A. Committee of Industrial Recovery).

Tuesday, June 12

9:00 A.M. A.B.M.A. General Session. Installation of officers, Resolutions, etc.

10:30 A.M. Boiler Manufacturing Industry (Code). General Session. Report of Code Authority. Report on election of Code Authority. Financial Report and Budget.

7:30 P.M. Banquet (Informal). Distribution of prizes. Dancing.

Wednesday, June 13

Boiler Manufacturing Industry and Affiliated Industries Meetings (Code).

9:00 A.M. Class One Welding Branch: E. C. Hutchinson, chairman.

9:00 A.M. H. R. T. Branch: Starr H. Barnum, chairman.

2:00 P.M. Watertube Branch: A. G. Pratt, chairman.

8:00 P.M. Postponed Unfinished business.

Thursday, June 14

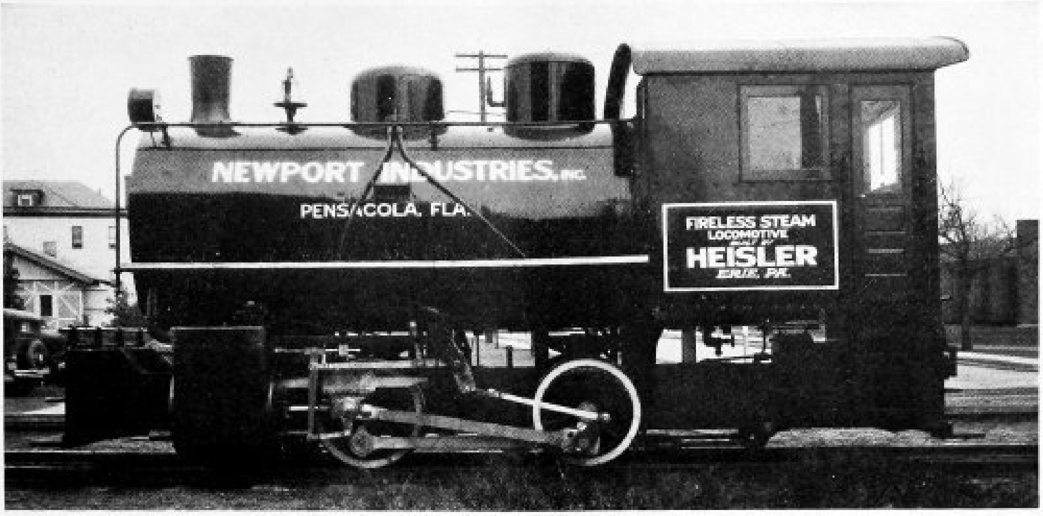
Boiler Manufacturing Industry and Affiliated Industries Meetings (Code).

9:00 A.M. Pulverizer Branch: A. W. Strong, Sr., chairman.

9:00 A.M. Air Preheater and Economizer Branch: chairman to be selected.

2:00 P.M. Superheater Branch: W. T. Conlon, chairman.

2:00 P.M. Stoker Branch: R. B. Mildon, chairman.



Locomotive ready for operation

Arc-welded tank installed on

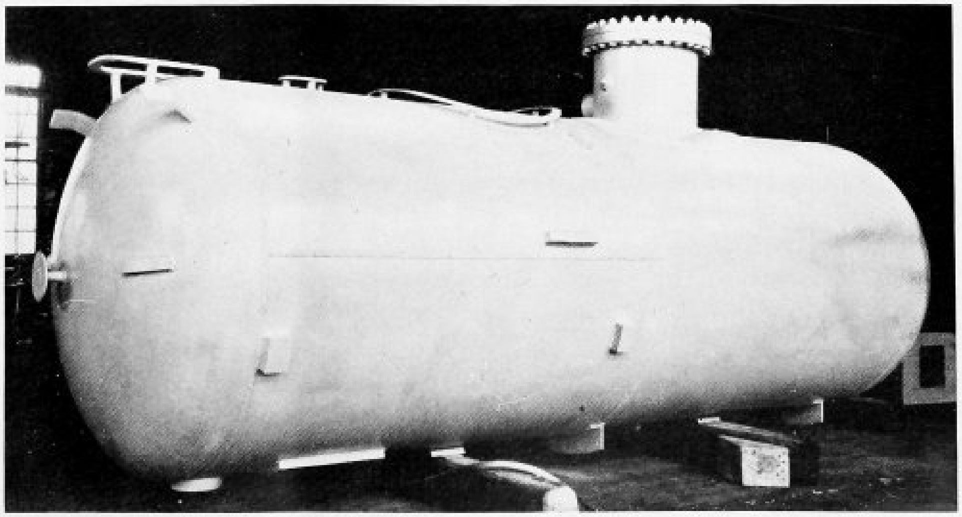
FIRELESS LOCOMOTIVE

The first known locomotive to use a fusion welded tank is a new fireless steam locomotive built by the Heisler Locomotive Works, Erie, Pa. Without boiler or firebox, this steam locomotive hauls a train of freight cars at rapid speed. The secret of the economy and unique advantages of this different type of motive power lies in the steam charged arc welded tank illustrated.

The tank is 69 inches in diameter and built for a working pressure of 215 pounds per square inch. It was built by the Struthers-Wells Company, Warren, Pa., using the shielded arc process. Welding and testing were in conformance to Class I of the A.S.M.E. Code for unfired pressure vessels. Welding was done with equipment manufactured by The Lincoln Electric Company, Cleveland.

This tank, which is heavily lagged and jacketed to prevent loss of heat, is filled with water to about four fifths of capacity. Then, by a steam pipe run from a stationary boiler to a point below the level of the water in the tank, the water is heated until the pressure and temperature in the locomotive tank are the same as in the stationary boiler from which the charge is being taken. It is from this heat stored in the water that the locomotive gets its power. For example, the tank on a 60-ton fireless locomotive, charged to 200 pounds pressure, stores sufficient energy to run the locomotive by itself over straight level track, a distance of about 95 miles, or to haul a train of three loaded freight cars weighing 210 tons a distance of 21 miles or more.

Riveted tanks used for fireless locomotives in the past have been a source of considerable trouble and expense, according to Heisler officials. "The rapid introduction into such tanks of high pressure and highly superheated steam now found in many modern plants, causes such rapid expansion of the tank plates as to open up the rivet seams. This is a serious matter, as the tanks need to be heavily lagged and jacketed, making leaks difficult to locate and expensive to repair. Even with low-pres-



Arc-welded tank for Heisler fireless locomotive for which high capacity and long-life are claimed by the builder sure steam a riveted tank has to be very carefully fabricated if laying up of the locomotive due to leaks is to be avoided."

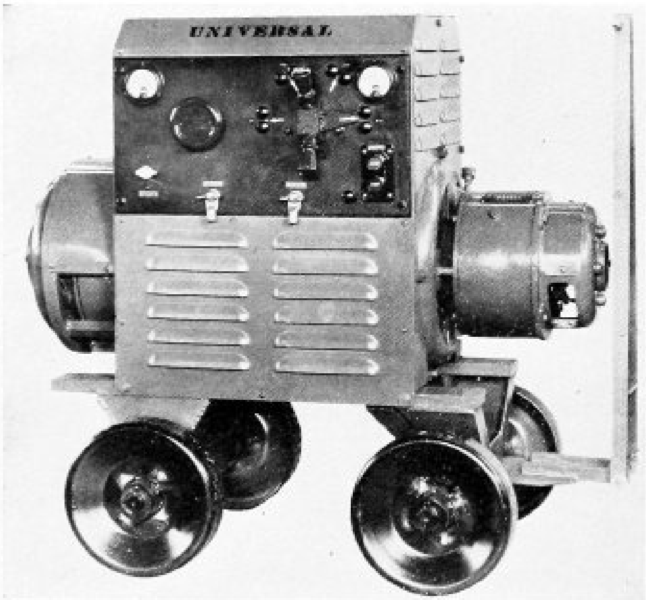
Advantages claimed for the fireless locomotive are lower initial cost, reduced maintenance, one man operation, longer useful life and 60 percent to 90 percent greater hauling power. Since there is no smoke or fumes, the locomotive may be operated inside buildings.

Explosions with this type of locomotive are unknown, because there is no crown sheet to burn on account of low water, no staybolts to break or flues to fail and weaken the boiler. No excessive pressures are possible. The simple tank construction enables every stress under all conditions to be calculated. This is not possible with a fired locomotive. Yet the factor of safety specified by the A.S.M.E. code is used for fireless tank design.

Arc Stability Feature of Universal Welder

The Universal arc welder manufactured by Universal Power Corporation, Cleveland, now incorporates an entirely new principle of arc stabilization which eliminates the need for the use of old-style power consuming reactors.

The company states that arc stability obtained is so smooth that operators lose minimum time in starting and



New Universal arc-welder

maintaining their arc, giving high operator efficiency. Machine efficiency is unusually high. So efficient is the deposit of weld metal—so low the power consumption that the margin saving in power and time over old style machines is enough to pay investment charges on the original cost of the welder.

Obsolete Machine Tools

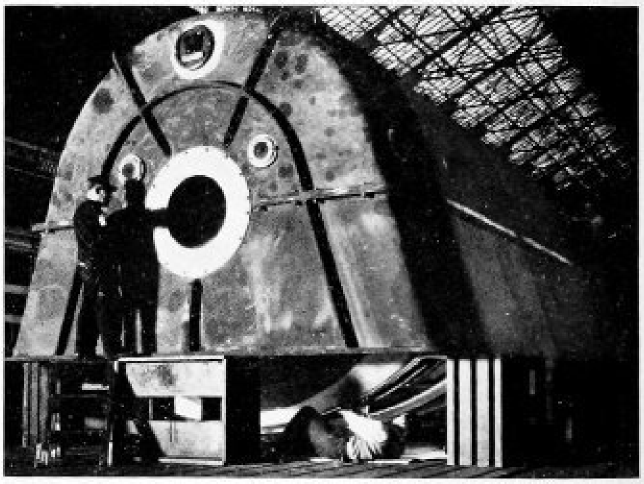
A striking example of the antiquity of some of the machine tools in active use was brought out in connection with an order received by the Warner & Swasey Company, machine tool builders, Cleveland.

The mail brought a request for a part of a 14-inch turret lathe. Correspondence showed that the serial number was missing but a detailed description of the lathe was given. Identification was finally made from old drawings in the files; the lathe was made in about 1900 and is now well over 30 years old.

While no parts for machines of that age are carried in stock, one was located and shipped. According to the owner, the lathe is still giving good service.

Building the Most Powerful Single-Shaft Generating Set

Building the stator frame for the world's most powerful single-shaft generating set is the task of these workmen in the East Pittsburgh shops of the Westinghouse Electric and Manufacturing Company. Being built for the Richmond Generating plant of the Philadelphia Electric Company on the Delaware River at Philadelphia, the set will consist of a 183,333-kilovolt-ampere, 13,800 volts, 3-phase, 60-cycle, 90-percent power factor generator driven by an 1800 revolutions per minute turbine. Fabricated of welded steel plate and cast iron end bells it will weigh 215 tons with punchings, the frame alone



Welded stator frame for generator

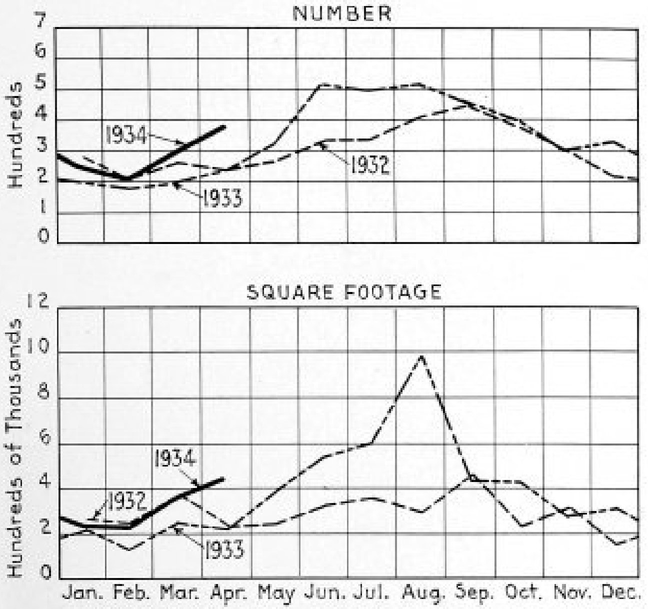
weighing 65 tons. Because of its size, it will be shipped in three sections and the laminations will be stacked at the Richmond Station. A special handling gear to turn the stator on its feet after stacking is being supplied as the station crane can lift only half the stator weight.

Ryerson Completes Plant Extension

The new addition to the Ryerson plant and equipment, at St. Louis, greatly increases facilities for storing and dispatching steel and allied products for the St. Louis area.

Approximately 40,000 square feet of floor space has been added by extending one of the large spans 165 feet and erecting a new building across the east end of the main warehouses. The greater part of this new space is given over to the warehousing of products requiring special protection from atmospheric changes. A circulating warm air heating system provides the necessary distribution of heat for the proper storing of sheets, tool steels, welding rod, cold finished bars, bands, hoops and other high grade steels. While the greater part of this new addition is heated, there is also a large space for mild steel bars, etc.; for cutting, shearing, loading and other general steel service.

Orders for Power Boilers and Equipment Show Great Improvement in Four-Month Period



Comparative production of steel boilers

The first four months of the year, according to information released by the Department of Commerce, Bureau of the Census, have evidenced a general improvement in the boiler manufacturing, the fabricated steel plate, and allied industries.

Orders for steel power boilers of all types, as reported by 68 manufacturers, for the four months, total 1135 as compared with 804 for the same period in 1933 and 989 in 1932. The heating surface produced totals 1,279,205 square feet in 1934, as against 816,993 square feet in 1933, and 1,120,662 square feet in 1932.

April production amounted to 380 units of 440,562 square feet of heating surface, as against March production of 294 units totaling 375,774 square feet. The curves of production for both number and heating surface indicate a definite trend which at the moment shows evidence of continuing upward. Table 1 gives complete production figures for the boiler manufacturing industry.

Fabricated Steel Plate Industry

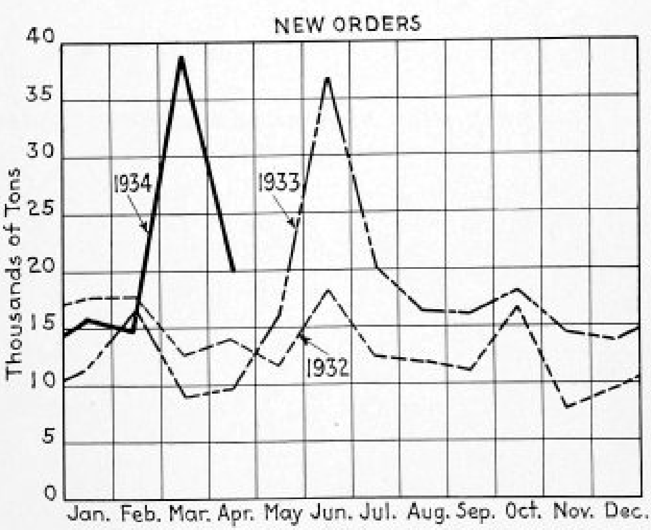
In the fabricated steel plate industry production rose to a peak in March and in April receded. The classes of work in which the recession took place are not classified, so it is impossible to determine the expectations for continued improvement.

Table 1.—Steel Boiler Production—New Orders, April, 1934

Item	1934		Total, 4 months (January-April)		
	April	March	1934	1933	1932
GRAND TOTAL:					
Number	380	294	1,135	804	989
Square feet	440,562	375,774	1,279,205	816,993	1,120,662
STATIONARY:					
Total:					
Number	361	283	1,081	765	961
Square feet	407,186	343,918	1,173,255	758,792	1,052,134
Water tube—					
Number	70	40	163	111	124
Square feet	273,081	219,640	718,607	435,114	611,798
Horizontal return tubular—					
Number	34	21	100	67	80
Square feet	47,420	29,280	135,809	83,009	92,539
Vertical fire tube—					
Number	32	38	124	102	119
Square feet	8,909	11,869	33,114	20,441	26,376
Locomotive (not railway)—					
Number	3	6	14	11	26
Square feet	3,489	2,518	10,187	7,445	25,985
Steel heating—					
Number	201	127	551	424	546
Square feet	54,440	42,600	176,829	162,673	243,335
Oil country—					
Number	2	17	34	3	1
Square feet	1,225	15,165	28,805	3,750	752
Self-contained portable—					
Number	14	33	87	42	58
Square feet	12,646	22,282	62,177	37,610	42,968
Miscellaneous—					
Number	5	1	8	5	7
Square feet	5,976	564	7,727	8,750	8,381
MARINE:					
Total:					
Number	19	11	54	39	28
Square feet	33,376	31,856	105,950	58,201	68,528
Water tube—					
Number	10	4	28	13	11
Square feet	31,000	22,348	89,152	36,002	57,324
Pipe—					
Number	......	......	4	1	2
Square feet	......	......	3,569	1,310	2,678
Scotch—					
Number	9	7	22	24	15
Square feet	2,376	9,508	13,229	19,789	8,526
Miscellaneous—					
Number	......	......	......	1	......
Square feet	......	......	......	1,100	......

Table 2.—Fabricated Steel Plate—New Orders, April, 1934

Item	1934		Total, 4 months (January-April)		
	April	March	1934	1933	1932
NEW ORDERS (TONS):					
TOTAL	20,085	38,924	89,547	46,769	62,000
Oil storage tanks	2,998	2,202	11,430	14,318	11,459
Refinery materials and equipment	2,338	2,495	6,650	1,443	1,770
Tank cars	128	356	810	146	181
Gas holders	1,174	65	2,335	801	3,126
Blast furnaces	......	......	105	38	349
Miscellaneous	13,447	33,806	68,217	30,023	45,115



Comparison of fabricated steel plate orders for the past three years

For the first four months of the year, production totaled 89,547 tons of fabricated steel plate products as compared with 46,769 tons in 1933 and 62,000 tons in 1932. New orders, however, fell off from 38,924 tons in March, 1934, to 20,085 tons in April. The chart indicates very graphically this recession.

Oil storage tank orders in April slightly exceeded those for March; refinery materials remained about the same; gas holders increased from 65 in March to 1174 in April, while the greatest drop occurred in miscellaneous production in which orders for 33,806 tons were placed in March and 13,447 tons in April. Table 2 indicates the orders by classes for this industry.

Oil Burners, Stokers and Pulverizers

In the field of products allied with power boiler manufacture the trend for the first four months of 1934 has been greatly improved. For this period there were orders placed for 18,669 oil burners, as compared with 12,418 units for the corresponding period in 1933. April figures show orders for 7479 units as against 5015 for March. Unfilled orders at the end of the month totaled 2486 compared with 1652 at the end of March.

The mechanical stoker industry in all its branches gained tremendously during the first four months over the like period in 1933 and in the power field approximately equaled its production in 1932. In the three classes of stokers for heating units production for the first four months of 1934 totaled 2412 units; in 1933 the total was 1369 units; and in 1932, production amounted to 1666 units.

In the field of heavy power, Table 3 gives the production for mechanical stokers. Class 4 consists of large commercial and high-pressure steam plants, having a capacity of over 300 pounds of coal per hour.

Table 3.—Mechanical Stoker Production—April, 1934

Item	1934		Total, 4 months (January-April)		
	April	March	1934	1933	1932
Class 4					
Total:					
Number	87	105	389	277	382
Horsepower	24,350	27,569	89,986	56,117	90,994
Installed under—					
Fire tube boilers:					
Number	48	62	259	190	273
Horsepower	5,640	9,110	32,985	25,891	36,972
Water-tube boilers:					
Number	39	43	130	87	109
Horsepower	18,710	18,459	57,001	30,226	54,022

Pulverizers in the first four-month period of 1934, totaled 38, as compared with 31 in 1933 and 31 in 1932. Sixteen were ordered in April as against 9 in March.

Code Authority Approved for Steel Plate Fabricating Industry

The National Recovery Administration recently announced through the office of Division Administrator George L. Borry, approval of the following as members of the Code Authority for the steel plate fabricating industry:

Bryan Blackburn, R. D. Cole Manufacturing Company, Newman, Ga.; H. G. Tallerday, Western Pipe & Steel Company, San Francisco; M. J. Trees, Chicago Bridge & Iron Works, Chicago; A. O. Miller, Petroleum Iron Works, Sharon, Pa.; V. P. Marran, Walsh Holyoke Steam Boiler Works, Holyoke, Mass.; W. F. Perkins, Bartlett-Hayward Company, Baltimore, Md.; and C. M. Denise, McClintic-Marshall Corporation, Bethlehem, Pa.

General Manager for Republic Subsidiary

L. S. Hamaker, sales promotion manager of Republic Steel Corporation, Youngstown, O., has been advanced to the position of vice-president and general manager of The Berger Manufacturing Company, Canton, O., wholly owned subsidiary of Republic, it is announced by B. F. Fairless, first vice-president of Republic. The appointment was effective June 1.

Mr. Hamaker began his career in the steel industry in the sales department of The Berger Manufacturing Company and later was made advertising manager. During a series of mergers he became advertising manager of United Alloy Steel Company, Central Alloy Steel Corporation, and finally of Republic Steel Corporation, when that organization was formed. He was appointed sales promotion manager of Republic in 1931.

Tank Car Service Code Approved

A code of fair competition for the tank car service industry was approved on May 23, by National Recovery Administrator Hugh S. Johnson, bringing to 439 the number of codes approved up to that time.

Sponsored by the Tank Car Service Association, the code provides for a 40-hour work-week for general employees and 44 hours for service employees, a minimum hourly rate for factory employees of 40 cents and a minimum weekly wage for office and clerical help of $15.

The code provides that under emergency conditions the Code Authority may cause to be established a rental minimum for tank cars which shall be the minimum for the industry, subject to the approval of the Administrator. The Code Authority will consist of five members elected by the members of the association, voting on a basis of tank cars owned and two elected on a basis of one vote for each member of the association. Members of the industry, not members of the association, shall elect a representative to the Code Authority and the President of the association shall be *ex-officio*, a member.

The code became effective on June 4.

Combustion Engineering Personnel

B. J. Cross, who from 1921 to 1931 was associated with the engineering activities of Combustion Engineering Corporation, recently rejoined the engineering department of the present organization, Combustion Engineering Company, Inc. He will be engaged in development and research work under the direction of John Van Brunt, vice-president in charge of engineering, and of Henry Kreisinger. Prior to 1921 Mr. Cross was with the United States Bureau of Mines and was identified with a number of notable investigations on the burning of fuels.

William Lloyd, for many years identified with the design, manufacture and sales of Coxe stokers, has again become associated with the engineering department of Combustion Engineering Company, Inc., in much the same capacity of that of some years past. While mechanical superintendent for the Lehigh Valley Coal Company, Mr. Lloyd became interested in the development of the Coxe stoker and was responsible for many of the earlier installations. In 1914 he became president of the Coxe Traveling Grate Company and later was made president of the Coxe Stoker Engineering Company which subsequently was affiliated with Combustion Engineering Corporation.

LESSONS IN ARC WELDING

It is the object of these lessons to present in a concise manner certain fundamental facts of welding, the knowledge of which will enable the operator to use the welding process successfully and economically. These lessons are based on the course in arc welding given by Arthur Madson at the plant of the Lincoln Electric Company, Cleveland, O. Preceding lessons were published on page 46 of the February issue, page 77 of the March issue, page 106 of the April issue, and page 135 of the May issue.

Lesson 19

OBJECT: To study expansion and contraction.
MATERIAL: 2-1/8-inch plates 4 inches by 12 inches.
2-1/4-inch plates 4 inches by 12 inches.
5/32-inch and 3/16-inch Stable arc electrodes.
PROCEDURE: When steel is heated it expands, when cooled it contracts. These rather simple facts are quite frequently overlooked, or ignored. It is well therefore to get them clearly in mind. A few simple examples or illustrations will be helpful. Suppose a rod of given length is heated throughout its full length to a certain temperature and this rod expands or increases its length, say 0.010 inch.

Now, if a rod of only half the length is heated to the *same* temperature as before, then the expansion will be 0.005 inch. If we allow these rods to cool to the same temperature the contraction for the first will be 0.010 inch and for the second 0.005 inch, or approximately equal to the expansion. It may therefore be stated that for a *given temperature rise (or fall)*, the expansion (or contraction) depends on the length of the part heated (or cooled).

Suppose the bar is heated to only 1/4 of the temperature rise, then 1/2, then 3/4. The expansion will be 0.0025, 0.005, 0.0075 inch for the longer bar and half this for the shorter bar.

This simple experiment which can be easily carried out, shows that the total expansion depends on the length of metal heated, and on the temperature to which it is heated. Keep these statements in mind. They will be found very helpful in welding problems involving expansion.

When metal cools, it contracts instead of expanding, but the same rules govern as for expansion, that is, the contraction depends on the length cooled, and the temperature drop. While it is being deposited, weld metal is molten, the edges of the plates being joined are molten, and the plates are hot for some distance back from the joint. When the deposited metal and the edges of the plate, both of which were molten, cool, they contract more for a given length than the other part of the plate because they were hotter.

The hot part of the plate does contract and this fact must not be ignored, in considering contraction. The various temperature drops and the entire mass of heated metal must both be considered. The problem is evidently very complicated.

Contraction if resisted will set up forces, and may cause serious distortion or warping of the completed part. By proper welding methods it is possible in some cases to modify these forces so that they are not particularly troublesome.

To illustrate some of these characteristics:

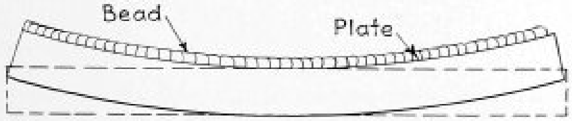


Fig. 31

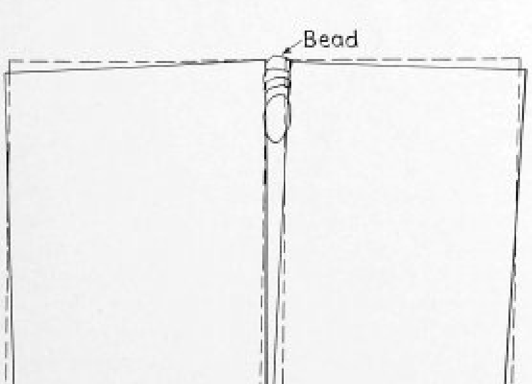


Fig. 32

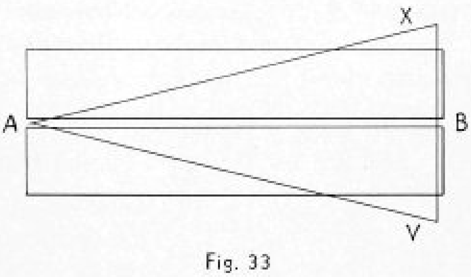


Fig. 33

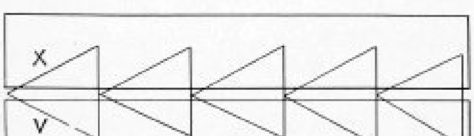


Fig. 34

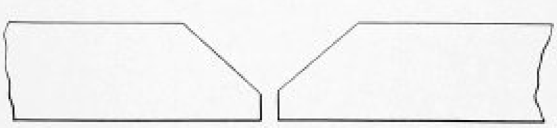


Fig. 35

Take a thin plate ($\frac{1}{8}$ or $\frac{1}{16}$ inch) and run a fairly heavy bead, lengthwise of the plate. Allow it to cool. Watch it carefully. You will find that, as the bead is much hotter than the plate, as it cools, it becomes shorter than that part of the plate to which it is welded and so the plate curls or bends, Fig. 31.

Take two heavier plates, say $\frac{1}{4}$ inch. Separate them about $\frac{3}{32}$ inch. Lay on the bench and weld a longitudinal butt seam. Use Stable arc electrode. The plates will pull together, Fig. 32.

Try increasing the speed of welding. The plates will not pull together so much.

This force is evidently rather large; refer to Fig. 33. We might represent it as the distance from line *AX* or *AV* to *AB*. If we could break this force up into smaller forces or parts we could reduce its effect.

Referring to Fig. 34; put in bead 1. The force is not very large. Follow with 2 and so on. While there is some force it is not very great and so the distortion is not as great as before. This is the step back method. Note carefully how this is done. The same beads in reverse order are merely interrupted beads and do not give as great a distortion reduction effect as the step back method.

Take two plates and weld as in Fig. 35. First use a large number of small beads. Then repeat but use a few large beads. The plates will move but in the case of the large number of small beads the distortion is greater than with the fewer beads.

We see therefore that we must keep in mind the temperature and the amount of metal heated; that the fewer beads give less distortion than a larger number; and that the step back method is very helpful.

These few facts will aid in working out contraction problems. They are not, of course, all the items to be considered. Each job has its own individual problems.

(To be continued)

S. H. Taylor, Jr., Appointed Pacific Coast Manager For Lincoln Electric

Closely identified with the welding industry for the last seven years, Seth H. Taylor, Jr., has been appointed Pacific coast manager for The Lincoln Electric Company, Cleveland. Mr. Taylor will make his headquarters at San Francisco.

For the last four years Mr. Taylor has been in charge of the Los Angeles office of The Lincoln Electric Company. Previous to that he spent some time at the Cleveland headquarters of the organization, where he was engaged in research and applications of production welding.

Since his graduation from Western University, Mr. Taylor has been constantly active in one branch or another of the arc-welding industry. He has the distinction of being partly responsible for one of the first arc-welded office buildings ever to be erected. He has been engaged in the job welding business. He has devoted not a little time to the study of automatic arc welding, having been employed by several large companies in that capacity.

This wide and varied experience forms an extensive background for the new position Mr. Taylor has taken over. As Pacific Coast manager, Mr. Taylor will have charge of sales and service of all Lincoln products in that territory, including arc welding machines, electrodes, accessories, motors, starters and other products.

Modification of Metal Tank Code Asked

A public hearing on proposed modifications to the approved metal tank code was held by Deputy Administrator Joseph Dilworth on May 29, in the Franklin Room of the Ambassador Hotel.

The amendments would change the minimum wage and maximum hour provisions of the code to correspond with those contained in the approved code for the steel plate fabricating industry, would provide a system of contributions by members of the industry toward the support of the code authority and would permit the last named body to figure a scale for the lowest reasonable costs for the industry, below which its products could not be sold.

TRADE PUBLICATIONS

Automatic Temperature Controls. — A folder describing the potentiometer controllers or recorders of standard range has been issued by the Brown Instrument Company, Philadelphia. These pyrometers are designed for any type of valves whether oil, gas or electric. They are equipped for any control problem either indicating, recording or signaling.

Seamless Steel Fittings.—The Taylor Forge & Pipe Works, Chicago, has issued a catalogue describing the complete line of seamless steel fittings for pipe welding produced by the company. The products include 90-degree Taylor forged weldells (standard and long radius type); 45-degree weldells; full branch welding tees; reducing tees; concentric and eccentric reducing nipples; welding caps; welding sleeves; Van Stone stub ends and forged steel flanges.

Tube Couplings.—A catalogue issued by the Parker Appliance Company, Cleveland, is the first of a series of new bulletins covering the complete line of production of this company. It is the aim to publish for the trade served complete engineering and dimensional data, price lists and technical information of value to purchasing, engineering, drafting, stockkeeping, installing and all other departments having to do with the specification, purchasing or installation of its products. Parker tube couplings are of the threadless type flared for industrial or domestic plumbing. The bulletin also includes descriptions and price lists of associated equipment.

Pulverized Fuel Equipment.—The Foster Wheeler Corporation, New York, has issued a bulletin describing in detail the impact mill and the Tricone ball mill for pulverizing fuel. The first half of the bulletin is concerned with the descriptions of the two mills and pulverized fuel systems in general, while the second section is devoted to auxiliary equipment used in this connection. This equipment includes intervane and cross-jet burners, level controllers for ball mills; dividers for unit systems; switching valves for unit systems and pulverized fuel feeders for storage systems.

Hoists.—The Harnischfeger Corporation, Milwaukee, Wis., has issued a new bulletin on hoists for every plant and purpose. This publication treats the application of hoists to both general and specific problems and is illustrated in colors with installation photographs and diagrams explaining simplified construction and operation and covers the vital points in modern hoist design. The bulletin lists the ratings and operating ranges for type R hoists together with specifications and electrical accessories.

Boiler Maker and Plate Fabricator

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New British Locomotive Has Tapered Boiler Barrel

By G. P. Blackall

The first of an entirely new series of three-cylinder 4-6-0 type superheated passenger tender locomotives has just been completed at the Crewe works of the London, Midland & Scottish Railroad to the design of W. A. Stanier, chief mechanical engineer of the company.

An interesting feature of this type of locomotive is the adoption of a tapered type of boiler barrel similar to that of the Great Western Railroad locomotives. The boiler of the new locomotive has a working pressure of 225 pounds per square inch, as compared with the 200 pounds pressure on the existing locomotives of the "5X" class which have the same wheel arrangement. A superheater is fitted, and the main regulator has been incorporated in the superheater header in the smokebox. A steam manifold, with a main shut-off valve, is provided on the top of the firebox door plate in the cab, and incorporated in this are the necessary valves for the ejector and steam brake, the injectors, car heating, whistle, pressure gage, and sight-feed lubricator to the regulator.

The boiler is fed with water through top feed valves provided on the second boiler barrel ring, with water distributing trays. Two pop type safety valves of 2½ inches diameter are fitted at the crown of the firebox, and the standard type of sliding firedoor is provided with a screen to prevent glare from the fire. On the fireman's (or right) side an exhaust steam injector is provided, and on the other side a live steam injector, both consisting of 11 millimeter cones. Other boiler mountings, such as the water gage frames and protectors, are of the railroad's standard type.

The following are additional dimensional details:

The barrel of the boiler is 13 feet 10$^{1}/_{16}$ inches long, with an outside diameter of 5 feet, increasing to 5 feet 8⅜ inches. The firebox is 10 feet by 4 inches outside dimensions, and inside 9 feet 1$^{15}/_{16}$ inches by 3 feet 2⅛ inches. The height is 6 feet 8⅝ inches by 51$^{11}/_{16}$ inches.

The superheater consists of 14 elements, 1⅜ inches diameter outside by 11 S. W. G. Fourteen superheater flues are 5⅛ inches outside diameter by 7 S. W. G. There are 160 small tubes, 2 inches outside diameter by 11 S. W. G.

The tubes provide 1462.5 square feet of heating surface; the firebox 162.4 square feet, giving a total of 1624.5 square feet and the superheater 227.5 square feet.

The grate area is 29.5 square feet and the tractive effort at 85 percent boiler pressure 26,601 pounds.

Amendment Approved for Code of Fabricated Metal Products Industry

National Recovery Administrator Hugh S. Johnson recently announced his approval of an amendment to the code of fair competition for the fabricated metal products manufacturing and metal finishing and metal coating industry under which is eliminated the necessity for organization of a supplementary Code Authority for many subdivisions of the industry.

The approved amendment permits members of the industry to operate under the code, with the assistance of such additional fair trade practice provisions as may be found necessary, without the submission of supplementary codes.

A further provision of the amendment permits groups or subdivisions which may be now or hereafter operating under approved supplemental codes to withdraw those codes and operate in accordance with the amendment. The amendment becomes effective June 16.

Appointment of Railey & Milam, Inc., 27-39 W. Flagler St., Miami, Fla., as distributors of Enduro stainless steel and Toncan iron, has been announced by N. J. Clarke, vice-president in charge of sales, Republic Steel Corporation, Youngstown, O. Mr. Clarke has also announced the appointment of the Ohio Valley Hardware & Roofing Company, Evansville, Ind., as distributors of Toncan iron.

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

Horizontal Tubular Boiler Mountings

Q.—What boiler mountings should be applied to a horizontal tubular boiler? M. D.

A.—Fig. 1 shows a typical illustration of a horizontal tubular boiler on which the various boiler mountings required by the A.S.M.E. code have been illustrated, the references shown correspond to the paragraphs in the A.S.M.E. Boiler Code relative to the part indicated. A synopsis of the paragraphs of the A.S.M.E. code referred to in Fig. 1 are as follows:

P-12. Cast iron shall not be used for nozzles or flanges attached directly to the boiler for any pressure or temperature.

Cast iron may be used for boiler and superheater connections under pressure, such as pipes, fittings, valves and their bonnets, for pressures up to 250 pounds per square inch, provided the steam temperature does not exceed 450 degrees F.

P-269. Boilers having more than either 500 square feet of water heating surface or 2000 pounds per hour generating capacity shall have two or more safety valves.

P-273. P-287. Only A.S.M.E. Standard Safety Valves are permissible.

P-278. Escape pipe must be at least full size of discharge opening, and must be supported. A drain is required in the escape pipe.

P-291. P-292. P-294. Each boiler shall have at least one water-gage glass, with connections not less than ½-inch pipe size. The water-gage glass shall be equipped with a valved drain.

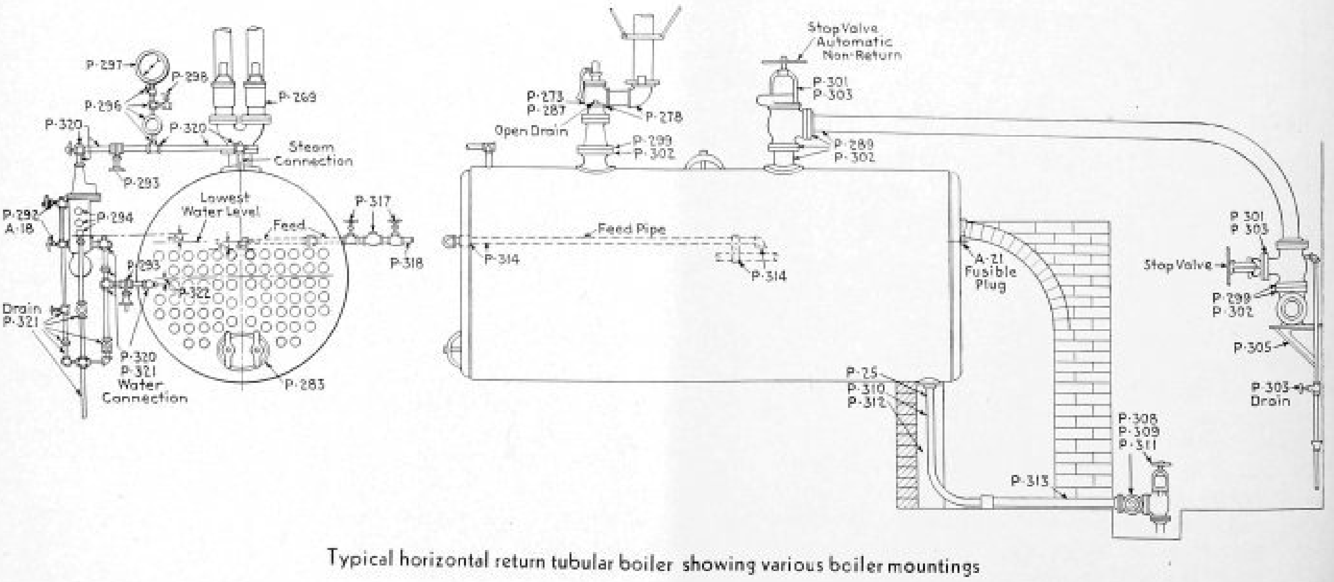
A-18. The lowest visible part of the water-gage glass shall be at least 2 inches above the lowest permissible water level, which level shall be that at which there will be no danger of overheating any part of the boiler when in operation at that level. The lowest permissible water level for the usual types of boilers is given in Par. A-21 of the Appendix.

Boilers of the horizontal fire-tube type shall be so set that when the water is at the lowest reading in the water-gage glass there shall be at least 3 inches of water over the highest point of the tubes, flues, or crown sheet.

Automatic water gages are permissible. Each boiler shall have been three or more gage cocks located within visible range of the water gage, except when heating surface does not exceed 50 square feet then two gage cocks are permitted.

P-293. When shut-offs are used on the connections to a water column, they shall be either outside-screw-and-yoke type gate valves or stop cocks with levers permanently fastened thereto and marked in line with their passage or of such other through-blow construction as to prevent stoppage by deposits of sediment and to indicate by the position of the operating mechanism whether it is in open or closed position; and such valves or cocks shall be locked or sealed open. Where stop cocks are used they shall be of a type with the plug held in place by a guard or gland.

P-296. Tee or lever handle cock is the only stop permitted between gage and boiler. For boilers carrying 500 pounds pressure or over, valves may be used in place of cocks. Gage connections which are filled with water at a temperature never greater than that of satur-



Typical horizontal return tubular boiler showing various boiler mountings ated steam at a pressure of 250 pounds per square inch, or 406 degrees F., shall be of brass, copper or bronze composition. Connections that are filled with steam or water of a temperature greater than that of saturated steam at a pressure of 250 pounds per square inch, or 406 degrees F., shall be of steel pipe or of other material capable of safely withstanding the temperatures corresponding to the maximum allowable working pressure. Where steel or wrought iron pipe connections are used they shall be not less than 1 inch pipe size.

P-297. The dial of the steam gage shall be graduated to approximately double the pressure at which the safety valve is set but in no case to less than 1½ times this pressure.

P-298. ¼-inch Globe valve for attaching test gage.

P-299. P-302. If pressure exceeds 125 pounds or if the fittings are below the water line, all fittings must be "extra heavy".

P-301. A stop valve is required on each steam line as near the nozzle as is practicable. Valves over 2-inch pipe size must be of outside screw and yoke, rising stem type.

P-303. When two or more boilers having manhole openings are connected to a common steam main, two stop valves, with an ample freeblow drain between them, shall be placed in the steam connection between each boiler and the steam main. The discharge of this drain shall be visible to the operator while manipulating the valve. The stop valves shall consist preferably of one automatic non-return valve (set next the boiler) and a second valve of the outside-screw-and-yoke type; or, two valves of the outside-screw-and-yoke type shall be used.

P-305. Steam pipe must be supported.

P-308. Globe valves must not be used as blow-off valves.

P-309. P-310. P-311. Two valves or valve and cock are required when pressure exceeds 125 pounds, except traction or portable boilers. Plug must be held in place by guard or gland. For pressures of 250 pounds steel valves must be used.

P-25. P-308. P-310. P-312. Blow-off piping shall be of black wrought iron or black steel (not galvanized) and shall be as heavy as required for the feed pipe and in no case less than extra strong pipe size, minimum 1 inch, maximum 2½ inches, and fully protected from direct exposure to flame. A bent pipe is preferred though a steel elbow is permissible.

P-313. Clearance to provide for free expansion and contraction of pipe.

P-314. Feed pipe must be carried through the head or shell near the front end and be securely fastened inside the shell above the tubes. Feed water must discharge at about ⅗ the length from the front head above central row of tubes.

P-317. The feed pipe shall be provided with a check valve near the boiler and a valve or cock (see Par. P-309) between the check valve and the boiler, and when two or more boilers are fed from a common source, there shall also be a globe valve on the branch to each boiler, between the check valve and the source of supply. Wherever globe valves are used on feed piping, the inlet shall be under the disk of the valve.

P-318. Boilers having more than 500 square feet of water heating surface require two means of feeding, one of which shall be a pump, inspirator or injector. On boilers having more than 100 square feet of heating surface the feed pipe shall not be less than ¾ inch pipe size.

P-320. P-321. P-322. Minimum size pipe between water column and boiler to be 1 inch. Use crosses at all turns. Water connection to boiler to be not less than 6 inches below center of shell. Water column, drain valve to be at least ¾ inch connected to ash pit.

A-21. Fusible plug shall be located at lowest permissible water level.

Spacing of Stays in Locomotive Boiler Backhead

Q.—Is it satisfactory, in computing the number of braces required to support a backhead of a locomotive boiler, to multiply the area to be stayed by the boiler pressure and divide by the allowable stress that can be carried by the diameter of the stay to be used? M. B.

A.—The method outlined in the question would provide an ample number of stays to support the backhead, if the backhead could be considered as a whole, or were it possible to so space the stays so that an equal distribution of the total load were placed on each stay.

With the locomotive backhead this is practically impossible, due to the irregularity of the area to be stayed and the necessity of providing space for washout plugs and other appurtenances.

The better method would be to multiply the area to be stayed by the boiler pressure and divide the allowable stress per square inch for the type of stay used, thus obtaining the required cross-sectional area of all the stays. The area to be stayed should then be divided into any desirable spacing of the stays and the size or diameter of the stay used, based on the load on each stay, precaution being taken so as not to exceed the maximum allowable pitch of stays for the thickness of the plate. The total cross-sectional area of the stays used being not less than the computed required cross-sectional area of all the stays.

Manhole Reinforcing Rings

Q.—Referring to paragraph P-259 of the 1933 A. S. M. E. Code, it states that manhole reinforcing rings shall comply with requirements of P-268(b). Will you kindly work out for me the size and thickness of the reinforcing ring for a 12-inch by 16-inch manhole opening? The inside diameter is 111 inches; thickness, $^{8}/_{10}$ inch; working pressure, 140 pounds. R. J. R.

A.—Fig. 1 illustrates a typical manhole reinforcing ring for a 12-inch by 16-inch manhole opening.

In accordance with Paragraph P-259 a manhole reinforcing ring, when used shall be of rolled, forged, or cast steel and shall comply with the requirements of Par. P-268(b).

Using the manhole reinforcing ring shown in Fig. 1, as an example, the requirements of Par. P-268(b) are checked as follows:

The weakest section will be along the center line *X-X*.

The neck of the reinforcing ring may be considered as reinforcement for a distance of 2½ times its thickness measured from the under side of the riveting flange. Therefore the distance of the line *A-B* (see Fig. 1) from the under side of the shell =

$$(2.5 \times 0.8125) + 0.8125 = 2.84 \text{ inches}$$

Cross section I $= 32 - (16 + 0.9375 + 0.9375) \times 0.8 = 11.3$ square inches

Cross section II $= 26.75 - (8.5 + 0.9375 + 0.9375) \times 0.8125 = 13.3$ square inches

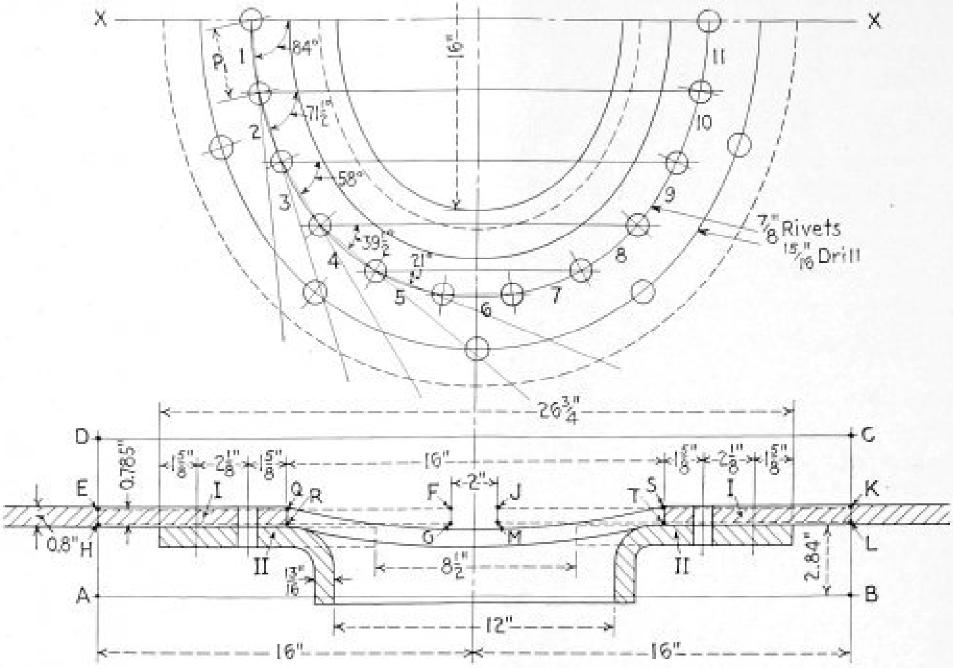
Total actual cross section 2.46 square inches

The required thickness when $E = 0.90$ is

Assuming from information given in question:

Inside diameter, 111 inches.

Thickness, 0.8 inch.



Details of manhole ring for 12-inch by 16-inch opening

Working pressure, 140 pounds per square inch.

$$t = \frac{140 \times 55.5}{11000 \times 0.90} = 0.785 \text{ inch}$$

Required cross section $= 0.785 \times (32-2)$
$= 23.55$ square inches.

Therefore the design meets the requirements of Rule (1) of Par. P-268(b).

Failure can occur by shearing of the rivets on one side of the section *X-X*. The ultimate strength of the rivets in shear is 44,000 pounds per square inch.

Area of rivets to one side of section =
$0.7854 \times 0.9375 \times 0.9375 \times 31 = 21.39$ square inches.

Ultimate strength of rivets in shear $21.39 \times 44{,}000 =$ 941,160 pounds.

Ultimate strength of reinforcing ring Area II $\times$ U.T.S. $13.3 \times 44{,}000 = 731{,}500$ pounds.

Ultimate strength of cross section represented by $(Q\,F\,G\,R + J\,S\,T\,M)\ 0.785 \times (16-2) \times 55{,}000 =$ 604,450 pounds.

Therefore the riveting meets the requirements of Rule (2) of Par. P-268(b).

The reinforcing flange as illustrated in Fig. 1 is inside of the shell and for this reason the rivets do need to be figured in tension.

However, were the flange placed on the outside of the shell, failure could also occur by the internal pressure blowing the manhole and flange off the shell. The ultimate strength of the rivets in tension is 55,000 pounds per square inch.

Total area of rivets =
$0.7854 \times 0.9375 \times 0.9375 \times 31 = 21.39$ square inches

Ultimate strength of rivets in tension
$21.39 \times 55{,}000 = 1{,}176{,}450$ pounds.

If the riveting is calked on the outside, then the required strength due to the internal pressure acting on a 26¾-inch by 30¾-inch elliptical calking edge, with a factor of safety of 5 would be

Area of an ellipse $= \pi ab$.

Where: — $a = \frac{1}{2}$ major axis
$b = \frac{1}{2}$ minor axis
$\pi = 3.1416$

Area $= 3.1416 \times 15.375 \times 13.375 = 646$ square inches.
$646 \times 140 \times 5 = 452{,}200$ pounds.

Therefore the riveting would meet the requirements of Rules (1) and (2) of Par. P-268 (b).

The shell plate may fail by tearing around through the rivet holes.

Checking by applying rules in Par. P-193 (c).

$P_1 = 3.125$ inches (see Fig. 1.)

$$\frac{P_1}{D} = \frac{3.125}{0.9375} = 3.33$$

Ligament	θ (See Fig. 1) degrees	$P_L = P_1 \cos\theta$	E (Fig. P-7)	$P_L \times E$
1	84	0.3265	1.30	0.424
2	71½	0.9915	1.11	1.100
3	58	1.6559	0.93	1.539
4	39½	2.4112	0.78	1.88
5	21	2.9175	0.705	2.05
6	....	3.125	0.695	2.17
7	21	2.9175	0.705	2.05
8	39½	2.4112	0.78	1.88
9	58	1.6559	0.93	1.539
10	71½	0.9915	1.11	1.10
11	84	0.3265	1.30	0.424
				16.155

Equivalent length removed from shell =
$(19.25 + 0.9375) - 16.155 = 4.0325$ inches

Actual efficiency of shell (see Par. P-180)

$$E = \frac{PR}{St} = \frac{140 \times 55.5}{11000 \times 0.8} = 88 \text{ percent}$$

Efficiency, using Rule 1 of Par. P-193 (c)

$$E = \frac{111 - 4.0325}{111} = 96.3 \text{ percent}$$

80 percent of actual shell efficiency =
$0.8 \times 0.88 = 70.4$ percent.

Efficiency, using Rule (2) of Par. P-193 (c)

$$E = \frac{30 - 4.0325}{30} = 86.5 \text{ percent.}$$

Therefore the design meets the requirements of Par. P-193 (c) as called for in Par. P-268 (b) and the reinforcement of the manhole opening is satisfactory.

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

States

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

Cities

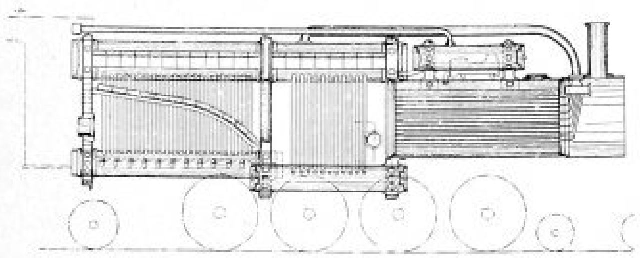
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,843,289. STEAM BOILER. ALPHONSE LIPETZ, OF SARATOGA SPRINGS, NEW YORK.

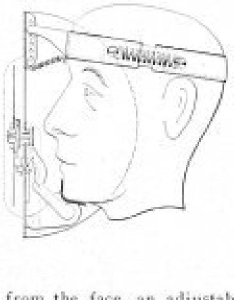
Claim.—A locomotive boiler comprising a fire chamber; a contracted heating chamber in advance thereof; a steam generator having a section



disposed in said fire chamber and a section disposed in said heating chamber and having upper and lower longitudinal drums and rows of substantially vertical, spaced, water tubes extending from top to bottom throughout the entire width of the heating chamber and connected to said drums; and a fire tube economizer forward of the heating chamber for heating feed water for said steam generator. Twenty claims.

1,842,675. MASK FOR WELDING AND LIKE OPERATIONS. KARL KANNENBERG, OF BERLIN, GERMANY.

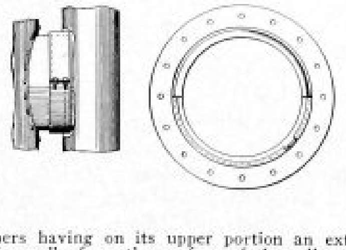
Claim.—In a mask of the kind described, a shield-like plate composed of insulating material and open on all sides, an attachment ring holding the



said plate at a distance from the face, an adjustable screen for protecting the eyes, a mechanism for adjusting the said screen causing the same to be unlocked, rotated and relocked in the fresh position, and a lever for causing the actuation of the said mechanism, the said lever being actuated by downward movement of the chin. Nine claims.

1,839,682. CONNECTING COLLAR FOR FURNACES. DORR L. LAMB, OF MARSHALLTOWN, IOWA.

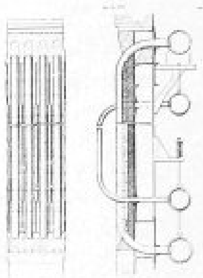
Claim.—In a connecting collar for furnaces, the combination of two collar members having their body portions rounded in transverse sections,



one of the members having on its upper portion an exterior groove and rib, both spaced inwardly from the surface of the collar, the lower portion of said collar member being projected outwardly beyond the upper portion and being formed with a rib and groove on its interior, the other collar member having its upper portion projected beyond the lower portion and having on the interior of said upper portion a rib and groove, and the lower portion of said collar member being formed with an exterior rib and groove both spaced inwardly from the surface of the collar, said ribs and grooves being shaped to coact and interlock when the collar members are moved to position in alinement and to form a smooth cylindrical outer surface, and a clamping member comprising a metal band with its ends extended to parallel positions, adjusting bolts in said ends, and an asbestos lining on the interior of the metal band fitted around and covering the joint between the collar members, substantially as and for purposes stated. Two claims.

1,839,224. FLUID HEATING APPARATUS. WALTER F. KEENAN, JR., OF PELHAM, AND HAROLD F. EDDY, OF GREAT NECK, NEW YORK, ASSIGNORS TO FOSTER WHEELER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

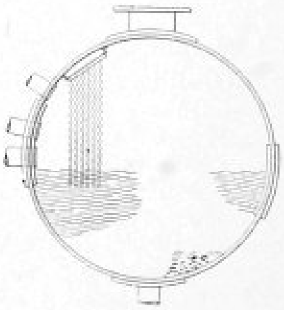
Claim.—In fluid heating apparatus having a plurality of fluid conduit elements spaced from one of the furnace walls thereof, the method of



regulating the amount of heat absorbed by the fluid in said conduits which comprises varying the heat radiating capacity of the adjacent furnace wall portions. Fourteen claims.

1,845,106. DEVICE FOR SECURING DRY STEAM IN BOILERS. WILFRED R. WOOD, OF LONDON, ENGLAND, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim.—In combination in a boiler, a drum, boiler tubes connected therewith, a steam offtake, and a plurality of reticulated members dividing



the interior of the drum and through which the steam delivered by the tubes must pass to reach the offtake, said members being in the form of chains suspended from their upper ends and having their lower ends free. Three claims.

Boiler Maker and Plate Fabricator

NRA
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CODE
GRAPHIC ARTS INDUSTRY

High Strength Steel

Developments in the science of metallurgy during recent years have almost completely changed the character of many structures that formerly utilized mild steel. Alloys of manganese, silicon and chromium have provided industry with steels improved in strength, toughness, resistance to corrosion and other characteristics of advantage in prolonging the life and service of structures to which they have been applied.

An alloy of comparatively recent application, which utilizes all three elements in a steel known as Cromansil, offers advantages of high strength, combined with ductility, not previously existing in alloys of any one of the elements. Briefly, Cromansil, as explained in an article in this issue, can be readily sheared, punched, drilled and riveted and cold worked. It does not harden when cut with the oxy-acetylene flame and will not develop brittleness when welded. It also can be hot-formed without the necessity of subsequent annealing. Its greater strength also permits lighter structures, so the element of higher cost does not preclude its use.

Modern Steam Locomotives

There can be little doubt but that the recent innovation of light-weight high-speed oil engine-driven passenger trains of streamline design will have an effect on the future development of the steam locomotive. The challenge does not involve the possibility of replacement of the steam locomotive with Diesel-driven motive power but rather constitutes one that must be met by improvement in design, construction and operating efficiency of the older form of power.

During the past ten years but comparatively little has been done in basic design, although a number of experimental locomotives have been built and tested in service. Longer runs are being made and in freight service the average speeds have been increased. New freight power, most of which has not yet been placed in service, will undoubtedly improve the running time. Every effort is being made on locomotives under construction to produce the most efficient and serviceable units that have ever been put into service. The difficulty is that the number being built will be entirely inadequate to make up the deficiencies of large groups of freight locomotives that have reached the stage of practical obsolescence.

Passenger locomotives have not progressed in their improvements to the same extent as freight power. The vast bulk of passenger traffic must continue to be carried on trains of considerable length rather than on the short multiple car units of the new streamline type. Such heavy service demands separate motive power units and for this the steam locomotive will continue to be utilized to the greatest extent. To meet the demand for high speed, locomotives of maximum power within weight limitations must be designed and built, without sacrificing reliability. Locomotives equipped with watertube fireboxes carrying pressures higher than in the conventional firetube type have been in successful service for some years. Eventually this development may evolve into a full watertube boiler carrying much higher pressures than are now possible. Experiments are under way with poppet valves which offer possibilities in obtaining higher speeds. Reduction in weight of passenger cars will aid in the attainment of greater effective horsepower. Streamlining, which offers no practical difficulties in the case of the steam locomotive, already is being incorporated by one railroad in its design of a train for high-speed service.

Replacement of obsolete motive power is becoming increasingly imperative. It is certain that tremendous improvements will be made in the steam locomotives that will be built and thus assure their continuance as the principal motive power of the railroads.

Questions on Laying Out Problems

The series of articles "Elementary Plate Layout" which commenced in the June issue is being published for the sole purpose of aiding our readers to a better understanding of the problems involved in the development of the almost infinite variety of plate constructions with which many have to deal. If in any way this purpose is not realized by real benefit to the greatest number interested in laying out work the effort will have been largely wasted.

In the early instalments the skilled and experienced layer-out will probably feel that the examples are too simple for his interest. The title suggests that the principles being demonstrated are "elementary." While little that is new to such individuals may be presented at first, if constructive criticisms and suggestions of the methods utilized are made by them, an extremely useful service to others, striving to progress in the trade will be performed. In later instalments it is hoped that even those of long experience will be able to gain real benefit from a study of the layouts presented.

For those readers who are inexperienced in the art of laying out, or who wish to study the subject in order to become proficient, it is suggested that they correspond with the author at this office whenever a difficulty occurs in understanding any of the steps followed in the problems published. The Questions and Answers Department has long served as a clearing house for the solution of all manner of layout problems but the present effort is being made to amplify this service. Our readers are invited to use this department and, where points are not clear in connection with the study of the laying out articles, write to us explaining the difficulty and the author will do his utmost to clarify matters.

CROMANSIL STEEL

The combination of high strength and good ductility characteristic of Cromansil steel, which is manufactured by the Lukens Steel Company, Coatesville, Pa., is obtained by the addition in correct proportions of small amounts of chromium, manganese and silicon to a low carbon steel. The following composition has given the best results for general use.

Chromium, percent	0.40 to 0.60
Manganese, percent	1.10 to 1.40
Silicon, percent	0.60 to 0.90

The carbon content may be varied, depending on the physical properties desired, and the thickness of the section. For general use, where the steel is to be cold worked, machined or welded, the most satisfactory results have been obtained with a carbon content of 0.15 to 0.25 percent.

Table 1 gives a comparison of the physical properties of various steels suitable for structural purposes in the "as rolled" condition. Table 2 shows the physical properties of Cromansil steel in the "as rolled" condition obtained with different carbon contents.

The unit weight of Cromansil steel is approximately the same as that of ordinary structural steel, a value of 0.282 pound per cubic inch being sufficiently close for all ordinary calculations.

TABLE 1.—COMPARISON OF CROMANSIL AND OTHER STRUCTURAL STEELS

Type of steel	Carbon content, percent	Yield point lb. per sq. in.	Ultimate strength, lb. per sq. in.	Elong., percent in 2 in.	Red. of area, percent
Cromansil	0.20	60,000	90,000	28	62
Cromansil	0.30	70,000	115,000	25	60
Silicon (0.40 percent Si.)	0.30	50,000	90,000	22	50
Manganese (1.50 percent Mn.)	0.30	60,000	95,000	24	55
Nickel (3.50 percent Ni.)	0.35	60,000	90,000	25	60
Plain carbon	0.25	38,000	65,000	24	45

Cromansil steel was developed to replace carbon steels in applications where a combination of high strength and good ductility in the "as rolled" condition are required. A steel suitable for structural purposes must be readily sheared, punched, drilled, and riveted and cold worked, and must not harden when cut with oxy-acetylene flame. It must be suitable for oxy-acetylene and electric welding without developing objectionable brittleness in the weld or adjacent metal and must be suitable for hot forming without the necessity for subsequent annealing. Cromansil steel fulfills these requirements and can be used advantageously in the form of plates, sheets, shapes, rods and seamless tubing. The limits of sizes available in Lukens Cromansil steel are only those imposed by the Lukens 206-inch mill which can roll plates up to 186 inches in width and up to 25 inches in thickness. Because of its higher strength, it permits lighter weight construction, and despite the higher unit cost the total cost may be less than when carbon steel is used

TABLE 2.—PHYSICAL PROPERTIES OF CROMANSIL STEEL

Size	C., percent	Cr., percent	Mn., percent	Si., percent	Yield point, lb. per sq. in.	Ultimate strength, lb. per sq. in.	Elong., percent in 8 in.	Red. of area, percent	Brinell number	Izod, ft.-lb. per sq. cm.
1-inch rod	0.05	0.25	1.12	0.87	54,000	71,000	31	75	130	64
1-inch rod	0.06	0.40	1.36	0.86	55,000	74,000	35*	80		
¾-inch plate	0.09	0.48	1.47	0.54	48,000	75,000	30	61	150	
1-inch rod	0.10	0.38	1.17	0.68	49,000	71,000	38*	77		
¼-inch plate	0.15	0.23	1.26	0.78	62,000	85,000	21			
1-inch rod	0.19	0.30	1.10	0.60	56,000	84,000	34*	73		
⅜-inch plate	0.20	0.49	1.27	0.92	67,000	95,000	20	44	200	
¾-inch plate	0.20	0.49	1.27	0.92	63,000	98,000	21	52	200	
1½-inch plate	0.20	0.49	1.27	0.92	68,000	96,000	21	52	200	
½-inch plate	0.21	0.47	1.17	0.72	50,000	92,000	20	56	210	36
1-inch plate	0.21	0.47	1.17	0.72	51,000	99,000	16		210	25
1½-inch plate	0.21	0.47	1.17	0.72	56,000	89,000	19		210	24
2-inch plate	0.21	0.47	1.17	0.72	53,000	86,000	20		210	20
½-inch plate	0.21	0.62	1.24	0.71	56,000	87,000	21	55	185	
1-inch plate	0.26	0.52	1.10	0.74	59,000	96,000	28*	63		
1-inch rod	0.30	0.54	1.03	0.96	64,000	108,000	23*	53	212	
¾-inch plate	0.30	0.45	1.39	0.86	65,000	114,000	20*	47	230	
3¼-inch rod	0.33	0.49	1.13	0.99	76,000	113,000	17*	31	210	
3¾-inch rod	0.37	0.50	1.14	0.84	76,000	118,000	18*	47	220	
¾-inch plate	0.39	0.50	1.41	0.81	67,000	128,000	16	43	270	
⅜-inch plate	0.46	0.67	1.19	0.82	91,000	143,000	19*		270	20

* Percent elongation in 2 inches.

Cromansil steel has practically the same coefficient of expansion as plain carbon steel up to a temperature of 500 degrees C. (932 degrees F.). The allowance for expansion and contraction should therefore be the same as when plain carbon steel is used.

While Cromansil steel is not intended for use at high temperatures, it is superior to plain carbon steels for this purpose. When subjected to an oxidation test of nine weeks' exposure to 815 degrees C. (1500 degrees F.), it showed only 78 percent as much loss in weight as plain carbon steel. It also possesses relatively good creep values at high temperatures as indicated by the following table:

Steel	Lb. per sq. in. creep stress*
0.20 percent C. Cromansil	5,750
0.26 percent C. Cromansil	6,570
0.20 percent C. plain carbon	3,900
0.45 percent C. plain carbon	4,500
0.34 percent C., 3.46 percent Ni.	5,000
0.40 percent C., 1.3 percent Ni., 0.66 percent Cr.	6,000
0.40 percent C., 0.79 percent Cr., 0.57 percent V.	6,000

* Stress required to produce 1 percent elongation in 10,000 hours at 1000 degrees F.

The thermal conductivity of Cromansil steel is relatively low, being only about one-quarter that of iron and about one-third that of firebox steel. The following tabulation shows actual values; *K* being expressed as gram calories per second per square centimeter, per centimeter per degree Centigrade:

Material	C., percent	Cr., percent	Mn., percent	Si., percent	K.
Cromansil steel	0.20	0.44	1.27	0.92	0.042
Firebox steel	0.20	—	—	0.02	0.111
Ingot iron					0.160

Cromansil steel of low carbon content possesses notably high impact strength at low temperatures, as shown in the following table:

Cromansil Steels: C., percent	Cr., percent	Mn., percent	Si., percent	Room Temp.	Charpy Notch Toughness—Ft.-lb.: 0° C.	20° C.	30° C.	40° C.	50° C.
0.06	0.40	1.36	0.86	59	56	51	44	41	37
0.20	0.42	1.05	0.67	30	27	19	8	7	5
0.23	0.45	1.21	0.68	19	8	6	3.5	3	3
Plain Carbon Steel									
0.25	...	0.49	0.014	18	4.5	3.1	3.3	2.5	2.2

Tests made on a Farmer type of testing machine show that Cromansil steel has a fatigue limit of 50 to 60 percent of the ultimate strength, while for plain carbon steel the limit is about 40 to 50 percent of the ultimate strength.

Fabrication and Shop Use.—The methods used for the fabrication of plain carbon steel can be used without essential changes when working with Cromansil steel. All ordinary shop tools, including pipe threading equipment, can be used without change in practice, but because of the greater strength of these steels somewhat more power is required for machining operations than is required for a plain carbon steel of the same carbon content.

No trouble is experienced in punching Cromansil steel, and a very clean hole with little or no taper is obtained. While somewhat more power is required for shearing this steel than for carbon steel, it shears very evenly and freely and there is no tearing of the material. It may be drilled with either plain carbon or high-speed drills, with or without the use of cutting compounds. It can be readily chipped with ordinary carbon steel chisels. It planes evenly with both light and heavy cuts.

Plate can be rolled into cylindrical shape with ease in the ordinary bending rolls. Due to its springiness it may be necessary at times to heat the entering end of the plate and to set it to the required radius before proceeding with the rolling.

Cromansil steel plate and rivets calk very well. Any of the ordinary calking tools employed in boiler or ship work can be used with excellent results.

Dishing and flanging can be done either hot or cold depending on the thickness of the plate and the radius required. When it is necessary to heat Cromansil steel locally in order to form it, care should be taken not to apply the heat too rapidly. On account of its relatively low heat conductivity there is danger of overheating the metal at the point where the flame is applied, if sufficient time is not allowed for the heat to travel from the point where it is applied to the surrounding metal. The physical properties are not impaired by heating to the temperature required for efficient hot forming. Only a very small amount of scale is formed on the surface when this steel is heated for forming, and it holds its shape easily when formed.

Cromansil steel is easily and cleanly flame cut by the oxy-acetylene process. There is some hardening at the extreme edge of the cut, and, if subsequent machining or chipping is necessary, it is best to remove this thin hardened zone by grinding before machining.

Riveting.—In order to take full advantage of the high strength of this steel in riveted structures, Cromansil steel rivets should be used. By their use it is possible to obtain riveted joints having strength equal to that of the plate itself. The rivets are driven hot in accordance with usual riveting practice, and no particular precautions need be observed. Cromansil steel rivets have a shear strength equal to that of the usual high manganese, high strength rivets, and have the decided advantage that they are much less brittle and are ductile enough to be chipped and calked when cold.

Tests conducted at Lehigh University on riveted joints made by riveting Cromansil steel plate with Cromansil steel rivets gave excellent results, as shown below. The analyses of the plates and rivets used were as follows:

	Plate	Rivets
Carbon, percent	0.21	0.05
Chromium, percent	0.47	0.25
Manganese, percent	1.17	1.12
Silicon, percent	0.72	0.87

Four joints were tested, two lap joints and two butt joints. One of the lap joints and also one of the butt joints were riveted with an air hammer. The other two joints were made with a hydraulic riveter. The plates were ⅝ inch thick and 12 inches wide. The rivets were 1 inch in diameter. The results are summarized in the following table:

Joint number	1	2	3	4
Type of joint	Butt, air	Butt, hydr.	Lap, air	Lap, hydr.
Ultimate load, lb.	583,700	585,500	456,000	533,000
Type of failure	In plate	In plate	Through rivets	Through rivets
Stress in plate* at failure, lb. per sq. in.	106,000	106,500	83,000	97,000
Stress in rivets at failure, lb. per sq. in.	103,800† 41,200‡	104,000† 41,400‡	67,000§	78,200§
Load at first slip, lb.	60,000	155,000	75,000	90,000
Stress in plate* at first slip (approx.), lb. per sq. in.	11,200	28,200	13,600	16,400

* On net area (5.5 square inches).
† In bearing.
‡ In double shear.
§ In single shear.

It will be noted that all joints developed high strength. The butt joints failed in tension of the plate at a section through the outer row of rivets. The stress on the net section at failure was about 106,000 pounds per square inch. The lap joints failed through shearing off the rivets. The stress in single shear of the rivets was 67,000 pounds per square inch for the air hammer joint and 78,200 pounds per square inch for the hydraulic joint. No trouble was experienced at any stage of the making of these joints.

The Wellman Engineering Company has also made extensive tests of Cromansil steel rivets and has obtained remarkable results which are described in detail by A. E. Gibson, vice-president, in *Steel*, October 2, 1933. Two grades of rivet stock of the following chemical and physical properties were tested:

	Type SN-7	Type SN-8
Carbon, percent	0.105	0.19
Chromium, percent	0.38	0.30
Manganese, percent	1.17	1.10
Silicon, percent	0.68	0.60
Elastic limit, lb. per sq. in.	59,000	60,000
Ultimate strength, lb. per sq. in.	77,000	89,500
Reduction of area, percent	77	71.4
Elongation in 2 inch, percent	37	32
Hardness, Rockwell B	80	84
Brinell	151	163

Rivets from both types of steel were used for making joints and were tested both in single shear and in double shear, with the following results:

		Average shearing load, lb. per sq. in.	
Type	C., percent	Single shear	Double shear
SN-7	0.105	78,060	73,580
SN-8	0.19	105,120	97,180

Tensile and hardness tests were also made both on undriven rivets and on driven rivets of the 0.19 percent carbon grade and gave rather interesting results. The heat-treatment that the rivets receive in the operations of heating and driving them results in greatly improved tensile and shear strength, with some increase in hardness, as shown below:

	Shearing load, double shear, lb. per sq. in.	Ultimate strength, lb. per sq. in.	Rockwell B hardness
Undriven rivet	63,615	89,500*	84
Driven rivet	112,220	150,000	90-100

* Rivet bar stock.

These tests clearly show the advantage of Cromansil steel rivets for high strength riveted structures.

Oxy-Acetylene Welding of Cromansil Steel.—For thin sheet the oxy-acetylene process is generally preferred. It may be used satisfactorily for plate up to about ¾ inch or even greater, in thickness.

In the following table are set down the conditions recommended for oxy-acetylene welding of Cromansil steel:

Plate Thickness, in.	Welding rod diam., in.	Welding tip, number	Oxygen pressure, lb. per sq. in.	Bevel, deg.
1/16	1/16	4	10	None
1/8	1/8	5	12	None
3/16	3/16	7	16	90
1/4	3/16	8	19	90
3/8	1/4	10	21	70
1/2	5/16	12	25	70
3/4 and over	5/16	15	30	70

Forehand welding, in which the flame points towards the unfinished part of the seam, is recommended for sheets ⅛ inch and less in thickness, as better speed and better control of the thickness of the weld are possible with this method. When the vee is used as on $^3/_{16}$-inch thick plates and heavier, the backhand method of welding is advised. The control of the fusion in the bottom of the weld and along the sides of the scarf is easier to obtain with backhand welding, and also the gases pass back along the completed portion of the weld and retard the cooling, with consequent reduction in hardening of the weld and adjoining base metal. Oxweld No. 1 high test steel welding rod is quite satisfactory for welding Cromansil ¼ inch and less in thickness. Here the volume of the deposited metal is small, and alloys received from the melted base metal strengthen the steel from the rod sufficiently to produce weld metal strength equal to that of the base metal. In material ⅜ inch thick and heavier, an alloy rod such as the Oxweld No. 22 manganese-molybdenum steel rod should be chosen because the volume of weld metal is great enough so that the steel melted from the base metal into the weld will not supply enough of the alloys to give the desired strength to weld metal obtained from the No. 1 high test type of rod.

The welding tip number and the oxygen pressure included in the above table are intended for the Oxweld Type W-1 blowpipe. If other blowpipes are used, the tip size and gas pressure may be regulated to give flames equivalent to those produced under the recommended condition. For vertical or overhead welding, smaller sizes of welding tips than are recommended in the table will be found advisable. The extent of the change will depend somewhat on the experience and skill of the welder in making the vertical and overhead types of welds.

Overheating of the melted weld metal should be carefully avoided and if the welder encounters any difficulty on this account when following the conditions recommended, it will be of advantage to use the next smaller size of welding tip.

Properly made oxy-acetylene welds have even greater strength than the 0.10 percent carbon Cromansil base metal, and the ductility will be sufficient so that in the free bend test the percent elongation as measured over the weld in the outside fibers will be on the order of 30 percent. In the 0.20 percent carbon Cromansil steel, the strength of the welds when made under the conditions advised will be about the same as that of the base metal, and the elongation in the bend test about 20 percent.

For welding Cromansil steel containing 0.25 percent carbon or more, particular care is necessary to avoid overheating. To produce best quality in the welded material, normalizing at a temperature of 1650 degrees F. is recommended.

Arc Welding of Cromansil Steel.—The electric arc welding process may be used for all commercial thicknesses, and is preferred for thicknesses in excess of ¾ inch. The conditions recommended for butt welding of Cromansil steel by the electric arc method are set down in the following table:

Plate thickness, in.	Coated electrode diam., in.	Current, amp.	Bevel, deg.
1/16	1/16	35	None
1/8	3/32	80	None
3/16	1/8	125	60
1/4	5/32	140	60
3/8	5/32	140	60
1/2	3/16	175	60
3/4	1/4	250	U Vee
1	1/4	250	U Vee
Over 1	5/16	300	U Vee

These conditions are for welding with heavily coated electrodes on plates in horizontal position. The welding is made easier by placing a grooved backing-up strip beneath the edges to be joined. If it is inconvenient to use the backing-up strip, welding with a small electrode is recommended for the bead in the bottom of the vee. For plate over ⅜ inch, $^5/_{32}$ inch electrodes are generally chosen. If the material is in the vertical or overhead position, it is necessary to use a small diameter electrode. The $^5/_{32}$ inch or ⅛ inch diameter with only a moderate amount of coating is most suitable for such welding. For material of given thickness, the next larger size of electrode than is indicated in the table should be chosen for lap or fillet welds.

The Cromansil steels most frequently welded are those containing approximately 0.10 to 0.20 percent carbon. When the steels are welded with the better grades of coated electrodes, strength of weld equal to that of the original base metal is obtained, and the ductility, as indicated by the free bend test measurement, is over 30 percent elongation for the 0.10 percent carbon Cromansil, and over 20 percent for the 0.20 percent carbon Cromansil. The tensile strength of weld metal from these electrodes is ordinarily about 65,000 pounds per square inch, but the alloy absorbed from the Cromansil base metal gives sufficient increase of strength to the weld metal. If plate ¾ inch or over in thickness is welded with the 60-degree vee, for example, this high strength will not be obtained because there is so much width at the top of the weld that the proportion of base metal fused during welding is too small to supply the alloys needed. One reason for recommending the U-shaped vee that has sides with very little slope is to reduce the proportion of metal supplied by the electrode. The second reason is the lower cost of supplying the smaller quantity of weld metal.

Ordinarily the Brinell hardness of the weld metal and of the base metal immediately adjoining the weld is increased to some extent corresponding to the strength of the steel; for 0.20 percent carbon Cromansil the increase will be less than 30 points. The depositing of the weld metal in layers as is commonly practiced on steel over ¼ inch thick serves to anneal the previously deposited weld metal and adjoining base metal, and practically eliminates an increase of hardness in this portion of the joint. Usually the increase of hardness is not objectionable, but if desired it may be removed by the stress relief annealing treatment which consists of heating to a temperature of 1100 to 1200 degrees F. for about 1 hour. The increase of hardness produced by the rapid cooling that attends arc welding should be expected because of the strengthening alloys contained in the Cromansil steel. Any conditions that encourage rapid cooling, such as a copper chill plate underneath the weld, should be avoided. The backing-up strip should be made of steel, and, if desired, may be heated to a moderate temperature before the welding is started.

When steel containing 0.25 percent carbon or higher is welded, a normalizing treatment will be required, if best physical properties are to be secured. About 1650 degrees F. is the temperature found most effective for producing uniform grain size in the weld metal, the metal adjoining the weld, and the base metal.

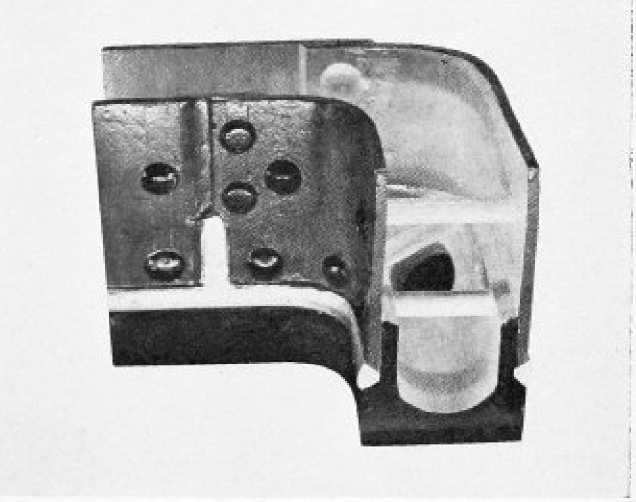
Application of Cromansil Steel.—The desirable qualities of Cromansil steel suggest its use for many different types of construction. Because of its higher strength, it permits lighter weight construction, and despite the higher unit cost the total cost may be less than when carbon steel is used. This applies particularly in cases where the weight of the structure is a large part of the load to be carried, as in the case of long span bridges.

In the construction of ships, the cost of the steel may be of only secondary importance. The reduction in the weight of hull and power plant results in other economies which may easily overbalance the premium paid for high strength steel. Thus for a ship of any given size and speed the capacity of boilers and engines can be reduced, resulting not only in a lower initial cost for the power plant but in a substantial saving of fuel. Similar savings may be obtained by the use of Cromansil steels in the construction of freight cars and trucks, as the pay-load can be increased by the amount that the deadweight is decreased without any increase in power or other costs.

The Lukens Steel Company will be glad to co-operate with metallurgists, engineers and designers who may be interested in the use of Cromansil steel, and to furnish such additional detailed information as may be desired.

Wilson Firebox Mud Ring

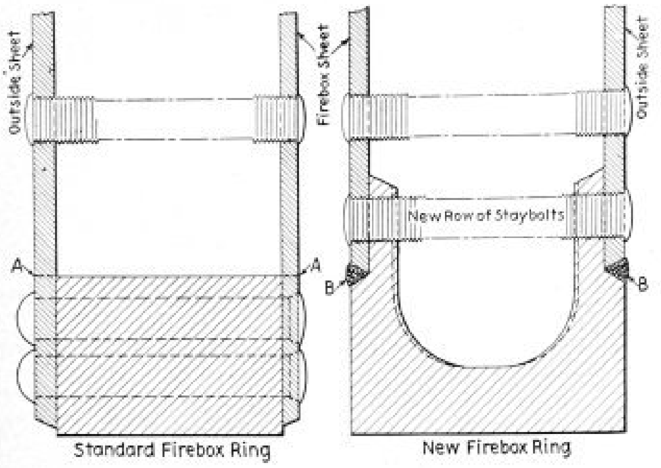
While many of the details which enter into the construction of a locomotive boiler have been materially improved in design and material, the lowly firebox mud ring has thus far been passed by, apparently without a thought as to its possible improvement. It has remained of essentially the same construction as that used in the very early boilers of what is known as the locomotive type and seems to have been considered as nothing more than a filling piece between the inside and outside firebox sheets, through which the rivets pass that are necessary to resist shearing stresses and to make the required joint. All railroad boiler makers know, however, that the



Model of Wilson firebox ring showing corner construction and method of joining mud ring and firebox sheets

ordinarily used rectangular cross-section mud ring may be the cause of much grief from leaky rivets, cracks between the rivet holes and erosion of the scarfed edges of the sheets resulting from such leaks.

An improved mud ring here shown has been developed and patented recently by George M. Wilson, chief boiler inspector of the American Locomotive Company. Instead of the solid rectangular cross-section to which the sheets are riveted, this new mud ring is of U-shape in cross-section, the rivets being done away with and the connection between the inner and outer sheets made by means of a new bottom row of staybolts. The lower edges of the sheets are welded to the shoulders formed by the set-back in the outer vertical flanges of the cast-steel ring. This welding is not relied upon at all for strength, but merely serves to seal the edges of the sheets to the mud ring. It has been the practice for some time to weld the edges of the sheets to the ordinary rectangular mud ring for a short distance from each firebox corner and some railroads require this sealing weld to be car-

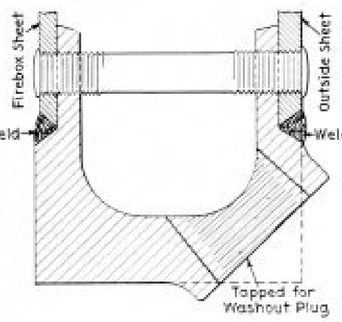


Standard firebox ring construction (Left)—replaced by new Wilson ring (Right)

ried all the way along the edges of the sheets. Therefore, such welding is not a new suggestion.

Another feature of merit in the Wilson mud ring is the arrangement of the washout plugs in the corners. Instead of being horizontal, they angle downwardly, giving a much better outflow when washing-out. Lugs for attachment to boiler supports are the same as commonly used.

This improved construction offers the advantages of a considerable saving in weight, while providing a more



Sectional view of Wilson mud ring showing corner location of washout-plug and method of attaching mud ring to firebox sheets

uniform distribution of metal in the casting, and thereby reduces the hazard of foundry losses. It has sufficient flexibility to adapt itself to the expansion and contraction caused by the changes in boiler temperature, and at the same time is of ample strength to withstand all shocks and strains of service.

While designed primarily for new locomotives where a saving in weight is always an advantage, there are many cases where it might be applied to existing boilers. This is accomplished by cutting or burning off the outer and inner firebox sheets just above the mud ring at points *A* indicated in one of the illustrations. The sheets are then beveled, the new type of mud ring applied with an added row of staybolts, and the welds made at points *B*. The older lower row of staybolts remains untouched.

J. H. Kohler, boiler maker foreman for the Northern Pacific, at Livingston, has been transferred to Pasco, Washington, as night round-house foreman. F. L. Johnson has been transferred to Livingston as boiler maker foreman from Wallace, Idaho, to succeed Mr. Kohler.

Boiler Explosion Takes Six Lives*

Six men were killed, nine were injured and property damage in excess of $44,000 resulted when a 150-horsepower horizontal tubular boiler exploded on January 13, 1934, at Hertford, North Carolina. The boiler was one of a battery of three used in a cotton-seed oil mill, which was seriously damaged by the blast.

The mill and attached powerhouse were of brick. The power plant consisted of three 150-horsepower horizontal tubular boilers and a Corliss engine. In the mill building was apparatus used to drive machinery and handle the cotton-seed, lint and oil. The power house was back of the mill building. Other buildings were grouped nearby.

At about 7:25 A. M. on the day of the explosion, the night boiler crew was just going off duty and the day crew was coming on. Some of the men were changing their clothes at lockers behind the boilers and others were near the front of the boilers. Six of these men, an engineer and five negroes, were killed by flying debris or by the scalding steam or hot water. The nine negroes who were injured were at various places in the mill and yard and were struck by debris, which literally rained over the entire area.

The boiler which exploded, a vessel 72 inches in diameter and 18 feet in length, was the center one in a battery of three, all the boilers being suspended from the same 20-inch I-beam girders. Operating pressure was about 125 pounds and the safety valves were set to blow at 140 pounds, which they were observed to do during the week of the accident.

The explosion was caused by a rupture at the bottom of the rear course of the boiler, the line of failure extending from the girth seam to the head seam in a comparatively straight line, passing through the opening for the blowoff pipe connection, and then across the skirt of the rear head flange and up into the rear head for a distance of about 8 inches.

From the appearance of the sheet along the line of failure it was concluded that there had been two bulges and that the tear started at the apex of one of them. At two places along the line of failure the plate was reduced from its original thickness of $^{17}/_{32}$ inch to $^{4}/_{32}$ inch, and at other places the plate thickness varied from $^{14}/_{32}$ inch to $^{4}/_{32}$ inch because of stretching due to heat and pressure. Along the bottom of the rear course the metal showed evidence of overheating for a distance of from 4 inches to 8 inches on each side of the line of failure. The violence of the separation was sufficient to shear the $^{7}/_{8}$-inch rivets in the girth seam. Rivets in the rear head seam sheared around three-quarters of the circumference with the exception of a short distance where the line of failure passed through the ligaments between the tube holes in the outer row. The tubes were pulled from the holes in the rear head.

The reaction of the great amount of escaping steam and water against the bottom of the combustion chamber and against the steel-encased furnace wall, projected the rear end of boiler No. 2 upwardly as the shearing of the girth seam was taking place. The steam drum and the 20-inch I-beams to which all of the boilers were connected were forced upward, lifting boilers Nos. 1 and 3 from their settings. Boiler No. 1 was thrown through the engine room wall, striking and breaking the 16-foot flywheel and other parts of the running

* Published through the courtesy of *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company.

engine. This boiler was turned end for end and came to rest 35 feet from its original setting.

Boiler No. 3 was under pressure, and when it was raised from its setting by the suspension girders and steam drum, the blow-off pipe, feed pipe, and possibly also the safety valve connections, were broken, releasing more energy to do damage. After the connections to the steam drum failed, this boiler was projected in a direction nearly opposite to that taken by No. 1 and fell upon the ground in the mill yard, about 45 feet from the boiler house. In its flight it knocked down the side wall of the setting, the side wall of the boiler room and the 100-foot steel stack.

The front head, front course and tubes of boiler No. 2 came to rest about 100 feet from the setting. Manhole reinforcement rivets and brace rivets were sheared off or considerably distorted as the boiler hit the roof structure or the steel rails of a railroad track along which it skidded to its final resting place.

The rear course with the rear head attached unrolled and flattened out. It must have traveled in a nearly vertical direction as it soared over the roof of the power house. This part of the exploded boiler, weighing approximately 5 tons, came to rest upon the top of the east wall of the main building 46 feet above the ground and 100 feet from its setting. One end of the sheet extended over the wall and the other end pierced the mill building roof and rested on the upper end of the cotton-seed elevator.

The steam drum and steam pipe with the throttle valve attached passed over the engine room and landed on a railroad switch track, damaging a cotton-seed conveyor in its flight.

The one story brick powerhouse was demolished. Practically one-half of the two story 36-foot by 120-foot mill building was knocked down and there was considerable damage to the expensive mill machinery.

Men in the linter room on the second floor of the mill miraculously escaped with nothing more serious than cuts and bruises. The floor on which they were working was raised several feet and then crashed down onto machinery below. One man was buried in the debris but he was able to crawl out. Flying bricks and structural steel did considerable damage to surrounding buildings.

The chain of circumstances which led to the explosion probably never will be known, but there are certain facts which investigators feel had a bearing on the accident.

Hertford is in the extreme northeast section of North Carolina about 40 miles west of Kitty Hawk and a little more than 20 miles south of the Virginia line. To the north of Hertford is the Dismal Swamp out of which runs the Perquimans River, along which the plant's wharfs were located. Water for the boilers was obtained from a well which connected with the river by a 24-inch diameter inlet. Last Fall a storm of unusual severity raged along the Atlantic seaboard and as a result a new channel was cut by the waves from the ocean through to Albemarle Sound, into which the Perquimans River empties. At Elizabeth City, Hertford, and other towns along or near the sound there were complaints of increased brackishness of the water. The rivers which formerly had been fresh contained sea water. Feed-water treatment changes became necessary and at some locations a revised cleaning procedure was called for by an increase in the amount of sediment.

It was reasoned from this that changes in the currents in Albemarle Sound and the Perquimans River which probably followed the storm of last Fall, had caused a shifting of the fine sand and bog material deposited on the bottom of the river and had resulted in more of this insoluble material being conveyed to the boiler intake. A collection of it at the bottom of the boiler would lead to the conditions preceding the explosion.

The accident had as its direct cause the weakening of the plate due to overheating. Overheating of a boiler comes about through two chief causes—low water or the presence of scale, sediment or oil within the boiler and between the shell and the water. In this case the overheating was attributed to the unexpected rapid accumulation of scale and sediment, which it is believed was occasioned by a change in the feed water as a result of the storm. There was no evidence of low water. The fusible plug in the rear head of the boiler was in good condition. As a matter of fact the violence of the explosion, revealing the presence of a vast store of energy, showed that an ample supply of water was carried.

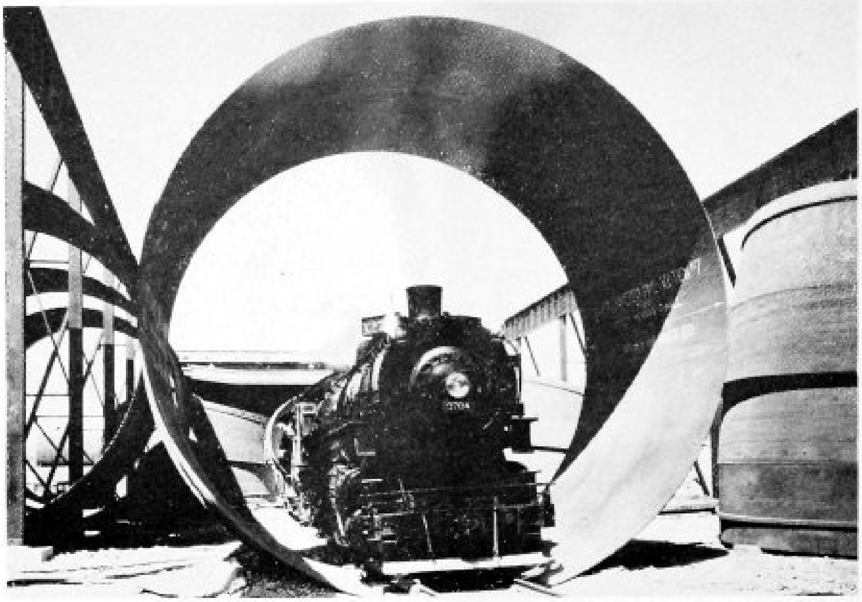
Scale in the boiler was about 1/16 inch in thickness on an average and was as thick as 1/8 inch in places. Loosened scale, in conjunction with a binder of black sediment, consisting of sand, iron and vegetable matter formed a coating as thick as 1/2 inch in places and was probably thicker than this on the plate which ruptured. The appearance of the ruptured plate after the accident indicated that loosened sediment had accumulated in two distinct mounds about 3 feet apart on the rear course, connected by deposits of lesser thickness.

The accident was a good example of how quickly a boiler may become unsafe if conditions are such as to prevent the free, rapid transfer of heat through the plate and into the water from whatever cause. It also emphasizes the enormous amount of energy which may be released when failure occurs, and brings out the fact that the safety of a boiler may depend at times upon conditions, such as contamination of the feed water, which are not directly under the control of the operators.

Hearing Held on Amendments to Plate Fabricating Code

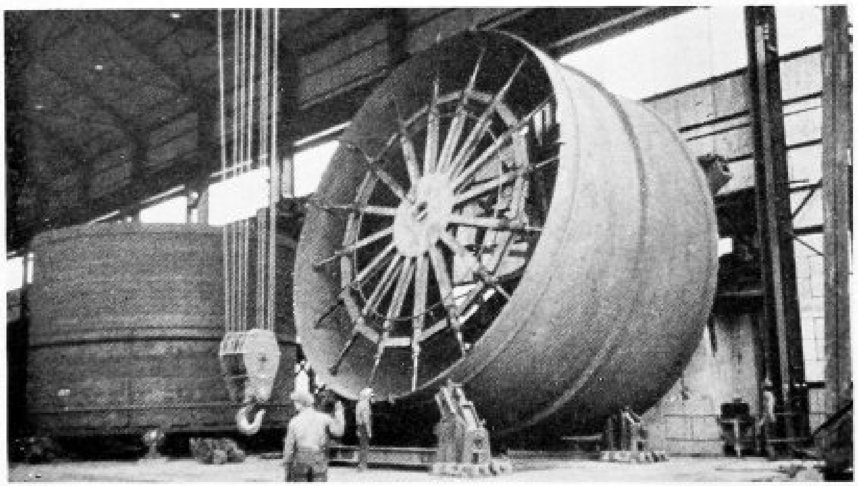
A public hearing on a number of amendments proposed by the Administration for the approved code of fair competition for the steel plate fabricating industry was conducted by Deputy Administrator Walter G. Hooke, beginning June 25, at Willard hotel, Washington, D. C.

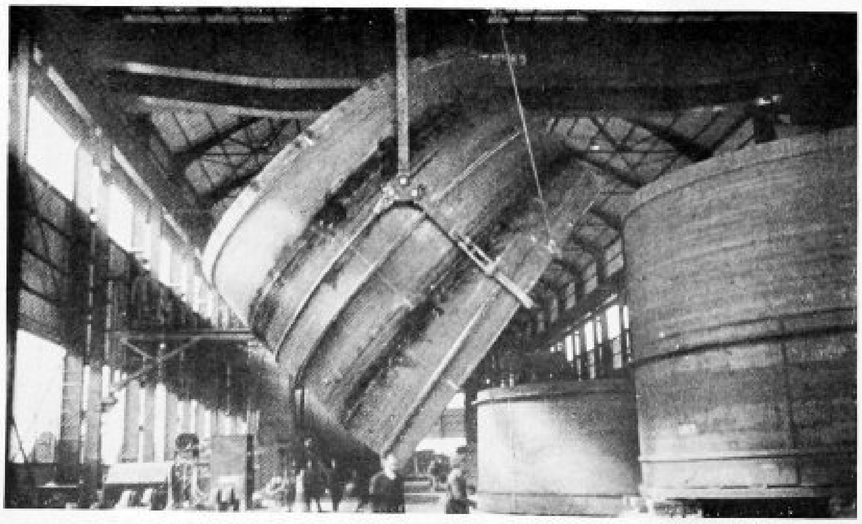
The amendments were proposed under the terms of the Administrator's Order approving this code on April 6, and involve the following changes: (1) Extension of the code to cover all territory subject to the jurisdiction of the United States, except the Philippine Islands; (2) Limiting the maximum work-week to a flat 40 hours, of 5 consecutive days and 8 consecutive hours each, with permission for employer and employees to agree to a lesser number of days not to exceed 9 hours each where it is necessary to work less than 40 hours per week; (3) Permission for overtime in cases of emergency, with all excess time to be paid for at the rate of time-and-one-half for shop work, and double time for all repair, renewal and construction or erection work; (4) Prohibition against employment of apprentices, except upon permission from the Administrator; (5) Increasing the minimum wage from 30 cents to 35 cents per hour in the states of Louisiana, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Florida and Mississippi; (6) Abolishing the population differential for clerical employees and establishing a flat minimum wage of $15 per week for all workers except factory and construction employees and commission salespeople; and (7) Inclusion of further safeguards for workers under the section dealing with general labor provisions.



FABRICATING PIPE SECTIONS

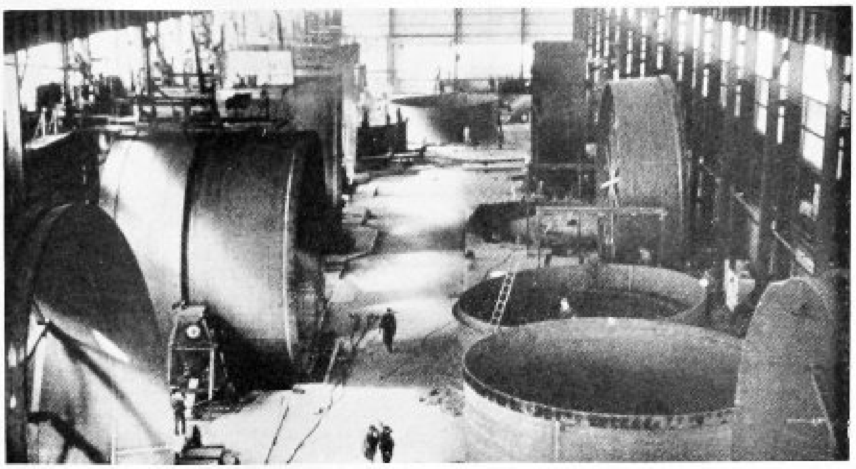
at Boulder Dam



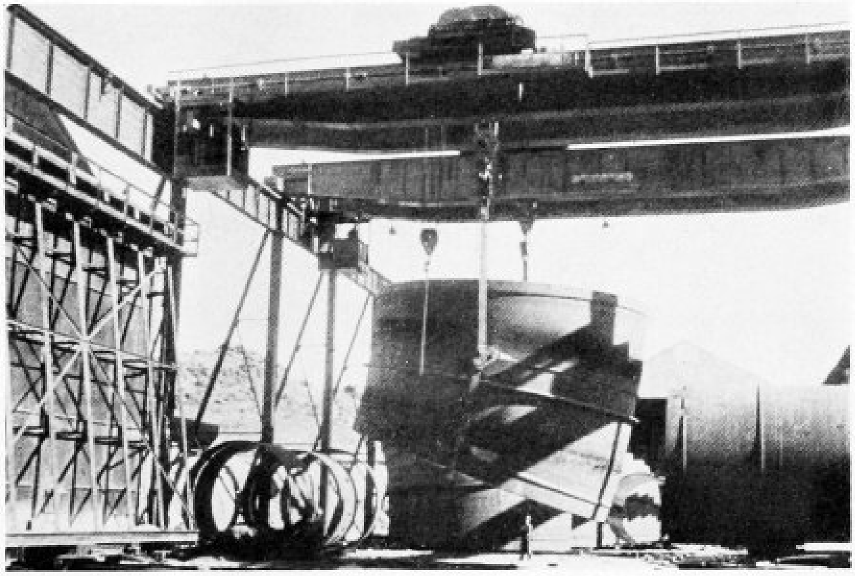


The first section of the enormous 30-foot diameter pipe will soon be installed at the foot of the intake towers at Boulder Dam. A description of the use and the method of fabrication and installation of this conduit system was given in the January issue. Some idea of the immensity of the pipes and the difficulties encountered in their fabrication can be realized from the accompanying illustrations, which show the progress made by The Babcock & Wilcox Company on this contract

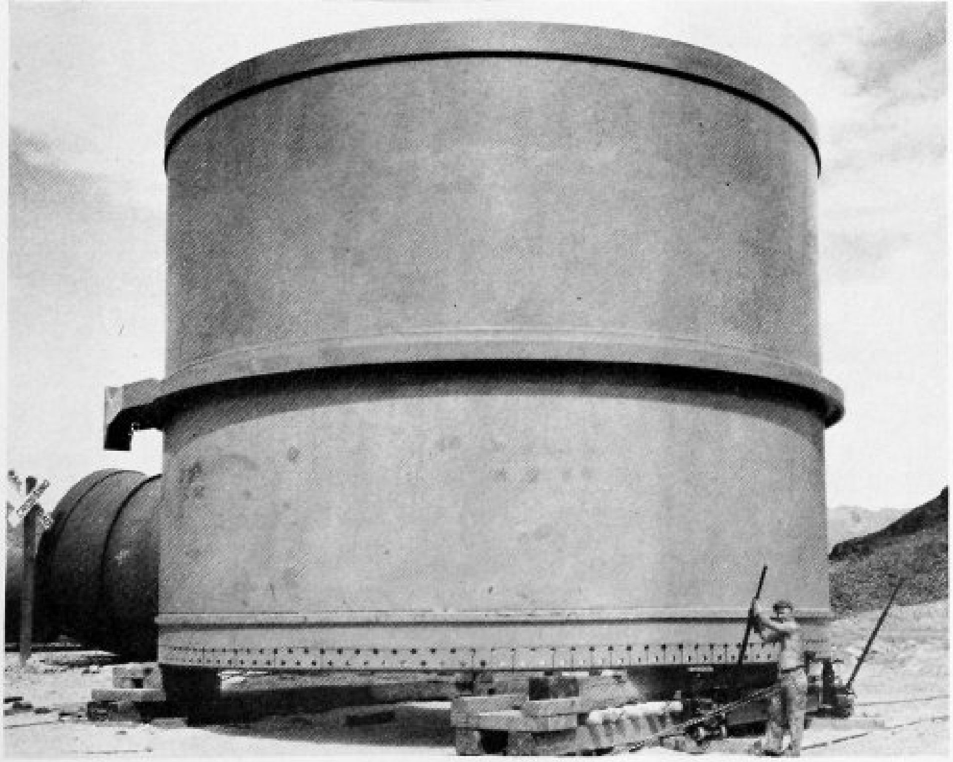
(Top) Locomotive passing through 30-foot diameter pipe section. (Center) Machining the end of a pipe section. (Bottom) Two 75-ton cranes and special rigging for handling sections



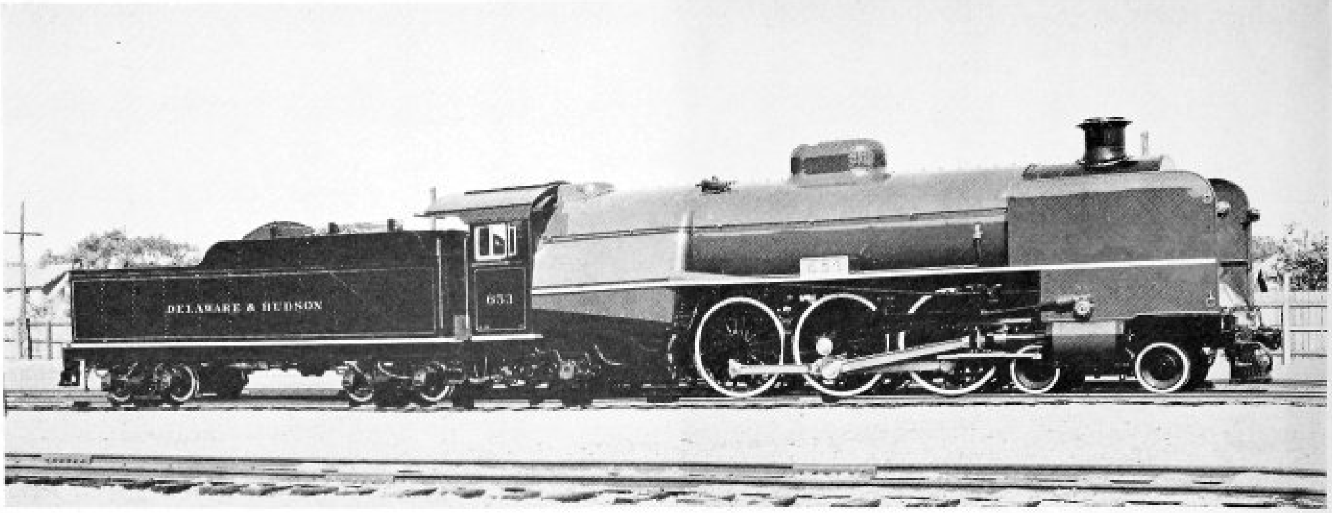
Interior of field fabricating plant of Babcock & Wilcox Company at Boulder Dam, showing 30-foot diameter pipe sections in various stages of completion



Handling a pipe section in the storage yard, by means of special rigging and two 75-ton cranes



A section in storage, ready for installation, at the field fabricating plant at Boulder Dam



Delaware & Hudson high-speed 4-6-2 type passenger locomotive with front side plates to carry up smoke clear of cab and train
325 lb. steam pressure, poppet valves, roller bearings for main and side rods

Higher speeds and light weight to mark future

LOCOMOTIVE DEVELOPMENT

Changes in locomotive proportions, which were a marked step in the evolution of the freight locomotive from a low-speed traction device to a producer of high horsepower and a high-speed traction device, were introduced about 10 years ago. Because of the declining rate at which motive power has been purchased since that time the extent to which these developments have been incorporated in the locomotive inventory of the railroads is no greater than might have been effected within a two- or three-year period under a reasonable replacement policy.

The largest single type of locomotives owned by the Class I railroads are the Consolidations which number 11,266—over one-fourth of the total road locomotive inventory—and average almost 26 years of age. Of the wholly modern types of power—those with four-wheel trailers—which have been built during the past ten years, there are 1046 in service, and not all of these are freight locomotives.

The study of repair costs made by Co-ordinator Eastman's Section of Car Pooling clearly establishes the fact that the unit cost of locomotive repairs increases definitely with advancing age. While this factor alone does not offer a complete basis on which to determine the economic life of locomotives, since it takes no account of the effect of improvements in locomotive design and construction on the cost of conducting transportation, the rate at which repair costs increase is alone sufficient to indicate clearly that a continuance of the present lack of policy with respect to obsolete equipment is wasteful.

The average age of the locomotives for which data were collected in the Co-ordinator's repair-cost study was 18.89 years. This implies an average life at retirement of about 38 years. The average age-of-use was 13.87 years. What would have been the effect on the cost of maintenance at present of an inventory in which retirements had been made at the age of 20 years and in which the average age of the locomotives now would be about 10 years? Assuming about the same relationship of age-of-use to average age of the locomotives owned, as obtains in the present inventory, the average age-of-use would now be 7.3 years. The average repair cost per horsepower unit of all the locomotives studied is $1.16 at age 13.87 years and 96 cents at 7.3 years, a difference of 20 cents per horsepower unit. On the basis of the average expenditure for locomotive repairs during the three-year period covered by the study, this is equivalent to a reduction of about $72,000,000 a year. To maintain the age conditions by which this reduction in repairs is effected would require approximately doubling the annual charges to depreciation. This would take an average of about $57,000,000 as of the years 1927, 1928 and 1929, leaving some $15,000,000 as a net reduction in total direct charges to locomotive maintenance. For the three years in question these charges—including repairs, depreciation and retirements—averaged about $479,000,000, of which the net saving is approximately three percent.

Obviously, such figures are of little value as a basis of procedure by any railroad in the development of a general policy with respect to its motive power. They do indicate, however, the fact that the saving in locomotive maintenance alone is sufficient to justify a careful study of the economic value of every locomotive over 20 years old and, no doubt, of some of less than that age.

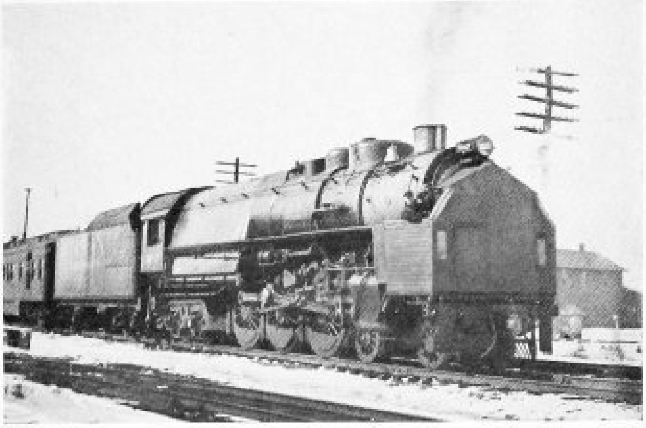
There has been a steady trend toward expedited freight service throughout the past 10 years. Average freight-train speeds have steadily increased, first with a reduction of delays and then by increased running speeds. To meet the latter condition locomotive horsepower—not tractive force alone—is required. The characteristics of modern freight locomotives, so few of which have as yet been placed in service, meet this trend in the requirements, and for this service large groups of existing freight locomotives are inadequate.

With a few notable exceptions, there has been little change in the passenger motive power owned by the railroads during the past 10 years. During this period the growing use of the rail motor car for local service, both on branch and main lines, reduced the volume of steam-train mileage and, generally speaking, there have been no changes in through service requiring increases in the number of locomotives for this class of service.

The present indications with respect to the development of passenger equipment point to a gradual reduction in passenger-train weight, with an ultimate place for lighter locomotives designed to operate on schedules averaging higher speeds than those of present long-distance runs. Where trains are short, self-propelled cars or train units offer advantages of weight and operating economy. As trains increase in length, however, the advantage in these respects becomes proportionately less and flexibility strongly favors the separate motive-power unit.

There is no lack of evidence that some of the present steam locomotives are capable of top speeds of 100 miles an hour and many of them are frequently required to reach 80 miles an hour. With reductions in the weights of passenger-train cars higher horsepower per ton may be obtained without exceeding present locomotive capacities. An increase in horsepower per ton facilitates higher operating schedules within a given top speed. Streamlining of the steam locomotive to reduce air resistance offers no inherent difficulty and will materially increase drawbar horsepower at high speeds.

The steam locomotive is facing a new competitor in the form of Diesel motive power, just as 30 years ago it faced the competition of electric traction. The advent of the internal combustion power plant for railway service has provided a highly useful facility. In the form of self-propelled cars the Diesel power plant is admirably adapted for certain light and relatively inflexible train services. The high acceleration of the Diesel locomotive at low speeds makes it particularly suitable for switching and transfer service and it can be used in any service for which units of sufficient capacity are available, if the use is sufficiently continuous to insure that fixed charges per unit of service shall not offset operating advantages. But for the bulk of the service, which provides a relatively low use factor owing to the spacing of schedules and seasonal fluctuations in the volume of traffic, the relatively low first cost of the steam locomotive is a factor of great weight, in keeping it as the center of the motive-power inventory of the railroads.



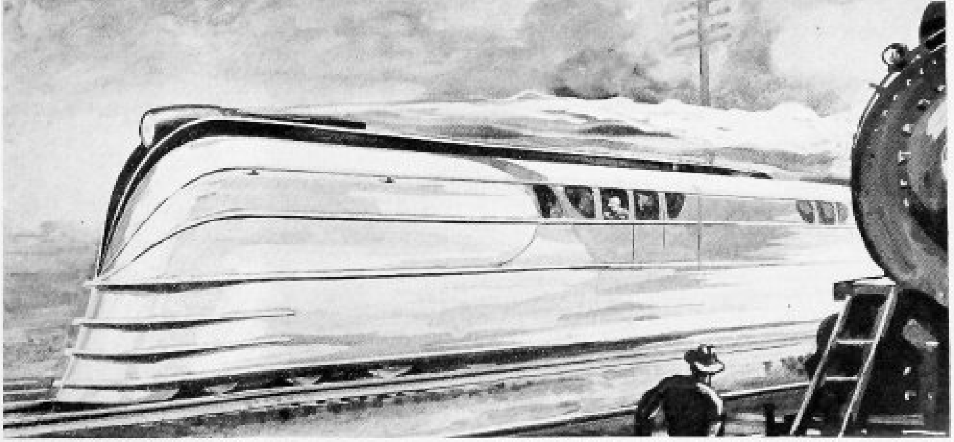
Photograph by Roy W. Carlson

B. & O. latest high-pressure high-speed 4-6-4 type locomotive No. 5047 on a test run—350 lb. pressure, Emerson watertube firebox

Unlike the case of passenger cars and freight cars, the present moment does not mark the beginning of a new epoch in the evolution of the steam locomotive. It was subjected to a period of intensive development following the close of the war, culminating in the introduction of the four-wheel trailing truck, which removed the limitations on firebox proportions then imposed by the single-axle trailer, and increases in boiler pressures.

Developments have not ceased, however. Watertube fireboxes, to carry boiler pressures as much higher than the 275 lb. to 300 lb., which mark the limit for use with fireboxes of staybolt construction as may be desired, have established themselves to a limited extent. Poppet valves are also receiving attention and have a promising field in connection with the trend toward higher speeds. The adaptation of the steam locomotive for use with light-weight passenger equipment in high-speed service is already under way and it will soon be taking its place in this class of service.

A leading eastern railroad already has designs developed for the construction of a fully-streamlined passenger train for high-speed service, motive power being supplied by a steam locomotive, which will incorporate all the latest developments and which will also be streamlined.



In the future, the trend toward streamlining, and light weight may bring such steam locomotives as this into being

ELEMENTARY PLATE LAYOUT — II

By George M. Davies

The pattern shown in Fig. 13 (*b*) is a true development of a four-piece 90-degree elbow, as shown in the elevation, with no consideration given to fabricating same.

One method of fabricating elbows is to construct the sections with large and small ends so that the sections can be fitted together by inserting the small end of one section into the large end of the other.

Provision for this method of fabricating the elbow can be made in the development of the elbow as follows:

Duplicate Fig. 13 (*a*) as shown in Fig. 14 (*a*).

Extend the line *M″-L″* some distance above *L″-K″* as shown and with the dividers set with a radius equal

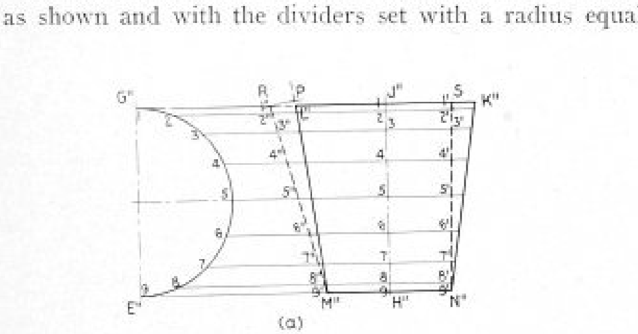


Fig. 14

to twice the thickness of the plate used; and with *L″* as a center, scribe an arc cutting the line just drawn at *P*. Then with *M″* as a center and with the dividers set with *M″-P* as a radius, scribe an arc cutting *K″-L″* at *R*. Connect *R-M″*. Then with *K″* as a center and with the dividers set with *L″-R* as a radius, scribe an arc cutting *K″-L″* at *S*. Connect *S-N″*.

The pattern is developed in the same manner as outlined for this pattern in Fig. 13 (*b*), with the exception that the various distances are measured from the line *R-M″* instead of *L″-M″* and *S-N″* instead of *K″-N″* as indicated.

In the pattern, shown in Fig. 14 (*b*), it will be noted that the lines of the pattern as obtained from the points in Fig. 14 (*a*) are taken as the rivet lines to which the lap is added to complete the pattern.

The development shows that the line *T-U* is longer than *V-W*, thus showing how the large and small ends are obtained. An elbow of any size can be laid out for any thickness of plate making the necessary allowance at *L″-R* and *K″-S*, Fig. 14 (*a*).

Parallel line method of development is applicable to all types of elbows or pipe sections in which the diameter of the elbow or pipe section is uniform throughout.

Intersection of Cylindrical Objects

The next type of parallel line development to be considered is the intersection of cylindrical objects of the same or different diameters.

Fig. 15 illustrates the intersection of two cylinders of different diameters, the cylinders being at right angles to each other.

The development of the cylinders is made as follows:

The end elevation is drawn first for the reason that all the lines in this view are of their true length; the intersection of the two cylinders in the side elevation being projected from the end elevation as follows:

Project the profile of the vertical cylinder in the end elevation on the center line *C-D*, as shown in Fig. 15 (*a*).

Divide one-half of the profile *G-D* into any number of equal spaces, the greater the number of spaces taken the more accurate the final development. Ten spaces are shown in this case; number the spaces from *1* to *11* as shown. Parallel to *C-D* draw lines through the point *1* to *11* extending same into the end elevation cutting the horizontal cylinder locating the points *1′* to *11′* as shown.

Then on the center line *E-F* of the side elevation project the profile of the vertical cylinder as shown in Fig. 15 (*b*).

Divide one-half of this profile as *K-L* into the same number of equal parts as previously taken and number the points from *1* to *11* as shown, the numbers corresponding to the same points as taken in profile 15 (*a*).

Then parallel to the center line *E-F* draw a line through the points *1* to *11* extending same down into the side elevation.

Then parallel to the center line *A-B*, draw lines through the points *1′-11′* of the end elevation extending same into the side elevation, cutting the parallel lines just drawn.

Where the parallel line extended from point *1′* of the end elevation intersects the parallel line drawn from point *1* of the profile Fig. 15 (*b*) locates the point *1″* of the side elevation. In the same manner the points *2″*, *3″*, *4″*, *5″* to *11″* are located. Connect these points with a curved line as *M-N* which represents the intersection of the two cylinders in the side elevation.

The pattern for the horizontal cylinder would be a rectangle whose length would be equal to the circumference of the horizontal cylinder as *A-H-J-C* of the end elevation, and whose width would be equal to *P-Q* of the side elevation.

To develop the pattern of the opening in the horizontal cylinder, draw *P′-Q′* parallel to the center line *A-B*. Extend the center line of the vertical cylinder *E-F* through *P′-Q′* as *E-X*. On *E-X* space off the distances

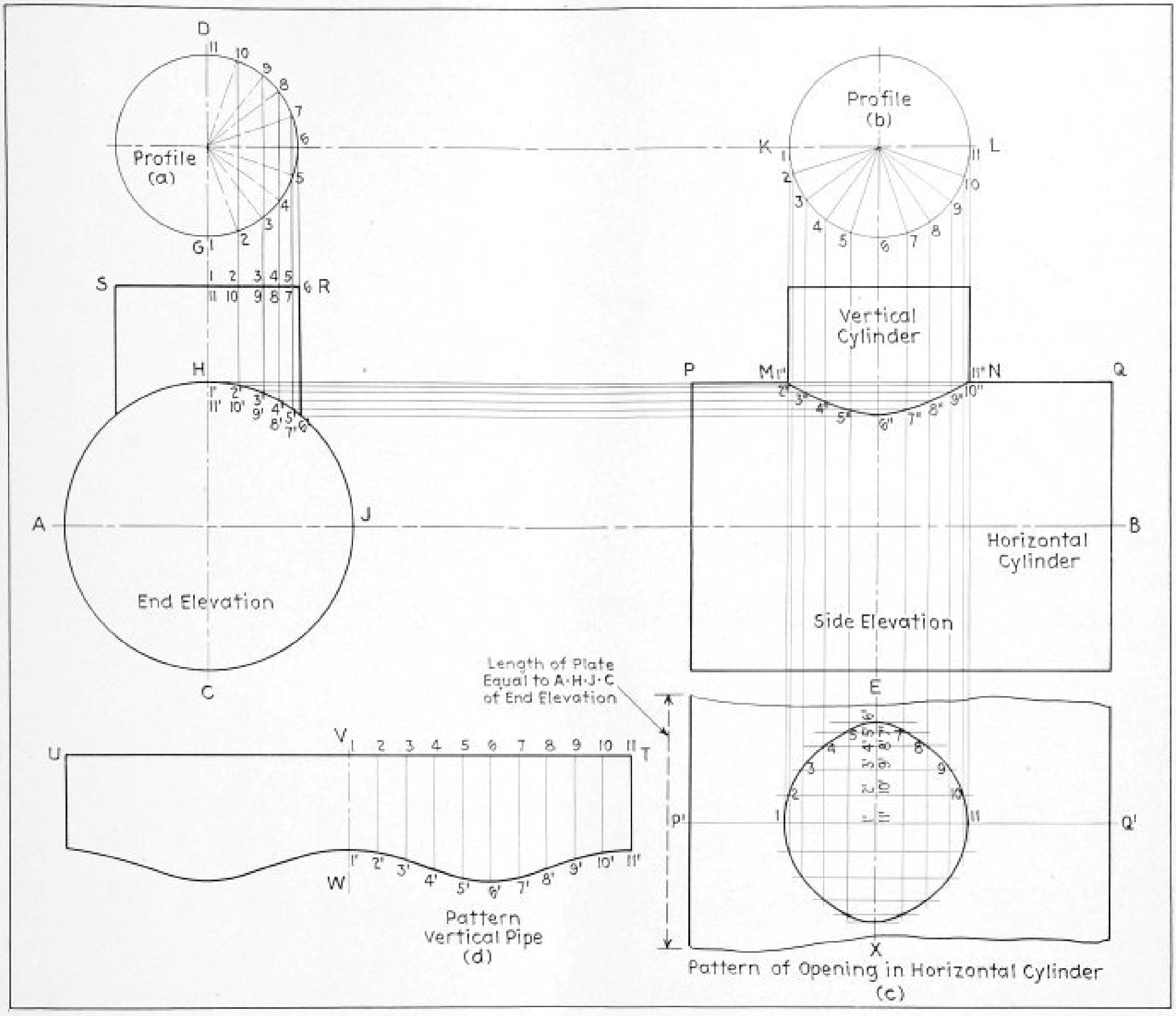


Fig. 15.—Intersection of two cylinders of different diameters

1'-2', *2'-3'*, *3'-4'*, *5'-6'*, etc., making these distances equal to *1'-2'*, *2'-3'*, *3'-4'*, *4'-5'*, *5'-6'*, etc.; of the end elevation respectively, as shown.

Draw lines parallel to *P'-Q'* through the points *1'*, *2'*, *3'*, *4'*, etc. Then parallel to *E-F* draw line through the points *1*, *2*, *3*, *4*, etc., of profile Fig. 15 (*b*), extending same cutting the lines just drawn parallel to *P'-Q'*. Where the line from point *1* of the profile Fig. 15 (*b*) cuts the line through point *1'* in the pattern, locates the point *1* in the pattern. In the same manner the points *2*, *3*, *4*, *5* to *11* of the pattern are located. Connect these points with a line, completing one-half of the pattern of the opening. Due to the fact that the center line *C-D* divides the object into two symmetrical halves, the pattern of the opening can be completed by duplicating the half pattern just constructed on the opposite side of the line *P'-Q'* as shown.

To develop the pattern of the vertical cylinder, draw any straight line as *U-T* and erect a perpendicular to it as *V-W*; on *U-T* starting from *V* step off the spaces *1-2*, *2-3*, *3-4* to *10-11* equal to *1-2*, *2-3*, *3-4* to *10-11* of the profile Fig. 15 (*a*) respectively. Erect perpendiculars to the line *U-T* at the points *1* to *11* inclusive. On the perpendicular to point *1* step off the distance *1-1'* equal to *1-1'* of the end elevation, locating the point *1'* of the pattern. On the perpendicular to point *2* step off the distance *2-2'* equal to *2-2'* of the end elevation, locating the point *2'* of the pattern. Continue in like manner until all points to *11'* of the pattern are located. Connect the points *1'*, *2'*, *3'*, *4'* to *11'* with a line, completing one-half of the pattern; duplicate this pattern of the opposite side of the line *V-W* as shown, completing the pattern of the vertical cylinder.

Any intersection of cylinders, irrespective of the angle at which the cylinders join each other, can be developed, by the parallel line method in similar manner, as illustrated in Fig. 15, provided the diameters of the cylinders or the profile of the object is uniform throughout.

Transition Piece Development

Transition pieces having certain characteristics can be developed by the parallel line method such as transitions from round to oblong, the oblong having circular ends, which are the same diameter as the round.

A transition piece having the characteristics stated

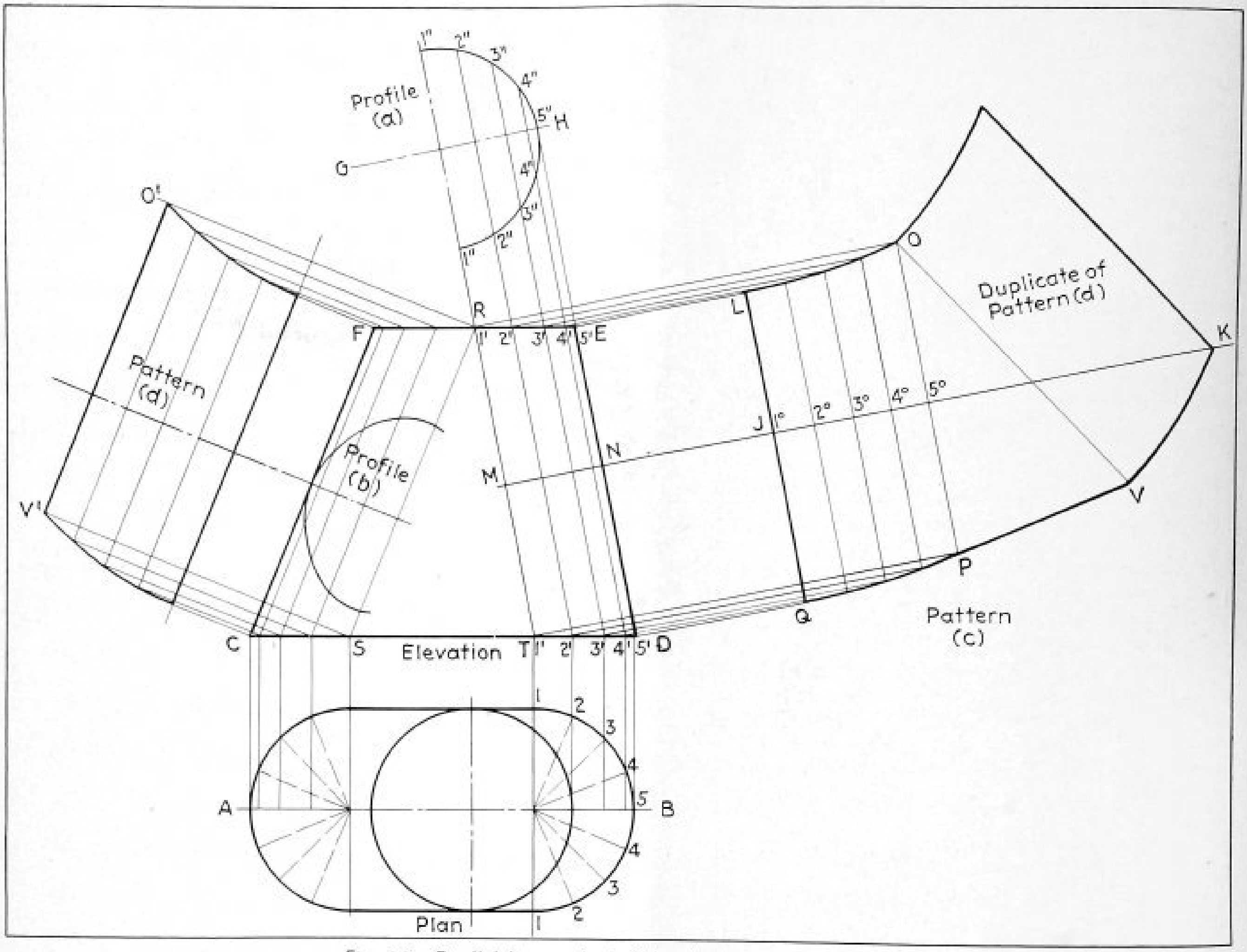


Fig. 16.—Parallel line method of developing transition piece

above is illustrated in Fig. 16 and is developed as follows:

Draw the elevation and plan views as shown, then divide the semi-circular end of the plan view 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 parts from *1* to *5* and *5* to *1* as shown.

Erect perpendiculars to the line *A-B* through points *1* to *5*, extending the perpendiculars to the line *C-D* of the elevation, locating the points *1'*, *2'*, *3'*, *4'*, *5'*.

Parallel to the line *D-E*, draw lines through the points *1'*, *2'*, *3'*, *4'*, *5'* cutting the line *E-F* at *1'*, *2'*, *3'*, *4'*, *5'*.

The next step is to construct the profile of the circular end, this profile to be taken along the line *M-N* which is drawn perpendicular to *D-E*.

Erect *G-H* perpendicular to the line *1'-1'* of the elevation, which has been extended.

Extend to lines *2'-2'*, *3'-3'*, *4'-4'*, *5'-5'* of the elevation each side of the line *G-H* as shown.

On each side of *G-H* on the line *1'-1'*, step off a distance equal to the vertical distance between the line *A-B* and the point *1* of the plan view, locating the points *1"-1"* in the profile; in similar manner each side of the line *G-H* on the line *2'-2'* step off a distance equal to the vertical distance between the line *A-B* and the point *2*, locating the point *2"-2"* in the profile. Continue in this manner until the points *3"-3"*, *4"-4"*, *5"-5"* are obtained. Connect these points as shown, completing the profile.

Profile Fig. 16 (*b*) is constructed in similar manner.

The next step is to construct the pattern. It will be noticed that the object is symmetrical about the line *A-B* of the plan and therefore a development of one-half the pattern will be sufficient and a duplicate of same would give a complete pattern.

Erect *J-K* perpendicular to *D-E* of the elevation. Step off on *J-K* distances *1°-2°*, *2°-3°*, *3°-4°*, *4°-5°*, equal to *1"-2"*, *2"-3"*, *3"-4"*, *4"-5"* respectively of the profile Fig. 16 (a).

Erect perpendiculars to *J-K* through the point *1°*, *2°*, *3°*, *4°*, *5°*, extending same both sides of *J-K*.

Next parallel to the line *J-K* draw lines through the points *1'*, *2'*, *3'*, *4'*, *5'* on the lines *E-F* and *C-D* of the elevation, extending same into the pattern cutting their corresponding lines in the pattern as shown, completing that portion of the pattern shown by *L-O-P-Q*.

Pattern Fig. 16 (d) is developed in the same manner.

Then with *O* as a center and with a radius equal to *R-S* of the elevation, scribe an arc, and with *P* as a center and with a radius equal to *S-T* of the elevation, scribe an arc cutting the arc just drawn, locating the point *V* of the pattern. Draw *O-V* and *P-V*.

To complete the pattern add that portion of the pattern developed in Fig. 16 (d), placing *O'-V'* on *O-V* as shown, completing the half pattern as shown in Fig. 16 (c).

(To be continued)

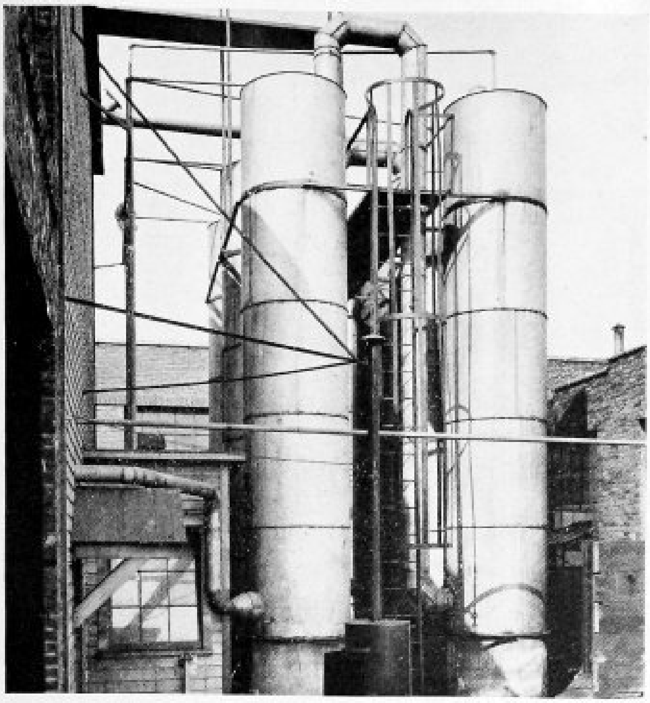


Fig. 1.—Stainless steel chemical processing towers

Special Vessels Fabricated by Arc Welding

The stainless steel towers and piping for a new chemical process, shown in Fig. 1, were fabricated by arc welding by The Thornton Company, Cleveland. The towers were built for a Cleveland chemical plant, the only plant in the United States manufacturing this particular product. Since the chemical process involved is secret, it is not possible to describe in detail the construction and operation of the plant. Highly corrosive chemicals are utilized, making the use of chrome-nickel alloy steels imperative. In building the equipment, there were no precedents to follow. Nothing similar had ever been attempted before. But all the necessary towers, piping, exchangers, tanks, etc., were fabricated by arc welding. Not a bolt was used.

In building the towers, the metal was flanged at the seams and arc welded, using special composition electrodes which were made especially for this job. The plant has now been operating successfully for some time.

Fig. 2 shows one of the tallest fractionating towers ever built. It was recently completed for the United Refining Company, Warren, Pa. This tower is 6 feet 9 inches in diameter and 110 feet high. It was constructed entirely by arc welding and shipped in one piece weighing 80 tons. The tower was welded by The Struthers-Wells Company, using the shielded arc process.

Fig. 2.—Tower being lifted onto foundation

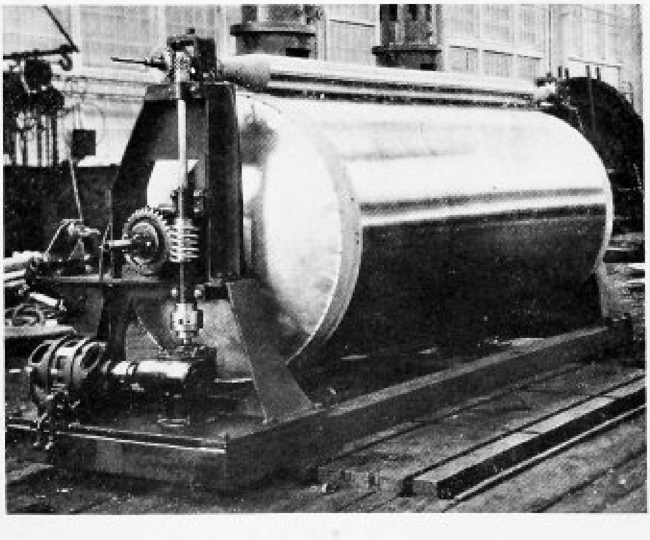
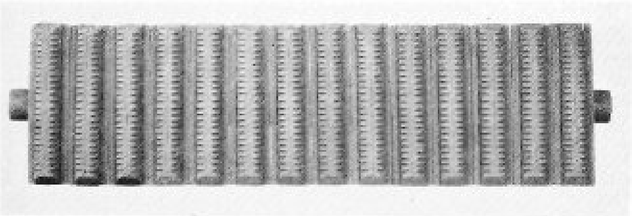


Fig. 3.—Rotary drum dryer of stainless steel and aluminum

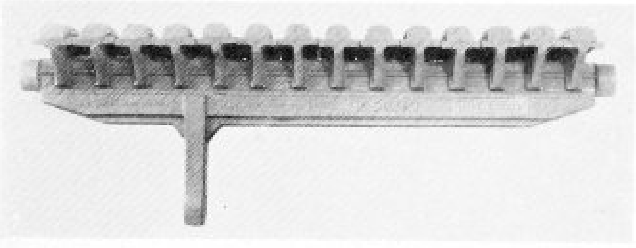
An unusual rotary steam drum dryer built of arc-welded stainless steel and aluminum for a large food manufacturer was also recently completed by The Struthers-Wells Company. The dryer, illustrated in Fig. 3, is 5 feet in diameter and 10 feet long. It is built to withstand 100 pounds working pressure. The heads are of high-carbon steel insulated and lagged with polished aluminum sheets. This drum, as in the case of work cited above, was welded throughout with equipment manufactured by The Lincoln Electric Company, Cleveland. The surfaces of the stainless steel main shell and top roll were machined and polished within a tolerance of 0.005 inch.

Unit Type Tuyere Grate Finger Casting

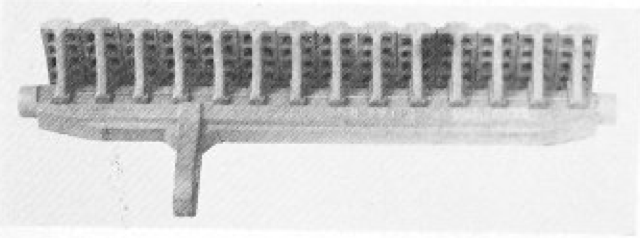
To reduce the number of castings and overall weight per square foot the tuyere-type grate, made by the Hulson Grate Corporation, Keokuk, Iowa, is now designed with unit-tuyere finger castings. The units are 2¼ inches wide, 9⅞ inches long, for carrier bars mounted on 10-inch centers, and weigh 6¾ pounds each. Compared with 77 to 83 pounds per square foot overall weight for the paired-finger design, the unit castings average 67 to 73 pounds. The finger castings alone average 57 pounds for the paired fingers and 44 pounds for the unit castings.



Top view of Hulson grate with unit type tuyere finger castings



Side view showing carrier bar with unit tuyere finger castings



View showing underside of unit tuyere finger castings mounted on carrier bar

The top surface of the unit is rounded to streamline the air discharge from the tuyeres and provide a uniform distribution over the entire grate surface. The air delivery is the same as used in the paired finger design, giving a baffled air admission which eliminates tearing action on the fire, an important advantage at high ratings with high firebox drafts. The tuyere openings are made with dry sand cores, giving a clean, uniform passage free from plugging. The air space is controlled by the tuyere opening and permits of accurate proportioning to suit the locomotive design. The grate illustrated may have a range of from 9 to 20 percent total air inlet.

Distortion and scaling are said to be eliminated in this design, as the heat absorbed by the top surface is rapidly dissipated through the body of the casting. A larger free opening is provided with the grate in full open position, thus reducing the number of strokes required to dump a fire quickly. Sufficient clearance is provided in the fit on the carrier bars so that the castings can be applied easily. Owing to their greater weight, shaking the grate loosens any possible corrosion and the castings remain free on the bar.

When making complete applications the frames and carrier bars are installed and connected and the units applied last. Approximately six unit castings are required per square foot of grate surface as compared with 12 and 14 castings of the paired design.

The only direct or straight draft opening is at the ends of the fingers where the maximum opening is ¼ inch. As there is no distortion of the casting, this clearance may be kept down without interference developing. Firing-up loss with any size coal is said to be less than ¾ pound per square foot grate surface. No ash-pan accumulation develops in service.

Worthington Type SA Feed-Water Heater

The Type SA locomotive feed-water heater equipment made by the Worthington Pump & Machinery Corporation, Harrison, N. J., is similar to the Type S, but differs from it in certain details, as all three essential parts have been redesigned and improved to secure added efficiency, dependability and economy. In these open-type heaters cold water from the tender is sprayed into the heating chamber where it contacts with exhaust steam from the locomotive cylinders. As the feedwater is heated, oxygen is driven off and escapes through the air vents to the atmosphere.

The equipment consists of three distinct units—the cold-water pump, the heater and the hot-water pump. These independent units are comparatively small and can be located to the best advantage for weight distribution, maintenance convenience, and appearance of the locomotive. The units are shown, diagramatically arranged, in the illustration.

Cold water from the tender is supplied to the heater by a variable-speed turbine-driven low-pressure centrifugal pump located on the side of the frame near the tender. The steam turbine drives the pump at a speed necessary to deliver the amount of cold water required. The heater is set in the smokebox, either in front or back of the stack. Locomotive exhaust steam passes into the exhaust inlet at the bottom of the heater and through the exhaust check valves to the heating chamber, where it contacts with the cold water which has been forced through the spray valve by the cold-water pump. The heated water flows down through the hot-water outlet to the hot-water pump which delivers it to the boiler.

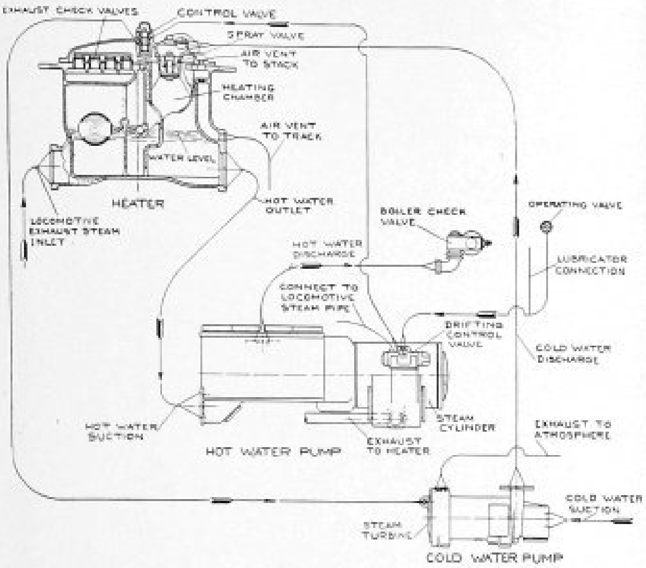


Diagram showing circulation of steam and water through the Worthington Type SA feed-water heater

The water level in the heater is controlled by a float-actuated control valve which regulates the speed and capacity of the cold-water pump by varying the steam supply to the turbine. The hot-water pump is of the horizontal reciprocating type. It is located as close to the heater and the boiler check valve as practical.

The type SQ equipment has a drifting control valve attached to the steam chest of the hot-water pump. This valve is operated by the pressure in the steam pipe or steam chest of the locomotive. When the locomotive throttle is closed or in the drifting position, this valve automatically reduces the quantity of steam for operating the pumps, thus limiting the amount of water fed to the boiler. The pumps will automatically speed up again when the locomotive throttle is opened. The drifting control valve relieves the engineman of the necessity of closing the pump-operating valve when drifting or making short stops.

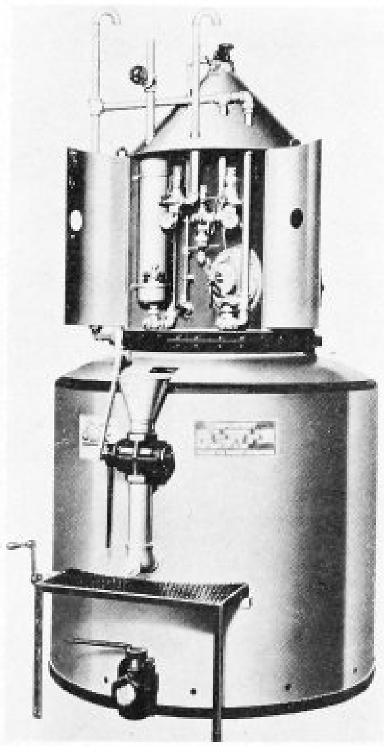
The Type SA equipment is furnished in three sizes, having capacities of handling 6600, 9000 or 12,000 gallons of water per hour.

New Stationary Oxweld Generator

The Linde Air Products Company, New York, has just announced another important addition to its acetylene generating equipment. This new automatic stationary generator, known as the Oxweld Type MP-5, is rated to deliver 1000 cubic feet of acetylene per hour, and thus takes its place as the highest-capacity, medium pressure model now available. It is listed by the Underwriters' Laboratories, Inc. Its advent should be of great interest to users who want high capacity without operating two or more generators simultaneously.

In general appearance it resembles the Oxweld Type MP-4 portable generator, recently announced, with which it is identical in principle, except for size and slight changes to make it suitable for stationary use.

Its compactness and efficiency show intelligent design in every detail. The feed is of the gravity type. The mechanism is of an advanced design, unlike previously employed gravity feed devices. The feed control unit is self-contained and is bolted to the inside of the carbide hopper. The feed valve unit is actuated by a diaphragm. Pressure on the diaphragm is exerted by a housed and loaded spring unit. The spring is encased in a small housing and set at the factory to deliver about 13 pounds per square inch pressure. This can be changed within a range of about 2 pounds per square inch by an external adjustment. The set pressure feature does away with the necessity of setting the pressure when the machine is started.


Automatic stationary acetylene generator

The carbide-charging door, the water-filling opening, the residue valve, and the handhole have been built on generous proportions so that time can be saved in emptying, recharging, and inspecting. The carbide hopper affords the greatest operating efficiency combined with easy cleaning; and the regulator filter unit, with its large capacity pads, is within easy reach inside the handhole.

Instead of having an external hose connection manifold, it has the service valve which is necessary on a stationary machine on the service pipe that leads directly from the back-pressure valve.

The relief valve arrangement on the Type MP-5 generator is particularly interesting. A separate relief valve with a separate outdoor vent line is provided for the back-pressure valve, and two other relief valves with a common outdoor vent line are provided for the generator chamber. Two relief valves are used because of the high capacity of the generator, and also because it is easier to get good seating and prevent leakage when two valves are used instead of one large one.

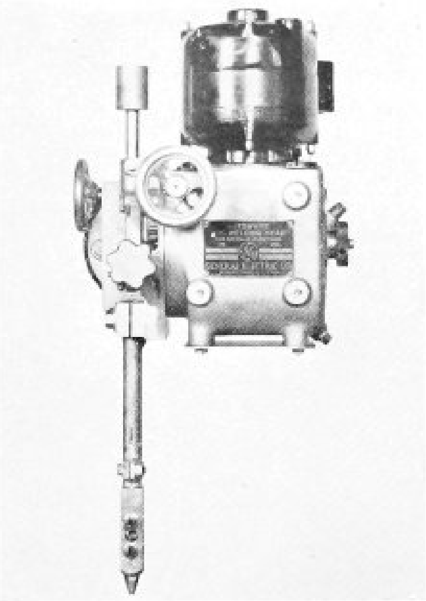
In general construction, this new generator has been made simple but rugged. Non-corroding materials are used throughout, and galvanized steel castings or stainless steel parts are used where exceptional strength is required. Most of the seams are bronze-welded; and some of the longer exposed joints on the water shell are double-vee welded, showing that no effort has been overlooked to make this of the finest and most permanent construction.

Every detail has been planned either to eliminate the necessity for repairs or, where this is impossible, to make maintenance so easy that it will never be neglected or postponed.

Automatic Arc-Welding Head and Control

Simplicity of design, control, adjustment to work, and maintenance are the features of the improved General Electric Type WFA automatic arc-welding head now available to industry.

One small motor drives the electrode feed rollers through a simple worm reduction gear and three-speed



G. E. automatic arc-welding head

transmission. At any of the three speeds, selected to suit electrode size, current, and rate of deposition of metal, the electrode is fed at a uniform rate and the arc voltage is accurately maintained. One small rheostat is the only adjusting element necessary. This means quick and accurate control of the electrode feed, as all other operations are fully automatic.

Handwheels swing the nozzle through complete circles in two planes at right angles to each other, thus permitting universal motion of the head. This feature provides the simplest and most accurate means for positioning the electrode with respect to the work or for following an irregular outline as the weld progresses.

The welding head complete consists of an insulated mounting support, an end plate which can be rotated and to which is attached an aluminum-alloy gear case containing the speed-reduction and transmission gears operating entirely submerged in grease. The motor is mounted vertically on the top of the gear case and is of the totally enclosed, ball-bearing type. It has adequate power, not only to feed the electrode but to straighten it as it comes off the reel. A circular aluminum-alloy plate carrying nozzle, wire guide, feed rollers, and feed-roller-pressure-adjusting knob is mounted on the left side of the gear case and can be rotated by means of a handwheel through a worm and worm wheel. A gear-shifting dial on the right side of the case permits ready selection of the desired transmission ratio.

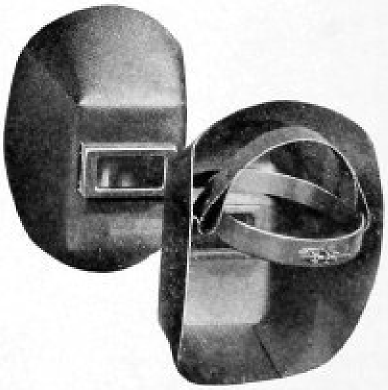
The electric control equipment consists of an enclosed panel on which are mounted standard G-E relays and contactors which maintain in proper sequence the operations necessary in starting, running, and stopping the automatic arc-welding head; and an instrument panel which may be located anywhere but preferably is placed as close to the welding position as possible. This instrument panel carries meters reading arc voltage and current, the arc voltage adjusting rheostat, start-stop buttons, a forward-reverse switch for the electrode feed mechanism, and a selector switch for either manual or automatic operation of a travel carriage if the latter is used.

The standard Type WFA automatic arc-welding head and control is arranged for operation from a 60-volt direct-current supply.

A New Welding Helmet

The No. 650 welding helmet developed by the Safety Engineering Bureau of American Optical Company, Southbridge, Mass., is particularly suited for work in confined spaces such as tanks, ships' hulls, locomotive front ends, fireboxes, and other places of a similar nature.

Designed to fit closely to the face and sides of the head without sacrificing ventilation or causing light leaks, the helmet is cool and comfortable under the most humid conditions. The Bakelite welding glass holder is



Welding helmet for use in confined spaces

outside of the helmet and is fully dielectric. It assures the wearer of freedom from burns if accidental contact is made with the electrodes while working. The added distance from the face to the welding plate permits the helmet to be comfortably worn with a respirator and also helps to prevent fogging. Noviweld glass, which screens out more than 99½ percent of all injurious light rays, is standard equipment.

A swivel connection between the helmet and headgear provides three positive positions in which the helmet can be set when in use. Looseness, slipping and sideplay are eliminated. The entire unit is extremely light in weight and the balance between the headgear and the helmet increases the speed and positiveness with which the helmet can be set in position.

SAFE BOILER CONSTRUCTION*

By Dr. D. S. Jacobus†

No term is as much misused as so-called "factor of safety." In the case of a boiler drum, factor of safety, as ordinarily defined, is the ratio of the ultimate strength of the material to the stresses caused by steam pressure. Where there are tube or rivet holes or the like, the average stress in the ligaments between the holes is used. No account is taken of the stress concentration at the sides of the holes, where stress may be more than twice as great as the average stress in the ligaments or of other elements, so that the factor obtained is far from being a factor of safety in showing the ratio of the strength of the material forming the drum to the maximum stress in any portion of the drum.

What are usually known as "factors of safety" are in reality design factors which in most cases have been arrived at through long experience in actual construction.

The A.S.M.E. Power Boiler Code provides for a so-called factor of safety of 5. This factor involves many elements. Study of these shows that the factor is far from being a measure of the safety and that it is considerably higher than the true factor of safety.

More and more attention is being given to stress concentration. The ductility called for in the specifications for steel plate for boiler construction provides a safety element in reducing stress concentration by allowing redistribution of the stresses in the metal at any point where the proportional limit is exceeded.

About five years ago, results were published for the stresses that produce creep in steel when subjected to high temperatures. These caused apprehension on the part of many engineers, and led to a paper entitled, "Working Stresses for Steel at High Temperatures," which I presented at the annual meeting of the American Society of Mechanical Engineers in December, 1929. The stresses in this paper were based on results secured in practice and were rationalized by employing certain creep values given in tests that had been made by Mr. French of the Bureau of Standards. It was emphasized in the paper that the working stresses given were those suitable for boiler drums, pressure vessels and superheater headers constructed of plain carbon steel and that different values should be used for other types of service and other kinds of materials.

The values now given in the A.S.M.E. Boiler Code are based on those published in that paper. That the values may have to be modified for different types of service is shown in the work of the Joint API-ASME Committee on Unfired Pressure Vessels for Petroleum Products, where higher allowable stress values are proposed in a preliminary report.

Another cause of apprehension has been the so-called "caustic embrittlement," about which there are still some differences of opinion. This action occurs with certain feed waters where caustic soda is present in the absence of certain other elements. Cracks of a peculiar form occur in the shell plate, particularly at riveted seams below the waterline. The cracks are, in general, intercrystalline, although in certain cases, after having been started through a caustic action, they may extend through the body of some of the crystals.

Although this phenomenon occurs only in stressed material, the cracks do not follow the lines of maximum stress and sometimes run past each other and around parts or islands in the plate. Fortunately, leakage usually occurs to such an extent that it serves as a warning before a drum explodes. Another warning is the dropping off of rivet heads, which usually takes place on the inside of the drum, the heads being found detached on making an inspection, or being readily broken off when struck by the inspector's hammer.

Much work has been done by The Babcock & Wilcox Company in investigating this subject, which started in the early days long before the theory of caustic embrittlement was evolved. It was claimed that the cracking might have come from poor workmanship rather than from the feed water. A vast amount of service data was collected. This, together with much laboratory research, led to the conclusion that the action might be inhibited by maintaining certain ratios of sodium sulphate to total sodium hydroxide and sodium carbonate alkalinity.

About ten years ago, these data were presented by H. J. Kerr of The Babcock & Wilcox Company to the Subcommittee of the Boiler Code Committee on Care of Steam Boilers and Other Pressure Vessels in Service, and ratios of sodium sulphate to total sodium carbonate alkalinity which he suggested were embodied in the Rules for the Care of Power Boilers which form Section VII of the A.S.M.E. Boiler Code. No difficulty has been experienced where these ratios have been followed, and up to the present time there appears to be no reason why the ratios should be changed.

There are some differences of opinion about this theory, but the fact nevertheless remains that there is a vast amount of cracking of this kind being discovered which warrants the taking of definite steps to prevent it. The only constructive suggestion that has been presented so far is the one just outlined. It is certainly much better to apply the best known remedies than not to take any precautions at all simply because one doesn't agree with the theory. There are undoubtedly many undiscovered cases, as is evidenced by the fact that disastrous explosions have occasionally occurred.

Where there is indication of caustic embrittlement, examination of the inside of the rivet holes may reveal the characteristic cracks. The Hartford Steam Boiler Inspection & Insurance Company has developed a microscope for examining and for photographing these cracks. In the past few years, that company's inspectors have discovered over 500 cases of caustic trouble, and I am told more are constantly being found.

The experiments made by Dr. D. J. McAdams, Jr., on the corrosion fatigue of steel show that this action should be considered, particularly in connection with the use of steels of higher tensile strength. Care in maintaining proper alkalinity of the feed water to render it non-corrosive would prevent the action, as far as is indicated by any data now available.

All these things are cited to emphasize the number of elements that must be considered in formulating rules

* From a paper read before the Engineers Club, Philadelphia, Pa.

† Advisory engineer, The Babcock & Wilcox Company, New York.

for the safe construction of boilers. Progress should be made on the basis of scientific data and facts. It was considered best by the Boiler Code Committee to provide broad rules, amply safe, rather than to sanction hair-splitting factors likely to give trouble.

The art of boiler construction has been carried to a point at which, under proper operation and good inspection, there is little or no chance of an accident. Indeed, the records of accidents to boilers in the past ten or fifteen years are positive evidence that latter-day standards have brought about a high degree of safety. Few, if any, accidents are due to structural weaknesses inherent in the design, workmanship or material used. Also, the use of the much criticized factor of safety has contributed to the long life of boilers by delaying the approach to the danger point because of various deteriorating influences.

Unfired pressure vessels in the power plant should be carefully built and maintained. Only regular and frequent inspections can prevent occasional failures. There is a tendency to neglect such apparently inconsequential pieces of apparatus, but, if uncared for, they are potential hazards.

Arc Welded Punch Press Repair

Arc welding saved $200 for the Defiance Pressed Steel Company, Defiance, O., in the repair of a cast-iron punch press frame which had broken at one bearing. In addition, the press was back in service 36 hours after the break occurred.

Cast-iron punch press frame repaired by arc welding

The Menna Welding Company of Toledo prepared the break for welding by cutting away enough of the cast iron around the break to permit the insertion of a number of steel studs—the customary practice with cast iron in order to obtain a strong, solid joint. The operator then applied a double layer of General Electric Type A welding electrode, which gave a layer of metal strongly bonded to the cast iron. Type F electrode was used to fill in the remainder of the gap on both sides of the bearing because of the saving in time and cost afforded by this particular electrode. In all, about 75 pounds of electrode were consumed in the repair.

The cost of a new frame, exclusive of its installation, would have been $200 greater than the cost of the welding job and the press would have been out of service for a longer period.

Whiting Corporation Celebrates Fiftieth Anniversary

The year 1934 marks the 50th anniversary of Whiting Corporation, with John Hill Whiting, the founder, still active as chairman of the board. Mr. Whiting began his business career in Detroit in the seventies as a clerk in a car wheel foundry.

By this time Mr. Whiting had already developed a number of improvements in cupola construction which formed the basis for what has since become America's standard iron melter. Having secured patents on this and other improvements, including a car wheel cleaning machine, the new business was launched. In spite of the predictions of others that there would be no market for foundry equipment, the business prospered and additional items of equipment were developed such as the Whiting patent straight-line car wheel system, ladles, core ovens, tumbling mills, cars, trucks, turntables, air hoists, hand-power cranes, etc. The success of the Detroit Foundry Equipment Co., as the company was called, proved that Mr. Whiting's judgment was correct—there was a market for standardized, scientific foundry equipment.

The World's Fair of 1893 brought Chicago into prominence as the business center of the Middle West. After much study, Mr. Whiting determined to locate in the Chicago area and in 1894 built a small portion of the present plant at Harvey, Illinois, and began to do business under the name of Whiting Foundry Equipment Co. (later this name was changed to its present form—Whiting Corporation).

Closely associated with Mr. Whiting for the past thirty years and now President of Whiting Corporation, is Gen. T. S. Hammond. The third generation is represented by Mr. Whiting's grandson, Stevens H. Hammond, assistant to the president. There are thus three generations in active direction of the company.

Fabricated Metal Products Code to Handle Trade Practice Complaints

Acting Division Administrator Barton W. Murray has approved a plan submitted by the code authority for the fabricated metal products manufacturing and metal finishing and metal coating industry for the administration of the fair trade practice provisions of the code and has authorized the code authority to handle all trade practice complaints. The order specifies that complaints by one member of the industry against another for failure to comply with the labor provisions of the code shall be classed as trade practice complaints.

LESSONS IN ARC WELDING

It is the object of these lessons to present in a concise manner certain fundamental facts of welding, the knowledge of which will enable the operator to use the welding process successfully and economically. These lessons are based on the course in arc welding given by Arthur Madson at the plant of the Lincoln Electric Company, Cleveland, O. Preceding lessons were published on page 46 of the February issue, page 77 of the March issue, page 106 of the April issue, page 135 of the May issue, and page 165 of the June issue.

Lesson 20

OBJECT: To study the electrode and its uses, and to run a horizontal bead.

MATERIAL: 3/8-inch plate—3/16-inch Fleetweld electrode.

PROCEDURE: Before doing any actual welding, it is well to see what the electrode is and how it works.

It is common knowledge with those familiar with arc welding that the molten weld metal as it is being deposited has an affinity for oxygen and nitrogen. Since the arc stream is maintained in an atmosphere composed chiefly of these elements, oxidation proceeds during the passage of the weld metal from electrode to work. In this way oxides and nitrides are formed in the weld metal. It is the presence of the oxides and nitrides in the weld metal which impairs its strength, ductility and resistance to corrosion.

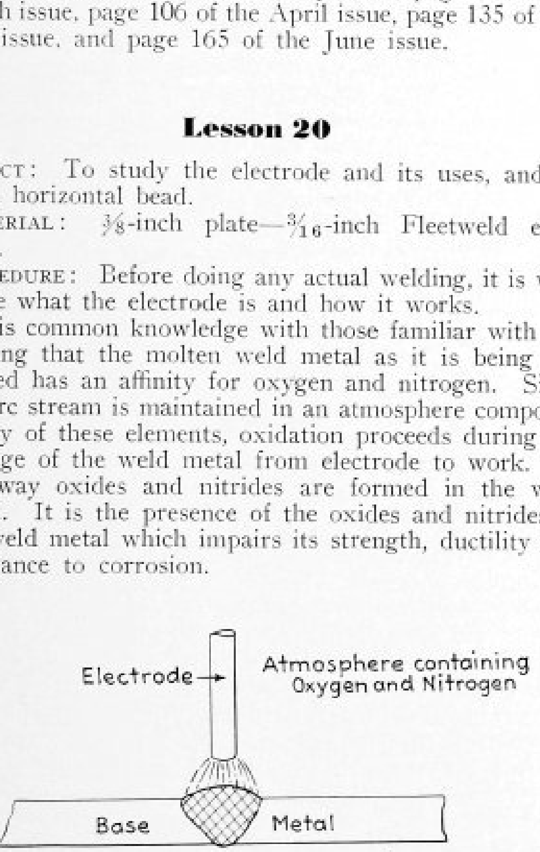


Fig. 36

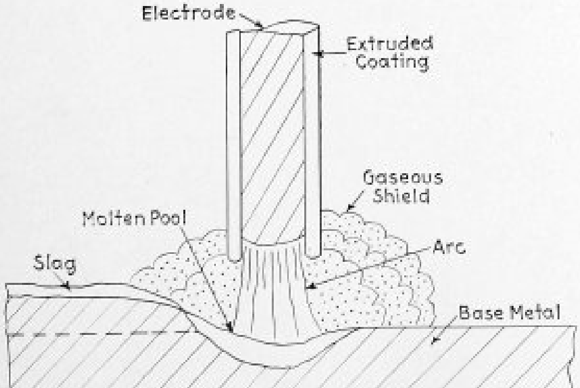


Fig. 37

If the molten weld metal is protected from contact with atmospheric oxygen and nitrogen during the process of deposition, the weld so produced will be free of oxides and nitrides. Thus, an arc, completely shielded from oxygen and nitrogen, deposits weld metal superior to that deposited by an ordinary arc.

This superiority is shown by the physical characteristics of pure weld metal made by shielded arc welding.

COMPARISON OF CHARACTERISTICS OF PURE WELD METAL OF SHIELDED ARC WITH WELD METAL OF UNSHIELDED ARC

SHIELDED ARC (FLEETWELD) CHARACTERISTICS

Tensile strength ....65,000 to 75,000 pounds per square inch
Ductility or elongation in 2 inches..20 to 30 percent
Impact (Charpy) ....30 to 40 foot-pounds
Fatigue ....28,000 to 32,000 pounds per square inch
Density ....7.82 to 7.86
Resistance to corrosion better than mild steel.

Note: It should be noted that these characteristics permit the *weld metal* to be *flanged* or *bent cold* with entire success.

UNSHIELDED ARC (BARE OR LIGHTLY COATED MILD STEEL ELECTRODES)

Tensile strength ....40,000 to 55,000 pounds per square inch
Ductility or elongation in 2 inches..5 to 10 percent
Impact (Charpy) ....3 to 8 foot-pounds
Fatigue ....12,000 to 15,000 pounds per square inch
Density ....7.5 to 7.7
Poor Resistance to corrosion.

Note: Impossible to be flanged cold or bent cold to any degree.

The method of shielding the arc can best be explained by a few simple diagrams. The unshielded arc is shown in Fig. 36. From this sketch it can readily be seen that the atmosphere has ready access to the metal while it is molten.

It will be noted that the shielding, Fig. 37, is obtained in three ways. First, the coating is consumed slower than the metal melts so that the coating, during welding, projects over the end of the metal electrode. Second, as the coating is consumed it forms an inert gas around the molten metal excluding the atmosphere. Third, a slag is formed over the deposited metal protecting it from the atmosphere while cooling.

Welds properly made with Fleetweld are so far superior to welds made with bare electrode or with an unshielded arc that it is almost unbelievable.

Now, read Lessons 2 and 3 as a review.

With a bare or washed electrode a very short arc is used, 8 to 22 volts, while with Fleetweld a much longer arc relatively is used from 28 to 40 volts. Part of the higher voltage is caused by the gas around the arc and part by actual mechanical increase in arc length. The beginner with Fleetweld usually tries to keep the voltage across the arc at about the same value as with bare or washed electrode. This is incorrect as the voltage across the Fleetweld arc is from 50 to 75 percent greater.

The proper arc length with Fleetweld is very important. Never have the arc length so short that the coating has a chance to touch the molten pool. If this is done porosity usually results.

Fleetweld is essentially a reversed polarity rod, that is, the electrode is usually positive and the work negative.

Fleetweld may be used with ordinary polarity but for best results reversed polarity should usually be used.

Alternating current can be used but is not recommended, and the deposited metal will not have the same characteristics; also the speed will be materially less and the deposition less.

Now, with 175-200 amperes and 28 arc volts with $\frac{3}{16}$-inch electrode run a horizontal bead 8 inches or 10 inches long.

Inspect this bead carefully. The first thing which will strike you as unusual is the slag.

Fleetweld has been designed so as to leave a slag which is highly desirable. As noted before the gas caused by the coating being consumed excludes the air from the metal as it goes across the arc and while it is molten. However, as the arc moves along, the metal might be exposed to the air before it solidified were it not for the slag which covers the molten metal and effectively excludes the air until it solidifies and cools. This slag covering also decreases the rate of cooling somewhat thus helping in the annealing effect on the weld metal. However, it is desirable that this slag be easily removable, and the operator should clean thoroughly of all slag before proceeding with the next bead, especially along the edges of the weld. This can be accomplished very easily by scraping the corner of a chisel or old file along the edges. It will be found that the slag comes off quite readily if allowed to cool, and a scraping action as mentioned will cause a great deal of it to crack off. Finish slag removal with a wire brush. Other means such as sandblasting, air hammer, etc., may be used.

After this chip the bead. See the kind of weld metal deposited. Practice this until you can lay down a bead properly fused, and of good high quality weld metal.

A few additional notes may be of interest.

To eliminate craters at the completion of a weld or when changing electrodes, withdraw the rod slowly at right angles until the arc is broken.

To start another electrode, strike the arc a little ahead of the crater, hesitate for a short interval and then move backwards to completely remelt and fill up crater, then

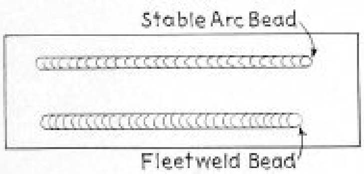


Fig. 38

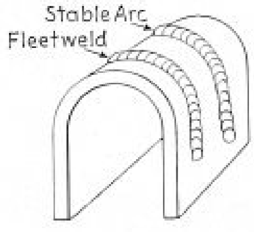


Fig. 39

proceed as usual. Be sure to keep the arc long enough to keep the slag out of the bead. An arc too short will result in a porous weld.

After a good Fleetweld bead can be run then lay down a Fleetweld bead on a plate, 4 inches by 8 inches approximately. Alongside this put a bead using stable arc rod. Put the plate in a vise and bend it with the beads on the outside of the bend. Watch carefully—note when fracture is shown. This will give you a very clear idea of the ductility or stretch of the two weld metals. Figs. 38 and 39 illustrate this point.

Lesson 21

Object: To make butt welds—no vee—no backing.
Material: $\frac{3}{16}$-inch plates — $\frac{1}{4}$-inch Fleetweld electrode.
Procedure: (See Lesson 10).

Set up plates with edges separated slightly. Use $\frac{1}{4}$-inch electrode, 190 amperes, 30 arc volts. Watch arc. Keep it at proper length (30 volts). Watch solidifying metal and advance arc at such a rate that no undercutting takes place. Too rapid advance will result in undercutting. When completed, break the weld and

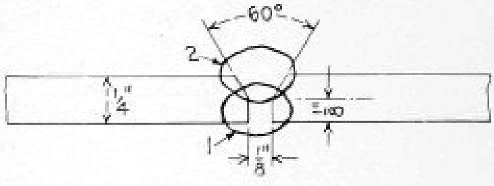


Fig. 40

note appearance of weld metal. Note carefully the high quality of joint, fusion, penetration.

Now, with $\frac{1}{4}$-inch plates, scarfed, Fig. 36, make a vee butt weld. Make sure of complete penetration on first pass. Watch arc length. Never have arc so short coating touches molten pool. Porosity will result. Clean weld thoroughly of all slag before depositing second bead. Take special care along edges of weld. Use $\frac{5}{32}$-inch rod 130 amperes, 25 volts at arc for first bead; $\frac{3}{16}$-inch rod, 175 amperes, 28 volts for second bead. Weave second bead, hesitating for a fraction of a second at the sides of the vee.

Put a small saw cut in weld—break it—note the fine texture, penetration, fusion.

Lesson 22

Object: To make horizontal lap weld.
Material: $\frac{1}{4}$-inch plate—$\frac{1}{4}$-inch Fleetweld electrode.
Procedure: See Lesson 11.

General Procedure: Always fit up work so that there is no appreciable gap. Speed of welding—current and quality of weld all vary directly with fit up. The electrode is held as in Fig. 37.

The angle between the electrode and horizontal plate is 45 degrees pointing backwards to make an angle of 60 degrees between electrode and vertical plane. The arc is played on extreme corner of upper plate. Do not weave arc. Draw electrode along in straight line, watching carefully the solidifying bead. Advance arc at proper rate so that full weld is made.

Use $\frac{1}{4}$-inch plate—$\frac{1}{4}$-inch rod, 250 amperes, 30 volts at arc.

After completion of joint, break it by inserting wedge

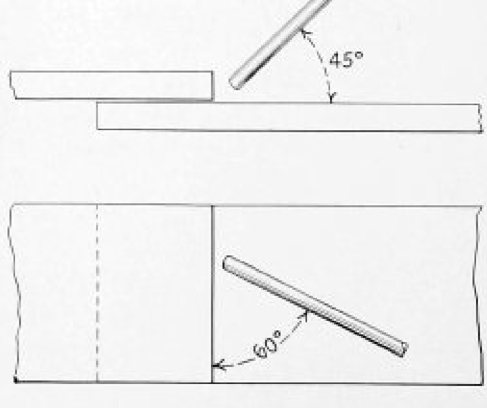


Fig. 41

between plates. Observe appearance of weld metal, penetration into corners.

In some cases it is possible to tilt work so molten metal pool is horizontal, with increased speed.

A tilt of 5 degrees will be satisfactory.

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 given records of the interpretations of this Committee in Cases Nos. 758, 772 and 773 as formulated at the meeting of April 27, 1934. They have been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 758.—(Annulled)

CASE NO. 772.—(*Special Rule*)

Inquiry: Is it permissible under the requirements of the Code, to construct heaters, evaporators, and heat exchangers for power-plant service with seamless drawn Admiralty metal tubes which comply with A.S.T.M. Specifications B 44-24 for Seamless Admiralty Condenser Tubes and Ferrule Stock to form the heat-transfer surface?

Reply: Although the Code contains no direct reference to, or specifications for, Admiralty metal tubing, it is the opinion of the Committee that tubes complying with A.S.T.M. Specifications B 44-33 may be used with safe results in unfired pressure vessels at temperatures not in excess of 406 F. When vessels are so constructed, it is the opinion of the Committee that the official Code symbol stamp for the particular type of vessel may be applied.

CASE NO. 773.—(*Interpretation of Pars. H-64 and H-117*)

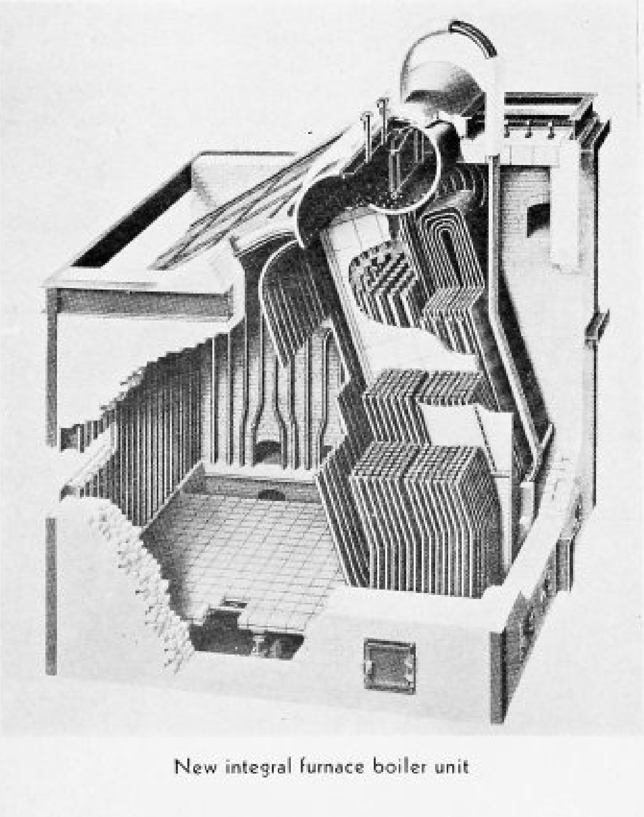
Inquiry: Will it be permissible to attach to a low-pressure steam-heating boiler a low-water fuel cut-off and/or water feeder which embodies a float and float bowl and is so constructed as to permit the flow of steam or water therethrough?

Reply: A low-water fuel cut-off and/or water feeder cannot be attached to a low-pressure steam-heating boiler unless it is so constructed that the water inlet valve cannot feed the water into the boiler through the float chamber and that the device is sufficiently isolated or insulated from the heat to insure a temperature at which scale will not be deposited therein.

Integral-Furnace Boiler

The Babcock & Wilcox Company, New York, announces a new boiler, designed to provide a completely co-ordinated unit comprising a two-drum boiler, a water-cooled furnace, burners for liquid, gaseous, or pulverized solid fuels, and, when needed, a superheater, economizer, and an air heater. This unit is particularly applicable in industrial plants where operation at high nominal ratings with high final steam temperatures, and where high efficiency is desired. The arrangement of the boiler proper, with inclined tubes entering an upper and a lower drum, and with the furnace paralleling the drums and separated from the rows of tubes by a furnace wall, instead of the conventional arrangement of boiler set over furnace, makes its installation advantageous where headroom is limited. The large furnace volume required for pulverized-coal firing of other types of boilers of the same capacities as the integral-furnace boiler, but with refractory-lined furnaces, has penalized this method of firing more than it has any other in first cost, operation, and maintenance. This new unit removes this handicap, since water-cooled furnace walls can be applied to this boiler at a fraction of the cost for applying this construction to conventional boilers of the same capacities.

The furnace is water-cooled to assure low maintenance costs and minimum outage for repairs and replacements. All the advantages of water-cooling are secured by an arrangement so simple that its cost is kept within the limits prescribed by the service for which the boiler is installed. This feature is shown by the arrangement of the cooling-water tubes, the simplicity of the supporting structure, the use of but two headers, and the necessity for but one small section of steel casing. The two side walls are of Bailey stud-tube construction employing tubes, suitably spaced, with the spaces between the tubes filled with plastic refractory material secured in place by studs welded to the tubes. Thus the wall is inherently



New integral furnace boiler unit

rigid and durable, since the studs reinforce the refractory material and conduct heat from the refractory to the cooling water within the tubes. The floor is water cooled. The cooling tubes are straight and are covered with standard Bailey bare-metal blocks. The tubes of the floor and outer sidewall connect to a common header in such a manner that positive circulation is assured through the floor and the wall. The rear wall, of refractory construction, is protected by a row of bare water-cooled tubes. Protection of the boiler tubes and superheater is obtained by a slag screen, formed by the first two rows of boiler tubes. These tubes are offset or staggered, and are spaced on wider centers than those directly behind them to cool the molten sticky slag, without, however permitting the slag to bridge across the tubes and thereby restrict the flow of gases. The unit is suitable for either wet or dry ash removal. In the boiler shown, arranged for dry ash removal, one ash pit, approximately 2 feet deep, extends across the back of the furnace, in the form of a trough, and provides a receptacle for ashes, which may be easily raked into it from doors at the floor level in the rear wall, or swept to the rear from the front wall by a steam lance. The ash pit is emptied through doors at the rear. Where conditions warrant their use, hopper-bottom and slag-tap types of furnaces provide alternate methods of ash disposal.

The boiler tubes are arranged in three passes, and are so spaced as to secure maximum heat transfer consistent with a draft loss that is sufficiently low to permit operation with natural draft up to fairly high ratings. The exceptionally high efficiency claimed for this boiler is also due, in part, to the cross-flow of gases over the tubes in all passes and to the fact that practically all the draft resistance is effective in promoting heat transfer, because of the scrubbing action of the gases on the tubes. The tubes in the first pass are 3¼ inches in diameter, and the diameter of those in the succeeding passes is 2 inches. Thus, those tubes subjected to the most severe conditions, and in which scale is most liable to accumulate, are of large size and easy to clean. For the less severe conditions in the later passes, which are less liable to collect hard scale, the use of smaller tubes is feasible and results in a considerable increase in the efficiency of the unit. The tubes are on alternate wide and narrow centers to facilitate their renewal. All tubes can be cleaned with standard turbines, and the outside of the tubes can be cleared of all ash deposits with a minimum number of soot blowers.

The drums are of fusion-welded or, if desired, riveted construction. The lower drum rests upon cast-iron saddles, which, in turn are supported by footings. It is anchored by the saddle near one end, but is free to move to the other end. The upper drum is supported by beams carried on corner columns and, in the larger sizes, by auxiliary guides and supports secured to the buckstays and rear corner angles. It is equipped with the necessary steam-and-water separator to assure the delivery of dry steam. Steam enters the dry pan at the front of the boiler where the water is comparatively quiet, passes over the length of the dry pan, and is taken away from the rear of the drum to the superheater.

Fuels, such as pulverized coal, oil, or gas can be fired singly or in any combination, and conversion from one or any combination of these fuels to another can be accomplished without any changes to either the boiler or the furnace.

Several of these units have been in very successful operation for a number of months. The design has definitely passed the experimental stage and the unit can be considered proved and dependable for the service for which it is designed.

Trade Publications

Genuine Wrought Iron Plate.—A bulletin which outlines the development, qualities and wide application of genuine wrought iron plates as produced with modern facilities has just been issued by the A. M. Byers Company, Pittsburgh, Pa. Genuine wrought iron possesses two features of interest to every engineer—an exceptional resistance to most types of corrosion and the ability to resist fracture from fatigue caused by vibration. Both these qualities are the result of combining a metallic iron of high purity with non-rusting slag. In order to indicate some of the services for which genuine wrought iron plates and sheets are being used, the bulletin has been profusely illustrated with examples of installations where its qualities have been of particular value and have resulted in increased life of such installations.

Testing Welders.—This recent publication by the Linde Air Products Company, New York, outlines simple tests for measuring the ability of welders, which is the first of the six essential steps in every procedure control for oxy-acetylene welding. It is pointed out that welding technique differs somewhat with the materials to be welded and with the type of joint used, so that it cannot be assumed that a man who can weld excellent joints in aircraft tubing can also do as well in 20-inch steel pipe. Separate sections of the book discuss in detail the fracture test, the bend test, the tensile test, and the observation test. To round out the booklet, a summary of existing and pending qualification tests for welding steel plate and pipe are given. This includes: the A.S.M.E. Unfired Pressure Vessel Code for both Class 2 and Class 3 welded constructions, the A.S.A. Pressure Piping Code (unofficial) and the specifications and standards covering welding of steel and wrought iron pipe of the Heating and Piping Contractors National Association.

Dust Collectors.—Pangborn Corporation of Hagerstown, Md., has just issued a new bulletin on the Type "CH" all-metal cloth screen, dust collector. This is one of the most complete catalogues published to describe and illustrate the many exclusive and new features not previously available in this class of equipment. Many large photographs, charts and drawings clearly illustrate the 14 outstanding points of superiority claimed for this new collector.

Portable Compressors.—A novel bulletin, describing the advantages of two-stage air-cooled portable compressors has been issued by The Ingersoll-Rand Company, New York. This compressor is built in 5 sizes ranging from 75 to 370 cubic feet per minute piston displacement. It is supplied in a variety of mountings from a steel wheel mounting with a towing speed of 10 miles per hour to the two-wheel trailer mounting which can be towed by a truck at 35 miles per hour. Both oil engine and gasoline engine-driven units are shown in the bulletin which gives details as to the amounts of fuel savings that can be expected compared with the operation of single-stage water-cooled compressors.

White Paint.—The New Jersey Zinc Company, New York, has issued a booklet containing the latest information on the heat reflection and heat radiation qualities of various colored paints. Applications of this paint to various heat and light reflection problems are described and illustrated.

Boiler Maker and Plate Fabricator

VOLUME XXXIV NUMBER 7

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Communications

How Many Square Feet in Any Boiler?

To the Editor:

In the May issue of Boilermaker and Plate Fabricator, page 138, there is an article by W. F. Schaphorst, entitled, "How Many Square Feet in Any Boiler?" To my view I consider the article useless. He does not say what the distance is between *A* and *C*, shape of the curve, *D*, pitch of spaces to equal height, or pitch of spaces to equal area, etc.

He says: "The dotted line drawn across the chart shows how easily it is done. The line passes through 10, in the curved column *B*, and through the 6, column *C*. The intersection with column *A* shows the area is 350 square feet."

Now instead of its being 350 square feet, it is 345.576 feet, nearly 4½ square feet less, as may be seen by the following calculation:

Circumference of a circle equals the diameter multiplied by Pi (3.1416).

Area of a circle equals the diameter squared and multiplied by 0.7854.

Therefore,	10 x 10 = 100
3.1416 Pi	0.7854
10 ft. dia.	100 dia. squared
31.4160	78.5400
6 ft. height	2 ends
188.4960	157.0800
157.0800 = area of 2 flat ends	
345.5760 = Total area	

Long Beach, Cal. I. J. Haddon.

The Author's Reply to Mr. Haddon

To the Editor:

Replying to the above by Mr. Haddon, my chart which was reproduced in Boilermaker and Plate Fabricator was plotted according to principles which are explained in detail in the book "The Construction of Alignment Charts" by Prof. George W. Swett of the Massachusetts Institute of Technology, and published by John Wiley & Sons of New York. The distance between columns *A* and *C* and the shape of the curve are of no great importance. Merely draw columns *A* and *C* parallel with each other and then locate a number of points in curve *B*. The location of the points determine the curve, which curve, so far as I know, is not a parabola, hyperbola, cycloid, etc., although it *may* be. The important thing is the development of a chart which is "accurate," that is a point which Mr. Haddon criticizes rather severely.

Most curves of this type are logarithmic, similar in a way to spacings on an ordinary slide-rule. Slide-rules, as Mr. Haddon very likely knows, are not absolutely accurate although they are made with great precision. Slide-rules certainly should be considerably more accurate than a chart published in a magazine from an ordinary engraving. Yet, using 350 square feet as the "answer" in this problem, it will be found to be within 98.74 percent of perfection. In other words, this chart is only 1.26 percent in error, which is perhaps as close as can be expected under the circumstances.

In my article I suggested increasing the length of column *C*, if necessary. In lengthening the column make the spaces exactly the same as in the chart reproduced in Boiler Maker and Plate Fabricator. In other words, if the length of the boiler is 20 feet make the length of column *C* twice the length as shown in the May issue.

Newark, N. J. W. F. Schaphorst.

Elementary Plate Layout -- Correction

In the first instalment of the article, Elementary Plate Layout, published in the June issue, an error occurs on page 149, third from the last paragraph, fifth line. The sentence "Draw *L-K* through the point *5* parallel to *C-D*," is in error. The letters *C-D* should be changed to *3-5*.

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

Connection of Circular Pipe and Conical Funnel

Q.—Would you kindly show a development of a connection of a circular pipe at right angles to a conical funnel? F. C.

A.—Lay out the conical funnel as shown by *A-B-C-D* and the circular pipe as shown by *E-G-H-F* in the elevation Fig. 1.

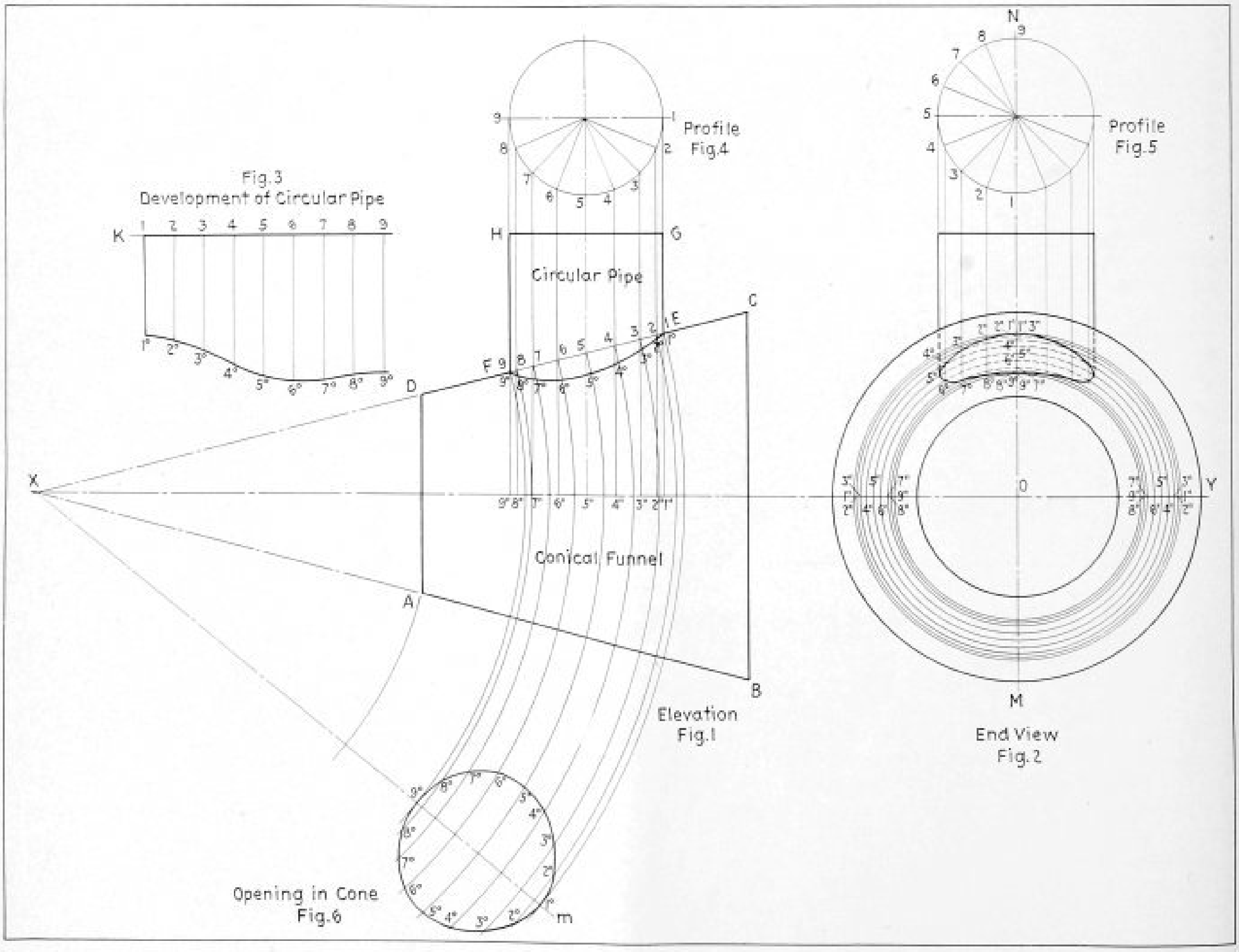
Extend *A-B* and *C-D* locating the point *X*. Draw the center line *X-Y*. Erect *M-N* perpendicular to *X-Y*. Project end view from elevation using *M-N* as the vertical center line.

Draw the profile of the circular pipe in both the elevation and end views; as shown by Figs. 4 and 5.

The first step is to develop the intersection between the cylindrical pipe and the conical funnel in both the end view and the elevation.

Divide the profiles, Figs. 4 and 5, into the same number of equal parts, eight in this case; number the divisions from *1* to *9* on both profiles in the manner indicated.

Parallel to *G-E* draw lines through points *1* to *9* of the profile, Fig. 4, cutting the line *C-D* at *1, 2, 3, 4, 5,* etc. and the center line *X-Y* at *1″, 2″, 3″, 4″, 5″*, etc.



Development of conical funnel and circular pipe connection

Then with *O* as a center and with *1-1″* of the elevation as a radius, draw circle *1″-1″-1″* in the end view, and with *2-2″* as a radius draw the circle *2″-2″-2″* continuing in the same manner using *3-3″*, *4-4″*, *5-5″*, etc. construct the circles *3″-3″-3″*, *4″-4″-4″*, *5″-5″-5″*, etc. in the end view.

Then parallel to the line *M-N* draw lines through the points, *1, 2, 3, 4, 5*, and where the line through *1* cuts the circle *1″-1″-1″* locate the point *1°* in the end view, and where the line through *2* cuts the circle *2″-2″-2″* locates the point *2°*, and in like manner until the points *3°-4°-5°-6°-7°-8°-9°* are located; connect these points completing the intersection of the pipe and the cone in the end view.

Parallel to the line *X-Y* draw lines through *1°-2°-3°-4°-5°*, etc. of the end view, cutting the lines *1-1″*, *2-2″*, *3-3″*, *4-4″*, *5-5″*, etc. respectively locating the points *1°-2°-3°-4°-5°*, etc. in the elevation. Connect these points completing the intersection of the pipe and funnel in the elevation.

The next step is to draw the half pattern of the circular pipe as shown, in Fig. 3. Extend *H-G* to *K* and on *H-K* step off the spaces *1-2, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9*, making these spaces equal to *1-2, 2-3*, etc. of the profile, Fig. 4. Drop perpendiculars to the line *H-K* at the points *1, 2, 3, 4, 5*, etc. and parallel to *G-K* draw lines through the points *1°-2°-3°-4°*, etc. of the elevation, intersecting the perpendicular lines just drawn, respectively, locating the points *1°-2°-3°-4°-5°*, etc. of the development. Connect these points completing the half pattern of the circular pipe.

The hole in the conical funnel is next developed.

Draw the center line *X-m*, Fig. 6. Then with *X* as a center and with *X-9* of the elevation as a radius, scribe an arc cutting the center line *X-m*; in like manner with *X* as a center and with *X-8, X-7, X-6, X-5, X-4*, etc. as radii, scribe arcs cutting the center line *X-m*.

On the arc drawn through point eight, step off the distance *8″-8°*, Fig. 2, each side of the center line *X-m*, locating the points *8°-8°*, Fig. 6, and in like manner on the arcs drawn through points *7, 6, 5, 4, 3*, etc. step off the distances *7″-7°, 6″-6°, 5″-5°*, Fig. 2, etc., respectively each side of the center line *X-m* locating the points *7°-7°, 6°-6°, 5°-5°*, etc.

Connect these points completing the outline of the hole in the conical funnel.

Correcting a Transition Piece

Q.—Our Engineering Department detailed the transition piece inclosed, but when it was layed out and formed up in the shop it was necessary to recut. Would you please tell me if the detail is correct and why it was necessary to cut the piece to make it fit? J. S.

A.—The elevation and plan views of the transition piece referred to in the question are illustrated in Fig. 1. The development of the transition piece as submitted in the question is illustrated in Fig. 2, and represents a one-quarter pattern of the transition piece.

Space will not permit a check of each individual surface or development line as shown in Fig. 2, however, a ready check of the development can be made by checking the true lengths of the lines *A-D, D-E, F-B, A-B, D-C* and *E-F* as shown in Fig. 2, which lines form the perimeter of the true development and also *D-C* which divides the pattern into halves.

In order to check the development Fig 3 is constructed, showing the elevation and plan of the transition piece, the dimensions shown being taken on the neutral axis of the plate, or as termed in Fig. 2, the center line of the plate.

The distance *A-D*, Fig. 2, represents one-quarter of the total circumference of the top of the transition piece as *A′-D′* of the plan view, Fig. 3. The diameter of the top is $36\frac{3}{16}$ inches and one-quarter of the circumference would be

$$\frac{36.1875 \times 3.1416}{4} = 28.421 \text{ inches or 2 feet } 4\tfrac{27}{64} \text{ inches,}$$

which checks the distance *A-D* of the pattern Fig. 2.

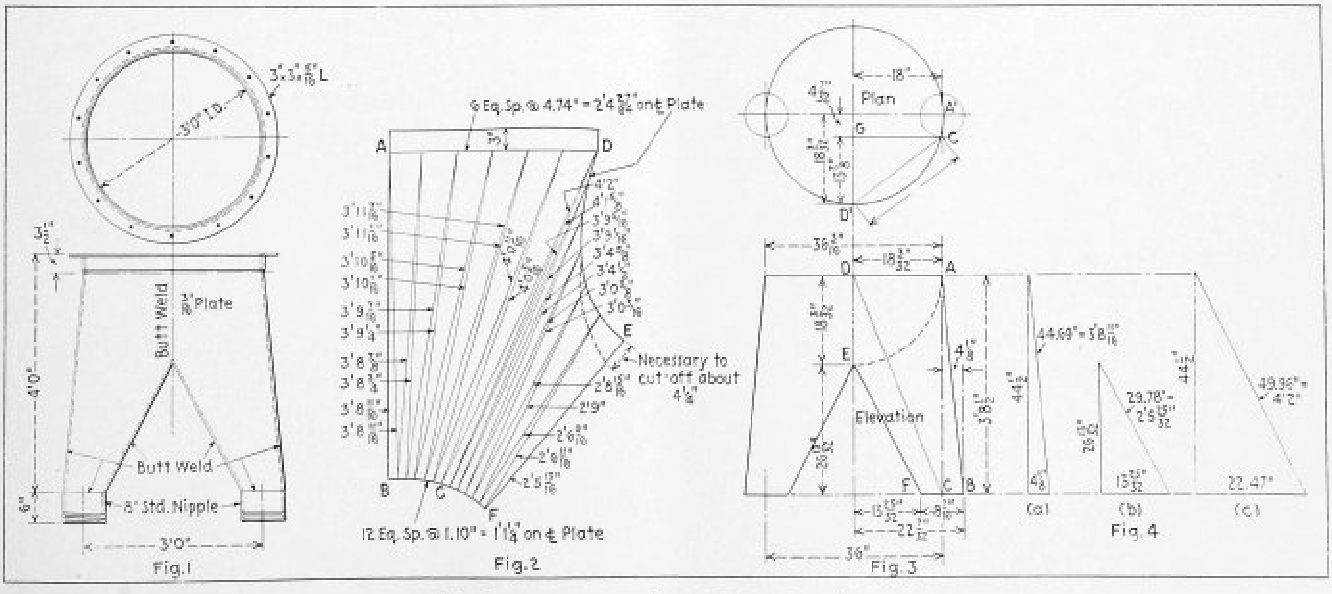
A-D and *D-E* of the pattern, Fig. 2, being the same length makes the radius of the arc *D-E* in Fig. 3 equal to one-half the diameter of the top or

$$\frac{36.1875}{2} = 18.0937 \text{ or } 18\tfrac{3}{32} \text{ inches as shown.}$$

The two outlets at the bottom are welded to 8-inch standard nipples, which have an outside diameter of $8\frac{5}{8}$ inches; deducting from this the thickness of the plate, making the diameter of the neutral axis of the plate $8\frac{7}{16}$ inches shown as *F-B* in Fig. 3.

F-B in the pattern, Fig. 2, represents one-half of the circumference of one outlet which would be

$$\frac{8.4375 \times 3.1416}{2} = 13.253 \text{ inches or 1 foot } 1\tfrac{1}{4} \text{ inches,}$$



Calculating corrections for transition piece layout checking the distance F-B of the pattern, Fig. 2.

A-B of the pattern, Fig. 2, is shown in its true length in the elevation of Fig. 3 and is the hypotenuse of a right angled triangle whose base is 4⅛ inches and whose altitude is 3 feet 8½ inches as shown in (*a*) Fig. 4.

$$A\text{-}B = \sqrt{4.125^2 + 44.5^2} = 44.69 \text{ inches or } 3 \text{ feet } 8\ 11/16 \text{ inches,}$$

checking the line A-B of the pattern, Fig. 2.

The next line check is D-C of the pattern, Fig. 2. First determine the length of D'-C of the plan view, Fig. 3, D'-C in the plan being the hypotenuse of the triangle D'-G-C in which G-C (18") is the altitude and G-D' (13 ⅞) is the base.

$$D'\text{-}C = \sqrt{13.875^2 + 18^2} = 22.72 \text{ inches.}$$

D-C of the pattern, Fig. 2, is the hypotenuse of a right angled triangle whose base is 22.72 inches and whose altitude is 3 feet 8½ inches as shown in (*c*) Fig. 4.

$$D\text{-}C = \sqrt{22.72^2 + 44.5^2} = 49.96 \text{ inches or } 4 \text{ feet } 2 \text{ inches,}$$

checking the line D-C of the pattern, Fig. 2.

E-F of the pattern, Fig. 2 is shown in its true length in the elevation of Fig. 3 and is the hypotenuse of a right angled triangle whose base is 13 25/32 inches and whose altitude is 26 13/32 inches, as shown in (*b*) Fig. 4.

$$E\text{-}F = \sqrt{13.78125^2 + 26.40625^2} = 29.78 \text{ inches or } 2 \text{ feet } 5\ 25/32 \text{ inches,}$$

checking the line E-F of the pattern, Fig. 2.

Having checked the lengths of the lines A-D, D-E, F-B, A-B, D-C and E-F and found same correct, would indicate that the pattern as shown in Fig. 2 is correct. Any error made between the line A-B, D-C, E-F would be readily found by the irregularity of the pattern at the point where the error was made.

The trouble experienced was either due to an error in the layout of the plate from pattern shown in Fig. 2 or due to the improper fabricating of the plate from the pattern to its proper shape.

Emergency Low Water Feeders

After an exhaustive investigation of emergency low water feeders for cast iron and steel heating boilers, the Engineers Conference of the Boiler and Machinery Department of the National Bureau of Casualty and Surety Underwriters, New York, has prepared standard requirements for the construction of such emergency low water feeders which it recommends to manufacturers and users of such equipment.

This, it is announced, is in no sense a definite ruling but represents recommendations based upon the results of many years of broad experience and the investigation of the cause of a large number of failures and accidents. The recommendations are as follows:

1. The water inlet valve to be separate from the float chamber and sufficiently isolated or insulated from the heat to insure a temperature at which scale will not be deposited.

2. The float to be of rugged construction and to have a displacement equivalent to a sphere 5 inches in diameter.

3. The bearings, pins, water valves and their seats and other moving parts to be of non-corrosive material.

4. All parts to be readily accessible for inspection, cleaning and repair.

5. To be provided with a blow-off connection to the float chamber to facilitate the removal of deposit in the float chamber, and to permit testing the device without lowering the water level in the boiler. Such blow-off connection should be either an independent connection to the float chamber or a connection in the water line to the feeder immediately below the float chamber.

6. The device to be set to function when the water level in the boiler is 1 inch above the bottom of the gage glass, assuming that the gage glass is set at the proper level and to be of sufficient capacity to maintain that water level when the return valve or valves are closed and the boiler is operated under the most forced conditions of firing.

7. The device to be so connected that it will feed through the regular feed connection and not the water column.

The recommendations as explained by J. P. H. de Windt, manager of the Boiler and Machinery Department of the National Bureau, relate to those emergency low water feeders installed on boilers which are used for the heating of residences, apartment houses, office and similar buildings. Such boilers are of the type where it is desired to feed the water to the boilers automatically, and to eliminate the possibility of lime or sediment deposit in the water feeder which render the same inoperative and thus cause the cracking of sections or destruction of boilers. It is also recommended that the cast iron or steel heating boilers fired by oil burners or stokers be equipped with low water cut-outs in addition to the low water feeders.

Republic's Sales Head to Manage Berger Manufacturing

Lawrence S. Hamaker, sales promotion manager of the Republic Steel Corporation, has been promoted to the post of vice-president and general manager of the Berger Manufacturing Company, Canton, O., a Republic subsidiary. The announcement was made from the Republic headquarters at Youngstown.

Mr. Hamaker succeeds Joseph B. Montgomery, Jr., who has resigned. He began his industrial career in 1919 in the sales department of the Berger Company, transferring to the advertising department in 1923. In 1925 he was appointed advertising manager of the United Alloy Steel Company, and upon the merger of that company with Central Alloy Steel Company of Massillon became advertising director of the new corporation.

Steel Tubular and Firebox Boiler Code Authority

Acting Division Administrator Barton V. Murray on July 6 notified the Code Authority for the steel tubular and firebox boiler industry that their plan for handling trade practice complaints with the Code Authority sitting as a trade practice complaints committee, had been approved by the National Recovery Administrator.

The members of the Code Authority are: Chairman, R. B. Dickinson, Kewanee Boiler Corp., Kewanee, Ill.; Homer Addams, president, Fitzgibbons Boiler Co., New York City; Frank Metcalf, president, International Boiler Works, East Stroudsburg, Pa.; J. F. Johnston, president, Johnston Brothers, Inc., Ferrysburg, Mich.; Charles Tull, president, Spencer Heater Company, Williamsport, Pa.; J. R. Collette, vice-president, Pacific Steel Boiler Corp., Detroit, Mich.; Col. Samuel Fleming, Administration Member, Harrisburg, Pa., and R. E. Locke, secretary, Middletown, Pa.

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

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

Cities

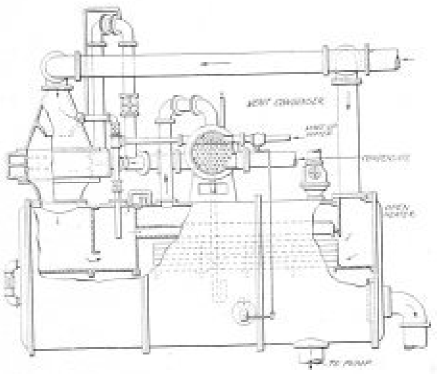
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,840,526. WATER HEATING AND DEAERATING APPARATUS. JAMES A. POWELL, OF READING, PENNSYLVANIA, ASSIGNOR TO COCHRANE CORPORATION, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

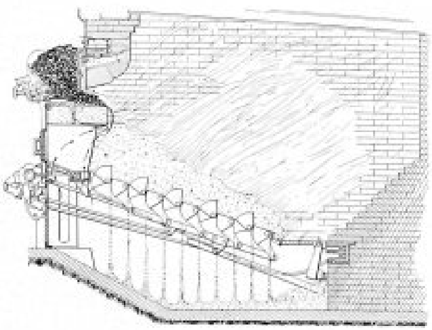
Claim.—Apparatus for heating and deaerating boiler feed water comprising the combination with a jet heater having a heating chamber wherein



steam is mixed with water discharged from a series of discharge nozzles, of an open deaerating heater having a water reservoir space receiving the discharge mixture from said jet heater, a tray stack located at one side of said reservoir space and a water box receiving the overflow from said reservoir space and adapted to pass water downwardly onto said tray stack. Seven claims.

1,845,415. COMBUSTION METHOD. CHARLES J. HUBER, OF BALTIMORE, MARYLAND, ASSIGNOR OF ONE-HALF TO FLYNN AND EMRICH COMPANY, OF BALTIMORE, MARYLAND, A CORPORATION OF MARYLAND.

Claim.—The method of burning coal in a furnace which consists in maintaining a bed of completely ignited and burning fuel, breaking the bed throughout its extent continually and passing air through it, dropping the fine unburnable residue, presenting a supply of green fuel and maintaining the same within the furnace above the fire at the forward end and extending across the entire width of the fuel bed at the front, heating the same by conduction, radiation and reflection from the fire to a temperature above the kindling point of the fuel and driving off gases



and vapors therefrom, admitting a supply of heated air above the fuel supply thus maintained and passing it over the fuel as it is heated, mixing the same with the gases and vapors given off from the newly heated fuel supply at a temperature above the point of ignition of said gases and vapors, burning the same and igniting the fuel supply thus presented, dropping the supply of burning fuel on the front end of the said bed of burning fuel on the fire across the entire width of the furnace, admitting air from below said fuel supply forward of the fuel bed and passing the air over the forward end of the fuel bed in contact with the recently deposited burning fuel and through the said dropping fuel causing the air to pick up and mingle with the gases and finely divided solid matter being released from the newly deposited burning fuel, burning the gases and completing the ignition of the fuel whereby a bed of fuel, all of which is fully ignited, is maintained throughout the length of the fire. Two claims.

Boiler Maker and Plate Fabricator

Coordinated Mechanical Association Conventions

The decision of the General Committee of the Mechanical Division of the American Railway Association at its meeting in June to hold a full membership meeting in 1935 has raised the question of the possibility of reviving the minor mechanical associations, among which is the Master Boiler Makers' Association. This association, which for 30 years has contributed materially to the welfare of the railroads of the country by disseminating a knowledge of the best locomotive repair and maintenance practice throughout its ranks, still has a function to perform that in the interests of efficiency and economy cannot be disregarded. Unless the interest in its work is revived among the officers and membership at this time with the objective of a 1935 convention in mind, it is doubtful if the disintegration that has occurred in four years of inactivity can ever be overcome.

Every argument that has been advanced for the renewal of general activities of the major mechanical associations applies with equal force to this association of boiler supervisors, since actual efficiency and safety in the maintenance of motive power of the railroads is to a considerable extent dependent upon the skill and knowledge exercised by the boiler shop personnel in executing instructions of the mechanical officers. In the light of the many changes that have occurred in four years in equipment materials and practice, brought about by altered operating conditions and the more stringent demands on power, it is essential that the collective experience in this field may be co-ordinated to the advantage of all railroads. The only way in which this may be consummated is in a thorough discussion of all boiler maintenance problems, which alone can be achieved through the medium of a general convention of boiler supervisors.

Because of the retirement of many older members of the staff and broad personnel changes which have brought younger men into positions of responsibility in the boiler department as elsewhere, there is real need, while the nucleus of the organization of supervisors to which they are affiliated still exists to rehabilitate it, as vital to their welfare and to the ultimate benefit of the railroads.

In brief, the moment is opportune for a co-ordination of the efforts of all these associations which will strengthen the effectiveness and prestige of each of them. To this end, a meeting will be held in September of the officers of the International Railway Fuel Association, the Master Boiler Makers' Association, the Traveling Engineers Association, the Airbrake Association, the International Railway General Foremen, the International Master Blacksmiths Association, the Car Builders and Supervisors Association, and the Tool Foremens Association, which will coordinate plans of these organizations for conventions in 1935.

When this meeting convenes it is absolutely essential that a comprehensive plan be developed for submission to the committee of the American Railway Association, dealing with the subject of conventions. The logical form, which this plan should assume and one which, without question, the officers of the Master Boiler Makers' Association would fully indorse, is that under the direction of the American Railway Association a program of meetings be arranged for the various groups to convene at the same place as the Mechanical Division, some to be scheduled just prior to others following it. Properly staggered, such meetings would in no way conflict with the major convention of mechanical officers and would avoid drawing too many of the supervisory force away from their duties at one time.

By thus concentrating the activities of all mechanical associations at one place in a comparatively short space of time—and under conditions which will produce the greatest return in concentrated effort—many advantages in efficiency and economy can be realized.

Not the least important of these would be the heightened interest of the railway supply manufacturers, in thus being able to present their products for the education of every mechanical department official in one complete exhibit. Formerly, many concerns have been obliged to exhibit at several widely scattered conventions at an expense, which under present conditions would not be justified. Many of the concerns, which have been approached on the subject, including the largest exhibitors at such conventions, have definitely stated that unless a plan of coordination be developed to bring all the scattered groups together at one place, they definitely will cease to support this vital feature of the conventions. On the other hand, if such a plan is executed, that will allow them to reach not only the higher mechanical officers but all others interested in their products, as they could if conventions were concentrated at one place, they will in 1935 present the most comprehensive display that they have ever attempted in the railroad field. It is fully expected that the Railway Supply Manufacturers' Association will welcome the proposal for thus coordinating activities in order that this organization, which is best fitted to control and manage an exposition of this character, may be enabled to do so to the ultimate degree of economy for all of the members of the supply fraternity and at the same time present the most comprehensive display of its products in its history.

There are three things to be accomplished by bringing groups of supervisors together in such meetings, no one of which is more important than the others; namely, to establish personal relations and exchange views individually concerning the problems which they

(Continued on page 222)

View from above northeast corner of General Electric mercury-steam-electric power plant

FUSION WELDING IN G-E MERCURY-STEAM PLANT

By R. H. Rogers*

The new power station at the Schenectady Works of the General Electric Company is unique in several ways. First, it is owned by an industry and operated by a utility, and the installed capacity is 26,000 kilowatts for the use of the New York Power & Light Company and 650,000 pounds of steam per hour for the use of the General Electric Company. Second, it is a mercury-vapor-steam plant with a product of the mercury-vapor cycle of 325,000 pounds of steam per hour and 20,000 kilowatts. Third, it is an outdoor station in that the main bulk of the steam and mercury boilers, the mercury and steam turbines and principal appurtenances are entirely exposed to the weather. Fourth, it is an arc-welded station throughout—structure, boilers, piping and equipment. Rivets and bolts are almost entirely absent except in some purchased equipment which is of standard manufacture.

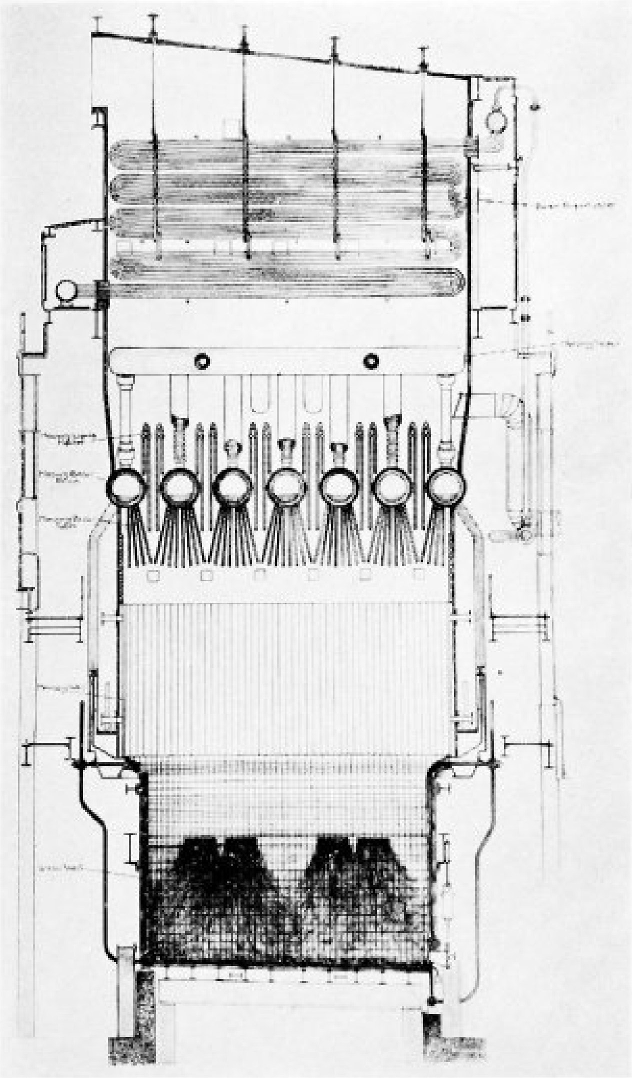
Two boilers are installed side-by-side each with its own complement of coal handling, storing, pulverizing and feeding equipment and other auxiliaries. One is a more or less conventional steam boiler for producing 325,000 pounds of steam per hour at 400 pounds pressure and 750 degrees temperature. The other is a mercury-vapor boiler with a capacity for operating a 20,000-kilowatt turbine. The upper portion of its furnace has mercury walls and the lower portion has water walls which produce 85,000 pounds of steam per hour.

The mercury vapor has a pressure of 140 pounds at the boiler and 125 pounds at the turbine; the temperature is 958 degrees. The condenser-boilers (which are the condensers for the mercury turbine) and furnace walls deliver 325,000 pounds of steam per hour. Steam transport lines involve one and three-quarter miles of high-pressure lines and water return lines carried in tunnels and on bridges to the older power stations from which it is distributed for testing, manufacturing and heating.

The structural work was fabricated and erected by the American Bridge Company. The piping was fabricated

* General Electric Company, Schenectady, N. Y.

How the A.S.M.E. Boiler Code welding was applied to the boilers, piping and other pressure equipment of the General Electric Company's outdoor mercury-steam-electric power plant at Schenectady is told in this paper which was presented at a joint meeting of the New York chapters of the American Society of Mechanical Engineers and the American Welding Society in January. In the construction of this plant, which supplies 26,000 kilowatts to the New York Power & Light Company and 650,000 pounds of steam per hour for the use of the General Electric Company, rivets and bolts are almost entirely absent

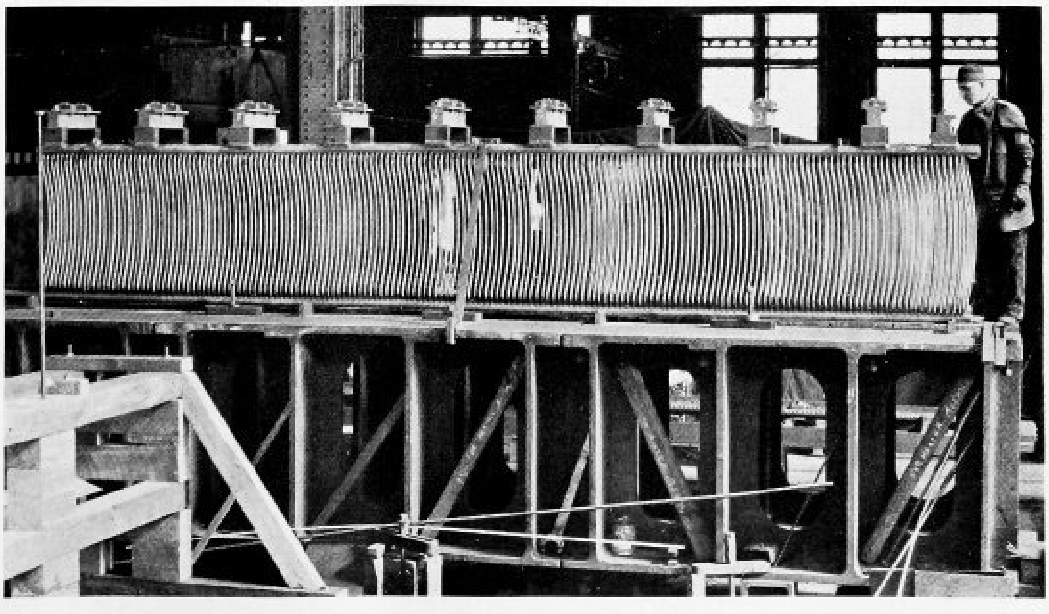


Vertical cross-section of mercury boiler showing furnace, water walls, mercury walls, boiler tubes and drums, mercury headers and steam superheater

and erected by the Pittsburgh Piping and Equipment Company. The mercury turbine equipment and accessories were fabricated in the General Electric plant. From the regular welding forces of the General Electric Company some thirty men were qualified through the Hartford Steam Boiler Inspection & Insurance Company for Class I Code welding. Of these, six were employed by the Pittsburgh Piping and Equipment Company for four months in erection work.

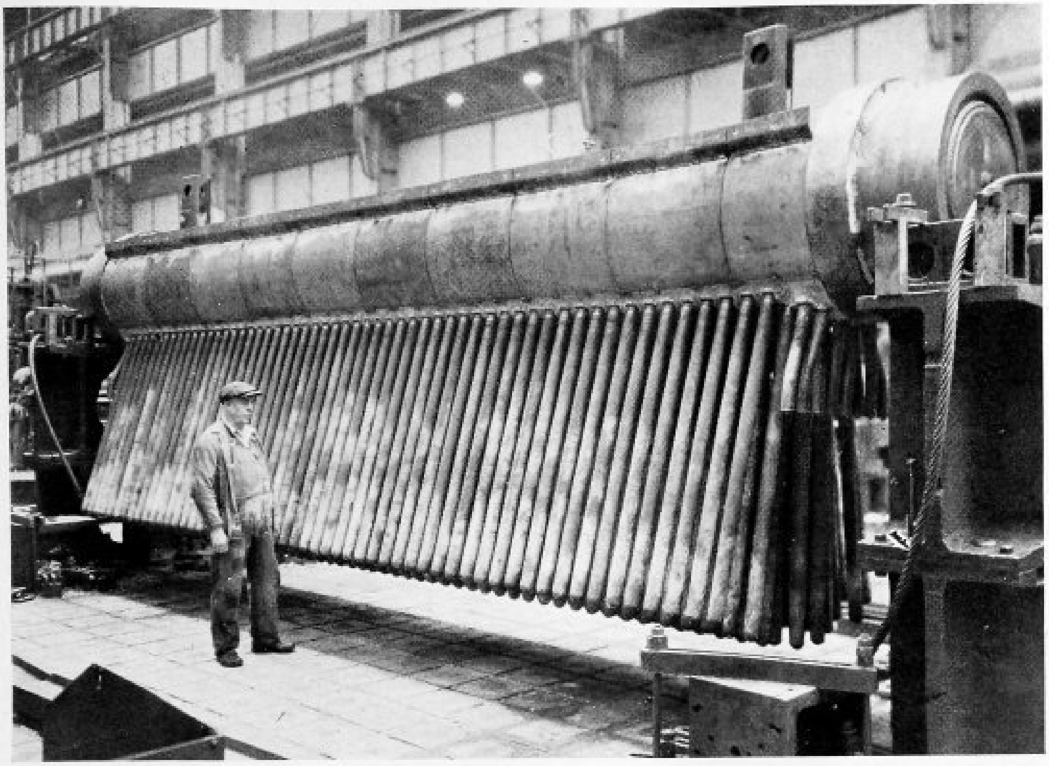
Detail specifications were prepared covering the procedure for qualifying welders and for the shop and field welding as well.

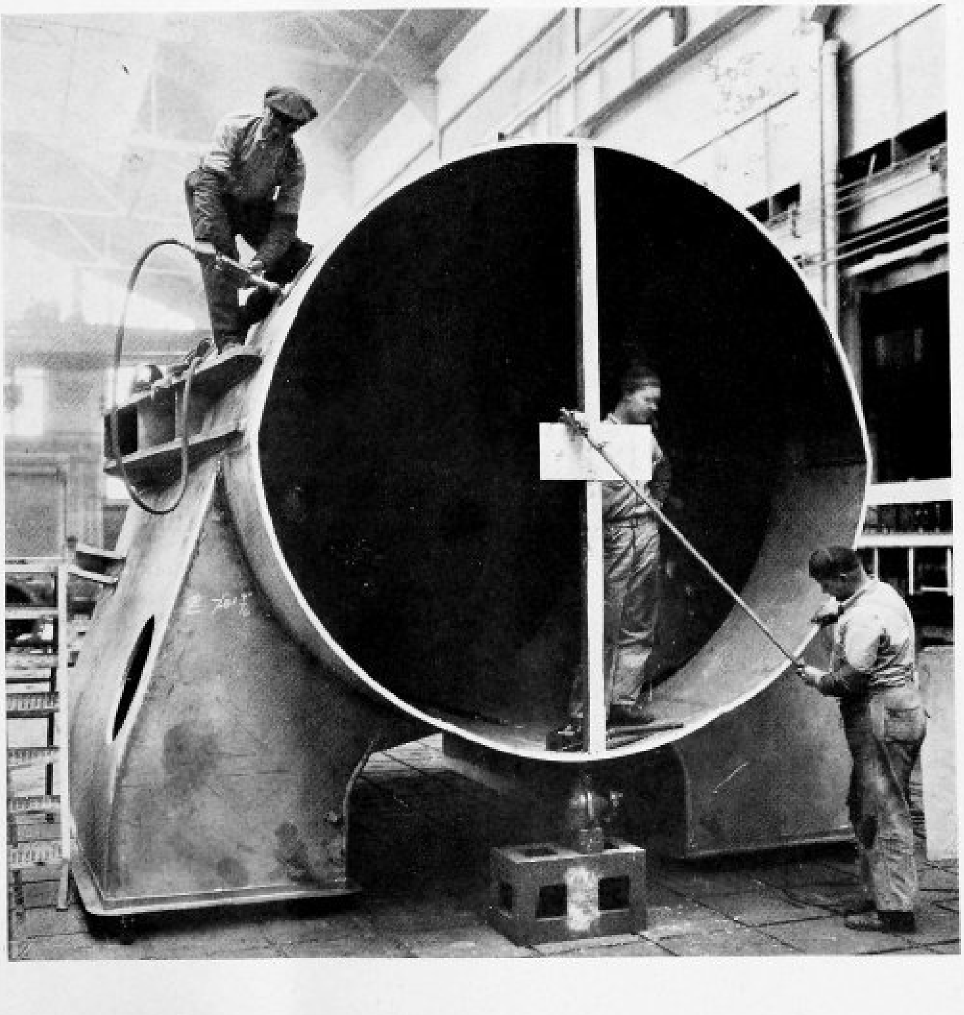
The mercury boiler consists of seven horizontal parallel drums of 30-inch welded pipe, four inches thick, suspended from trusses. Down-hanging from each drum are 440 porcupine tubes welded inside the drum. In spite of the fact that the welders had to work in this 30-inch diameter space under forced ventilation only two leaks developed during hydrostatic test in the 3080 tube joints involved. The mercury liquid heaters and mercury furnace walls are examples of intricate shop fabrication. Among the other heavy units Code-welded in the shop were the governor and safety valve body for the mercury turbine and the mercury turbine condensers.



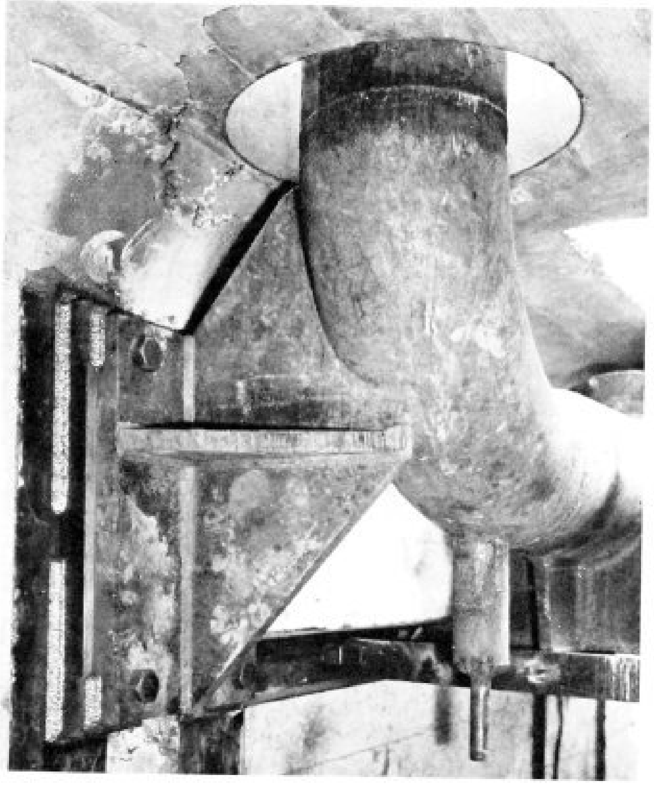
One of the twenty-four mercury liquid heaters which involved a total of over 8000 welds

One of the furnace walls in place. Each group of three tubes is enclosed between corrugated welded plates with the interstices filled with molten copper to obtain maximum heat transfer





(Above) One of the seven drums with 440 welded-in porcupine tubes which go to make up the mercury boiler. A total of 3080 tube-to-drum welds were made. (Right) Shop welding one of the two condenser boilers which are stood on end in service and connected to the exhaust hoods of the mercury turbine. Condensing the mercury vapor generates high-pressure steam



Welded pipe bend and anchor where 18-inch, 400-pound, 750-degree steam line goes up from tunnel to bridge

Where 18-inch steam line and 8-inch water return lines emerge from tunnel and are carried on bridge to steam distributing point

The piping involved carries liquid mercury, mercury vapor steam at 400 pounds, 750 degrees, water at 600 pounds pressure as well as pipes for oil, gas, pulverized fuel and air. The pipe in general is extra heavy, ranging from one inch to 18 inches in diameter. Flanges were avoided wherever possible, flangeless valves were used and long radius bends prevail at the turns.

Among the many features of interest, one of the most important was the design of the steam lines between the power station and the General Electric works. These lines convey steam for heating, turbine testing and for manufacturing purposes from the new power plant to distributing points in two old power stations. The total distance involved is 3735 feet, requiring the installation of 4865 feet of 14-inch high-pressure lines and 4433 feet of condensate return lines, mostly 8 and 10 inch. Steam is delivered at 400 pounds and 750 degrees F. at a maximum rate of 500,000 pounds per hour. The transmission of so much energy through this distance together with the high temperatures, high pressures, and the accompanying expansion problems made this a major piece of work, adjunct as it is, to one of the most interesting power stations in the world.

The steam and return lines are carried in a reinforced concrete tunnel. Short sections where entry is made to the old power stations are carried on skeleton bridges, because they cross various obstructions that precluded the use of tunnels.

In service, the 14-inch high-pressure lines contain 2½ tons of steam, traveling at a speed of 4000 feet per minute. The temperature rise to 750 degrees F. involves, in the 4865 feet of 14-inch pipe, a total linear expansion in the neighborhood of 30 feet with a potential pipe thrust of 400,000 pounds. Without insulation, the radiation at 750 degrees F. would be the equivalent of more than 20,000 kilowatts, equal to the total output of the mercury turbine! These figures make evident the responsibility of the anchorages, the expansion joints, the welded joints and the insulation.

The high-pressure piping is seamless, has a half-inch wall and the 35-foot lengths weigh about 2300 pounds. They were tack welded to form 200-foot lengths and the welding of the joints was completed as the sections were rotated. Position welds joined them to flangeless slip expansion joints which in turn were welded to H-sections embedded in the tunnel side wall, thus providing a rigid anchorage. Self-sealing packing is used under light mechanical pressure as the steam pressure tends to press the truncated-cone rings against the pipe. The joint provides for 18 inches expansion of which from 14 to 18 inches is actually used.

Weld-fabricated compound roller supports are located under the pipe through the length, at 25-foot intervals. Approximately twenty-two 90-degree bends were used, those leading to the bridges are of 12-foot radius. In general, anchor brackets were welded to the short radius bends and in turn to H-frames embedded in the concrete walls or roof.

Stands for the expansion roller supports were fabricated and welded in place. The pipe was brought in through the hatchways and hauled to location on trucks. Fusion rings one-inch wide by ⅛ inch thick, rolled from strip, were tack-welded in the delivery end of each pipe, the welds being made at the inside edge of the ring within the pipe. The lengths were then lifted onto the stands and placed on temporary roller dollies. Six lengths with the last one cut to make approximately 200 feet, including the chromium plated sliding section in the expansion joint, were strongly tack-welded together at six points at each joint. A split gear was clamped on and the 200-foot length was rotated at about one revolution in six minutes, or at a peripheral speed of a little over 7 inches per minute, by a small adjustable speed motor operating through a gear reducer and chain.

The welding of roll joints involved five passes using heavily coated G-E W-21 electrodes, starting with $\frac{3}{16}$ inch at 200 amperes and finishing with $\frac{1}{4}$ inch at 275 amperes. After each pass the slag was chipped off with an air tool which provided some peening effect. The first pass was laid straight and succeeding passes were oscillated increasingly as required to fill the 60-degree beveled groove. The last pass was slightly crowned and was about $\frac{3}{4}$ inch wide. The welding was all done by hand, using the single operator type of motor-generator welding sets.

Only one position weld was required at each expansion joint, that being where the 200-foot line was welded to the stationary member of the expansion joint. These position welds were made with G-E W-20 electrodes in four passes. The weld passes were started at the bottom of the joint and finished at the top, alternating the halves. The succeeding passes were started and finished at staggered points to prevent concentration of starting and finishing joints.

After the position welds, the roller dollies were removed and the roller support members were welded to the underside of the pipe and to the stands. The expansion joints were then anchored by welding. Fitted blocks were welded between the embedded H-section and the joint anchorage bases.

The 8-inch and 10-inch water pipe was handled in the same manner as outlined above except that the expansion joints were spaced 400 feet apart. The expansion joints were fitted with anchorage members by the manufacturer but the anchorages on the bends were fabricated at the Schenectady Works. The vertical risers, two of 28 feet and one of 34 feet, were position welded with G-E W-20 heavily coated electrodes.

Nine test specimens from tested welds were subjected to reduced-section tension tests, nick-break tests and bend tests. Specifications, covering in detail, the entire welding procedure were rigidly adherred to throughout the fabrication of these pipe lines. It is significant that not a single leak developed under steam test among the great number of roll welds and horizontal and vertical position welds.

The electrodes used on the pipe and accessories amounted to 2155 pounds. The welding cost was 3 percent of the cost of the line exclusive of tunnel and bridge construction.

The intricate detail, erection difficulties and the magnitude of the work can best be appreciated by an inspection of the pictures taken during the construction period. They give a good idea of the essential and practically indispensable nature of the arc welding in an undertaking of this kind.

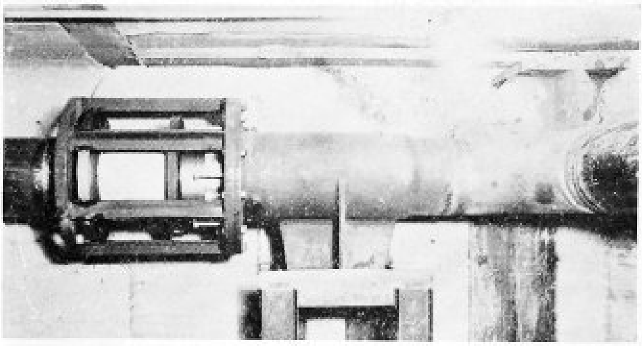
Test Data on Welded Pipe Joints. Endeavoring to secure accurate data on the characteristics of arc-welded pipe joints, General Electric, last year, conducted a series of tests. It was necessary to establish certain limitations for the investigation. Standard 6-inch diameter pipe was decided upon. Its average physical characteristics were as follows:

Ultimate tensile strength, 60,800 pounds per square inch.

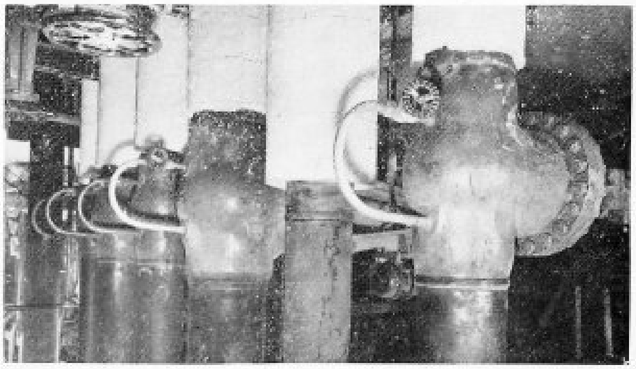
Yield point, 42,700 pounds per square inch.

Elongation in two inches, 48 percent.

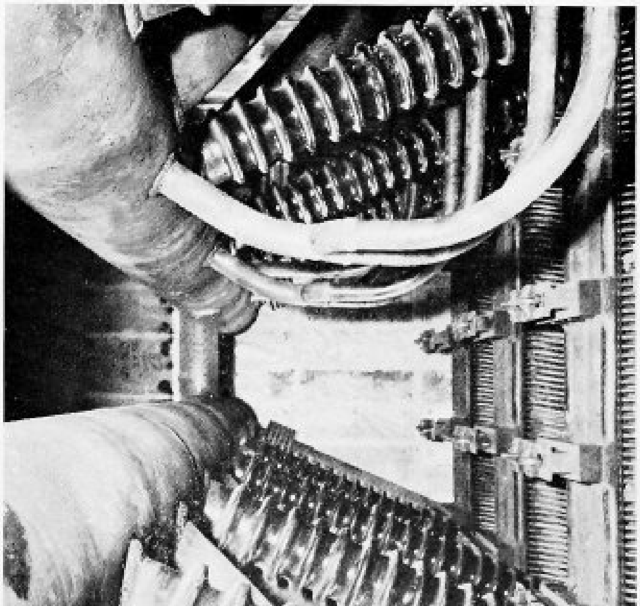
In making these tests, consideration was given to the number of passes of weld metal layers, the electrode diameter, the advisability of fusion rings, etc. Joints were position welded as well as roll welded. The welding current, arc volts, polarity, joint spacing and welding



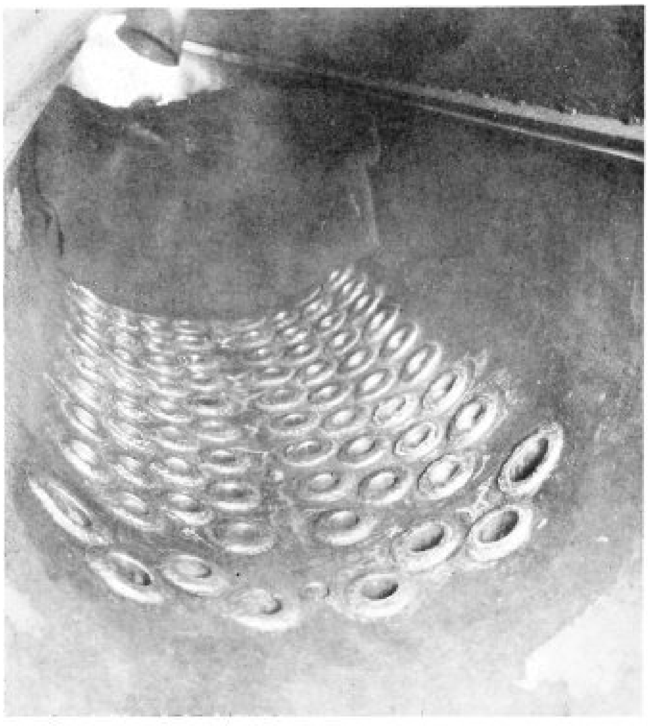
Expansion joint, roller support and anchor at turn in 18-inch pipe



Group of steam lines with welded-in flangeless valves just before insulating



Mercury vapor pipes from seven drums to two headers. Expansion met by use of corrugated pipes



View inside 30-inch drum showing tubes welded to 4-inch drum shell

speeds were consistent with best welding conditions.

Heavily-coated electrodes, sometimes known as shielded arc electrodes, are now standard in all kinds of arc welded piping and were used in conducting these tests,—G-E Type W-20 for the position welds, and G-E Type W-21 for the roll welds. It will be evidenced by the data given that heavily-coated electrodes have decided advantages over bare or lightly-coated electrodes both from a quality and a production standpoint.

From this series of tests, the following conclusions were drawn as applying to pipe joints:

(1) Arc welded pipe joints have physical characteristics superior to pipe joints made by other methods, as shown herewith:

Average tensile strength, above 60,000 pounds per square inch.

Average ductility by free-bend test—45 percent.

Freedom from slag inclusion and porosity come well within the A.S.M.E. Boiler Code requirements for Class II Pressure Vessels.

(2) Heavily coated electrodes are to be preferred over bare or lightly coated electrodes because of the quality of welds produced.

(3) The use of fusion rings is not absolutely necessary as shown in the table by the tensile strength for roll welds made with and without fusion rings under duplicate conditions — 64,500 compared with 61,200 pounds per square inch. It is probable, however, that welders would more readily succeed in making better quality welds with fusion rings on a production basis since 100 percent penetration is more nearly assured. It is recognized that fusion rings have the disadvantage of resisting flow, a condition less serious in larger diameter pipe, and it is probable that they will not be used to any large extent in welding heating systems for low-pressure operation. In these cases, the joint strength lost by incomplete fusion will be somewhat compensated for by the usual weld metal crown or reinforcement of the joint circumference. For securing best quality welds consistently, the straight butt joint with fusion ring (often called chill ring) is to be preferred over other types of joints for 6-inch pipe.

(4) Two passes instead of three are to be preferred on 6-inch pipe joints due to the saving in time and expense. The average tensile strength for roll welds made in two passes is 64,000 as compared to 64,500 pounds per square inch for three passes, a negligible difference.

(5) Position welded joints made with fusion rings are closely comparable in strength to roll welds made under similar conditions, e. g., 61,800 compared with 63,700 pounds per square inch.

(6) The ductility of all types of welded pipe joints made with the electric arc and heavily-coated electrodes approaches that for the pipe material more closely than does any other type of pipe joint.

(7) The density of the weld metal is comparable with that of the pipe material and the resistance to impact and corrosion is greater.

A.S.M.E. Reduced-Section Tension and Free Bend Ductility. The following test data were secured from welds made on 14-inch diameter, ½-inch wall thickness, seamless steel tubing in the qualification of three welders for making position pipe joints on the Schenectady Works mercury-steam-electric power station:

Welding position	Welder number	Ultimate tensile strength, lb. per sq. in.	Ductility free bend, percent
Flat	1	65,200	35.5
Flat	2	63,350	36
Flat	3	64,400	30
		Average 64,320	33.8
Vertical	1	65,000	35.5
Vertical	2	55,900	36
Vertical	3	71,700	26
		Average 64,200	32.5
Overhead	1	65,300	34.2
Overhead	2	62,400	38.3
Overhead	3	64,450	35.5
		Average 64,050	36.0

The yield point for W-20 welds, when reduced-section tension specimens are tested, ranges from 40,000 to 50,000 pounds per square inch.

Physical Characteristics of Welds Made from W-21 Electrodes. The testing methods employed in securing the data contained herein conform with those set forth in the A.S.M.E. Boiler Code. The following data apply to flat butt joints, welded in accordance with Paragraph III-A.

Ultimate Tensile Strength	*Pounds per square inch*
Reduced-section tension-test specimens	65,000 to 70,000
Yield point	40,000 to 50,000
All-weld-metal tension-test specimens	65,000 to 70,000
Yield point	50,000 to 55,000
Steel boiler plate-A.S.M.E. S-1 tensile strength	55,000 to 65,000
Yield point	27,500 to 32,000
Ductility	*Percent*
Free bend test specimens	35 to 50
Elongation in 2 inches—all-weld metal tension test.	25 to 35
Comparative Specific Gravities	
Steel boiler plate	7.80 to 7.85
Minimum specified by A.S.M.E. Boiler Code, Class I	7.80
Type W-21 deposited weld metal	7.80 to 7.857

Conditions Under Which Six-Inch Pipe Joints Were Butt Welded and Results of Tensile and Ductility Tests

Joint No.	Roll or position	Chill ring	Electrode Diameter in.	No. of passes	Actual average welding time, min.	Tensile strength reduced section A.S.M.E.	Tensile strength reduced section 2 in. Rad.	Ductility free bend, percent
1	Roll	No	3/16	3	9:42	58,900	61,200	51.8
2	Roll	Yes	1/4	2	6:07	59,700	63,700	49.9
3	Roll	Yes	3/16	2	10:54	59,400	64,300	53.0
4	Roll	Yes	3/16	3	11:15	57,900	64,500	58.5
5	Position	Yes	5/32	2	15:31	62,200	61,800	46.4

Rules for the Construction of Unfired Pressure Vessels Subjected to External Pressure

For many years the pressure-vessel industry has felt the lack of adequate rules for computation of vessels subjected to external pressure such as vacuum tanks, the inner shells of jacketed vessels, and the like. There have been wide variations of practise in this field, dependent upon certain formulas acquired from varying sources, and rather unsatisfactory results have been experienced, as there have been collapses in certain instances and considerable uncertainty about operating conditions in others. Numerous questions have accordingly come to the A.S.M.E. Boiler Code Committee concerning the design and construction of vessels subject to collapsing pressure.

About five years ago the committee made formal request to the Research Committee of The American Society of Mechanical Engineers to undertake the preparation of adequate formulas, either by general investigation or research, for the computation of this class of vessels. The Research Committee acted promptly on the request and selected a special committee that undertook the investigation and studiously and carefully investigated this particular field. It was found that the existing data were very inadequate and considerable investigation would be necessary to check the existing formulas with actual construction. In the course of the work a large amount of experimental work was contributed by the U. S. Navy Department and certain interested manufacturers.

Considerable time was required to interpret the data obtained into form such that it would be useful for code purposes, but the special committee has finally succeeded in outlining rules that will influence safe construction of vessels subjected to external pressure. Report has been made thereon to the Boiler Code Committee and it is understood that the rules recommended will be issued as addenda to the Code for Unfired Pressure Vessels late in August.

The rules are as follows:

Cylindrical Vessels Subjected to External Pressure. The rules for this class of vessels shall apply only to cylindrical vessels of the three types (either with or without stiffening rings) illustrated in Fig. 1, when constructed of steel complying with Specifications S-1 for Steel Boiler Plate, S-2 for Steel Plates of Flange and Firebox Qualities for Forge Welding, S-4 for Seamless Steel Drum Forgings, S-17 for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes, S-18 for Welded and Seamless Steel Pipe, or S-25 for Open-Hearth Iron Plates of Flange Quality, and when operated at pressures not in excess of 500 lb. per sq. in. and temperatures not in excess of 700 F. Corrugated shells subjected to external pressure may be used in unfired pressure vessels in accordance with Par. P-243 of the Power Boiler Code.

Working pressure shall be the safe operating pressure, which shall be the maximum possible difference in pressure between the outside and inside of the vessel at any time and shall be one-fifth the collapsing pressure.

Shell Thickness. The minimum required thickness of the shell plate shall be determined from the chart as shown in Fig. 2.

In this diagram the abscissas are L/D, the ordinates are working pressures, and the curves represent different values of t/D, where, as shown in Fig. 3.

L = length of vessel between centers of head seams or between centers of circumferential stiffeners, in.

D = outside diameter, in.

t = minimum required thickness of shell plate, in.

In no case shall the external working pressure for which the vessel is designed be taken as less than 15 lb. per sq. in. (corresponding to a collapsing pressure of 75 lb. per sq. in.).

Instructions for Use of Chart. To use the chart, Fig. 2, the value of L/D is computed and, with the given working pressure, the corresponding value of t/D is read off. With this value of t/D, the required thickness t is found. When a vessel has an L/D ratio greater than 20, the same t/D ratio shall be used as for a vessel having an L/D ratio of 20.

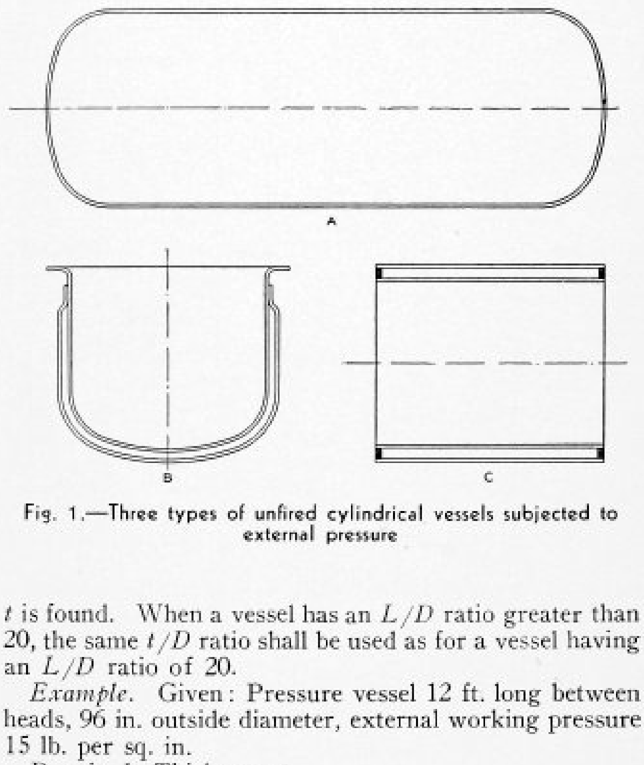


Fig. 1.—Three types of unfired cylindrical vessels subjected to external pressure

Example. Given: Pressure vessel 12 ft. long between heads, 96 in. outside diameter, external working pressure 15 lb. per sq. in.

Required: Thickness, t.

Solution: $L = 12 \times 12 = 144$ in. $D = 96$ in. $L/D = 144/96 = 1.5$. From Fig. 2, for a working pressure of 15 lb. per sq. in. and an L/D ratio of 1.5, the ratio t/D is found to be 0.0046. Therefore: $t = 0.0046 \times D = 0.0046 \times 96 = 0.44$ in.

Out-of-Roundness. The out-of-roundness e, or difference between the maximum and minimum diameters in any plane perpendicular to the longitudinal axis of the vessel, expressed as a fraction of the shell thickness, shall not exceed that given by the chart, Fig. 4, except that on vessels having longitudinal joints of lap construction, the difference between the maximum and minimum diameters may be as great as that given by the chart, Fig. 4, plus the thickness of the plate (see also paragraph referring to longitudinal joints, page 214). Measurements shall be taken on the completed vessel in a sufficient number of planes to insure that the entire surface of the shell meets the requirements.

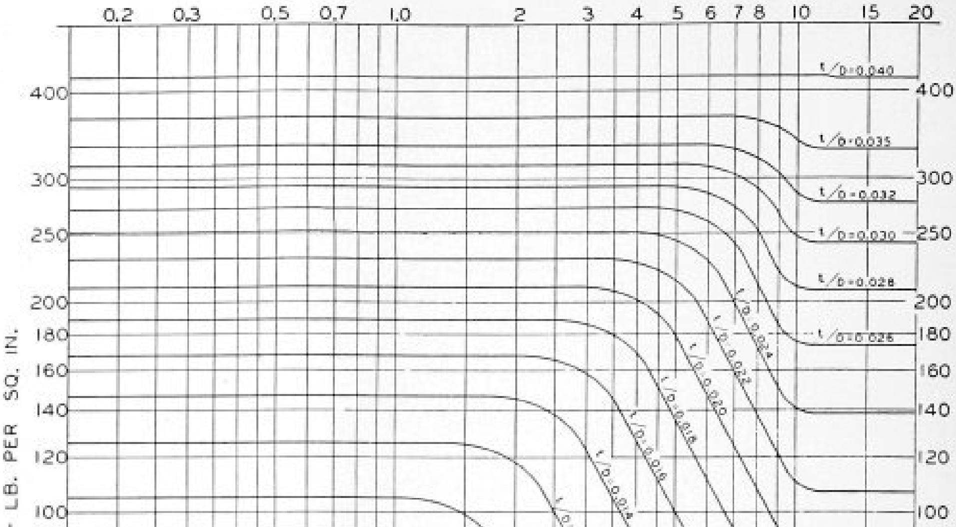


Fig. 2.—Chart for determining shell thickness of unfired cylindrical vessels subjected to external pressure when constructed of steel complying with specifications S-1, S-2, S-4, S-17, S-18 and S-25

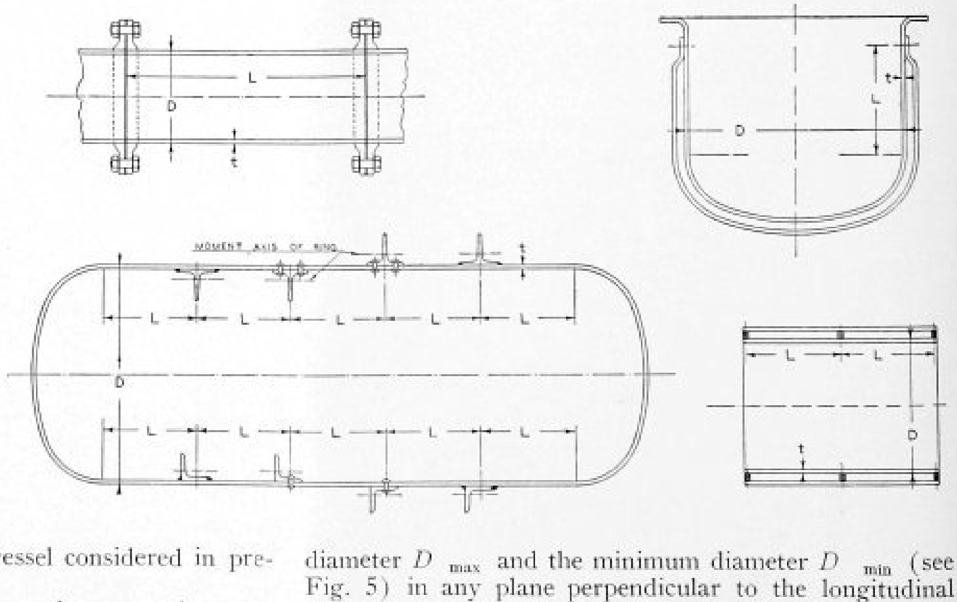


Fig. 3.—Diagrammatic representation of variables for design of unfired cylindrical vessels subjected to external pressure

Example. Given: Pressure vessel considered in previous example.

Required: Maximum out-of-roundness permitted.

Solution: From Fig. 4, for a t/D ratio of 0.0046 and an L/D ratio of 1.5, e is found to be $1.0t$.

This means that the difference between the maximum diameter D_{max} and the minimum diameter D_{min} (see Fig. 5) in any plane perpendicular to the longitudinal axis of the vessel, shall not exceed the shell thickness.

Stiffening Rings. Circumferential stiffening rings composed of bars or structural shapes secured to the shell of the vessel may be used, in which case the distance L

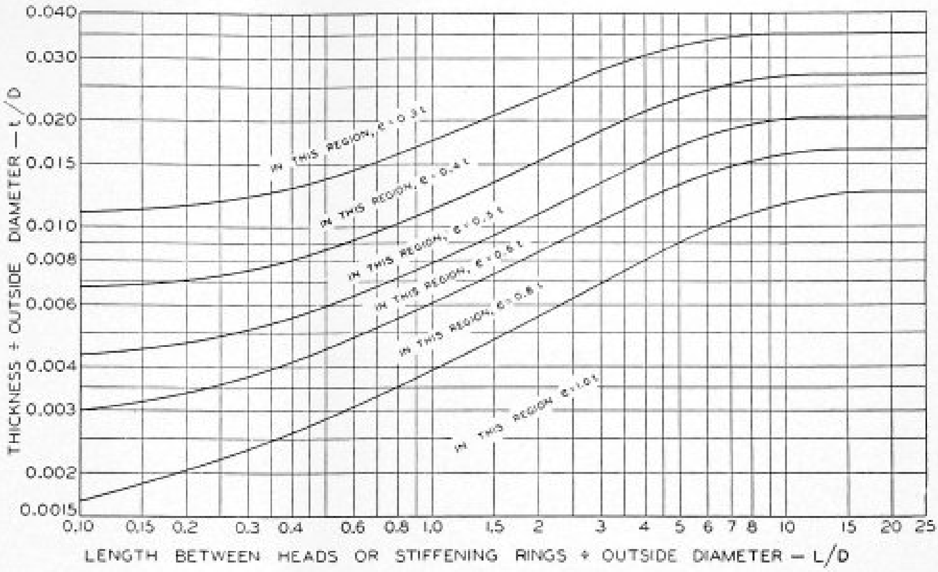


Fig. 4.—Allowable difference in maximum and minimum diameters for unfired cylindrical vessels subjected to external pressure (maximum diameter — minimum diameter = e)

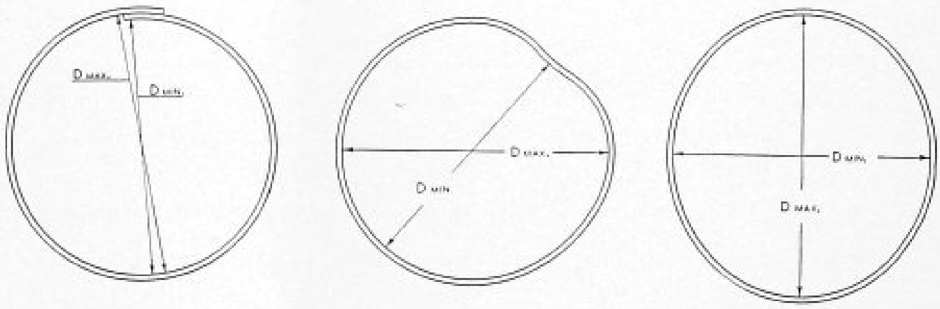


Fig. 5.—Examples of variation from circular form in unfired cylindrical vessels subjected to external pressure

may be considered as the length, measured parallel to the axis of the vessel, between the centers of adjacent stiffening rings, provided the moment of inertia of the rings is not less than that obtained from the chart, Fig. 6.

Stiffening rings shall extend completely around the circumference of the vessel. Any joints between the ends or sections of such rings, as shown at *C, D, F,* and *G,* in Fig. 7, and any connections between adjacent portions of a stiffening ring, lying inside and outside the shell, as shown at *H* in Fig. 7, shall be so made that the full stiffness of the ring is maintained.

Stiffening rings placed on the inside of a vessel may be arranged as shown at *A* and *B* in Fig. 7, provided the moment of inertia required by Fig. 6 is maintained within the sections indicated. The moment of inertia of each section shall be taken about its own neutral axis. However, any gap in that portion of a stiffening ring supporting the shell, as shown at *A* and *E* in Fig. 7, shall not exceed the length of arc given in Fig. 8 unless additional reinforcement is provided as shown at *H* in Fig. 7.

Particular attention is called to the fact that any arrangement of the structure which does not permit uniform radial contraction of the shell will weaken the vessel. Internal radial stays or supports for any purpose shall not bear against the shell of the vessel except through the medium of a substantially continuous ring.

Example. Given: Pressure vessel 50 ft. long, 200 in. outside diameter, working pressure 40 lb. per sq. in.; to be stiffened by circumferential rings.

Required: Thickness t, best frame spacing L, proportions of stiffening rings, and allowable out-of-roundness.

Solution: If it is desired to use a minimum plate thickness (which will usually be the most economical design), the vessel must be designed with the lowest permissible t/D ratio for the working pressure of 40 lb. per sq. in. From the chart, Fig. 2, it will be found that this t/D ratio is 0.0038, and the corresponding maximum L/D ratio is 0.25. Then, $t = 0.0038 \times D = 0.0038 \times 200 = 0.76$ in. and $L = 0.25 \times D = 0.25 \times 200 = 50$ in. It should be noted that any further reduction of the L/D ratio below 0.25 does not lower the t/D ratio. Therefore, a spacing of stiffening rings at 0.25 D or 50 in. is the smallest that can be used to advantage.

The moment of inertia of the stiffening ring is obtained from Fig. 6. For $L \times P = 50 \times 40 = 2000$, and a diameter D of 200 in., I is found to be 96 in.^{4} A 9-in., 30-lb. I-beam is shown in standard handbooks to have a moment of inertia I about the neutral axis perpendicular to the web, of 101.4 in.^{4} Such a beam is satisfactory. Stiffening rings must be placed every 50 in. along the vessel, and the shell must be not less than 0.76 in. thick.

The maximum out-of-roundness permitted is obtained from Fig 4. For a t/D ratio of 0.0038 and an L/D ratio of 0.25, e is found to be $0.6t$. That is, the difference between the maximum diameter D_{max} and the minimum diameter D_{min} in any plane perpendicular to the axis of the vessel shall not exceed $0.6 \times 0.76 = 0.46$ in. (approximately).

Attachment of Stiffening Rings to Shell. Stiffening rings, if used, may be placed on the inside or outside of a vessel and they may be attached to the shell by riveting or welding. If the rings are outside and are riveted, the nominal diameter of the rivets shall be not less than the thickness of the shell plate and the center-to-center distance of the rivet holes shall not exceed that shown in Fig. 9.

If the rings are outside and are welded, the total length of the welding on either side of the stiffening ring shall be not less than one-half the outside circumference of

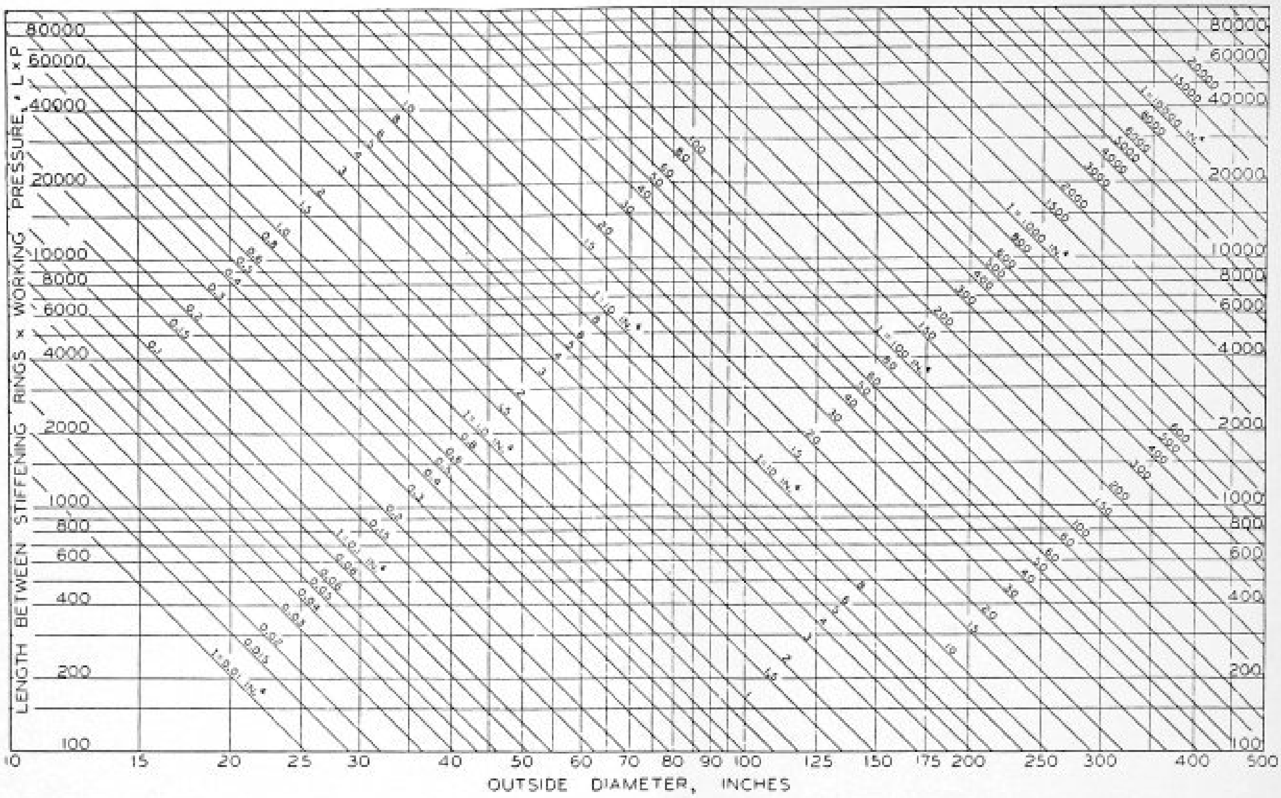


Fig. 6.—Required moment of inertia of stiffening rings for unfired cylindrical vessels subjected to external pressure

the vessel. The arrangement and spacing of such welds, if of the intermittent type, shall be in accordance with Fig. 9.

Stiffening rings placed on the inside of a vessel shall be in adequate contact with the shell sufficiently secured to the shell to hold them in their proper position under any normal condition of operation.

All welding for attachment of stiffening rings shall comply with the requirements of the code for the class of vessel in question.

Supports. The supports for a vessel shall be such that no concentrated loads are imposed which would cause deformation of the vessel in service exceeding the limits of out-of-roundness permitted by these rules.

Note: Attention is called to the objection of supporting vessels through the medium of legs or brackets, the arrangement of which may cause concentrated loads to be imposed on the shell. Vertical vessels should be supported through a substantial ring secured to the shell. Horizontal vessels, unless supported at or close to the ends (heads) or at stiffening rings, should be supported through the medium of substantial members extending over at least one-third of the circumference, as shown at *K* in Fig. 7.

Attention is called also to the danger of imposing highly concentrated loads by the improper support of one vessel on another or by the hanging or supporting of heavy weights directly on the shell of the vessel.

Heads. The design of the heads shall comply with the requirements for dished or flat heads as given in the Code for Unfired Pressure Vessels. Attention is called to the allowable pressure on a dished head when the pressure is on the convex side.

Longitudinal Joints. Longitudinal joints may be of any type permitted by these rules, except that if a lap joint is used, either riveted, welded, or brazed, the allowable working pressure shall be 50 percent of that computed by the rules given herein. Longitudinal joints, if riveted, shall have an efficiency of 50 percent or greater and in no case less than $PD/S \times 2t$, where

P = working pressure, lb. per sq. in.
D = outside diameter, in.
S = working stress, lb. per sq. in., given by Table U-3.

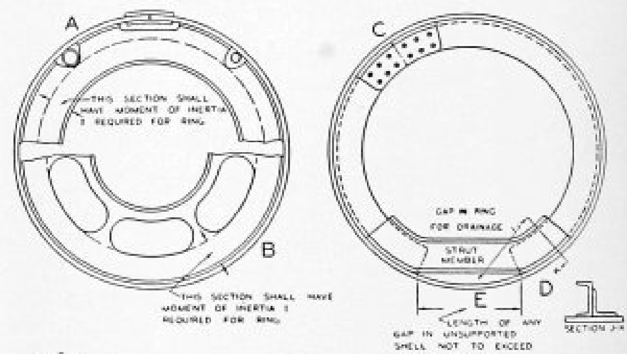


Fig. 7.—Various arrangements of stiffening rings for unfired cylindrical vessels subjected to external pressure

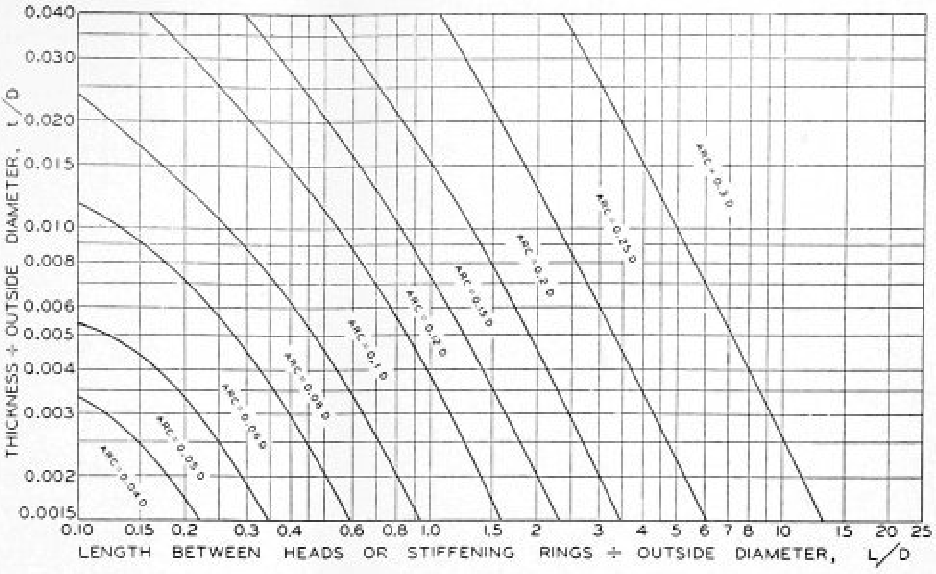


Fig 8.—Maximum arc of shell left unsupported because of gap in stiffening ring of unfired cylindrical vessels subjected to external pressure

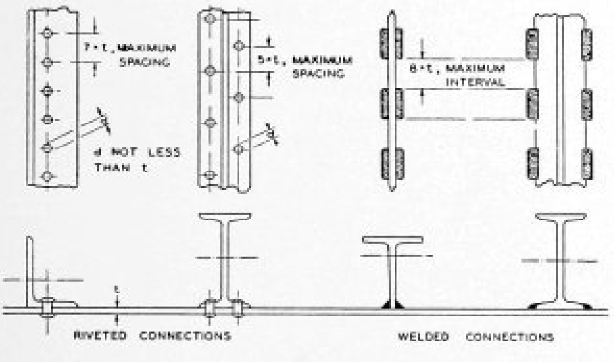


Fig. 9.—Methods of attaching stiffening rings to shell of unfired cylindrical vessels subjected to external pressure

Circumferential Joints. Circumferential joints may be any type permitted by these rules. The strength of riveted circumferential joints shall be sufficient, considering all methods of failure, to resist the total longitudinal force acting on the joint with a factor of safety of five.

Nozzle Openings. Unreinforced openings in the shell shall conform to the requirements of Par. U-59*a* where

$$K = \frac{\text{thickness required by Fig. 2}}{\text{actual thickness of shell}}$$

Reinforced openings in the shell shall conform to the requirements of Par. U-59 *b* where *t* is thickness required by Fig. 2.

Make the following additions to Paragraph U-64 and U-66 of the Unfired Pressure Vessel Code:

U-64 *Hydrostatic Test.* Vessels constructed to operate solely under the external pressure of the atmosphere shall be subjected to an internal pressure of not less than 15 lb. per sq. in.

U-66 *Stamping.* Vessels constructed to operate solely under the external pressure of the atmosphere shall be stamped "vacuum."

Stanley A. Knisely, who has been appointed sales promotion and advertising manager of the Republic Steel Corporation, will have his headquarters at Youngstown, O. Mr. Knisely was formerly director of research and advertising for the National Association of Flat Rolled Steel Manufacturers.

1300-Pound Boilers Show High Availability

Further proof that the availability factors of high-pressure installations, when properly designed, are as good as those of moderate pressure, is to be found in the record of Boiler Room No. 3 at Lakeside Station of the Milwaukee Railway and Light Company. This boiler room contains four units operating at 1300-pound steam pressure and 750 degrees F. steam temperature. The first unit was installed in 1926 and the others in 1929-1930. Disregarding the first unit, which because of the superheat and reheat arrangement is slightly less flexible, the average availability for the three later units for the year 1933 was 98.1 percent. The number of times these boilers were banked during the year were, respectively, 224, 230 and 233, and of the time the units were actually out of service only about 60 percent was chargeable to maintenance.

These units are of the Combustion Engineering bent-tube type, rated at 250,000 pounds of steam per hour but operated at times up to as high as 350,000 pounds. They are fitted with radiant type superheaters and fired with a bin-and-feeder pulverized coal system in which the mills are located directly in front of the boilers and the coal dried in the mills by waste flue gases.

Orders for Locomotives

Shipments of railroad locomotives from the principal manufacturing plants reported to the Bureau of Census, Department of Commerce, in June totaled 3 as compared with 34 in May; 2 in June, 1933 and 17 in June, 1932. Unfilled orders at the end of June, 1934, totaled 138 as compared with 136 at the end of May; 71 at the end of June, 1933 and 129 at the end of June, 1932.

The shipments for June included two electric locomotives for domestic service and one steam locomotive for foreign service. Unfilled orders at the end of June included 67 steam locomotives for domestic service; 11 steam locomotives for foreign service and 60 electric locomotives for domestic service.

These statistics do not include data on locomotives produced by the railroad companies in their own shops.

ELEMENTARY PLATE LAYOUT—III

By George M. Davies

The next method of plate development to be considered is triangulation. This method is applied to objects that cannot be developed by the parallel line method because they are irregular, their profiles changing in either size or shape from one end of the object to the other.

The triangulation method of development can be applied to any object, the surface lines of any object being found by the simple construction of a right-angled triangle, which is the basis for this method of development.

The properties of a right-angled triangle are derived from geometry as follows:

Right Angle: That which is formed by one line meeting another line so as to make equal angles with each other. The lines forming a right angle are perpendicular to each other, as illustrated in Fig. 17.

Triangle: A figure bounded by three lines, called sides, and having consequently three angles, hence the name of the figure. Any one of the three lines may be called the base, and the line drawn from the angle opposite the base and at right angles to it is called the altitude of the triangle as illustrated in Fig. 18.

Acute-Angled Triangle: If all the angles are less than 90 degrees the triangle is called an acute, or acute-angled, triangle as illustrated in Fig. 19.

Obtuse-Angled Triangle: If one of the angles is larger than 90 degrees, the triangle is called an obtuse-angled triangle as illustrated in Fig. 20.

Both the acute-angled and obtuse-angled triangles are known under the common name of oblique-angled triangles.

Right-Angled Triangle: If one angle is a right or 90-degree angle, the triangle is a right, or right-angled, triangle as illustrated in Fig. 21.

The properties of triangles are such that when the sides and angles are not known they can be found when

(1) All three sides are known,

(2) Two sides and one angle are known,

(3) One side and two angles are known.

In other words, if a triangle is considered as con-

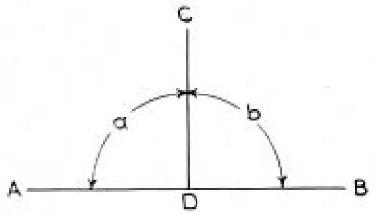


Fig. 17.—Angle (a) equals angle (b). CD is perpendicular to AB. Angles ADC and BDC are right angles

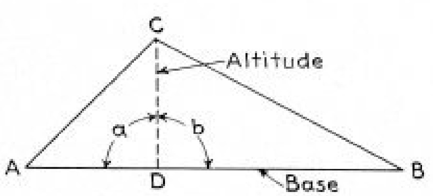


Fig. 18.—Triangle ABC

C D is perpendicular to A B through the point C of the angle A C B, which is opposite the base line A B. Angles (a) and (b) are right angles and C D is the altitude of the triangle A B C.

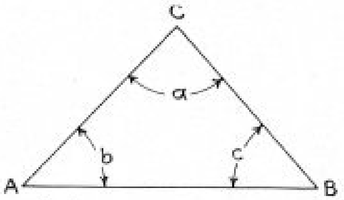


Fig. 19.—Acute-angled triangle ABC. Angles (a), (b) and (c) are less than 90 degrees

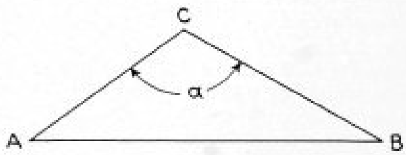


Fig. 20.—Obtuse-angled triangle ABC. Angle (a) is greater than 90 degrees

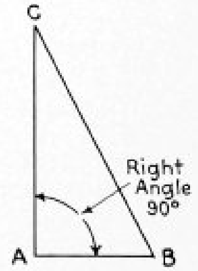


Fig. 21.—Right-angled triangle ABC. Angle BAC in a right angle

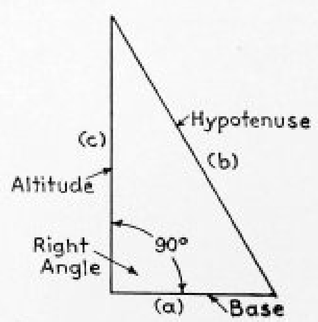


Fig. 22.—Right-angled triangle

sisting of six parts, three angles and three sides, the unknown parts can be determined when any three parts are given, provided at least one of the given parts is a side.

For the right-angled triangles used in triangulation, the conditions in (2) are used, the known angle in all

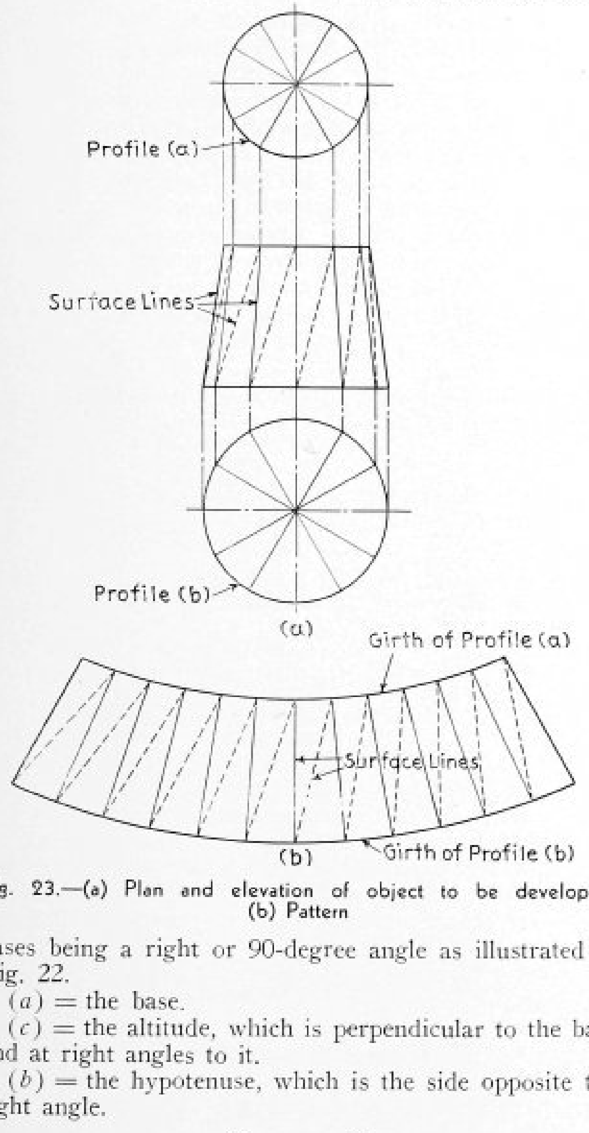


Fig. 23.—(a) Plan and elevation of object to be developed. (b) Pattern

cases being a right or 90-degree angle as illustrated in Fig. 22.

(a) = the base.

(c) = the altitude, which is perpendicular to the base and at right angles to it.

(b) = the hypotenuse, which is the side opposite the right angle.

Problem 11

Given: (a) and (c), Fig. 22.
Problem: To find (b).
Method: $(b) = \sqrt{(a)^2 + (c)^2}$

Example

Given: $(a) = 5$ inches and $(c) = 12$ inches.
To find: $(b) = \sqrt{5^2 + 12^2}$
$(b) = \sqrt{25 + 144}$
$(b) = \sqrt{169} = 13$ inches.

Problem 12

Given: (a) and (b).
Problem: To find (c).
Method: $(c) = \sqrt{(b)^2 - (a)^2}$

Example

Given: $(a) = 5$ inches and $(b) = 13$ inches.
To find: $(c) = \sqrt{13^2 - 5^2}$
$(c) = \sqrt{169 - 25}$
$(c) = \sqrt{144} = 12$ inches.

Problem 13

Given: (b) and (c).
Problem: To find (a).
Method: $(a) = \sqrt{(b)^2 - (c)^2}$

Example

Given: $(b) = 13$ inches and $(c) = 12$ inches.
To find: $(a) = \sqrt{13^2 - 12^2}$
$(a) = \sqrt{169 - 144}$
$(a) = \sqrt{25} = 5$ inches.

In developing patterns by the triangulation method, the profile or plan of each end of the object to be developed gives the girth or edge line of each end of the pattern, with the surface lines between the girths to complete the pattern, as illustrated in Fig. 23 (a) and (b). The surface lines are obtained by constructing a series of right-angled triangles.

In all objects whose sides do not lie in a vertical plane, the length of a line running parallel with the form cannot be determined from the elevation or from the plan. The elevation shows the distance from end to end of the line, vertically to each other, as the line appears to the eye. To get the slope forward or backward of the line, it is necessary to use the plan. From the foregoing, it is plain that the true length of a straight line lying in a surface of irregular form can be found by constructing a right-angled triangle whose base is the horizontal distance between the points and whose altitude is the vertical distance of one point above the other. The hypotenuse of this triangle is the true distance between the points, or the required length of the surface line.

To illustrate, let *ABCD*, Fig. 24, be the elevation of a conical object and *M* its corresponding plan view. It

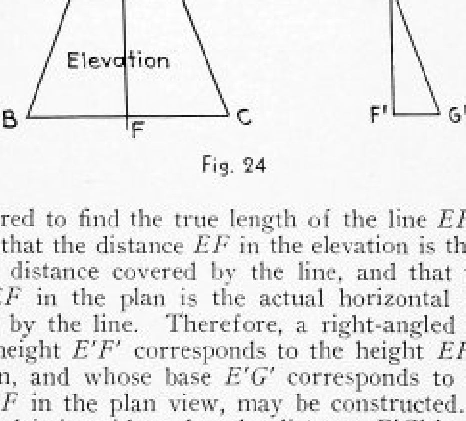


Fig. 24

is required to find the true length of the line *EF*. It is evident that the distance *EF* in the elevation is the actual vertical distance covered by the line, and that the distance *EF* in the plan is the actual horizontal distance covered by the line. Therefore, a right-angled triangle whose height *E'F'* corresponds to the height *EF* in the elevation, and whose base *E'G'* corresponds to the distance *EF* in the plan view, may be constructed. Draw *E'G'*, and it is evident that the distance *E'G'* is the true length of the line *EF*. This is the principle upon which triangulation is based.

(To be continued)

Czarniecki Elected Vice-President of A. M. Byers Company.—At a meeting of the board of directors of A. M. Byers Company on July 30, M. J. Czarniecki was elected vice-president in charge of sales, succeeding H. W. Rinearson, resigned. Mr. Czarniecki was formerly general manager of sales.

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 given records of the interpretations of this Committee in Cases Nos. 768, and 774 to 778 inclusive, as formulated at the meeting of May 25, 1934. They have been approved by the Council. In accordance with established practise, names of inquirers have been omitted.

CASE No. 768 (*Special Rule*).—*Inquiry:* Will low-pressure heating boilers fabricated by fusion welding under the requirements of the welding section of the Code for Low-Pressure Heating Boilers meet the Code provisions if the base metal is a high-strength copper alloy of the following chemical and physical properties:

Copper, percent, approx.	96.00
Silicon, percent, approx.	3.00
Manganese, percent, approx.	1.00
Iron, percent, maximum	0.25
Other elements, percent, maximum	0.50
Tensile strength, lb. per sq. in., minimum	52,000
Yield point, lb. per sq. in., minimum (taken as load producing an extension under stress of 0.50 percent)	18,000
Elongation in 2 in., percent	65

The plate is hot rolled and light annealed at 1022 F. (550 C.), is free from injurious defects and flaws, and has a workmanlike finish.

Can plate thickness for this application be made less than ¼ in.?

Is it permissible to use a pipe size of less than 1 in. if the pipe and fittings used for attaching a water column to a steam-heating boiler are made of brass?

Reply: It is the opinion of the Committee that annealed copper-alloy plates or sheets having the chemical composition and the minimum physical properties specified in the inquiry may be used under Code requirements for heating boiler construction. Under Par. H-70 the allowable working stress of this material would be 5600 lb. per sq. in.

It will not be permissible to use a lesser plate thickness than specified by Par. H-11 in view of the low yield point of this material.

Par. H-36 establishes the minimum size of pipes connecting a water column to a boiler as 1 in., no matter whether the material is ferrous or non-ferrous.

CASE No. 774 (*Special Rule*).—*Inquiry:* In vertical-fired boilers with outside diameter not exceeding 38 in., and for working pressures not exceeding 250 lb. per sq. in., is it not permissible to use circular washout openings in the form of couplings welded to the shell in conformity with the present Code requirements and extending through the insulation to the outer steel jacket, said washout openings to be closed with non-ferrous removable plugs?

Reply: It is the opinion of the Committee that for boilers of the type referred to in the inquiry, it is permissible to use circular washout openings not less than 3-in. pipe size.

CASE No. 775.—(In the hands of the Committee).

CASE No. 776.—(In the hands of the Committee).

CASE No. 777—(*Interpretation of Par. P-278*).—*Inquiry:* Par. P-278 of the Code provides that the openings in the boilers for safety valves shall not be less than given in Table P-15. Are outlet openings of connections between the boiler and the safety-valve flange also required to be of a size to comply with Table P-15?

Reply: It is the intent of Par. P-278 to require on tubular boilers, which include horizontal-return tubular boilers, openings, both on the boiler and on the outlet, or outlets of intervening fittings of a size not less than required by Table P-15.

CASE No. 778 (*Special Rule*).—*Inquiry:* Will unfired pressure vessels fabricated by fusion welding under the test requirements of Par. U-69 of the Code meet the Code provisions if the base metal is a high-strength copper alloy of the following chemical and physical properties:

Copper, percent, approx.	95.25
Silicon, percent, approx.	3.25
Zinc, percent, approx.	1.00
Tin, percent, approx.	0.50
Tensile strength, lb. per sq. in., minimum	52,000
Yield point, lb. per sq. in., minimum (0.50 percent of extension under stress)	22,500
Elongation in 2 in., percent	40
Elongation in 8 in., percent	25

The plate is hot rolled and annealed, is free from injurious defects and flaws, and has a workmanlike finish.

Reply: It is the opinion of the Committee that annealed copper-alloy plates or sheets having the chemical composition and minimum physical properties specified in the inquiry may be used for the construction of unfired pressure vessels by fusion welding under the general requirements of Par. U-69, the exceptions from which are that the elongation as determined by the free bend test shall not be less than 40 percent, the tensile strength shall not be less than that of the base metal, and that stress relieving is not required for this kind of annealed material. The operation temperature shall not exceed 406 F. The maximum allowable unit working stress shall not exceed 9000 lb. per sq. in. for the material, and (S × E) equals 7200 lb. for joints welded as above specified.

Toncan Iron Car Roofs Resist Corrosion

Inspection of the sheet iron roofs of 250 passenger cars of the elevated lines of the Chicago Rapid Transit Company, Chicago, Ill., recently revealed that the roofs, installed in 1913, are still in excellent condition—after 21 years of service. According to Mr. H. A. Otis, engineer of car equipment for the Rapid Transit lines, none of the Toncan iron sheets used for the 250 roofs has been replaced because of rust or general corrosion.

In view of the severe service conditions under which elevated cars operate in a city like Chicago, exposed as they are to all kinds of weather, smoke, soot and fumes from industrial plants, this 21-year record of trouble-free service is a tribute to the lasting qualities of modern sheet iron.

Report on locomotive construction covering

HIGHER BOILER PRESSURES

At a meeting of the General Committee of the Mechanical Division of the American Railway Association held in Chicago on June 27 and 28, reports of the various standing committees were presented. The report of the Committee on Locomotive Construction covered twelve subjects, the first of which was a discussion of the advantages and disadvantages of higher boiler pressures, as follows:

Higher Boiler Pressure

Multiple-Pressure Locomotives.—The 2-10-4 Canadian Pacific multiple-pressure 250-850 lb. three-cylinder oil-fired locomotive No. 8000, was placed in service July, 1931. Details entering into the construction showed excellent examples of how metallurgical developments have permitted constructions not possible a few years ago, for instance—stainless steel for valves and valve seats have surmounted the limitations of bronze and the corrosion defects of ordinary steel, and stainless steel baffle plates for protecting direct oil flame contact with the drums. Low-carbon nickel steel for seamless drum construction has permitted a high factor of safety with reduced weight, and nickel steel boiler plates in the low pressure boiler has also given requisite strength with approximately 30 per cent reduction in weight.

Performance has been reported as showing considerable saving in fuel.

The New York Central multiple pressure 250-850 lb. three-cylinder 4-8-4 type locomotive No. 800, owing to general conditions, has not been placed in service, nor have any road tests as yet been conducted.

Water Tube Firebox Boilers.—As stated in former reports the B. & O. placed in service January, 1931, two locomotives of the 4-8-2 type and two of the 2-6-6-2 type, designed for 250 lb. steam pressure, one each with a watertube firebox and the other with a conventional radial-stay firebox and syphons. Reports of October, 1933, showed that the 2-6-6-2 locomotive with conventional firebox operating in freight service has had side-sheets and syphons renewed once, and was again being held for second set of side sheets, on account of cracks developing around staybolt holes.

The 4-8-2 locomotive, with water-tube firebox, accumulated 221,933 miles to September, 1933, and the 2-6-6-2 locomotive with the same type of firebox 161,091 miles at the same time. No repairs to either of the water tube fireboxes have been made since they have been in service. Both engines, however, have received new flues on account of the heads being fire cracked.

A passenger engine, 4-6-2 type with 80 in. drivers and 230 lb. steam pressure equipped with water-tube firebox boiler up to September 30, 1933, had made approximately 350,000 miles.

From these encouraging results the B. & O. built at its Mount Clare Shops, December 1933, a 4-6-4 type passenger locomotive with the same type water-tube firebox boiler, but to operate with 350 lb. steam pressure, 74 in. drivers, tractive force 52,000 lb., with booster 64,100 lb., firebox heating surface 825 sq. ft. with boiler capacity (Cole rating) of 124 per cent. Opportunity will thus be offered to learn what effect the higher pressures and temperatures will have on the boiler and steam distribution.

The Delaware and Hudson water-tube firebox of their design as applied to locomotive No. 1400 built in 1924, 350 lb. pressure; 1401, 400 lb. pressure; 1402, 500 lb. pressure led to the building of the fourth locomotive No. 1403, (The L. F. Loree), 500 lb. pressure,—being a four-cylinder compound 4-8-0 type. It was exhibited at The Century of Progress Fair, Chicago, and has had little service. They advise that these pressures have worked out satisfactorily and up to the present nothing has developed from a boiler or an engine standpoint that would justify a discontinuation of such pressures and the advantages that can be obtained through the use of same.

Conventional Radial-Stay Firebox Boilers.—The Atchison Topeka & Santa Fe reports that as regards locomotives carrying boiler pressures of 220 to 300 lb., the situation remains unchanged since the report a year ago. No new locomotives have been built since nor have they reduced the boiler pressure of any locomotives carrying 275 to 300 lb. pressure, neither have they increased the pressure on any other locomotives. Their locomotives carrying 275 and 300 lb. boiler pressure are giving satisfactory boiler performance and there is no outstanding feature in the maintenance or operation of these boilers to distinguish them from others of similar size and capacity that are operating under similar conditions.

The Canadian National Railway in previous reports advised that high silicon steel was being used in barrel courses, dome liners and welt strips, this permitted the use of thinner sheets, and that all staybolts were made of steel. No further information is available, excepting that they are convinced that the aim should be for higher boiler pressure.

The C. & N.W. and the C.St.P. M. & O. reports that the 12 C. & N.W. 2-8-4 type freight locomotives which carry 240-lb. steam pressure, have been in service over six years, the service has been very satisfactory, and maintenance on the boilers is no greater than for the boilers carrying lower pressure. The thirty-five, 4-8-4 type freight and passenger locomotives which carry 275 lb. pressure, have been in service over four years with the same satisfactory service. The material for the boilers of these locomotives is carbon steel, and the staybolts and radial stays are of wrought iron. From experience had with these locomotives they believe that to obtain the greater economy and the best operating service from locomotive boilers, the steam pressure should not be less than 250 lb.

The Kansas City Southern reported that work on Mallet No. 750, pulverized coal and lignite oil burner, was discontinued due to conditions, but hope by next year to have additional information.

The Lehigh Valley has 11 locomotives operating at 250 lb. boiler pressure and 11 at 255 lb. The first of these locomotives were placed in service about three years ago and the entire boiler, with the exception of material entering into the construction of syphons and smokebox sheets was of nickel steel. The fireboxes and combustion chambers were all welded, no rivets being used in the construction of the firebox. With the exception of one row above the mud ring which is hollow drilled rigid bolts, the balance of the bolts are hollow drilled Flannery two-piece flexible staybolts. So far these boilers have given very good service and practically no maintenance, and no firebox trouble known of any of them, with the exception of one small crack in an inside throat sheet. They contemplate purchasing some additional locomotives on which the boiler pressure will be 275 lb., and it is the intention to have the boilers designed along the same lines as the 22 now in service.

The Missouri Pacific reports that it has eight locomotives of the 2-8-2 type carrying 250 lb. steam pressure; these boilers are built of carbon boiler steel and so far have given the best of results, with no increased maintenance cost. Five of these same have been in passenger service seven years and the others four years. It has also twenty-five 2-8-4 type locomotives carrying 240 lb. steam pressure which have been in freight service for four years. The boilers are constructed of regular carbon boiler steel; repairs on these boilers no greater than on boilers carrying less pressure.

The New York Central reported in 1932 that it had equipped two 4-6-4 type locomotives operated at 225 lb. steam pressure with nickel steel shell courses for experimental purposes. Since that time these two engines have been shopped and the indications, up to the present time, are that equally as good service may be expected from the nickel steel as from regular specification steel and with a considerable reduction in weight.

The Pennsylvania has some nickel steel barrel sheets in use; these have not been in service sufficiently long to furnish definite information as to their life and service. Also have some special staybolt material on trial, but have not changed their standard, and have found no reason to do so. Their boiler pressure for all new locomotives has been 250 lb. for a number of years, and have not exceeded this up to the present time.

The Union Pacific does not have any locomotives carrying boiler pressure higher than 220 lb. but does have 88 locomotives of the 4-12-2 type, three cylinders, carrying 220 lb. boiler pressure. These engines have been in service from four to six years. The boilers are of the conventional radial stay type using plain carbon steel plates, and the performance of these boilers has been very satisfactory. If building new locomotives would probably go to 250 lb. or even 275 lb. boiler pressure.

The subcommittee report was signed by G. H. Emerson, (chairman), J. E. Ennis and A. H. Fetters.

LESSONS IN ARC WELDING

It is the object of these lessons to present in a concise manner certain fundamental facts of welding, the knowledge of which will enable the operator to use the welding process successfully and economically. These lessons are based on the course in arc welding given by Arthur Madson at the plant of the Lincoln Electric Company, Cleveland, O. Preceding lessons were published on page 46 of the February issue, page 77 of the March issue, page 106 of the April issue, page 135 of the May issue, page 165 of the June issue, and page 193 of the July issue.

Lesson 23

Object: To make tee or fillet weld.
Material: ¼-inch Fleetweld electrode. ¼-inch plates.
Procedure: (See Lesson 12).

Set up the plates at right angles to each other and tack in position. Weld in one corner only.

The electrode is held in the position shown in Fig. 42; the angle between the electrode and the horizontal plate being 30 degrees, pointing backwards to make an angle of 60 degrees between electrode and the vertical plate.

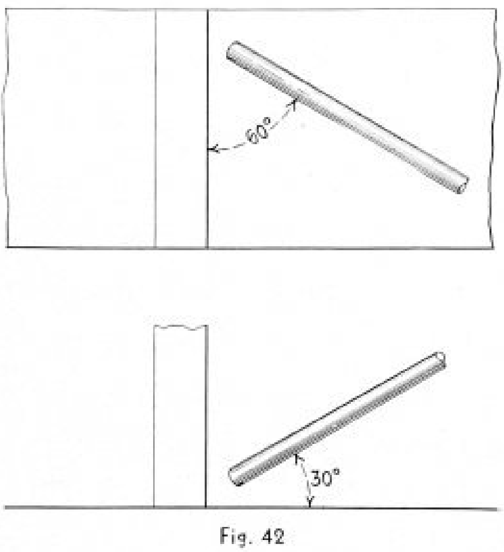


Fig. 42

The arc is held somewhat shorter than on previous welds and directed into the corner if the plates are of the same thickness. In case the plates are of unequal thickness, the arc is directed a bit more on the thicker plate. The point is to heat both plates to about the same temperature.

In making this type of weld, do not weave the arc. Simply draw the electrode along in a straight line, watch carefully the solidifying bead. Directly under the arc, there will be considerable undercutting of the vertical plate, however, if the arc is advanced at the proper rate, the bead will pile up and solidify, to fill in the undercut and result in a good fillet weld.

Use ¼-inch plate—¼-inch electrode, 190 amperes, 30 volts at arc.

When work can be tilted so that molten pool is horizontal much higher current may be used and increased speed obtained.

Use ½-inch plate. Tilt as shown, Fig. 42.

Plate Thickness	Passes	Wire Size	Current	Volts
½	1	⅜	350	36

Upon completion of welding allow to cool and then hammer plates over against the weld. Reverse this until weld is broken. Observe appearance, bead must be down into corner with good fusion.

Lesson 24

Object: To make vertical weld with Fleetweld.
Material: $\frac{3}{16}$-inch plate—⅛-inch and $\frac{3}{16}$-inch V Fleetweld electrode.
Procedure: Set up plates with joint as in Fig. 43, in a vertical position.

It should be noted that ⅛-inch and $\frac{5}{32}$-inch Fleetweld is used for either horizontal, vertical or overhead work. In case of the $\frac{3}{16}$-inch size a slightly different coating is used which is known as $\frac{3}{16}$-inch vee. Larger than $\frac{3}{16}$-inch heavily coated electrode is not generally used for vertical or overhead and is not generally recommended although it has been used in some cases.

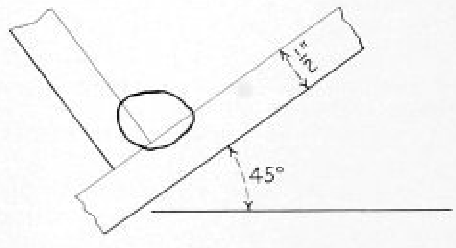


Fig. 43

The best all around electrode for vertical welding is the $\frac{3}{16}$-inch V. When welding on thin plate or where gaps between plates are small ⅛-inch and $\frac{5}{32}$-inch may have to be used to prevent burning through on thin gages and to secure proper penetration on some tight fit ups. The electrode with proper current, which is very important, is held approximately at right angles to the work, the welding starting at the top of seam and progressing downward.* A slight sideward weave of electrode from ¼-inch to ⅜-inch is very helpful in holding a steady arc and getting proper flow of metal. With a short arc length the molten metal has a tendency of boiling, causing sticking of the electrode—lengthening the arc a trifle will relieve this condition causing molten pool to become quiet. The proper arc length if measured at the arc will be around 25 volts. The weld should be completed with the least number of arc interruptions, however, at the finish of an electrode or a necessary break in the arc, the crater should be thoroughly cleaned of slag before again starting to weld.

At the completion of the first pass of the weld, the weld should be thoroughly cleaned, being sure to eliminate the slag at the edges of the weld. The elimination of slag at this point is very important.

The second pass is then woven over the bead just hesitating for a fraction of a second at the sides of the Vee. The various beads should be put on in such a manner that the top of the finished weld is parallel with the plate. In welding plates ½-inch thick and heavier, it is recommended after the finish of the first bead that beads No. 2 and No. 3 be placed on the sides of the Vee, following with the remaining beads No. 4 and No. 5. Each bead should be thoroughly cleaned before making the next weld.

To make sure of 100 percent penetration sometimes a wash bead, a small bead on back side of the plate,

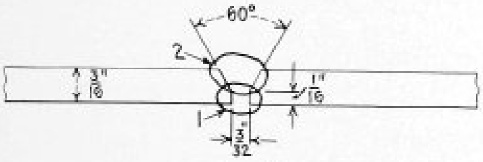


Fig. 44

is used, Fig. 44. It is advisable to thoroughly clean out all slag by running a diamond point chisel down until the weld metal is reached. This insures 100 percent penetration and against slag inclusions.

Plate Thickness	No. of Passes	Wire Size	Current	Arc Volts
See Sketch No. 1	1	⅛	110	25
3/16	2	3/16 V	150	25

* Some operators proceed upward. This is a matter of personal preference; either may be used, but as a usual rule a higher speed is secured by welding down.

Lesson 25

OBJECT: To make vertical lap and fillet welds.

MATERIAL: 3/16-inch or ¼-inch plates—3/16-inch V electrode, Fleetweld.

PROCEDURE: In general the same welding procedure as given for vertical butt welds applies to vertical lap and fillet welds (See also Lesson 11). Care must be taken

Fig. 45

so that no undercutting or flow of metal from plate edge is permitted. This is a matter of speed control.

Set up ¼-inch plates, Fig. 45. Use 3/16-inch V Fleetweld electrode, 150 amperes, 25 arc volts, two passes. Hold electrode at right angles to work.

After completion of weld, put wedge between plates and break it. Observe texture of metal, fusion, penetration.

Lesson 26

OBJECT: To weld overhead with Fleetweld—butt weld.

MATERIAL: 3/16-inch or ¼-inch plates—3/16 V Fleetweld electrode is used to execute this lesson.

PROCEDURE: (See Lesson 16).

Place plate in horizontal position so that the underside may be easily and comfortably reached. Use ⅛ and then 3/16 V electrode.

Run a bead on the underside of plate. Change arc length and observe appearance of bead. Practice until a good bead is deposited. Do not be satisfied with anything less than a good bead. The arc is held somewhat closer than for horizontal welding. It is moved along at an even, steady rate. Observation will soon tell you the correct speed.

In general the same preparation, fit up and currents used in vertical welding apply to overhead welding with the exception the weld is generally made with a number of straight beads. However, weaving is sometimes accomplished by running small overlapping beads back and forth across the weld, the idea being always to keep the

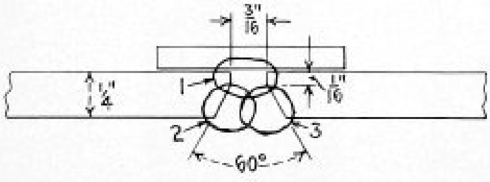


Fig. 46

molten pool as small as possible. Extreme care must be taken to thoroughly clean all slag from bead before another is applied.

See Fig. 46; set up ¼-inch plates as shown. Use ⅛-inch rod, 110 amperes, 25 volts for first bead. 3/16-inch V rod, 150 amperes, 25 volts for second and third beads. Hold electrode at right angles to work. Check the quality of weld metal. Be sure to clean slag off very carefully, after each bead.

Lesson 27

OBJECT: To weld overhead with Fleetweld, lap and fillet welds.

MATERIAL: 3/16-inch or ¼-inch plates. 3/16-inch V Fleetweld electrode.

PROCEDURE: The remarks of lesson 26 apply. Be careful the edge of plate is not allowed to flow or undercut, Fig. 47. Set up plates as shown. Use 3/16-inch V,

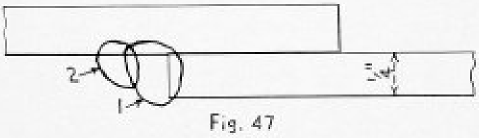


Fig. 47

150 amperes, 25 arc volts for first bead; ⅛-inch rod, 110 amperes, 25 volts for second bead. After completion of the weld, break it open by means of wedge inserted between plates. Examine for fusion into corner, quality of metal.

Lesson 28

OBJECT: To demonstrate penetration of Fleetweld electrode (cutting).

MATERIAL: Scrap ¾-inch plate. 3/16-inch Fleetweld electrode.

PROCEDURE: Set machine at maximum capacity (wide open).

Place ¾-inch scrap plate so it projects over edge of table.

Use 3/16-inch electrode. Hold at right angles to plate. Strike arc and force through plate. A 3/16-inch electrode will put a ½-inch (approximately) hole through a ¾-inch plate, using 2 inches of electrode.

Notice how cool the electrode is, even after this great overload (200 percent—300 percent); how smooth the hole is; how fast it is done.

(The End)

Helmet That Protects Faces from Disfigurement

Many workers whose jobs involve risk of disfigurement of the face as well as injury to the eyes require special equipment which will give them wide angle horizontal and vertical vision at the same time that it gives them comfortable and dependable face and eye protection.

Helmet designed to protect face as well as eyes

To meet these requirements, the American Optical Company, Southbridge, Mass., has developed the No. 660 helmet. It is made of tough fibre to withstand the blows of flying particles, yet is light in weight and does not tire the worker. The headgear is adjustable and the helmet can be set easily and quickly in either an "on" or "off" position.

Blow-Off Tanks*

***By E. R. Fish*†**

In order to prevent damage to the sewers, the laws of many cities prohibit the blowing of boilers directly into them. Where such laws are in force the boiler user must blow-down either through a pipe open to the atmosphere, or else into a blow-off tank. However, the use of the tank is advisable under all conditions, for it is a safety measure that lessens the danger of scalding persons who might be near the end of an open blow-off pipe when the blowing takes place.

The principal function of a blow-off tank is to absorb the impact of the water issuing from the boiler and to provide a place for the liberation of the steam which forms when the pressure is reduced. Such a tank also affords temporary storage for the blow-down water.

There is no established practice as regards the size or design of these tanks. A good rule is to make them large enough to hold the amount of water represented by one gage of the largest connected boiler. Ordinarily, one tank in a plant is sufficient, all boilers being connected to it, but large plants might require two or more.

There is no general agreement as to the pressure for which a blow-off tank should be designed. That some pressure will build up is inevitable, as is evidenced by numerous failures, some of which were disastrous. The best practice is to design the tank to carry the boiler pressure, although there are very few tanks so constructed. Certainly they should be capable of safely sustaining at least half the normal boiler pressure. Many light cast iron tanks are in daily service and their continued use should be discouraged. Steel tanks should preferably be built in accordance with the A. S. M. E. Code rules for unfired pressure vessels; and if fusion welded they should comply with Class 2 requirements.

To be insurable, blow-off tanks should not be buried but should be so installed that they can be completely inspected. They should be so located that water from the boiler will flow into them by gravity and for this reason it is usually necessary that they be placed in pits. The pit should have good drainage facilities and should be large enough to permit a thorough inspection of the tank, as tanks of this kind are likely to be subjected to both internal and external corrosion and hence there must be ready access to both inside and outside surfaces. Therefore, means of access must be provided.

Blow-off tanks are usually closed; and for their safe operation they should be vented to the atmosphere. The vent pipe should have an area of about four times that of the inlet pipe. There should be no shut-off valve or other obstruction in the vent pipe, which should end in a safe place not less than 15 feet above the top of the tank. This pipe should also be as straight as possible, be well constructed and rigidly held in position.

The inlet pipe should enter the side of the tank near the top and the outlet or overflow connection should be at about the same height as the inlet. This outlet connection should have an internal pipe leading down to within a few inches of the bottom of the tank.

It is obvious that a dangerous pressure will build up in a blow-off tank if there is any obstruction to the escape of either water or steam. When a tank is properly installed the pressure within it during the blowing down is only a small fraction of the boiler pressure; but conditions sometimes develop which cause the pressure to rise, and it is against any such unexpected condition that adequate provision should be made.

* From *The Locomotive*.

† Chief engineer, boiler division, The Hartford Steam Boiler Inspection and Insurance Company.

Coordinated Mechanical Association Conventions

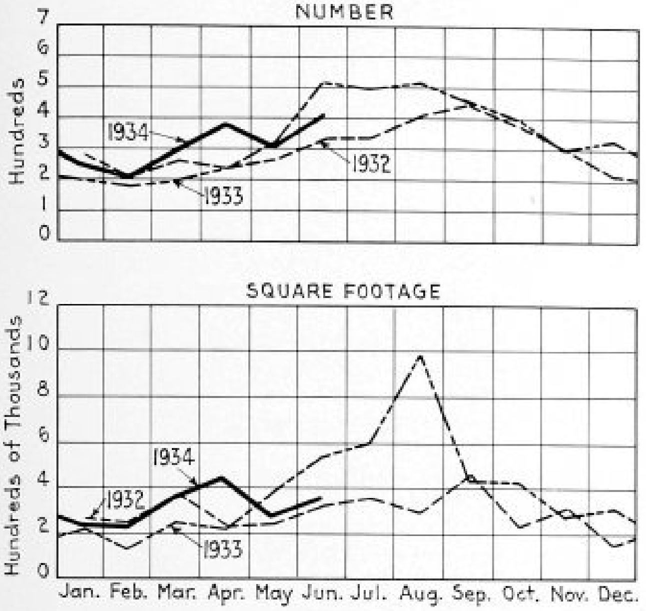
(Continued from page 203)

encounter; formally to discuss outstanding developments that have occurred since the last meeting and establish standards of practice, and finally to inspect and discuss with authorities in the supply trade important developments in tools, equipment and materials that in the light of progress in any industry must continually go on.

For four years the Master Boiler Maker's Association and all the other organizations involved in the present proposal have definitely been cut off from the beneficial contacts that spell progress. Unless the present opportunity is grasped to re-establish each of them on a sound practicable and above all—coordinated basis, with the cooperation of the American Railway Association, the possibility of consummating such a plan later will be extremely doubtful.

With unity of thought and action by the officers of these groups and the support that already has been evidenced on the part of several mechanical officers individually, there is little question but that complete endorsement of the plan will be obtained.

Orders for Steel Boilers and Fabricated Steel Plate Increase in Six-Month Period



Steel power boiler production for the last three years

The first six months of the year, according to information released by the Department of Commerce, Bureau of the Census, have evidenced a decided improvement in the boiler manufacturing, the fabricated steel plate, and allied industries.

Orders for steel power boilers of all types, as reported by 68 manufacturers, for the six months, total 1854 as compared with 1643 for the same period in 1933 and 1580 in 1932. The heating surface produced totals 1,916,050 square feet in 1934, as against 1,762,212 square feet in 1933, and 1,687,266 square feet in 1932.

June production amounted to 415 units of 359,759 square feet of heating surface, as against May production of 304 units totaling 277,086 square feet. The curves of production for both number and heating surface indicate a definite trend which at the moment shows evidence of continuing upward. Table 1 gives complete production figures for the boiler manufacturing industry.

Fabricated Steel Plate Industry

In the fabricated steel plate industry production rose to a peak in March, receded in April and has steadily increased in May and June.

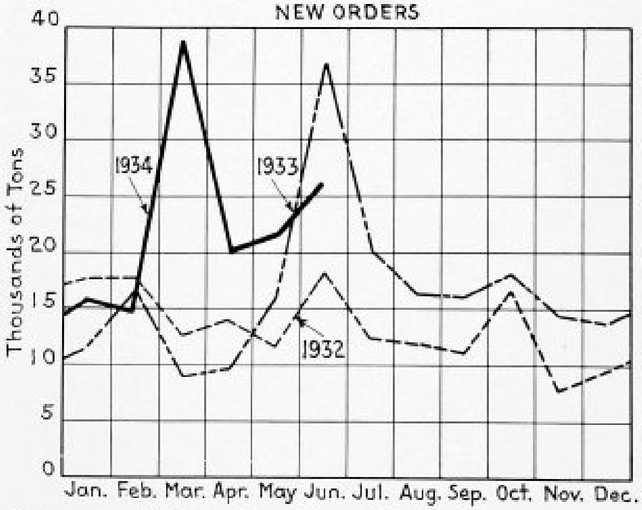
For the first six months of the year, production totaled 137,929 tons of fabricated steel plate products

Table 1.—New Orders for Steel Boilers

Item	1934 June	1934 May	Total, 6 months (January-June) 1934	1933	1932
GRAND TOTAL:					
Number	415	304	1,854	1,643	1,580
Square feet	359,759	277,086	1,916,050	1,762,212	1,687,266
STATIONARY:					
Total:					
Number	402	294	1,777	1,568	1,540
Square feet	346,892	272,527	1,792,674	1,638,263	1,604,009
Watertube—					
Number	43	46	252	235	197
Square feet	141,166	139,500	999,273	957,839	872,311
Horizontal return tubular—					
Number	53	31	184	148	114
Square feet	68,035	41,889	245,783	188,411	140,328
Vertical fire tube—					
Number	32	29	185	161	191
Square feet	10,481	9,197	52,792	35,705	57,951
Locomotive (not-railway)—					
Number	8	1	23	19	33
Square feet	6,435	373	16,995	12,054	31,974
Steel heating as differentiated from power boilers—					
Number	234	163	948	907	904
Square feet	91,070	69,155	337,054	349,383	422,096
Oil country—					
Number	1	4	39	8	1
Square feet	1,264	1,605	31,674	9,833	752
Self-contained portable—					
Number	25	20	132	75	91
Square feet	26,867	10,808	99,852	61,604	68,521
Miscellaneous—					
Number	6	.....	14	15	9
Square feet	1,524	.....	9,251	23,434	10,076
MARINE:					
Total:					
Number	13	10	77	75	40
Square feet	12,867	4,559	123,376	123,949	83,257
Watertube—					
Number	4	.....	32	33	12
Square feet	7,512	.....	96,664	93,287	59,849
Pipe—					
Number	.....	.....	4	1	2
Square feet	.....	.....	3,569	1,310	2,678
Scotch—					
Number	3	9	34	40	24
Square feet	373	1,656	15,258	28,252	15,256
Miscellaneous—					
Number	6	1	7	1	2
Square feet	4,982	2,903	7,885	1,100	5,474

Table 2.—New Orders for Fabricated Steel Plate

Item	1934 June	1934 May	Total, 6 months (January-June) 1934	1933	1932
NEW ORDERS (TONS):					
TOTAL	26,491	21,891	137,929	100,032	92,171
Oil storage tanks.........	11,019	8,746	31,195	38,070	16,627
Refinery materials and equipment	1,359	1,767	9,776	4,134	2,225
Tank cars	913	131	1,854	479	204
Gas holders	382	445	3,162	4,994	5,475
Blast furnaces	80	....	185	136	349
Miscellaneous	12,738	10,802	91,757	52,219	67,291



Comparison of fabricated steel plate orders for the past three years as compared with 100,032 tons in 1933 and 92,171 tons in 1932. New orders increased from 21,891 tons in May, 1934, to 26,491 tons in June. The chart indicates very graphically this improvement.

Oil storage tank orders in June exceeded those for May; refinery materials and gas holders decreased, while tank cars and miscellaneous production increased strongly.

OIL BURNERS, STOKERS AND PULVERIZERS

In the field of products allied with power boiler manufacture the trend for the first six months of 1934 has been greatly improved. For this period there were orders placed for 32,117 oil burners, as compared with 24,306 units for the corresponding period in 1933. June figures show orders for 5445 units as against 8003 for May. Unfilled orders at the end of the month totaled 1923 compared with 2618 at the end of May.

The mechanical stoker industry in all its branches gained tremendously during the first six months over the like period in 1933 and in 1932. In the three classes of stokers for heating units production for the first six months of 1934 totaled 4275 units; in 1933 the total was 2471 units; and in 1932, production amounted to 2176 units. In the field of heavy power, the total number of units produced was 703, as against 572 in 1933 and 564 in 1932.

The total production of range boilers for this first six months of 1934 was 284,922, as compared with 297,109 for 1933 and 247,342 for 1932. New orders for this period totaled 283,638 in 1934, 317,431 in 1933 and 257,907 in 1932.

Advanced Course In Welding Engineering

Beginning July 23, a special five-day course in welding engineering is being offered in Cleveland by the John Huntington Polytechnic Institute in cooperation with The Lincoln Electric Company. The course, being repeated at this time due to increased activity in the welding industry and to demand for an intensive advanced training course, will be conducted once each month except during August of this year. This course will provide engineers, welding supervisors and foremen an opportunity for intensive study of the practical and theoretical sides of welding. Engineers from three foreign countries and 15 states attended one of the recent sessions of this course.

Day sessions will be held between 10:30 A.M. and 4:30 P. M. at the plant of The Lincoln Electric Company which has offered the facilities of its welding school under the direction of Arthur Madson and Dean Newton. Evenings between 7:30 and 9:30 will be devoted to lectures and discussions at the John Huntington Polytechnic Institute.

The course will cover the following subjects: value and use of the shielded arc; calculation and distribution of stresses in welded joints; study of polarized light and rubber weld models; penetration; designing for arc welding; organization of welding departments and estimating welding costs, etc.

This course is not to be confused with the regular Lincoln Welding School which has been in session regularly since 1917 when it was first inaugurated. The Lincoln Welding School is one of the largest of its kind in the world and thoroughly trains welding operators in every aspect of electric welding.

Complete information on the five day course may be obtained from E. W. P. Smith, Welding Engineering Department, John Huntington Polytechnic Institute, Cleveland, O.

New Line of G-E Indoor Disconnecting Switches

A new line of indoor disconnecting switches, with ratings as high as 1200 amperes at 5000 volts, featuring silver-to-silver line-pressure contacts, has been announced by General Electric's Switchgear Sales Division, Philadelphia, Pa. The silver, applied to the contacts by a special G-E process which produces a surface of unusual wearing qualities, eliminates troublesome oxidation and its inherent disadvantages. A test, consisting of 30,000 opening and closing operations, failed to harm the silver-contact surfaces.

The complete line includes hook-operated, single- and double-throw, double-throw double-blade transfer switches with half- or full-capacity blades, single-throw tandem transfer switches with full-capacity blades, and group-operated switches controlled manually or electrically. The single- or multi-pole switches are mounted on compound insulators and metal bases. The insulators are made of non-inflammable, arc-resisting Cetec cold-molded material and have a dry flashover of 25 KV.

Obituary

Josiah Buell Warner, for over forty years a chief inspector with the Hartford Steam Boiler Inspection and Insurance Company, died recently at his home in Alameda, California. Mr. Warner joined the company in 1884 when it extended its business to the Pacific Coast. He served in the west continuously until his retirement from active service in 1927. Previous to his connection with the company he had been a marine engineer. Mr. Warner was a member of the committee which drafted the original Boiler Safety Orders in California and he held Certificate of Competency No. 1 of the Industrial Accident Commission, a deputyship from the Board of Mechanical Engineers of the City of Los Angeles; was an honorary member of the American Society of Marine Engineers, a member of the National Association of Power Engineers and of the National Board of Boiler and Pressure Vessel Inspectors. He was born in Hebron, Connecticut, December 14, 1857.

J. B. Warner

Boiler Maker and Plate Fabricator

VOLUME XXXIV NUMBER 8

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Communications

Compactness Feature of Design of New European Power Units

To the Editor:

The modern tendency in designing power plant units seems to be towards the production of compact plant, generally of high speed or high performance and efficiency. The Velox boiler is an outstanding example of this trend. Another example, produced in the United Kingdom, is not so novel, yet it offers a completely self-contained power unit of well-thought-out design. The equipment provides in one unit a boiler along the lines of the ordinary Lancashire type, with the usual accessories; a superheater (optional); air preheaters with air and gas ducts and dampers; fans driven by engine, turbine, or motor; feed-heater, using low-pressure or high-pressure steam, exhaust steam or gases; optional dome or steam separator; feed-water regulator; steam, feed, exhaust piping, and valves with the necessary auxiliary fittings.

Apart from its compactness, this plant presents several noteworthy features. The boiler is made for steam pressures up to 300 pounds per square inch, and, although it is of the Lancashire type, the length is generally not greater than 20 feet. The fuels for which it is suitable—coal, coke, oil, or wood—can be fed manually, mechanically, or by other means. On test this generator steamed from cold to 100 pounds pressure in 90 minutes, and to 200 pounds in 105 minutes. The gross overall thermal efficiency was stated to be 84.13 percent.

London, Eng.

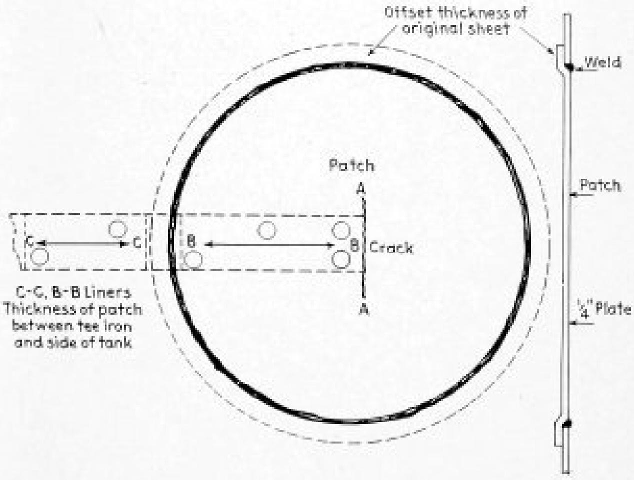
G. P. Blackhall.

Repairing Crack in Locomotive Tank

To the Editor:

The accompanying sketch shows a method of repairing a crack in the side of a locomotive tank.

From the present construction of tanks, where the tee or angle bars run horizontally alongside of a tank,



Repairing crack in side of locomotive tank

cracks frequently develop at the ends of these bars. The box patch, as shown, will make a neat, clean and strong job. Offset patch the thickness of the original piece cut out, then fill up leaving the necessary space between the offset and side of the tank for electric weld.

Jacksonville, Fla. Frank Handlee.

Steel Plate Fabricating Industry Budget

The Code Authority for the steel plate fabricating industry submitted to the National Recovery Administration last month an application for approval of its budget and a basis of contribution by members of the industry for the expense of administering its code.

The total amount of the budget is $53,250 for the period from May 1, 1934, to May 1, 1935. The basis of contribution is three-tenths of one percent of monthly billings of all fabricated materials coming within the code and a monthly minimum charge of $5.

Members of the industry were requested to file any objections to this budget or the basis of contribution with Deputy Administrator Walter G. Hooke, Department of Commerce Building, Washington, D. C., prior to July 28.

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

Fitting Up Elbows

Q.—I find in reading in BOILER MAKER AND PLATE FABRICATOR you are giving a series of geometrical drawing and practical laying out problems. In studying Figs. 12 and 13, page 148, June issue, I find that in using ¼-inch steel for elbows, they should be larger at one end so that in assembling them they would slip into each other instead of flaring them, which has to be done in riveting. The flaring makes a very unfinished looking job. J. L. T.

A.—The method of developing sections for elbows larger at one end, so that in assembling they will slip into each other instead of flaring them, is illustrated in Fig. 14 (*a*) and (*b*) of the article on Elementary Plate Layout, page 184, of the July issue.

Rivets for Locomotive Boilers

Q.—What grade of steel should be used for locomotive boiler rivets?

A.—The rivets used in locomotive boilers should be at least as good as the plates into which they are driven. Rivets that have a high sulphur content, and consequently red shortness, cause trouble. The best firebox flange steel is the best steel made, and every rivet used in fabricating it should be equally as good. A good policy is to carry in stock only one grade of rivets, and that the best. There will then be no question of failures or waste or of the rivets being unsatisfactory for any class of work regardless of whether it is for tanks, cars, boilers or fireboxes.

Welding in Marine Boiler Repairs

Q.—To what extent can welding be applied in repairing marine boilers?

A.—Section 25, Rule II, of the General Rules and Regulations of the Bureau of Navigation and Steamboat Inspection, Department of Commerce, as recently amended contains the following provisions regarding the use of welding in marine boiler repairs:

No repair work by any welding process shall be allowed on marine boilers until coupons showing the character of the work proposed to be done by the applicant shall have been tested and submitted, together with an explanation and report of the test, to the local inspectors of the district where the work is to be done. The local inspectors shall then satisfy themselves whether or not such process can be used with safety on the boilers of steam vessels.

In every case where repairs are to be made by these processes on boilers of steam vessels subjec to the inspection of this service, the engineer in charge and the parties making the repairs are required to notify the office of the local inspectors, giving a full detailed description of the repairs to be made, the location of the vessel, and the time the repairs are to be begun, so that inspection may be had, if practicable, prior to and during the time the work is being done, which reports must be confirmed in writing to the local inspectors.

The application for permission to use these processes on boiler repairs of any particular vessel implies a guaranty on the part of the applicant that the work shall, in material, flux, and workmanship, be equal to that of the samples furnished.

The following repairs to marine boilers may be made by any process of fusion welding:

All calking edges on internally fired boilers may be reinforced.

Calking edges of the shells of externally fired boilers, above the fire line may be reinforced by welding, but no such welding shall be permitted below the fire line.

Cracks extending from rivet to calking edge in circumferential seams of externally fired boilers above or below the fire line may be repaired, if the crack does not extend beyond the rivet hole, by cutting out the rivet, veeing out the crack, then welding the crack from the edge of the rivet hole to the calking edge, and redriving the rivet.

Cracks not exceeding 30 inches in length in back connection sheets, wrapper sheets, bottoms of combustion chambers, heads, and other stayed surfaces may be repaired by welding.

Where cracks are repaired by welding, holes shall be drilled entirely through the plate at each extreme end of the crack, except in small cracks from rivet to calking edge, and the cracks V'd out before welding.

Circumferential or lengthwise cracks not exceeding 20 inches in length in plain or corrugated furnaces may be welded.

Where plates in back sheets of back connections, wrapper sheets of sides and bottoms of back connections of any boilers, side sheets and legs of furnaces and bottoms of furnaces of firebox boilers, and other stayed surfaces are reduced in thickness not exceeding 40 percent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 400 square inches in any one plate.

The application of welding to heads of rivets or riveted staybolts is not permissible, and where stayed surfaces are reinforced as provided in the preceding paragraph, such rivets or staybolts shall be renewed and shall extend completely through the reinforcing.

When the corroded portion of stayed or riveted surfaces of the back sheets or wrapper sheets or bottoms of back connections of any boilers, or side sheets and bottom sheets of furnaces of firebox boilers, exceeds 400 square inches, the same may be repaired by the removal of the corroded portion and the replacement thereof by a new piece of plate, the edges of the new plate being welded in position.

Staybolts, braces, or rivets shall pass through the body of the new plate in accordance with the provisions of sections 16 and 18, Rule II, the area of the new piece shall not exceed 24 by 24 inches, or 30 inches, in any one direction, the plate edges to be V'd or beveled along the joint prior to welding.

Cracks extending through rivet holes in single-riveted or double-riveted seams in stayed surfaces of back connections of any boilers or side sheets of legs or bottoms of firebox boilers which are stayed surfaces may be welded up to a length of 6 feet.

Where cracks extend through rivet holes in stayed surfaces, the piece extending from the rivet to the edge of the lap may be removed where convenient to do so, and the place where the piece has been removed may be replaced by being built up and reinforced.

Where leaks develop around staybolts and the staybolts are otherwise intact, the nuts may be removed from the ends of the staybolts, and the staybolts may be welded to the plate by welding a beveled collar or ring around the staybolt. The width and depth of such collar shall equal one-half of the diameter of the staybolt.

Cracks in wrought iron or wrought or cast steel, also sand holes in cast steel, headers, manifolds, crosses, tees, and ells may be repaired by welding the cracks or flowing metal into the sand holes, provided that the cracks in headers or manifolds do not exceed 25 percent of the length or circumference. Such repaired material other than headers and manifolds shall be subjected to a hydrostatic test of three times the working pressure, after such repairs are made. Reinforcing by building up of any of the above-mentioned articles other than headers shall not be allowed.

Where tube sheets of boilers have deteriorated not to exceed 25 percent of their original thickness, or where cracks have developed in tube sheets, the same may be reinforced and repaired by fusion welding, and the beading on the ends of tubes may be welded to the tube sheets by the same process.

Any feature of welding not covered by these rules may be accepted and approved by the Supervising Inspector General, if, in his opinion, it meets with the obvious intent of the rule. (Secs. 4405, 4418, R. S.).

Pipe Intersections

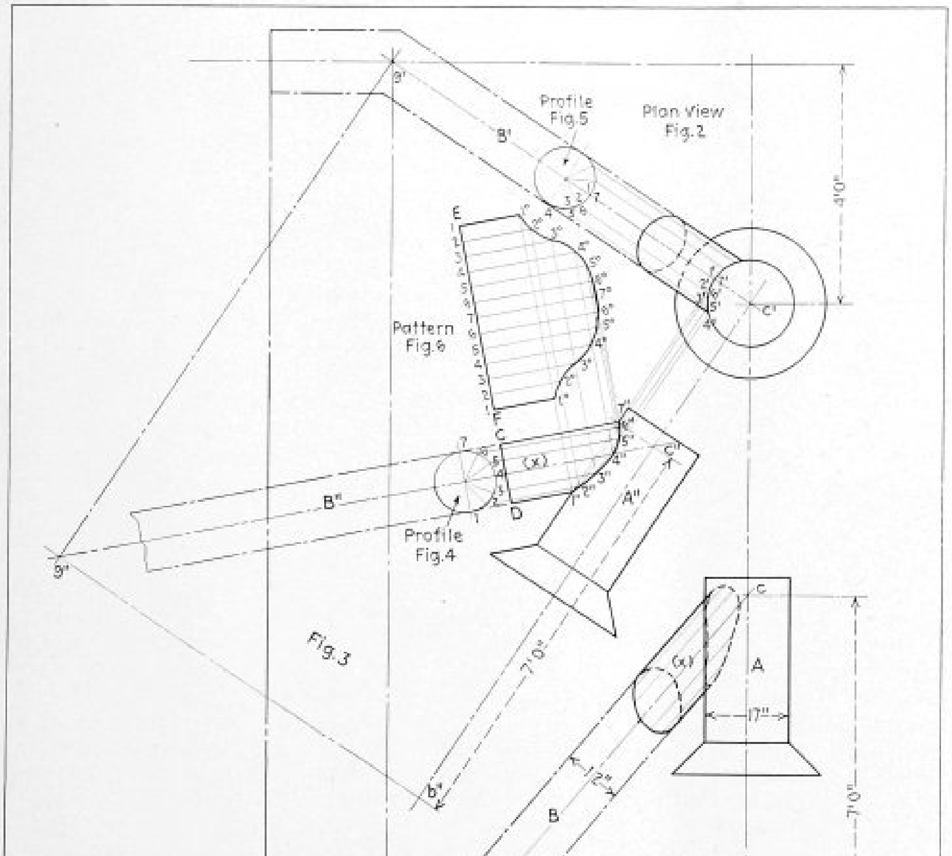
Q.—Would you please supply at your earliest convenience the solution to the inclosed problem. It is a 12-inch pipe intersecting a 17-inch pipe at a double angle and I do not seem to grasp the idea where to get the true lengths of the particular piece marked *X*. Also would you send the names of some sheet metal books where this problem and other similar ones are solved. G. C.

A.—The double-angled pipe connection submitted with the question is illustrated in Figs. 1 and 2, elevation and plan views respectively.

It will be noted that pipe *A* is shown in its true length in the elevation. Pipe *B* intersects pipe *A* obliquely and is not shown in its true length in either the elevation or plan view. The first step is to obtain a full view of both pipes *A* and *B*, showing their true relationship, miter line and angle between. Fig. 3 illustrates the manner in which this is accomplished and is constructed as follows:

Erect a perpendicular to the line a'-c' of the plan view at the point c', and on this perpendicular step off the distance c''-b'' equal to c-b of the elevation, and through b'' draw a line parallel to a'-c' of the plan. Next erect a perpendicular to a'-c' of the plan at the point a', cutting the line just drawn locating the point a'', Fig. 3. Connect a''-c'' which is the true length of the pipe *B*. Pipe A'', Fig. 3, is a duplicate of pipe *A* in the elevation; points c and c'' being identical. Pipes A'' and B'' show the true relationship that exists between pipes *A* and *B*.

The next step is to obtain the miter line of the connection between pipes A'' and B'', Fig. 3. On the line a''-c'' draw the profile Fig. 4 and divide one-half the profile into 6 equal parts, numbering same from *1* to *7*, as shown. Draw lines parallel to a''-c'' through the point *1* to *7* extending same up into the pipe A''.



Layout of pipe intersections

Next on the line a'-c' of the plan view, draw the profile Fig. 5, dividing same into the same number of equal parts as taken in profile, Fig. 4. Number the points from *1* to *7* as shown, the points *1* to *7* of profile, Fig. 5, are numbered so as to agree with the points *1* to *7* of the profile Fig. 4. Through the points *1* to *7* of the profile, Fig. 5, draw lines parallel to a'-c', extending same cutting the perimeter of the pipe *A* in the plan at the points *1'* to *7'* as shown.

Through the points *1'*—*7'* of the plan draw lines parallel to c'-b'' extending same cutting the lines drawn parallel to a''-c'' through the corresponding points *1* to *7* of Fig. 4, locating the points *1''* to *7''*, Fig 3. Connect the points *1''*-*7''*, Fig. 3, completing the miter line between the pipes *A''* and *B''*.

To develop the pattern of the part marked (*X*), extend the line *C-D* to *E* and step off *E-F* equal to the circumference of the pipe *B*. Divide *E-F* into 12 equal parts, numbering same from *1* to *7* to *1* as shown. Erect perpendiculars to the line *E-F* at the points *1* to *7* to *1* as shown.

Parallel to *E-F* draw a line through the point *1''*, cutting the perpendicular to the line *E-F* from the points *1*, locating the points *1°*, then parallel to *E-F* draw a line through the point *2''* cutting the perpendicular to the line *E-F* from the points *2* locating the points *2°*; continue in like manner until the points *3°*, *4°*, *5°*, *6°* and *7°* have been located. Connect the points *1°* to *7°* *to 1°*, completing the pattern, Fig. 6.

Development problems of this type and others similar are explained in detail in *Laying out for Boiler Makers*, which can be obtained for examination by writing for same in care of this publication.

Trade Publications

Pneumatic Tools.—"The World's Most Popular Pneumatic Tools" is the title of a new eight-page bulletin (2037-A) recently issued by Ingersoll-Rand Company, New York. The bulletin lists for the first time the company's new sizes of "Multi-Vane" drills and "Multi-Vane" push-throttle screw drivers and nut setters. It also illustrates and gives size-and-capacity tables of the I-R pneumatic drills, grinders, riveters, chippers, rammers, wrenches, hoists, etc. A copy of the new bulletin may be obtained by writing the above address; or from any I-R branch office.

Air-Acetylene Flame.—The publication of a new 8-page illustrated booklet entitled, "101 Uses for the Air-Acetylene Flame", has just been announced by The Linde Air Products Company, New York. The field of this pamphlet is so large and the subject is treated in such a comprehensive manner that every repair shop will welcome it eagerly as a handy reference guide. It is pointed out that the air-acetylene flame does not take the place of the widely-used oxy-acetylene flame, but serves as a supplementary tool for use where lower flame temperatures are required. The booklet goes on to describe the outfit necessary for the work and discusses the advantages of the process. It then proceeds to take up in succession a number of different fields where the process is extremely useful. These include plumbing and piping, air conditioning and refrigeration, marine work, automotive repair, power and electrical, and others. All repair men whose work includes soldering, brazing or heating operations will want to have a copy of this new booklet. Copies will be furnished by The Linde Air Products Company upon request.

Design of Jigs and Fixtures.—The Linde Air Products Company, New York, has issued an interesting 12-page booklet which consolidates and crystallizes current ideas on how to design jigs and fixtures for welding, whether it be production fabrication or repair work. The importance of proper design of jigs can hardly be over-emphasized. It is a consideration which bears directly on the production cost of a welded article. Labor, time and handling charges, in an operation that has to be repeated in the manufacture or repair of similar articles, can be substantially reduced by properly designed work-holding devices. And this booklet tells what considerations must be taken into account in order to realize to the maximum such benefits. The four definite advantages derived from the use of fixtures and jigs—convenience to the operator, a reduction of the cost of the articles, standardization of articles, and accuracy in fabrication—are discussed in their relation to the economics of production. The fundamentals of design are given and their influence on cost reduction discussed. Clamping devices are described, with suggestions on how they are made. The why's and wherefore's of locating points are considered. And, of the highest importance, the control of heat effects on the jig from the blowpipe flame is treated at some length. The booklet is plentifully illustrated with photographs and sketches showing every point, and many useful ideas can be gleaned from the pictures alone.

Oxwelding Corrosion-Resisting Steels.—With the rapidly increasing use of corrosion-resisting alloy steels has come the problem of fabricating these alloys by modern methods, one of the most important of which is the oxy-acetylene welding process. Extensive research has been carried out on the subject in recent years not only by the makers of these steels but by the oxy-acetylene industry. Recommended practices for oxwelding corrosion-resisting steels, based on the comprehensive investigations of Union Carbide and Carbon Research Laboratories, Inc., are given in an 8-page booklet on "Oxwelding Corrosion-Resisting Steels" published by The Linde Air Products Company, New York. The currently-used chromium steels have certain idiosyncrasies depending on the varying proportions in the steel not only of chromium but of other alloying agents which affect the material's weldability. For this reason in this booklet the stainless steels are divided into eight groups, each group having similar welding properties. For each group there is a detailed discussion on welding procedures as well as treatment before and after welding where this is necessary. Stainless steels and irons can be properly and satisfactorily welded by the oxy-acetylene process in accordance with the outlined procedures. Full advantage should be taken of this opportunity for learning the latest methods, and engineers, executives, welding shop superintendents as well as contract welding shop proprietors will find much of value in the booklet, which can be secured without obligation by writing to The Linde Air Products Company.

Maintenance of Reciprocating Parts.—The Linde Air Products Company, New York, has just announced a new publication in its wide range of technical literature on oxy-acetylene welding. This new booklet, "The Maintenance of Reciprocating Parts", deals with the application by the oxy-acetylene process of wear-resisting bronze to the wearing surfaces of sliding parts.

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

Cities

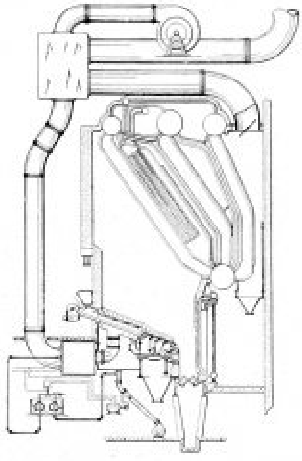
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,847,633. COMBUSTION APPARATUS. EARLL R. STONE, OF LANSDOWNE, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

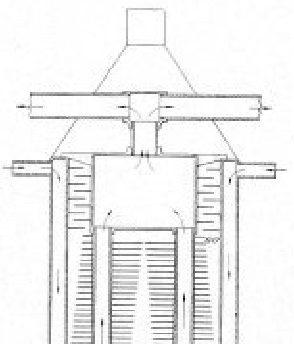
Claim.—In combustion apparatus, the combination with an underfeed stoker comprising a fuel-feeding retort and an air-emitting grate; of conduit means for supplying preheated air to the grate; conduit means for



subjecting the walls of the retort to a stream of relatively cool air, whereby such walls are maintained at all times in a cool condition; and means providing for the flow of air from the cool air conduit means to the preheated air conduit means. Ten claims.

1,851,851. HEATER. LEIF LEE AND HUGH H. HAMILTON, OF YOUNGSTOWN, OHIO.

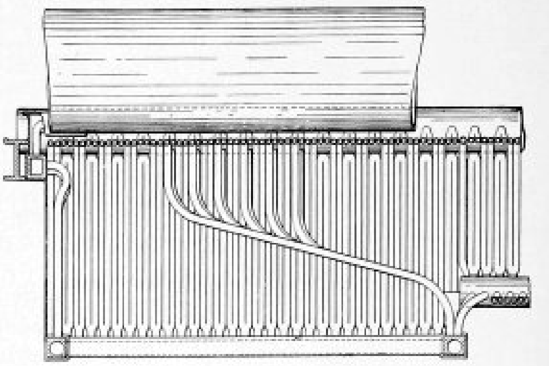
Claim.—A heater comprising an inner combustion chamber and an outer fluid chamber, fluid conduits disposed in the combustion chamber and in communication with the outer fluid chamber, baffles of good heat con-



ducting material in the combustion chamber disposed to force the combustion gases toward the outer fluid chamber and transfer heat to the fluid conduits, a hot water storage tank within the combustion chamber, and means for causing fluid to traverse the outer fluid chamber and then said fluid conduits and be delivered to said hot water storage tank. Three claims.

1,852,284. WATER TUBE FIRE-BOX BAFFLE. AUGUST B. BLOME, OF ST. GEORGE, NEW YORK, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

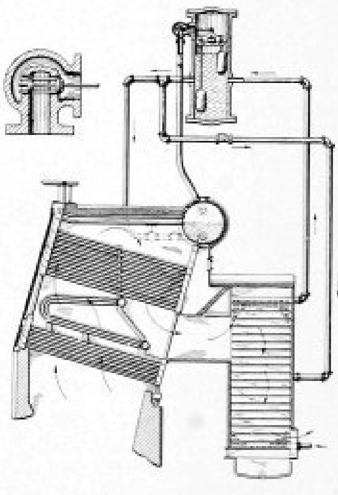
Claim.—The combination in a fire-box of longitudinal water-containing means in the upper portion of the fire-box, a transverse water containing member in the lower portion of the fire-box, water tubes arranged in groups transversely of the fire-box and having their lower ends connected into said member and having their lower portions set close together to form a baffle, the tubes of one group having their upper portions spaced apart and connected into said means along lines parallel to the central longitudinal axis of the fire-box and the tubes of another of



said groups having their upper ends spaced apart and connected into said means along lines parallel to the lines along which said first mentioned groups are connected to said drums but at higher levels thereon. Five claims.

1,847,691. APPARATUS FOR CONDUCTING STEAM FROM AN ECONOMIZER TO A BOILER. DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

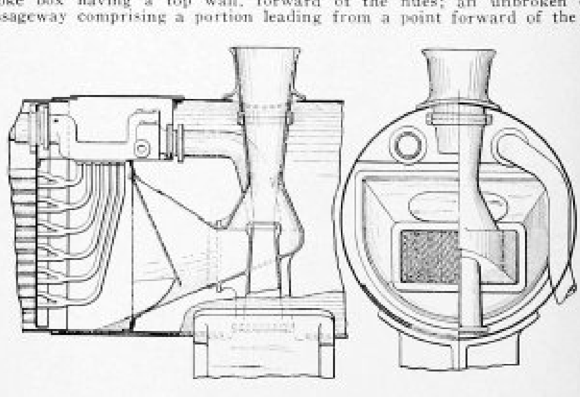
Claim.—In combination with a boiler, an economizer, a steam and water separator through which the feed water from the economizer passes on



its way to the boiler, a conduit connecting the steam space of said separator with a steam space of the boiler, a valve in said conduit and means for opening and closing said valve controlled by the steam generated in said economizer. Ten claims.

1,853,893. DRAFT APPLIANCE FOR LOCOMOTIVES. ALFRED W. BRUCE, OF NEW YORK, N. Y.

Claim.—In a locomotive, the combination of, a boiler having flues; a smoke box having a top wall, forward of the flues; an unbroken draft passageway comprising a portion leading from a point forward of the flues



longitudinally through the smoke box toward the front thereof, and a portion above the longitudinal portion leading vertically upward from the longitudinal portion and out through the top wall of the smoke box, the said passageway having a bottom wall inclined upwardly toward the front of the smoke box; and an exhaust nozzle projecting through said bottom wall and extending upwardly through said longitudinal portion and opening within the vertical portion of the passageway. Six claims.

Boiler Maker and Plate Fabricator

Organize for a 1935 Convention

At a meeting which is being held in Chicago, September 17 and 18, to co-ordinate activities of various railroad mechanical associations, it is expected that committees from the nine, among which is the Master Boiler Makers' Association, which are involved will arrive at some definite plan for holding conventions in 1935. The background of the situation was outlined at some length editorially in the August issue of the Boiler Maker and Plate Fabricator. The problem which undoubtedly will be settled at Chicago is not whether there will be conventions of these associations but where and how they will meet to bring the greatest benefit to all concerned. Briefly reviewed, the situation requiring consideration at this meeting is as follows:

The Mechanical Division, through its General Committee, has already decided to hold a full membership meeting next year. Whether it will be accompanied by exhibits depends upon the Railway Supply Manufacturers' Association and this, in turn, will depend upon the improvement of business conditions between now and the time that it will be necessary to make the decision as to whether or not the exhibits will be held. The situation is made more complicated by the fact that this decision must be made many months in advance of the convention, because of the large amount of detail work involved in organizing and arranging for the exhibits.

In general, the suggestion that some arrangement be made whereby all of the mechanical conventions meet at about the same time, in order that the railway supply people will be warranted in putting on one large exhibit, seems to meet with considerable favor. Most of the railway supply people express enthusiasm over the possibility of making an exhibit, provided an adequate attendance can be assured, and also, of course, that business conditions will be such as to warrant the necessary expenditure. Many of the railway supply representatives feel strongly that the expense of setting up an exhibit is so great that some plan should be worked out whereby only one exhibit will be necessary for all the associations. This might be made possible and at the same time not take too many key men from the railroads at one time, by having the Mechanical Division meeting immediately preceded and followed by some of the other association meetings—a week-end intervening either before or after the Mechanical Division meeting.

The consensus seems to be that Atlantic City is the only place that can house the large exhibit. There is the feeling in some quarters, however, that the attendance at the minor mechanical association meetings may be adversely affected if they are scheduled for Atlantic City, because of the long distances that will have to be covered by members from the western railroads. Most of these associations have normally held their meetings in Chicago, because of its more central location and greater accessibility for the men in the Middle West and West.

From the standpoint of the Master Boiler Makers' Association, which is only one out of the nine associations involved, the decision reached in Chicago will be acceptable, so long as it results in a convention next year. As in the case of the other associations, which have not met for a number of years, there is the necessity almost of reorganizing the membership. As soon as the decision is reached assuring an opportunity for the convention, every effort of the officers of the association must be directed toward reviving interest in its work.

With the broad changes that have occurred among the membership, certainly an immediate canvass should be made to check the actual support that may be expected. The second effort which should be made is to develop papers on outstanding improvements and changes during the past four years in equipment, materials and tools.

To this end, after a thorough study of the subject possibilities, committees well informed on these matters should be appointed to prepare such papers. These subjects need hardly be concerned with practice, but rather should constitute a review of all major developments in locomotive boiler construction and shop operation since the last meeting.

For technical subjects to be discussed there are papers presented in the "Convention in Print" issue of the Boiler Maker, October, 1933, which are still timely and can be opened for discussion by the members at the 1935 convention.

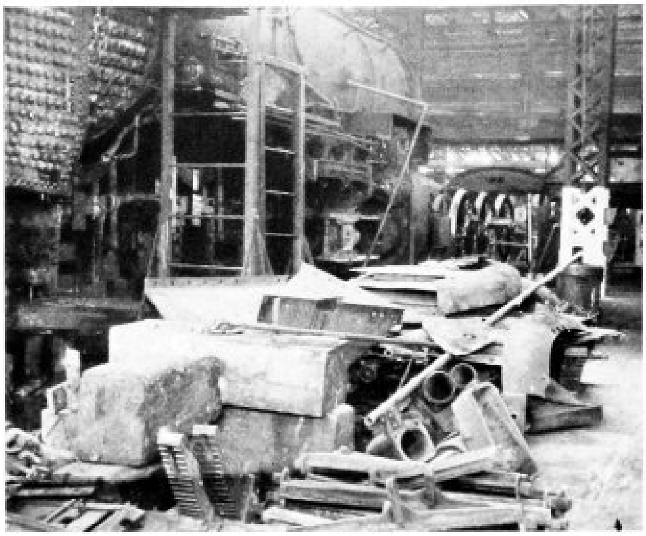
Code Operation of the Boiler Industry

While a number of industries are experiencing difficulties under N. I. R. A. code operation, that of the boiler manufacturers has, through the co-operation of its member concerns with the Code Authority, worked out its major problems and arrived at a state of harmony that in the past few months has resulted in a wide improvement in its methods of conducting business.

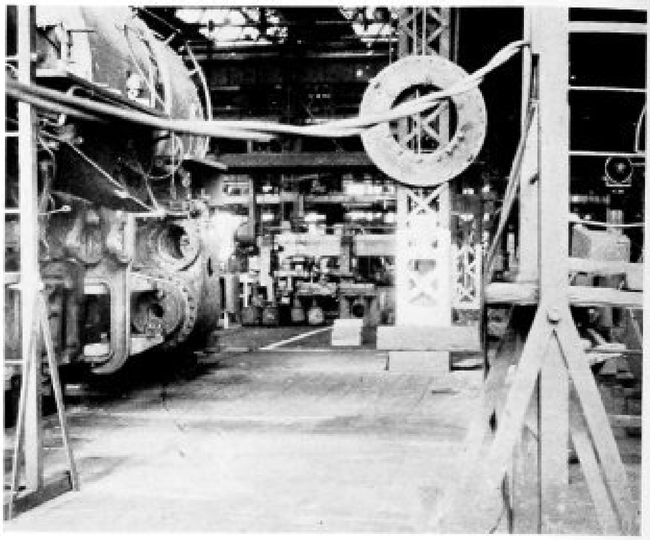
Fear has been expressed by members of the industry that recent events may result in radical changes to the N. I. R. A. and that pressure may be brought to bear to lessen its effectiveness between now and the time of its expiration next year.

Quoting a prominent boiler manufacturer, who recently addressed the Code Authority on this subject:

(*Continued on page 252*)



Under the old system the erecting pits were congested with parts stripped from locomotives



With the parts in their proper department the erecting floor can now be kept clear—Smokebox fronts are hung on columns

PROGRESSIVE SPOT SYSTEM ON THE LEHIGH VALLEY

The application of the progressive system in the Sayre, Pa., locomotive shop is one of the first efforts to apply modern straight-line methods to the transverse type of shop

In an effort to meet the ever-increasing demand for improved service and higher operating speeds the mechanical department of the Lehigh Valley found it necessary to assure a higher quality of workmanship in locomotive repairs and a more thorough inspection of locomotive parts during the progress of the work in the shop. During the past few years practically all of the major heavy locomotive repair work on that system has gradually been concentrated at the system's shops at Sayre, Pa. The Sayre shop is of the transverse type, having erecting bays on both sides of the shop and light and heavy machine bays in between. The shop is served by an outside turntable at the main entrance rather than by a transfer table.

In spite of the fact that the facilities at Sayre have been continually improved and progress has been made over a period of years in the method of operating the shop, it was found, after a thorough study was made of the demands on the shop under present conditions, that the desired objectives in locomotive repair work could not be reached under the conventional system of operating this type of shop; namely, that of spotting locomotives on erecting pits and performing all of the work from stripping to reassembling in the one position. This system made it necessary particularly to store parts adjacent to locomotives undergoing repairs in such a manner as to result in considerable congestion in the erecting shop, plus the fact that it required the transportation of locomotive parts to be repaired or to be applied over long distances to and from the several departments in the shop.

To meet present-day conditions the Lehigh Valley mechanical department developed a progressive spot system of locomotive repairs which is, after all, merely an adaptation of progressive repair methods applied to a transverse type of shop. While up to quite recently the volume of work handled at Sayre shop has not been sufficient to permit conclusions to be drawn as to the ultimate advantages of this progressive system, it is true that during the past year that it has been in operation there are many indications that the new method of handling the work of repairing locomotives has resulted in sufficient advantage to justify the change that has been made. The changes that were necessary in the shop incident to the actual installation of the progressive system extended over a period of about seven months.

Table I—Work Handled in Major Sections

Section	Operation	Work Performed
A	Stripping	Locomotive completely stripped outside of shop excepting removal of driving wheels, engine and trailer trucks.
B	Heavy boiler work	Fireboxes, flues, throat, flue and side sheets, boiler courses, cylinder work, cylinder and valve-chamber bushings, frame work, frame braces, deck castings, pedestal binders, waist sheets, furnace and deck sheets, layout shoes and wedges, guide yokes, apply throttle, steam and dry pipes, auxiliary dome, arch tubes, smokebox, fronts, stacks, cinder pockets, dome covers, guide yoke and knees, sand box, superheater header.
C	Light boiler work	Flues, units, patches, stay and crown bolts, caps, cylinder work, cylinder and valve-chamber bushings, frame work, frame braces, deck castings, pedestal binders, waist sheets, furnace and deck sheets, layout shoes and wedges, guide yokes, apply throttle, steam and dry pipes, auxiliary dome, arch tubes, smokebox fronts, stacks, cinder pockets, dome covers, guide yoke and knees, sand box, superheater header.
D	Boiler testing	Apply pressure fittings—test boiler—apply jacket, lagging, cab, canopy, dome casings, blowout cylinders and steam passages, apply air reservoirs, air-pump brackets, ash pans, boiler mountings, buffers, couplers, drawbars, fire-doors, flagstaffs, grate bearers, grate-shaker, fulcrums, cylinder jacket, power reverse bracket, reverse-shaft counterbalance, reverse-shaft, running boards, throttle and reverse levers, boiler checks, safety valves, steam turret, steam-pipe casings, springs, equalizers and saddles, shoes and wedges, stoker and conveyor, valve-gear frame, water columns, whistle, brake cylinders, deck boards—sheets, blow-off cock, miscellaneous small brackets.
E	Assembling	Wheel engine—apply pistons, valves, guides, crossheads, rods, motion work, air pumps, auxiliary locomotive and booster throttles, booster pipes, blower connections, bumper beams, cylinder heads and casings, cutting lever, damper valves, exhaust stand and nozzle, feedwater heater and pump, mechanical lubricator, pedestal binders, pilot and steps, power reverse gear, smoke-box braces, fire-door shields—grate lever locks—shields, hand railing and safety appliances, smoke-box door, steam chest cover and casings, valve chamber heads and casings, air-brake appliances.
F	Finishing	Cab work, train control, electrical work, set valves, all pipe work, apply apron, bell, brake rigging, brick arch, cab fittings, cylinder cocks and rigging, draft applicances, drifting valve, flue blower, generator, grates, headlight, injectors, markers, sanders, stack extensions, water glasses, test air, painting and general finishing up of engine.

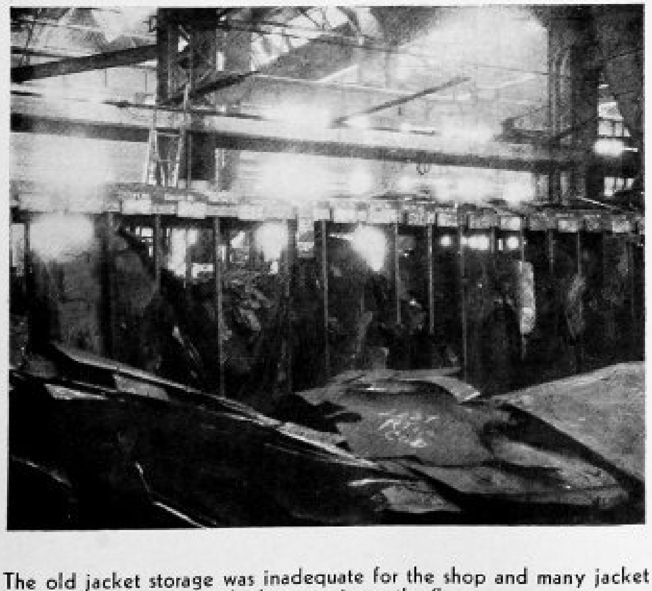
Generally speaking, the principal difference between the progressive spot system of repairing locomotives in this shop and the conventional system formerly in use is that, whereas materials and workmen went to the locomotive which was in a fixed location, the locomotive now moves from one specialized location to another and the re-arrangement of departments, and to a certain extent facilities, has been such that under the present system, in so far as physically possible, each department and facility has been located at the shortest possible distance from the point in the shop where the repaired parts are reapplied to the locomotive as it passes through the shop in the process of repair and assembly. One of the handicaps of the former system was that there was possible no systematic method of storing locomotive parts while awaiting repair or after having been repaired, plus the fact that the storage locations then available were not only in locations where, in many cases, it was highly undesirable to have stored parts, but they were also of inadequate capacity.

This applied particularly to such classes of material as jackets and piping. The old jacket storage, for example, had only nineteen sections, which was entirely inadequate, whereas the new storage location is equipped with forty-nine sections, which is entirely sufficient to accommodate in each section the complete jacket for each locomotive in the shop undergoing repairs. Similar conditions existed in connection with the storage of locomotive piping. Whereas under the old system piping was stored in some twenty-two locations about the shop, under the new system all of the piping is on racks so designed that the piping from each individual locomotive in the shop is on a portion of the rack by itself. It is not only possible to see at a glance the condition of the piping, but the systematic method of storing it also lends itself to a more efficient method of repairing piping and, in addition, assures that very little of the piping from a locomotive is ever lost.

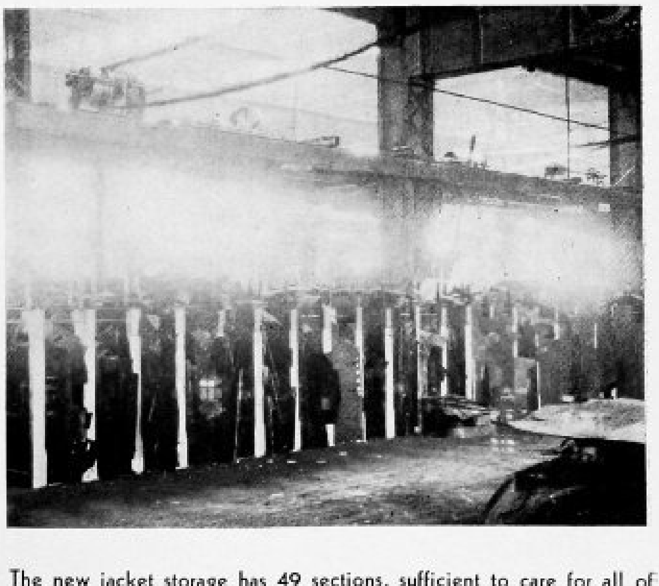
Mention is made of the method of storing jackets and piping merely because it is typical of the manner in which the storage of materials and parts all through the shop has been carried out. It will be noticed from the full-page shop layout accompanying this article that these storage locations and departments have been located in such a manner as to facilitate in every way possible the maximum efficiency in repair work.

Movement of Locomotives and Parts

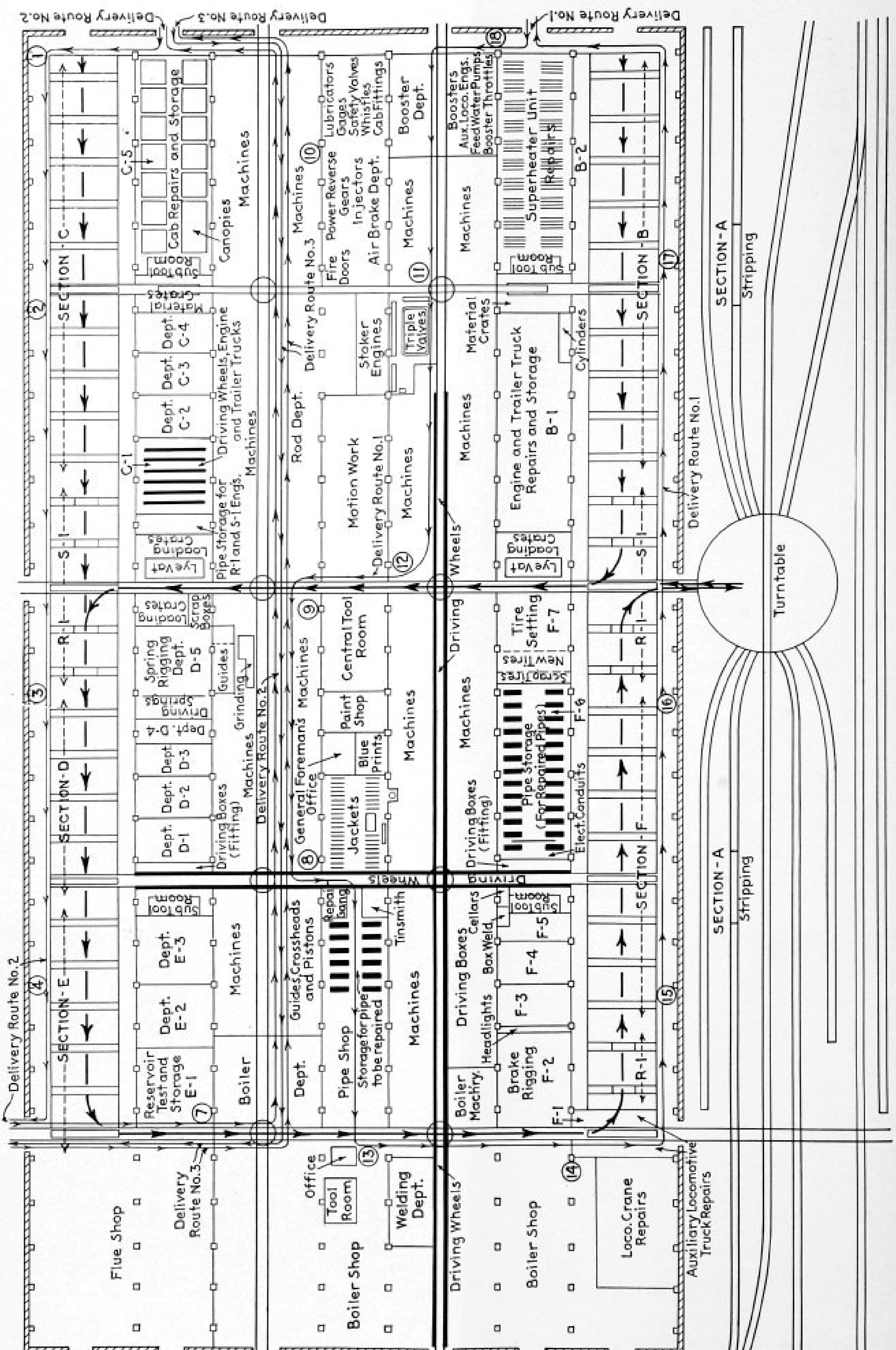
All work pertaining to locomotive repairs in the Sayre shop is now done under one main roof, with the excep-



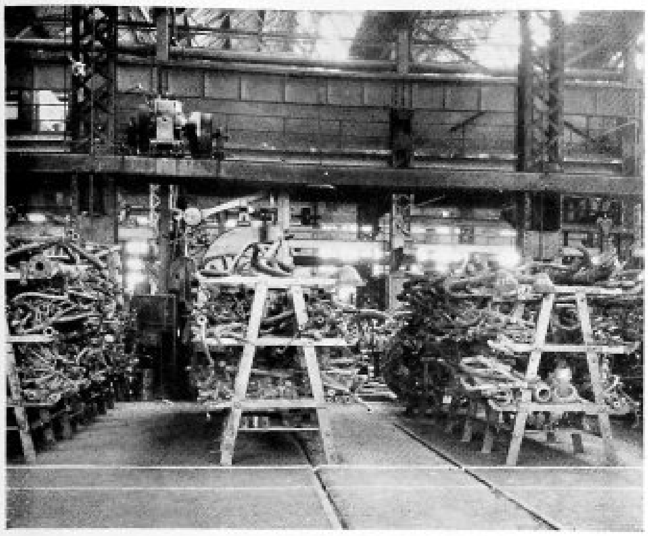
The old jacket storage was inadequate for the shop and many jacket parts had to remain on the floor



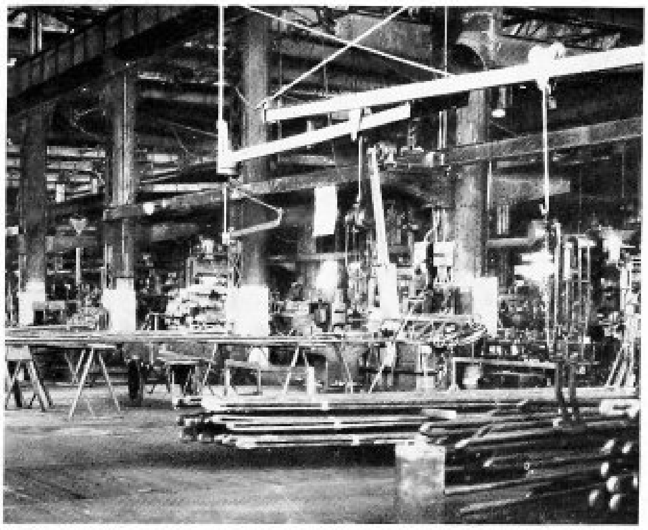
The new jacket storage has 49 sections, sufficient to care for all of the locomotives undergoing repair



Layout of the Sayre locomotive shop showing various sections and material delivery routes



Piping which, under the old system, was usually left at some point near the pit, is now repaired and placed in racks



The superheater-unit-repair department, typical of the orderly arrangement of materials under the new system

tion of repairs to generators and electrical equipment which are handled in a specialized shop. In conjunction with the installation of the progressive spot system, a materials and parts delivery system was developed to meet the new conditions. By reference to the general layout of the shop and the information given, it will be possible for the reader to follow with very little difficulty the movement of a locomotive through the shop and to trace the movement of any individual locomotive part as it passes through the shop for repairs and reapplication.

All locomotives at Sayre are stripped outside the shop on the tracks marked "Section A." The stripping is complete, with the exception of the removal of the driving wheels and engine and trailer trucks. The engine is then run over the turntable and moved inside the shop. Here the locomotive is placed in either Section B or C. Into which of these two sections the locomotive goes depends entirely at this stage of the operation upon the amount of boiler work to be done. Locomotives requiring a comparatively light amount of boiler work are placed in Section C and from there continue in their progressive course around the shop.

Locomotives which require a large amount of boiler work, such as new fireboxes or an unusual number of sheets, if placed in Section C at the outset would merely hold up the progressive movement to successive sections. These locomotives are, therefore, placed in Section B and all locomotives in this section have no particular schedule in relation to the shop as a whole, but the heavy boiler work is performed here and when it has progressed to a state where the locomotive can be placed in the progressive line without holding up the scheduled movement, it is then taken out of Section B and placed in Section C. Other than the boiler work, the work on parts to be repaired in Sections B and C can be seen by reference to Table I.

After the necessary work on locomotives in Section C has been completed, the locomotive is picked up with the overhead crane and moved to Section D. Incidentally, practically all of the movements of the locomotive from one section to the other are made at night so as not to interfere with the normal operations on the day shift. The principal work performed in this section is shown again by reference to Table I.

Section D has been especially equipped for the work of boiler testing and each pit in this section has been fitted with a complete layout of steam and water lines, making it unnecessary to use long hose lines for the testing of boilers.

Upon completion of the work in Section D the locomotive is then moved over into Section E where the work of reassembling finally begins. The wheeling of a locomotive, for example, is done in Section E.

After the locomotive leaves the assembling Section E, it is moved across the shop, turned and lifted over into Section F where the final finishing work is performed. Here such work as the application of cab fittings, train control, electrical work, all pipe work, valve setting and painting, is done. Here also the shop testing is performed and, after this is completed, the locomotive is ready to leave the shop for final testing under steam.

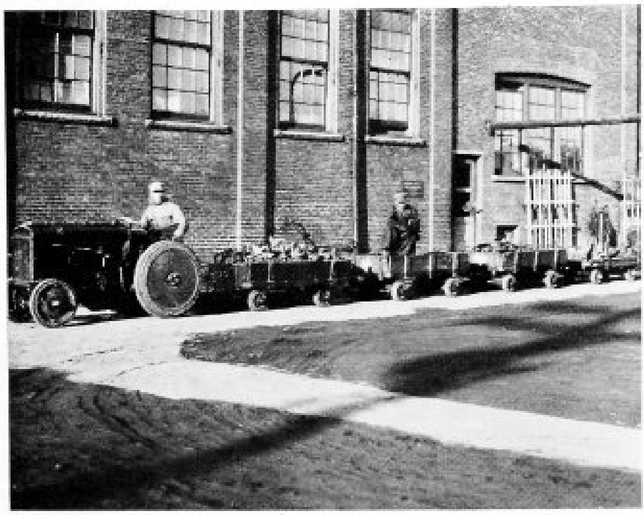
It will be noticed, by reference to the shop layout, that eight pits adjacent to the central shop track and two pits adjacent to Section F near the brake-rigging department are set aside for R-1 and S-1 class locomotives. It so happens that these Lehigh Valley locomotives are of such length that they cannot readily be moved to other sections of the shop.

Reference Key to Departments Not Otherwise Identified in the Layout on the Opposite Page

Dept. or section	Parts or Work Handled
C-2	Shoes and wedges and binders.
C-3	Steam pipes, throttle, dome and turrets.
C-4	Brake cylinders, frame braces, deck and center castings, guide yokes, drawbars, cylinders.
D-1	Miscellaneous small brackets, deck boards and sheets, firedoor shields, shaker locks and guards.
D-2	Stoker department—Firedoors, shaker castings.
D-3	Special tools and appliances.
D-4	Stacks, smokebox doors, sand boxes.
E-2	Hand rails, safety appliances, pilots, steps, smokebox braces, running boards, dome castings, flue blowers, operating levers.
E-3	Steam-pipe casings, valve-chamber heads and casings, cylinder-head casings, valve-gear frame, exhaust pipes and nozzles, couplers, coupler pockets, steam-chest covers and casings.
F-1	Auxiliary locomotive truck repairs.
F-3	Headlight generators, train control, bells.
F-4	Draft appliances, stack extensions.
F-5	Grates, fire brick and grate rods.

Shop Delivery System

Under the jurisdiction of the stores department a material delivery system has been developed at Sayre which, in conjunction with the progressive spot system, has re-



Material-delivery train leaving the storehouse

sulted in a great saving in time in the handling of parts and materials. The delivery trains moving over designated routes are dispatched from a central point and on regular schedules. No special trips are made. The delivery system not only serves the main locomotive repair shop, but also serves the passenger-car repair department and the enginehouse.

As far as the locomotive work is concerned, the delivery trains move over two general routes, the courses of which are designated by the lines with arrowheads on the shop layout drawing. At fixed locations on these routes are permanent delivery and pick-up stations which are designated by station numbers in circles on the shop layout drawing.

Over route No. 1 tractors with trailers leave the storehouse every hour, beginning at 8 a.m., passing through the blacksmith shop, the east erecting bay, returning through the east machine bay and the blacksmith shop to the storehouse. On each alternate trip the station order is reversed to take care of the movement of material going in opposite directions.

Over route No. 2 tractors with trailers leave the storehouse every hour, beginning at 8 a.m., passing through the blacksmith shop and the west erecting bay, but return through the west machine bay and the blacksmith shop to the storehouse. On this route, as on route 1, on each alternate trip the station order is reversed to take care of the material going in opposite directions. Outside of the main locomotive shop delivery route 2 also goes in the course of its travels to the electric shop and the enginehouse.

These routes are manned by a tractor operator and laborer who handle the movement of all new materials from the stores department to the shops and the movement of all materials and parts between various departments of the shops in the territory covered. The routes are so laid out that they pass all salient points where loads accumulate and deliveries are made.

While there are delivery stations throughout the plants established by the mechanical department, the operators do not arbitrarily make deliveries to these stations, but endeavor to deliver all heavy or bulky material that would require considerable labor in rehandling as near as possible to the point where it is to be used.

No verbal orders are accepted for transportation service via the delivery system. The delivery of new material is covered by a carbon copy of the material order, which shows the material required and the delivery point. Inter-dependent and inter-shop movements are covered by an inter-shop transportation order. Material and transportation orders are deposited in station boxes by shop foremen and are picked up by tractor operators as they pass along the routes.

New materials orders are brought to the storehouse on the return trip where they are stamped with a time stamp and turned over to the man in charge of loading trailers to be loaded for delivery on the next trip. Any shop transportation orders are examined by the operators and the movement specified is handled on the same trip on which the order is picked up. These orders are then checked as completed by the operators and turned in to the transportation foreman's office on each return trip, where they are time stamped and placed on file.

In addition to the transportation of materials and supplies new applications of the material handling equipment are continually being found. As an example of an operation which is saving considerable money as well as providing a worthwhile service for the mechanical department is the collection and disposal of ashes, refuse and small scrap which accumulates in and around the repair pits in the locomotive shop. These pits are cleaned once a week and, under the new system, a train is made up of a tractor, three 1½-yd. capacity gravity dump trailers and two standard material trailers equipped with box bodies. This train passes down through the erecting bays, back of the erecting pits, and the accumulation removed from the pits is loaded by shop laborers.

In order to assure the maximum efficiency of the material delivery system approximately 20,000 sq. ft. of concrete roadways of 8-ft. width were laid.

Conclusion

The application of the progressive spot system of locomotive repairs in the Sayre shop has resulted in the concentration of specialized work at a number of fixed points throughout the shop in such a manner that the movement of materials and parts has been confined, in so far as possible, to the shortest possible distances. An effort also has been made to eliminate back-tracking. To the outside observer one condition is especially noticeable—the relative absence of workmen and supervisors moving about the shop. The progressive spot system has to a great extent eliminated the necessity for doing this because of the fact that not only the locomotives, but also the materials and parts, come to the workmen—it is rarely necessary for them to leave the department in which they are employed.

The principle of "a place for everything and everything in its place" has been carried out to the highest degree and the result is that even in such small departments as sub-toolrooms the workmen who are responsible for conditions in those departments have become imbued with the idea that an orderly shop is the shortest cut to the way in which to perform a given job with the least effort. Having eliminated a great part of the lost motion within the shops, the entire efforts of the workmen can be devoted to the problem of improving the quality of workmanship on each job performed. Better workmanship and more thorough inspection in the shop brought about as a result of this system are becoming noticeable in the better performance of locomotives on the road. The objective of the management in locomotive repair work is to turn out a locomotive in such a manner that it can perform road service with a minimum of delays due to mechanical causes. The object of this radical step in the method of repairing locomotives has been to assure more dependable service from motive power without increasing the cost of maintenance.

Revision of Construction Code Necessary to Avoid Infringement on Heavy Industries

A condition of overlapping between codes governing industries under the N. I. R. A. has arisen that at the moment urgently demands adjustment if progress within the heavy industries is to continue. The boiler manufacturing industry and that of the steel plate fabricators are deeply concerned in the provisions of the Construction Code as now constituted, which has such broad coverage that every concern manufacturing and installing products coming within the scope of heavy plate production would be affected by it.

Hearings by the N. R. A. intended to consider the functions which logically come within the category of general construction will shortly be held in Washington. As yet the date has not been decided upon. Unless representatives from all heavy industries (for no one is exempt from conflict with this Construction Code) take occasion to protect themselves against the provisions of this code as they now stand, its continued application will undo in great part the harmony and morale which have with so much difficulty been built up. Fields such as that of boiler construction and plate fabrication now functioning smoothly, after months of struggle in organizing these industries, will be adversely affected by the Construction Code. In order that an organized effort may be made against this code as it stands, the following outline of the facts will serve to advise readers of the conditions which must be combated.

Expansion of Construction Code Considered Illegal

All manufacturing industries and the public in general are vitally interested in the manner in which the construction industry with the aid of Division 3 of N. R. A. has expanded its scope in what is considered an illegal manner.

The Code of Fair Competition for the Construction Industry and its chapters are claimed to be in violation of Section 3(a) (1) of the N. I. R. A. which says that associations or groups sponsoring a code must be truly representative of the trade, industries or subdivisions thereof for which the Code is intended. The sponsors of this Code and Chapters cannot possibly be truly representative of the industry as defined as an examination of Article II Definitions clearly discloses as follows:

Section 1. The term "construction industry" or "the industry" as used herein shall include the designing and the constructing of (and the installing and the applying, including the assembling at the site, of manufactured parts and products incorporated in and to):

(a) building structures, including modifications thereof and fixed construction accessory thereto, intended for use as shelter; and other

(b) fixed structures and other fixed improvements and modifications thereof, intended for use in industry, commerce, sanitation, transportation, communication, flood control, power development, reclamation, and other similar projects or services; and such related divisions or subdivisions thereof as may be defined in chapters hereof and included hereunder with the approval of the President.

This definition is so broad that it not only may be, but has been interpreted to include not only the designing and constructing of all of the types of structures enumerated and any modification of them, but the installing and the applying, including the assembly at the site of all manufactured parts and products incorporated in and to such structures, which latter phrase has been expanded in the definition of the various chapters to include the installation of all manufactured products no matter by whom performed. This definition should be revised to show clearly that the various functions defined constitute a part of the industry only when performed by a member of the industry for compensation or hire.

Section 3. The term "member of the industry," as used herein, includes any individual or form of organization or enterprise engaged in any phase, or undertaking to perform any of the functions of the industry as defined in Section 1 hereof, either as an employer or on his own behalf, including also, but without limitation, architects, engineers, contractors and sub-contractors.

This section clearly indicates the monopolistic intent of the Code, as it does not confine the membership of the industry to those represented by the sponsors as defined in Section 9; namely, architects, engineers, contractors and sub-contractors, but puts before them in order of importance *any individual or form of organization or enterprise engaged in any phase, or undertaking to perform any of the functions of the industry as defined in Section 1.* This clearly includes all manufacturers, property owners, and tenants, and certainly these sponsors cannot be truly representative of them, as probably not more than one percent of those whom they are supposed to represent know anything about what is being done.

This definition should confine the membership of the industry to those whom the sponsors may truly represent, namely, architects, engineers, contractors and sub-contractors.

Section 5. The term "employee," as used herein, shall include any person engaged in any phase of the industry, however compensated, but excluding members of the industry.

This definition includes everyone except members of the industry engaged in any phase of the industry however compensated, and regardless of by whom employed. This, in conjunction with Article III—Hours, Wages and Conditions of Employment, is clearly a violation of Section 5 of the N. I. R. A. which provides that nothing in this Act shall prevent an individual from pursuing the vocation of manual labor and selling or trading the products thereof.

This section should be amended to include all persons other than members of the industry, that are employed by a member of the industry to engage in any phase of the industry.

Section 6. The term "employer," as used herein, includes anyone by whom any such employee is compensated or employed.

This definition is clearly improper for the same reason that Section 5 is improper and should be revised to include only *members of the industry* by whom employees as defined are employed.

These criticisms may seem to some to be rather finedrawn, but when these attempts to regulate and control all those outside the industry, as properly defined, are considered in conjunction with direct attempts which have been made by various divisions of this industry through their Supplementary Codes and otherwise to take from other industries operations which have always been recognized as belonging to those industries, and appropriate them to themselves and to encroach upon the inherent rights of individuals, organizations or enterprises by illegally regulating or controlling the manner in which they may perform certain operations on their own premises and for their own use, they have a seriousness which cannot be overlooked particularly when it is recognized that all of these acts have been fostered and approved by one particular division of the N. R. A. in spite of the objections of the various boards set up to advise them.

The Chapter for the Heating, Piping and Air Conditioning Contractors Division deliberately includes the installation of high and low-pressure boilers, stokers, and all apparatus and appurtenances in connection therewith, which installation has always been performed by the manufacturers and is now being performed by them under the approved Code for the Boiler Manufacturing Industry. This inclusion was protested for several months, but was finally put through to approval by Division 3 on July 25 in spite of many protests by other industries and many objections by the various Advisory Boards.

After months of effort, the Structural Steel and Iron Industry succeeded in drafting a Code acceptable to themselves and to the various Advisory Boards and this Code was sent through to the Division Administrator of Division 3 for approval by the Administrator. The Code was returned approved but with "erection" deleted from the definition of the Industry, with the explanation that erection belonged under the Construction Code. Inasmuch as the erection of Structural Steel and Iron has always been a recognized and important part of the Steel Fabricating Industry, this Industry could not submit to any such unwarranted encroachment and so notified the President and refused to accept the Code as approved.

On June 25, 1934, at a Hearing of proposed modifications of the Labor Provisions of the Steel Plate Fabricating Code, representatives of the Construction Code Authority and of the General Contractors Division Code Authority appeared and requested a revision of the definition of Steel Plate Fabricators Industry to eliminate erection, claiming that such erection was included in the Construction Code. Erection is and always has been a part of the Steel Plate Fabricating Industry and never a part of the Construction or Contracting Industry.

The history of many divisions of the construction industry particularly in large cities is such that suspicion attaches to any of their acts. The work of the Lockwood Committee in New York City in 1921 discloses that collusive agreements between contractors and labor unions in the building trades were practically general and resulted in the indictment of 416 individuals and 250 corporations. Two hundred and eight pleaded guilty and were fined in the aggregate $550,000 and 29 men were sent to jail.

The Code for the Construction Industry was the first code to provide for a joint committee to handle matters relative to the standards of wage rates, hours and other conditions of employment in the various divisions, and subdivisions and also provides for a National Construction Planning and Adjustment Board with extremely broad powers as to the establishing of hours, wages, and conditions of employment, to consist of 21 members; 10 representing labor, 10 representing employers and a chairman appointed by the President upon recommendation of the Administrator. The ten representatives of labor who have been appointed, are the chairman of the Building Trades Division of the American Federation of Labor and nine presidents of building trades unions.

This means that the officers of some of the same unions that figured in the Lockwood Committee investigations now have an equal voice in determining the labor policies of the entire construction industry, which if the definitions heretofore referred to are not revised, includes everyone doing any designing, constructing, or remodeling of structures, or any installing or applying of manufactured parts and products incorporated in or to such structures. In other words, all such construction, reconstruction or installing has become a closed shop.

It requires little imagination to see what the result of all this might be in connection with the Government program of fostering building construction and reconstruction through the use of taxpayers' money. Closed shop operations are always more costly than open shop operations, with the result that far less will be accomplished through this expenditure either in work performed or in increased employment, as the work will be given to favored employees at high wages and will not be distributed among the numerous unemployed perfectly capable of doing it and glad to secure work at a living wage rather than receive a dole. The large percentage of skilled and semi-skilled workers still unemployed is not ordinarily employed in the building trades, but in the heavy goods industries which will not be immediately benefited, if at all, by this building construction and reconstruction program. This is certainly not the way that a relief program should be handled with the use of the public's funds.

Official View of Overlapping Codes

The National Recovery Administration is endeavoring to deal with situations occasioned by overlapping between codes, in which category belongs the conflict between the Construction Code and heavy industry. The official view of the situation as it appears in a recent issue of the *Blue Eagle* is quoted below:

The National Recovery Administration recently moved to a solution of the problems of overlapping codes and multiple code coverage. Conceding that there is no cure-all, a policy was outlined to govern the treatment of the problem in the nondistributive trades.

Two keys to the situation are provided. First, definitions are to be carefully delimited so as to confine the scope of the code to the industry actually represented by the applicants. This does not mean that codes will not continue to cover minorities but it does mean that the type of operations included within the code must be carefully defined in such fashion as to cover only the operations performed by the sponsors of the code.

The second key to the situation is the application of the "integral part" test. This is not an infallible guide but wherever it is clear that an operation is an integral part of the principle operations of the particular industry, the Administration will be able to state with some assurance that such integral part is within the Code for the principal operations and not under any other Code.

The keys to the multiple code coverage problem which is disturbing some large employers are as follows:

First, simplification and standardization of code provisions covering kindred industries by amendment based on conference between and recommendations from the industries involved looking toward making all provisions for kindred industries simple and identical.

Second, where possible segregation of operations in fact or on the books of the employer so as to conform to the separate codes is the course to be followed pending simplification as suggested.

Third, where segregation is not feasible, the employer should comply with the several Codes as to labor provisions by observing the shortest hours and highest wage provisions for the type of work as set forth in the Codes in question. It is conceded that this is not possible where provisions vary substantially.

Finally, where a concern is covered by several codes as to some nonsegregable combination of operations and the labor provisions in those codes are substantially diverse, exemptions are to be granted if there is undue hardship. Such exemptions are to be conditioned on compliance with simple hour and wage standards appropriate for groups of kindred industries. Such simple standards are now being evolved as an objective in simplification of the Code structure within groups of kindred industries and to be available for such uniform conditions in cases of hardship.

The text of the Office Memorandum outlining the new policy is as follows:

A. Overlapping Codes

1. We must avoid future overlapping between different codes and to cure situations in which that condition now exists.

2. There is no cure-all, but the following will govern the nondistributive trades in endeavoring to effectuate the above policy:

(*a*) If definitions of industries, as included in codes, are carefully delimited so as clearly to confine the scope of the code in accordance with the act, overlapping will be reduced to a minimum. Section 3 (*a*) of the act provides for the approval of Codes for "*the * * * industry or subdivision thereof * * * represented by the applicants,*" and requires a finding by the President that the applicants are "truly representative of *such* * * industries or subdivisions thereof."

(*b*) It will frequently, but not always prove helpful in drawing a definition of the boundary line of an industry to consider whether doubtful operations are or are not an "*integral part*" of the principal operations of the particular industry. An "integral part" of an industry, of course, normally will be under its Code. (*See "examples" attached.*)

B. Multiple Code Coverage

1. In many cases, although there is no overlapping of the *codes* involved, still a single concern may find *its operations* covered by two or more codes (multiple coverage.) While this type of case is unavoidable where unrelated businesses are conducted by a single concern, still confusion and hardship may arise where the operations carried on are not or cannot practically be segregated.

2. The following principles should be employed except where found to operate inequitably under particular circumstances:

(*a*) *Amendment to make provisions identical:* Hardship arising from multiple coverage may frequently be eliminated by simplifying and standardizing code provisions governing kindred industries by amendment on the basis of conference between and recommendations from the industries involved, so that the provisions for kindred industries are, so far as possible, simple and identical.

This course should afford sufficient relief from multiple trade practice provisions, and even from multiple labor provisions, where their requirements do not vary substantially. Exemption will normally not be considered in such cases until the possibilities of such amendment have been explored.

(*b*) *Maintenance of fair competition:* In order to maintain fair competition no concern should be exempted from requirements under which his competitors within the industry must operate, except to the extent required by conditions of special hardship under the peculiar circumstances.

(*c*) *Where segregation of operations feasible:* No exemption should be granted where it is practicable for the employer to segregate operations in fact or on his books so as to have each segregated operation conform to a separate code. It is believed that this rule will dispose of most cases.

(*d*) *Where segregation not feasible:* Although segregation, as above, is impracticable, there should still be no exemption in labor provisions where the employer can comply with the several codes. This he can do by observing the shortest hours and highest wage provisions for the type of work, as set forth in the codes in question. This is possible where such provisions do not vary substantially. Amendment, as suggested should be employed to simplify such related codes.

(*e*) *When exemptions are appropriate:* In the final residue of cases in which several codes, having substantially divergent labor provisions, cover some nonsegregable combination of operations, properly conditioned exemptions may be granted if undue hardship is proved.

Examples of the application of the policy announced in the foregoing memorandum are:

Examples

(*a*) If all the manufacturers of a certain type of machinery normally sell the same completely installed and themselves do all the installation of such machinery and a code is approved covering manufacture and installation of such machinery, an Installation Code purporting to cover all machinery installation would in terms overlap the Machinery Code. It is obvious that the applicants for the Installation Code could not possibly be truly representative of the installers of such machinery, unless representatives of the particular machinery industry had joined in the application for the Installation Code. The trouble would be avoided by limiting the definition of the Installation Code by a clause excepting such operations where performed within the terms of any other Code. It is clear in such a case that installation is an "integral part" of the operations of the machinery industry.

(*b*) It would clearly be impossible for any applicants (short of representatives of all industries), to make valid application for a code governing all duplicating and mailing operations in industry, such operations to a greater or less extent being performed as an "integral part" of all industries. The test of true representation in this particular situation would no doubt limit the definition to such operations performed "for compensation." The duplicating operations performed within an industry in instructing its own salesmen and staff are clearly an "integral part" of that industry's operations and not a part of any other industry.

(*c*) An example of the more difficult overlapping problems, requiring careful study to ascertain what the industry is: Making of some sort of castings may be a specialized industry in itself; but it may be also an "integral part" of the manufacture of certain types of heavy machinery, as such manufacture is conducted. In such a case all such casting operations cannot be covered by the code applied for by the castings specialists. Those casting operations which are an "integral part" of operations of another industry whose true representatives obtained a code for such other industry, fall within such code and, to avoid overlap, such castings code should be delimited accordingly.

Restore a Sane Policy of Locomotive Maintenance

Although there has been a decided reduction in the rate at which deferred maintenance of cars and locomotives has been accumulating during the recent spring and summer months, the railways as a whole have not yet built-up their equipment-repair programs to a point where they are keeping even with the demands for repairs which current use is creating. Four years' accumulation of deferred maintenance has yet to be dealt with. Sooner or later, with the advance of general business recovery, the growth in the volume of traffic will be such that the problem of restoring the large accumulation of worn-out equipment to service will have to be dealt with. When that time comes some conditions which did not exist, or at least were not so pronounced, during the years immediately prior to the depression will have to be taken into consideration.

During the past four years there has been a marked change in maintenance policy. Perhaps it would be better to characterize the change as an absence of policy, at least in the long-term sense. Such policy as the railways have had has been one of expediency—of reducing expenditures at any cost. This has resulted in an increase in the practice of fabricating materials and manufacturing parts which, during normal times, were supplied by purchase. In many cases, the curtailment in purchases of necessary materials left no other recourse open to the officers and supervisors of the mechanical department.

This tendency has also been accelerated by the natural desire of the railway managements to supply as much work as possible for their own employees during the emergency. It has led in some cases to undertaking the manufacture of parts for which the railway shop organization is ill-fitted by training. In some instances the lack of appreciation of the essential value of correct materials has been very costly. In other cases the lack of adequate engineering, particularly as related to the cheapening of production costs, as well as a lack of knowledge of the whole subject of production-cost-finding, make the results economically unsatisfactory.

Another condition which has been rapidly changing during the depression is the reduction in shop capacity which the concentration of repair work in central shops, accompanied by the permanent closing of outlying plants, has effected. When it becomes necessary to deal vigorously with the accumulated deferred maintenance this reduced shop capacity, although now in excess of actual use, will soon be overtaxed.

The roads will then face the necessity for a reconsideration of maintenance policies. Shall they continue their extended manufacturing operations and take up the maintenance slack by contracting for repairs with outside plants, as was done in the case of the accumulation of deferred maintenance following the end of U.S.R.A. operation and the strike of 1922, or shall they curtail manufacturing and fabricating activities, and utilize all of their facilities to the utmost for the reconditioning of existing equipment, depending upon a liberal retirement program to take care of the excess?

In following the first alternative during the years after the strike of 1922, the railways restored many obsolete units of equipment through outside contracts, the later performance of which scarcely justified the high costs of the repairs and betterments. The railways know that the lack of proper facilities for locomotive repair operations did not make for economy on many of these maintenance contracts. Do they recognize that a similar lack of facilities for production operations is inimical to economy of manufacturing operations in railway shops?

Many operations of a manufacturing character have been undertaken in railway shops on the theory that idle space and facilities were available and, therefore, only immediate out-of-pocket costs need be considered in competition with commercial prices. But when equipment-repair operations again tax the capacity of existing shop facilities the continuance of such operations can then only be justified if the full cost of space and facilities, with the proper share of other overhead items, are taken fully into account when comparing with commercial prices. Then the time comes when the apparent savings to the railroad, based on the idle-capacity theory, are used as an argument to justify additional investment to expand the plant in order that such operations may be continued or expanded.

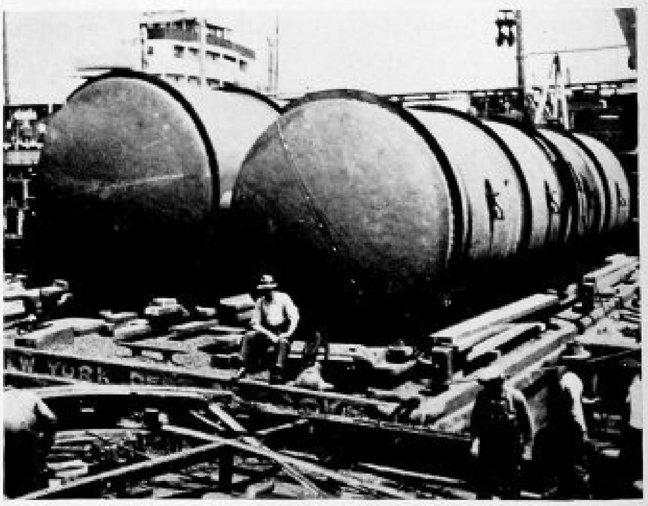
Can the railways justify the use of their credit for the expansion of facilities far removed from the production of transportation when such facilities are already available without financial risk to themselves? The best results can scarcely be obtained by contracting with outside manufacturers for excess repairs and devoting repair-shop facilities to manufacturing operations.

Arc-Welded Pontoons for Seaplane Ramp

The large tanks illustrated herewith are part of New York City's new seaplane ramp located in the East River at the foot of Wall Street. This ramp is the first of two planned for use by the Dock Department as public aircraft terminals, the second to be located at the foot of East Thirty-first Street.

Four of these tanks were built of arc-welded steel for the first ramp. Two serve as inboard pontoons, measuring 46 feet by 12 feet inside diameter, with $\frac{3}{8}$-inch steel walls and $\frac{7}{16}$-inch steel heads.

The other two serve as outboard pontoons, measuring 46 feet by 11 feet inside diameter, with $\frac{5}{16}$-inch steel walls and $\frac{3}{8}$-inch steel heads. Steel plates arc welded inside on 11.3 feet centers divide each tank into four watertight compartments.



View of the finished pontoons

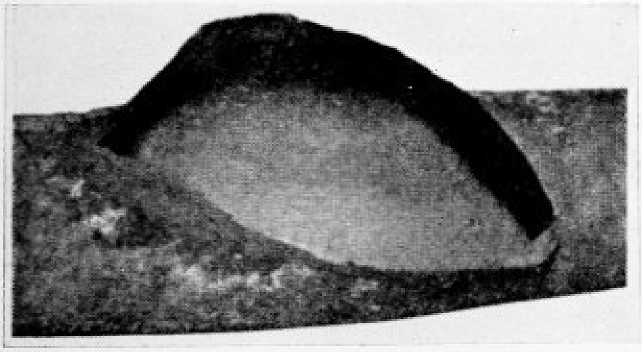
Each tank weighs approximately 12 tons, so that about 96,000 pounds of steel was fabricated, involving about 6000 feet of arc welding. The tanks were welded both inside and outside with ¼-inch bare wire and Hobart arc welders. All welding was done in the Arlington, Staten Island plant of the Buffalo Tank Corporation.

The ramp itself was built in the Brooklyn Navy Yard and weighs 165 tons, covering an area of 85 by 45 feet, to accommodate a turntable, a fueling station, a waiting room for passengers and other features. From it will be operated a daily commuter air service to Long Island points.

Tube Failures Inconvenience Industrial Plants

Tube failures in watertube boilers and accidents to superheaters interrupted production or caused considerable inconvenience to power plant operators recently, according to information given in a recent issue of *The Locomotive* published by The Hartford Steam Boiler Inspection and Insurance Company.

At a large New England silk mill one of the tubes in a watertube boiler overheated, bulged and ruptured,



Tube failure which had serious consequences

draining the boiler so rapidly that in spite of every effort to pump water, 44 tubes were damaged by the residual heat in the setting. This accident occurred on February 13, 1934. The split in the tube, as shown in the illustration, was about 12 inches in length. Other tubes damaged by the accident were not ruptured but were warped so badly that replacement was considered necessary.

One man was scalded and more than 2000 shoe workers in five plants were inconvenienced on February 9, 1934, when a 4-inch tube in a 500-horsepower boiler burst, putting out the fire and filling the boiler room with steam. Some power and heating needs were supplied by two 300-horsepower boilers which were brought up to pressure following the accident. However, other power needs were not filled until some three and a half hours later when an electrical connection was made with a local utility line.

Scale, which so filled 38 tubes that it about cut off all circulation through them, was blamed for an accident to a boiler in a Wisconsin paper mill on March 6, 1934. The trouble was manifested by the pulling of one of the tubes from the tube sheet after it had been overheated and had warped. A fireman who mounted to the top of the boiler immediately after the accident to close the valve was overcome by smoke and gas, but suffered no serious consequences. The repair of this accident was expedited by "Hartford Steam Boiler," and by intensive work 60 leaky tubes were tightened, 4 new ones installed, and the brick baffles completely rebuilt, within 24 hours after the accident.

Loss of the use of a watertube boiler at a Virginia utility plant for one and one-half days resulted from an accident to two superheater tubes on April 2, 1934. The failure was attributed indirectly to the quality of coal formerly used by the plant. The fuel had an ash with a low fusing point and this was blamed for the slag which was found on the outside of the superheater tubes. This slag closed up passages and by sending the gases through other passages brought about the overheating, bulging and leakage of certain of the tubes.

Overheating also was blamed for an accident to superheater tubes in a watertube boiler owned by a Maryland chemical company. On February 7, 1934, one tube ruptured, necessitating its immediate replacement. Six days later a tube in an adjoining superheater failed.

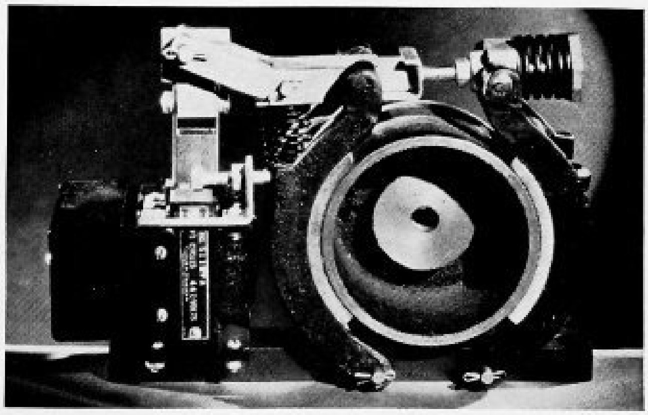
New Small Electric Brakes

A new line of small A.C. and D.C. solenoid operated brakes is announced by Cutler-Hammer, Inc., Milwaukee, Wis. Three new brake sizes are included with torque ratings ranging from 3 to 75-pound feet. These torque ratings are in accordance with NEMA standards, conforming closely to the full load torque ratings of small standard motors.

The brake wheel is relatively large, allowing low total brake shoe pressures, which, distributed over the large brake lining area, results in low unit pressure on the lining and therefore long, even wear of the friction surfaces. The low shoe pressure also results in low stresses on all pins and pivot points, assuring longer wear for these parts, and allows the use of a small operating solenoid which requires less current, thereby affecting a slight saving in operating costs of the brake.

The dimensions of the A.C. and D.C. brakes are interchangeable, so that machine designers can provide standard mounting holes and apply either the A.C. or D.C. brake as needed. Brake shoes use molded brake lining and provide 180-degree braking service.

These new brakes are intended for applications on machine tools, conveyors, small hoists, and small machines where quick, sure stops are required.



Small electric brake for use on machines or hoists

ELEMENTARY PLATE LAYOUT—IV

By George M. Davies

The triangulation method of development may be applied to irregular forms such as transition pieces, where the shape and size varies from one end to the other.

Fig. 25 illustrates a transition piece tapering from an elliptical to a round end, and is developed in the following manner:

Lay out the elevation and end view as shown in Fig. 25.

The method of constructing an ellipse is illustrated in Fig. 26. Draw two circles from the same center, whose diameter are respectively equal to the major and minor axes of the required ellipse. Having divided both circles into the same number of equal spaces, beginning at corresponding points in each, as at *A* and *A'* and shown by the points *1, 2, 3* and *4* on each, draw lines outward from points on the inner circle, parallel for instance, to the diameter *B-C,* which intersect by lines from points of corresponding number on the outer circle, drawn inward and at right angles to the first, as shown at *1', 2', 3'* and *4'*, through which trace the curve as shown from *B* to *A'* completing one-quarter of the ellipse.

Construct a complete ellipse in this manner, completing the end view, Fig. 25.

An inspection of the end view will show that the center line *A-B* divides the object into two symmetrical halves, consequently a development of the pattern for one of these halves will also serve for the other half.

In working out this problem, divide *R-S-T* into any number of equal parts, the greater the number of equal parts taken, the more accurate the final development, ten being taken in this case. Number the points from *1* to *11* as shown. In the same manner divide *P-K-J* into the same number of equal parts as taken for *R-S-T* and number the points from *1'* to *11'* as shown.

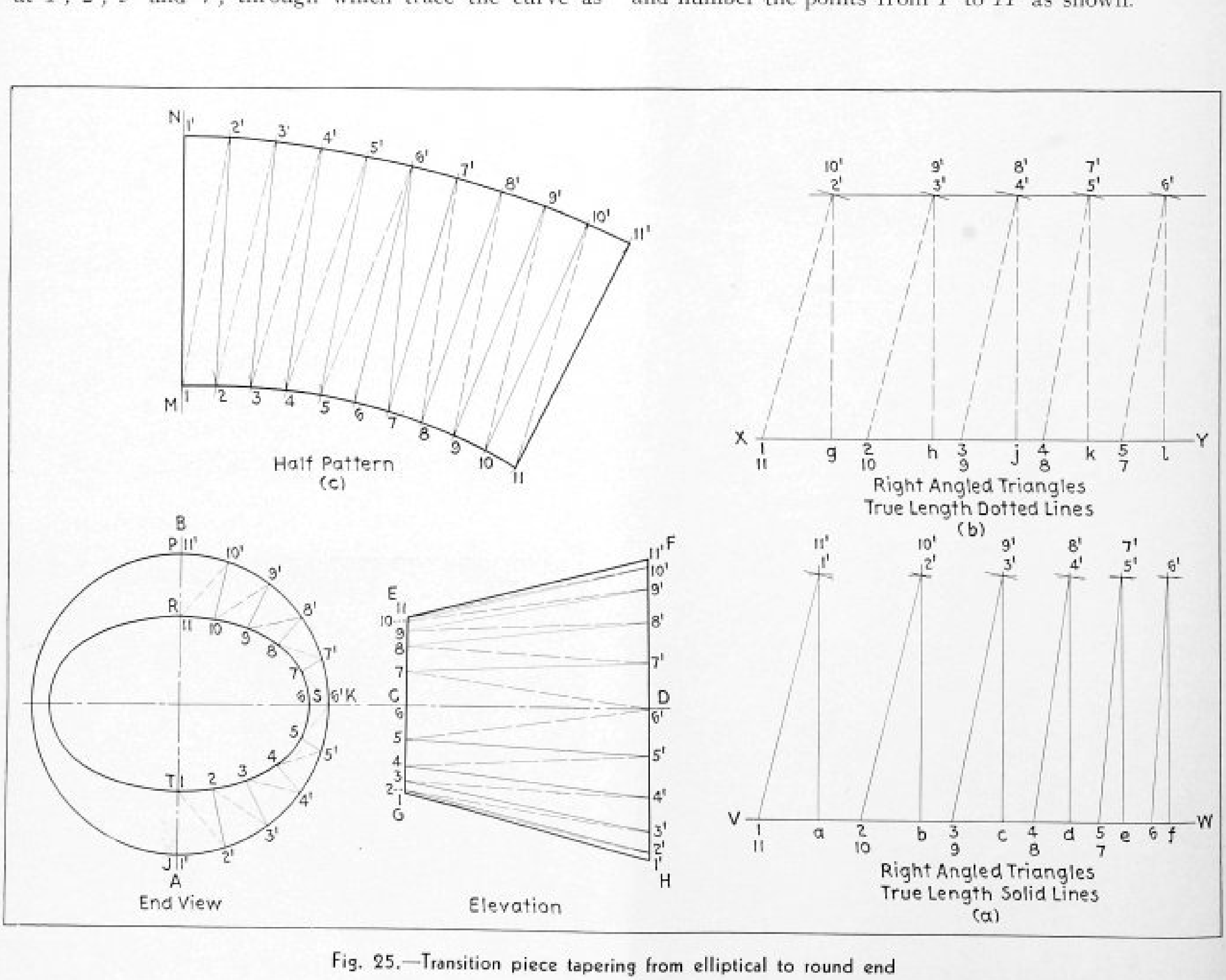


Fig. 25.—Transition piece tapering from elliptical to round end

Connect the points *1* to *11* and *1'* to *11'* with full and dotted lines as shown. Project the points *1* to *11* and *1'* to *11'* from the end view into the elevation, and connect the points with dotted and solid lines as shown. These lines represent the surface lines of the object and, in order to construct the pattern, it is necessary to obtain the true lengths of these lines by constructing a series of right-angled triangles. The triangles will have bases equal to the length of lines drawn between points on *R-S-T* and *J-K-P* and altitudes equal to the distance between *E-G* and *F-H* which in this case will be the distance *C-D*.

The diagram of triangles for determining the lengths of the solid surface lines in the elevation is shown in Fig. 25 (a). To obtain these triangles, draw any horizontal line as *V-W* and at any point on this line as (*a*) erect a perpendicular and make it the same height as *C-D* in the elevation. Thus *1'-a* equals *C-D* of the elevation. Next from (*a*) step off on the horizontal line *V-W*, *a-1* equal to *1-1'* of the end view; connect *1-1'* Fig. 25 (a) completing the right angled triangle *1-a-1'*. The hypotenuse *1-1'* represents the true length of the surface line 1-1' of the elevation. In like manner construct a series of right-angled triangles as shown, whose perpendiculars are equal to *C-D* of the elevation and whose bases *b-2, c-3, d-4, e-5, f-6, e-7, d-8* to *a-11* are equal to *2-2', 3-3', 4-4', 5-5', 6-6', 7-7', 8-8'* to *11-11'* respectively of the end view.

The hypotenuses of these triangles will give the true lengths of the solid surface lines of the elevation; their numbers corresponding.

In like manner construct the series of right-angled

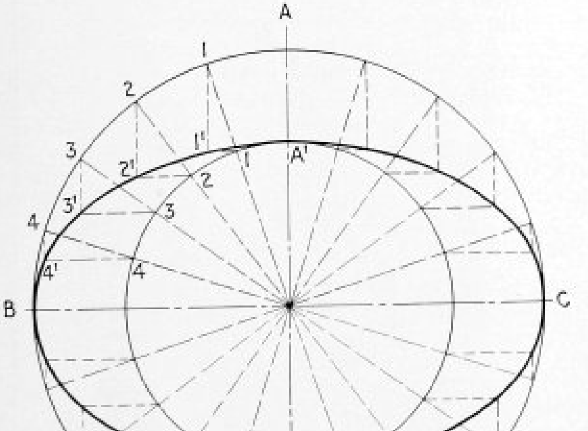


Fig. 26.—Method of constructing ellipse

triangles shown in Fig. 25 (b); the hypotenuses of which equal the true length of the dotted surface lines in the elevation. The altitudes in all cases are equal to *C-D* of the elevation and the bases *g-1, h-2, j-3, k-4, 1-5, 1-7, k-8* to *g-11* being equal to *1-2', 2-3', 3-4', 4-5', 5-6', 6'-7, 7'-8,* to *10'-11* respectively of the end view; thus obtaining the true lengths of all the dotted surface lines of the elevation.

In working this or any other article by triangulation, it will be found very convenient to have two pair of dividers, one pair for the large spaces on *J-K-P* and the other for the smaller spaces on *R-S-T*, thereby avoiding chances of error in resetting. Also, if two sets of trams were used, one for the solid lines and one for dotted lines, it would save time.

For the pattern, begin by drawing any line as *M-N*, Fig. 25 (c) on which set off the distance *1-1'* equal to *G-H* of the elevation or *1-1'* in the diagram of solid lines, Fig. 25 (a). Then with the dividers set to the large spaces on *J-K-P*, and with *1'* as a center scribe an arc. Then with the point *1* as a center and with the trams set equal to *1-2'* in the diagram of dotted lines Fig. 25 (b) scribe an arc cutting the arc just drawn, locating the point *2'*. Next with *1* as a center and with the dividers set equal to the small spaces on *R-S-T* scribe an arc, then with *2'* as a center and with the trams set equal to *2-2'* in the diagram of solid lines, Fig. 25 (a), scribe an arc, cutting the arc just drawn, locating the point *2* of the pattern. Then with *2'* as a center and with the dividers equal to the larger spaces on *J-K-P*, scribe an arc. Then with *2* as a center and with the trams set equal to *2-3'* of the diagram of dotted lines, scribe an arc, cutting the arc just drawn locating the point *3'* of the pattern. Continue in this manner until all the solid and dotted surface lines in Figs. 25(a) and 25(b) are used. Connect the point *1* to *11* and *1'-11'* with a curved line, completing the half pattern of the object. A duplicate of this pattern on the opposite side of the center line *M-N* would give the complete pattern.

Three-Piece Transition Elbow

The next development to be considered in laying out by the triangulation method is a three-piece transition elbow tapering from square to round as illustrated in Fig. 27.

First draw the elevation and plan views. The connection between the circular top section and the transition piece in the plan view is developed as follows:

Extend the center line *H-K* and on same, draw the half profile as shown in Fig. 27(a). Divide the half profile into any number of equal parts, six in this case; the greater the number of equal parts taken, the more accurate the final development. Number the divisions from *1* to *7* as shown. Parallel to *H-K* draw lines through the points *1* to *7* of the profile Fig. 27(a) and extend same into the elevation cutting the lines *A-J* and *B-G*. Number the intersections on *A-J* from *1* to *7* and on *B-G* from *1'* to *7'* as shown. Next extend the center line of the plan view *M-N* and on same draw the half profile, Fig. 27(b). Divide this into the same number of equal parts as taken in profile Fig. 27(a). Number the points on this profile so that the points correspond to the same numbers on the profile, Fig. 27(a); parallel to *M-N* draw lines through the points *1* to *7* extending same out into the plan view. Then parallel to *A-J* draw a line through the point *2'* in the elevation extending same into the plan view, cutting the line drawn parallel to *M-N* through the point *2* of profile, Fig. 27(b), locating point *2'* in the plan view. In the same manner draw lines parallel to *A-J* through the points *3', 4', 5', 6', 7'* of the elevation and extend same into the plan view. Where these lines cut corresponding lines drawn parallel to *M-N* through the points *3-7* of the profile Fig. 27(b), locates the points *3'* to *7'* of the plan view. Join these points with an elliptical shaped line, which line represents the connection between the circular top section and the transition piece, thus completing the plan view.

An inspection of the end view will show that the center line *M-N* divides the object into two symmetrical halves, consequently a development of the pattern for

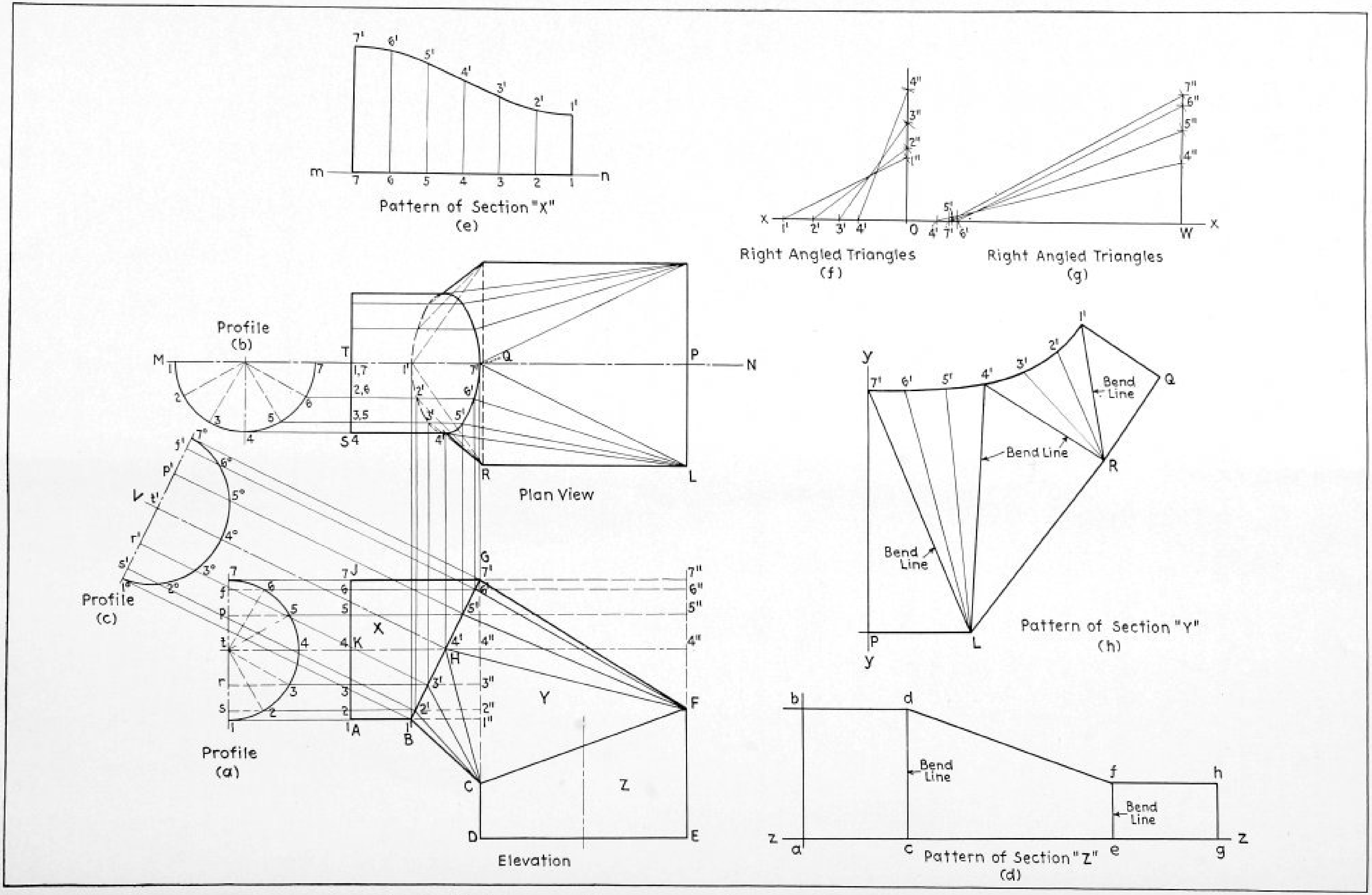


Fig. 27.—Developing a transition piece, tapering from square to round by triangulation

one of these halves will also serve for the other half.

The pattern of the circular top section marked *X* in the elevation is constructed as follows: Draw any line as *m-n*, Fig. 27(e) and on *m-n* step off the distances *1-2*, *2-3*, etc., to *6-7* equal to distances *1-2*, *2-3*, etc., to *6-7* of the profile Fig. 27(a). Erect perpendiculars to *m-n* at the points *1* to *7*. On the perpendicular at the point *1* step off the distance *1-1'* equal to *1-1'* of the elevation; on the perpendicular at the point *2* step off the distance *2-2'* equal to *2-2'* of the elevation. Continue in this manner until the points *3'*, *4'*, *5'*, *6'*, *7'* of profile Fig. 27(e) have been found. Connect the points *1'* to *7'* with a curved line, completing a half pattern of Section *X*.

The pattern for the square bottom marked *Z* in the elevation is constructed as follows: Draw any line as *z-z*, Fig. 27(d) and step off *a-c* equal to *P-L*, *c-e* equal to *L-R*, and *e-g* equal to *R-Q* of the plan. Erect perpendiculars to *z-z* at the points *a*, *c*, *e* and *g*, and on these perpendiculars step off from *g*, *g-h* equal to *C-D*; from *e*, *e-f* equal to *C-D*; from *c*, *c-d* equal to *E-F*, and from *a*, *a-b* equal to *E-F* of the elevation. Connect the points *b*, *d*, *f*, *h* and *g* with a line, completing the half pattern of the square section *Z* of the elevation.

Before constructing the pattern for the transition piece marked *Y* in the elevation, it is necessary to obtain the true length of the miter line *B-G* as follows: Erect a perpendicular to *B-G* at *H* as *H-V*. At *t'* any point on *H-V* erect a perpendicular to *H-V* extending same above and below the line *H-Y*, as illustrated in Fig. 27(c). Parallel to *H-V* draw a line through the points *1'* to *7'* on *B-G*, extending same into the profile Fig. 27(c), cutting the line drawn perpendicular to *H-V* at *t'*. On the line drawn from point *6'* of the elevation, step off *K-6°* equal to *K-6* of profile, Fig. 27(a) and in the same manner step off *p'-5°* equal to *p-5*, *t'-4°* equal to *t-4*, *r'-3°* equal to *r-3* and *s'-2°* equal to *s-2*, locating the points *1°* to *7°*. Connect these points with a curved line which will be the true length of the miter line *B-G*.

The next step is to find the true lengths of the surface lines of the transition piece. Connect points *4'*, *5'*, *6'*, *7'* of the elevation with *F* and points *4'*, *3'*, *2'*, *1'* with *C* and the points *4'*, *5'*, *6'*, *7'* of the plan with *L* and points *4'*, *3'*, *2'*, *1'* with *R*. These lines are the surface lines of the transition piece and their true lengths are found by constructing a series of right-angled triangles as shown in Figs. 27(f) and 27(g).

In Fig. 27(f) draw any line *x-x* and at *O* any point on *x-x* erect a perpendicular. From *O* on the line *x-x* step off the distances *O-1'* equal to *R-1'*, *O-2'* equal to *R-2'*, *O-3'* equal to *R-3'*, and *O-4'* equal to *R-4'* of the plan. From *O* on the perpendicular to the line *x-x* step off the distances *O-1"* equal to *C-1"*, *O-2"* equal to *C-2"*, *O-3"* equal to *C-3"* and *O-4"* equal to *C-4"* of the elevation. Connect the points *1'-1"*, *2'-2"*, *3'-3"*, *4'-4"*, Fig. 27(f). These lines are the true lengths of the surface lines *R-1'*, *R-2'*, *R-3'*, *R-4'* of the plan.

Next at *W* any point on *x-x* erect a perpendicular. From *W* on the line *x-x* step off the distances *W-4'* equal to *L-4'*, *W-5'* equal to *L-5'*, *W-6'* equal to *L-6'* and *W-7'* equal to *L-7'* of the plan. From *W* on the perpendicular to the line *x-x*, step off the distances *W-4"* equal to *F-4"*, *W-5"* equal to *F-5"*, *W-6"* equal to *F-6"* and *W-7"* equal to *F-7"* of the elevation. Connect the points *4'-4"*, *5'-5"*, *6'-6"* and *7'-7"*, Fig. 27(g); these lines being the true lengths of the surface lines *L-4'*, *L-5'*, *L-6'*, *L-7'* of the plan.

The pattern of the transition piece marked *Y* in the elevation is constructed as follows: Draw any line as *y-y*, Fig. 27(h) and step off the distance *P-7'* equal to *F-7'* of the elevation, and at *P* erect a perpendicular to *y-y* and step off *P-L* equal to *P-L* of the plan view. Connect *7'-L* with *7'* as a center and with the dividers set equal to the distance *7°-6°* of the profile, Fig. 27(c), as a radius scribe an arc; then with *L* as a center and with the trams set equal to *6'-6"*, Fig. 27(g), scribe an arc cutting the arc just drawn locating the point *6'*. Next with *6'* as a center and with the dividers set equal to *6°-5°* of Fig. 27(c), scribe an arc; then with *L* as a center and with the trams set equal to *5'-5"*, Fig. 27(g) as a radius, scribe an arc cutting the arc just drawn, locating the point *5'*. Continue in this manner, using the distance *5°-4°*, Fig. 27 (c) and *4'-4"*, Fig. 27(g) drawing the line *L-4'*.

Next with *L* as a center and with the trams set equal to *C-F* of the elevation as a radius, scribe an arc; then with *4'* as a center and with the trams set equal to *4'-4"*, Fig. 27(f) as a radius, scribe an arc cutting the arc just drawn locating the point *R*.

Continue in same manner as for the section of the pattern from *7'* to *4'*, taking *4'-3'*, *3'-2'* and *2'-1'* equal to *4°-3°*.*3°-2°*, *2°-1°*, of Fig. 27(c) respectively and *R-3'*, *R-2'* and *R-1'* equal to *3'-3"*, *2'-2"*, *1'-1"* of Fig. 27(f) respectively, completing the pattern to the line *R-1'*.

Next with *R* as a center and with the trams set equal to *R-Q* of the plan view, scribe an arc, then with *1'* as a center and with the trams set equal to *B-C* of the elevation, scribe an arc cutting the arc just drawn, locating the point *Q*.

Connect the points *7'*, *6'*, *5'*, *4'*, *3'*, *2'*, *1'*, *Q*, *R*, *L*, *P* completing the one-half pattern of the transition piece Y.

(To be continued)

National Exposition of Mechanical Engineering

Space is filling rapidly and a number of the most unusual mechanical exhibits ever seen are being planned for the Eleventh National Exposition of Power and Mechanical Engineering to be held December 3 to 8, 1934, at the Grand Central Palace, New York. "Making a conference appointment with 40,000 technical men," is one of the accurate slogans of this year's Power Show. The truth of this dramatic thought is drawing not only the constant exhibitors, but many new ones. The calculated attendance of 40,000 is based on the fact that 38,000 registered at the last Exposition, 36,000 at the one before that. Every indication points to greatly increased attendance during the present year. Some large industrial units whose earlier budget did not permit them to participate, are making special appropriations to insure their participation in the Eleventh National Exposition of Power and Mechanical Engineering. These firms believe that the Exposition is timed just right for their presentation of new products which the quiet years have enabled them to develop. The last Exposition was held in 1932, and the next one will not occur until 1936. The 1934 Exposition marks, therefore, a key-point in a four-year period. This year's audience will be open-minded and searching—responsible for the expert purchasing of equipment to bring production industries up to date.

Obsolescence in the fields which the Power Exposition serves is an important incentive, and plant idleness during the past several years calls urgently now for repair and renewal. Research and development have made strides during the enforced idleness of years when production was slowed down. Progressive exhibitors are now ready with improvements of equipment and process. These are geared to mechanical advance, likewise they are designed to facilitate production economy.

Meeting the revitalization of industrial purchasing, the aim of exhibitors will be to show exactly the status of their production development and latest products and to prove the oft questioned factors of performance and profit. This exhibitor attitude is responsive to this year's exposition audiences which are critical but open-minded and who will purchase when they are convinced.

To the buying audience every form of approach is being utilized increasingly by the sales forces of all branches of mechanical industry. From a sales promotion standpoint, the economy of the Exposition as a place to show the actual products and the machines so that they can be examined by so large an audience is unique.

The most important role which the Eleventh National Exposition of Power and Mechanical Engineering will assume during its week in December is that of prime mover or stimulus to industrial progress. Naturally this reflects in terms of production, and sales. A national exposition is to be thought of as competitive to no other medium, but rather as the builder of business which will justify more of every other form of useful promotional activity. Exposition uniqueness rests on its modern maintenance of one of the oldest forms of commercial activity, namely, the market place where buyers and sellers meet. Responsive to motives of enlightened self interest, thousands of people from far and near attend such a meeting place of industrial development. There, in a space of hours, the audience, collectively, can cover years, bringing itself up to date by witnessing the final effect of invention, analysis, and classification by experts. Now, several months in advance of the Exposition, the exhibitors are active, evaluating, selecting, and arranging their most significant achievements to present them in a pyramid of appeal.

The week of the Exposition, December 3 to 8, coincides with that of the National midwinter meeting of the American Society of Mechanical Engineers, a factor of great convenience to the thousands of mechanical engineers who come to New York to attend both. The Eleventh National Exposition of Power and Mechanical Engineering, like those preceding, is under the direction of the International Exposition Company, with Charles F. Roth, again personally in charge.

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. Anyone 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 given records of the interpretations of this Committee in Cases Nos. 775, and 779 to 783, inclusive, as formulated at the meeting of June 29,1934. They have been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 775.—(Annulled)

Case No. 779.—(In the hands of the Committee)

Case No. 780.—(*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 pressure vessel when computed at that stress for use at 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? 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 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. 781.—(*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 head when figured in accordance with the requirements of Par. U-36.

Case No. 782.—(*Special Rule*)

Inquiry: Will it be permissible to use firebox-quality steel plate not over ⅝ inch in thickness conforming to Specifications S-1 for Steel Boiler Plate, except that 1½ to 2½ percent nickel is added, resulting in physical qualities as follows:

Tensile strength, lb. per sq. in.	70,000 to 80,000
Yield point, per sq. in., min.	0.6 ts
Elongation in 8 in., percent	$\frac{1{,}600{,}000}{ts}$, but not less than 25 percent

for the firebox sheets of fire-tube boilers provided that the maximum allowable working stress is not greater than 11,000 pounds per square inch?

Reply: It is the opinion of the Committee that the material specified in the inquiry and used as so outlined will meet Code requirements. If the boiler complies in all other respects with the Code requirements, it may be stamped with the Code symbol.

Case No. 783.—(In the hands of the Committee)

Removal of surplus steel

Use of portable machines for

GAS CUTTING OPERATIONS*

Refinements in the art of oxy-acetylene cutting have recently been accomplished that show the widespread desire of the oxy-acetylene industry to keep pace with the metal working industry's demands for finer and more precise equipment of a more specialized nature than the simple hand operated cutting blowpipe. Such apparatus does not encroach upon the well-established utility of the hand blowpipe but rather refines and increases the scope of the process in that intermediate realm where the utility of the hand apparatus leaves off and the greater scope and precision of the stationary cutting machine begins. In other words the portability and ease of operation of the hand operated cutting blowpipe has been extended for simpler work that previously was done by machine cutting.

The maintenance man can now carry his cutting machine to the job instead of carrying the job to the machine. The steel fabricator can do the same. For instance:

A chemical company received four new agitators which were needed for installation in one of its plants. Through some quirk of chance the agitator plows, already installed in the assemblies, were found to be considerably larger than specified. Inasmuch as this equipment was needed as soon as possible some remedy was sought that would not necessitate the return of the parts to the manufacturer.

These plows are made of cast steel. Of the four agitators, two contain 150 plows each, and the other two 75 each. The plows are of low-carbon cast steel, each varying in thickness from ½ inch to 2½ inches.

An oxy-acetylene service operator was asked for his opinion regarding cutting off the excess metal by means of the blowpipe. A brief survey showed how to do the job.

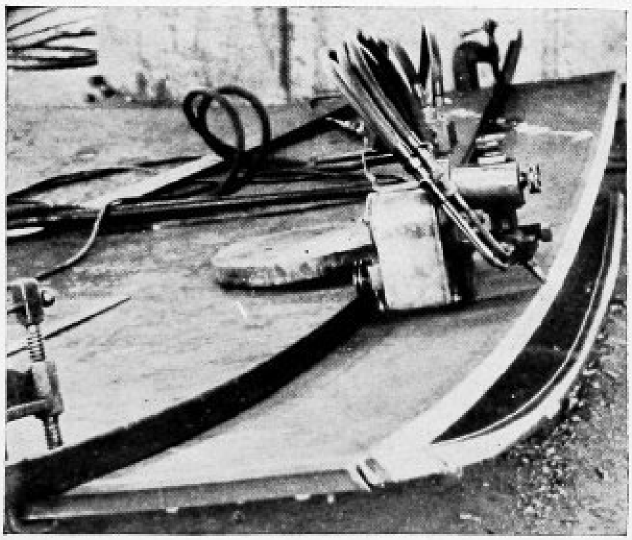
A special plate which fitted the outside curve of the plows was first made up. On this was placed a guide which not only followed the outward curve of the plows but also the downward pitch, in other words, a compound curve. Another track to fit the idling wheel of the portable cutting machine was also made up and attached by oxwelding to the template guide. Obviously the making of the guide was a sizable job in itself, but considering the amount of time and money involved in the whole operation it was certainly justified.

To make a long story short, the 450 plows were trimmed each with a tapered cut of approximately ⅛ inch to ½ inch in thickness. The cutting machine was set to travel 6 inches per minute with the result that about 12 cuts per hour were accomplished. This last figure, of course, includes the time necessary for setting up the template for each cut.

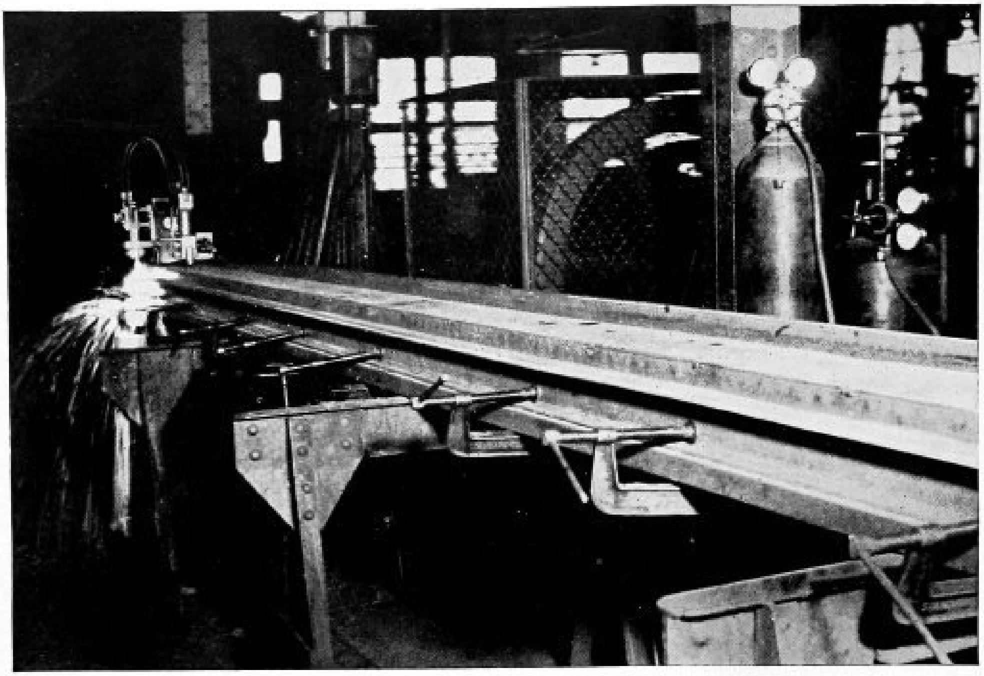
This work was accomplished with the usual results: a highly pleased plant personnel and an estimated saving of $4000.

A second job of interest called for the trimming and

* This article is published through the courtesy of Oxy-Acetylene Tips.



Trimming plate for shell section



Shaving the flange of 20-foot channels is easily accomplished by machine gas cutting

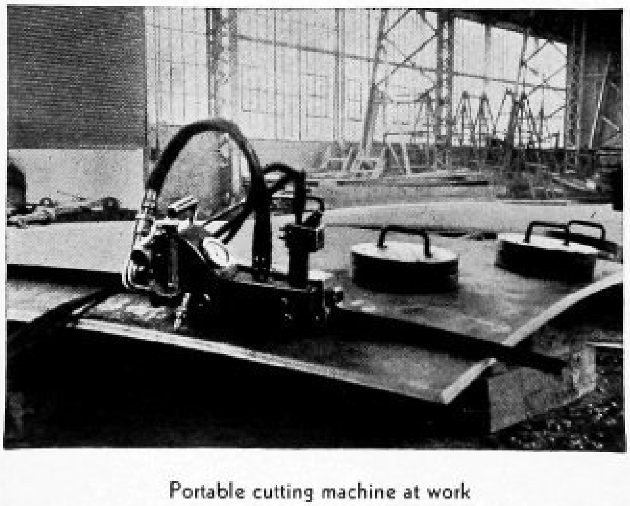
beveling of plate sections that would ultimately be assembled into the shell of a spheroidal gas holder. Here again a compound cut was necessary because not only was the plate curved in two directions (similar to a wall section cut from a ball) but the angle of the edges of the plate varied in some cases. Ingenuity in the making of the guide for the cutting machine and the changing of the angle of the blowpipe to take care of the bevel of the edges again solved a difficult problem and in the end meant a faster, more economical, and a better job. The accompanying illustrations show the various steps in this work much more clearly than any word description.

A third example further illustrates the point of this article.

An iron company in the Great Lakes region secured a job of cutting off part of the flange on 20-foot channels. This would involve about 6700 linear feet of cutting. As each cut would be 20 feet long and had to be accurate a clever jig was devised to guide the cutting blowpipe.

A 22½-foot I-beam was set up on its side and by means of tack-welding, a flat strip of steel placed between the edges of the two flanges on which the cutting machine was to run. On the side of the beam against which the channels were to be cut an arrangement of two channels was made up and welded to the flat web. It was then a simple matter to put a channel in place, clamp it tight, and start cutting. A simple enough job, after all, when the proper set-up and good equipment are used.

These three brief summaries show clearly some of the interesting work that is now being accomplished by means of the portable oxy-acetylene cutting machine. While not specifically developed to carry out some of the more intricate cutting operations mentioned it has been found to be simple enough to do reasonably difficult work that, because of the desired degree of precision, would hardly be a suitable job for the hand-operated blowpipe. Because it is a portable machine, it becomes a useful adjunct and accessory to the larger cutting outfits.



Portable cutting machine at work

Lloyds to Register Welded Pressure Vessels

By G. P. Blackall

An important advance in the acceptance of fusion welding technique in the United Kingdom is represented by the issue of a specification relating to fusion-welded pressure vessels for land usage by Lloyd's Register of Shipping. This publication of the requirements of Lloyd's Register, regarded internationally, is not, of course, a pioneer effort. However, the Register is the first important insurance body in Britain to take so progressive a step.

In the new regulations, which cover seven pages, the first noteworthy point is that the term fusion welded is defined as applying only to types of welding in which the parent metal and the weld metal are at all times protected from atmospheric contamination. The specification accepts the oxy-acetylene or the oxy-hydrogen process, the metal-arc process with covered electrodes, or other electric-arc process in which the arc stream and the deposited weld metal are shielded from atmospheric contamination. The specification makes it clear that scope is offered for special types of electric welding which differ from the stereotyped metallic-arc process employing coated electrodes. Many of these special methods involve the use of automatic or mechanical feeds.

The second important feature of the specification is the distinction it draws between fired pressure vessels subject to internal steam pressure above 50 pounds per square inch (Class I vessels), and pressure vessels not included in this category (Class 2 vessels). The requirements for the latter class appear to be somewhat less stringent than those for Class I, both in regard to the character of the precautions and tests to be taken by the surveyor to ensure the soundness of the finished welds, and to certain of the scantlings, such as those for dished end plates.

An X-ray test is called for in connection with the welding of Class I vessels. It is first required that any concern aspiring to be ranked as competent to carry out Class I work, after having satisfied Lloyd's Surveyors that it is properly laid out for the execution of welding work of that grade, shall carry out a number of qualifying tests. Among these is the submission of X-ray photographs of portions of the test plate welds, together with photo-micrographs of the weld metal, fusion zone, and plate. These X-ray photographs and photo-micrographs are to be placed on record by Lloyd's Register. Whatever the reaction of the welding industry to the comparative severity of these requirements, it will at least be evident that the intention of Lloyd's Register is to confine the execution of this type of work to thoroughly efficient undertakings, properly staffed on the scientific side. Thus the possibility of poor workmanship will be avoided at the start.

When welding is actually being carried out on Class I vessels the specification requires that X-ray photographs are to be taken of the entire length of each welded seam both longitudinal and circumferential, the photographs being marked for identification with the parts of the seams. The X-ray methods employed are required to be sufficiently accurate to reveal a defect having a quantitative thickness greater than 2 percent of the depth of the weld, this being checked by a negative supplied by the manufacturer. Defects revealed by the X-rays are to be cut out, rewelded, and again X-rayed.

A series of seven separate tests are required of the welds themselves as follows: (1) An all-welded metal tensile test, for weld metal cut from an extended portion of the welded joint: (2) a bend test taken across the weld; (3) an impact test, to test the junction of weld and parent metal; (4) an impact test of the worth of the weld metal itself; (5) a tensile test of the strength across the line of the joint; (6) a test of the density of weld metal, which is not to fall below 7.8; and (7) photographic tests.

One photo-micrograph of 100 magnifications is to be taken at four points on a cross-section of the parent metal and weld; i.e., in the parent metal remote from the weld, in the parent metal close to the weld, actually across the weld, and in the weld metal. A further requirement is that a photo-micrograph also be taken presumably to cover four similar points, and both sets of pictures are required to show a sound homogenous weld and a normal refined and uniform grain structure.

Class 2 vessels are accepted if manufactured with fusion-welded joints satisfying rather less stringent requirements than those outlined in the foregoing for Class I vessels. For example, the X-ray test is not specified, reliance being placed on an overload hydraulic test. This test, incidentally, must also be carried out on the Class I jobs in addition to the X-ray tests.

Generally speaking, this specification appears to bring British welders into line with their American and Continental colleagues and gives them an excellent opportunity of proving the worth of the claims which they have been making for a number of years past. Britain is the last great nation to put the seal of its approval on welding.

General Electric A-C Arc Welding Equipment

In addition to its line of direct-current arc-welding equipment, General Electric now has available a complete line of alternating-current arc-welding equipment including transformer units, electrodes, and automatic welding heads and control. The new alternating-current equipment is intended for heavy-current welding, primarily automatic welding because of the heavy currents involved, but otherwise equally well suited to hand applications.

G. E. heavy welder

Alternating-current arc welding is not new, but the remarkable development of arc-welding electrodes during the last few years has only recently made it possible to benefit from the major advantage of the alternating-current process—that advantage being the absence of magnetic blow in the arc, and therefore superior quality in the resulting weld. It follows, of course, that this advantage becomes particularly apparent with the heavier welding currents (above 250 amperes) because of the greater magnetic effect at these currents. Slightly greater welding speeds are possible when using alternating-current. In making fillet welds and in working into corners and other parts of intricate structures, the alternating-current arc permits full penetration to be obtained.

The new transformer units are available in three sizes having one-hour ratings of 500, 750, and 1000 amperes. Primaries are wound for 220, 440, or 550 volts; 60, 50, or 25 cycles; single phase. Extra attachments are available for reducing the secondary open-circuit voltage to approximately 50 percent of its normal value (normal being 80, 90, or 100 volts), and for obtaining currents down to 10 percent of the one-hour rating.

The transformers themselves are of the high-reactance type, air-cooled and enclosed in a sturdy cylindrical shell. A suitable arrangement is provided to vary reactance so that the full welding range of the equipment can be obtained on any one of three secondary open-circuit voltage settings, the latter being selected by means of taps on the primary winding.

The electrode recommended for the alternating-current process is the General Electric Type W-23, a heavily coated electrode especially suited to alternating-current welding.

The new alternating-current equipments are intended primarily for shop use in semi-permanent locations, a lifting eye being provided on top of the transformer unit by means of which the set can be readily moved by a crane.

WELDING'S CHALLENGE*

By Everett Chapman†

In traveling around the country in the interest of welded steel construction, two major impressions are outstanding—first, the woeful lack of knowledge of steel on the part of the average user, and, second, his tremendous curiosity concerning the nature of steel. His capacity for absorption of all the fascinating technical details—causes of laminations, ingot structure, influence of open hearth charge, rolling operations, mechanism of flame-cutting—is unrealized. He is a tonnage consumer of potatoes, steel, coal, cotton, sugar and other commodities; with a latent desire to discuss any fascinating subject, particularly if he can become more familiar with the vagaries of the materials with which he must live. This consumer emptiness is hardly assuaged by knowledge of the base price of steel, while the additional information regarding the extras is of no help at all. Is it any wonder that his sources of steel or for that matter, steel itself, are more or less hazy, impersonal things that he accepts as a matter of course? Steel to him is an old drudge, a somewhat dependable old hag who has her price and a modicum of temperament.

Yet in steel he has a material possessing a set of physical characteristics unmatched by those of any other material, characteristics that can be flexed and molded to meet the most stringent conditions. Does he want the stiffest material that is commercially available? Does he need unsurpassed strength at some point? Does he need a material that he can repeatedly beat upon, something that he can abuse? Does he wish to absorb energy? The answer of the steel industry to date has been largely, "just get some rolled steel."

But the answer has not been sufficient to elevate steel from the commodity class in the consumer's mind, for the simple reason that the consumer has not been taught the manipulation of the properties of steel which results in the superb performance of which steel is capable under the severe demands of present-day industrial duty. The consumer does not realize that rolled steel, despite its low base price of less than two cents a pound, offers him the very properties that he so often seeks in materials at far higher prices. The glamorous romance of steel that could have such an appeal to the consumer has been dimmed and buried by two facts, its price, and the apparent unwillingness of the steel industry to talk very much about anything else except price.

The consumer has had to be his own teacher and what he knows of the use and abuse of steel has been learned principally in the hard school of experience in the grim shadows of tradition. In applying welded steel construction to the consumer's real needs, it has been found necessary to discuss such fundamentals as modulus of elasticity and deflection phenomena; fatigue characteristics, endurance limits and the mechanism of fatigue failures; carbon content and general chemical analysis as they affect the thermal abuse administered to steel when welding or flame-cutting it; impurities and the segregation of impurities as they affect the weldability of steel; open hearth chemistry and the structure of open and killed ingots as they respectively affect the soundness of the resulting rolled product; rolling operations; heat treatment and stress relief of resulting structures; contraction phenomena of the weld metal and its relation to locked-up stresses; the effect of locked-up stresses upon the subsequent service behavior; and a multitude of other technical details and ramifications, all of which the consumer finds utterly fascinating and which are vital to his intelligent use and engineering appreciation of rolled steel. Those things that one knows and understands are first in our esteem. It would seem that the picture that welded steel can present to industry is the perfect medium for the dissemination of the information the steel consumer needs and desires. And the picture is broad. It is pretty well established in the minds of some few people at least that the limit of the possibilities of the welding method of construction is only that imposed by the engineer's imagination. Properly used, the process allows an engineer the freedom to function as an engineer, since the inhibitory restrictions of the old established practices are absent. It constitutes a tremendous challenge to the engineering profession in that it presents a perfect tool with which to integrate an assembly of steel units into a whole. Its magnificent potential appeal to the most fertile field for steel's promotional work is the implied challenge to the steel industry.

Judging by the content of many interviews and interest at the various meetings around the country, users of steel and potential users of steel are voracious for information on steel for welding, welding methods, and welding design. To date, everyone interested in the welding process has participated in this development but there has been no organized participation by the steel industry, which can probably gain more through the advancement of welding than any other group, not merely in direct tonnage gains but in an opportunity to present steel as an entity, with a personality, on a stage which can be set for it with its own properties, in strict conformity with the most modern methods of marketing.

Aside from the marketing angle, the welding development carries another challenge to the steel mills. Modern weld metal is a freak metal. It is freakish in that similar physical characteristics cannot be produced in the open hearth today. Compared with open hearth steel of the same chemical analysis, it shows markedly superior physical characteristics. At a carbon content of from eight to ten points, it will exhibit a tensile strength of 65,000 pounds per square inch. At that tensile strength, it will show a degree of ductility as measured by 35 percent elongation in two inches. These figures can hardly be reconciled with the properties of any mild rolled steel that we know today, and they become more surprising when it is realized that this material shows these properties in the cast condition. A cross-section through a weld made in one pass shows an obvious columnar type of crystallization. Cor-

* Paper presented at the meeting of the American Iron and Steel Institute, Hotel Commodore, New York, May 24, 1934.

† Vice-president, Lukenweld, Inc., Division of Lukens Steel Company, Coatesville, Pa.

relative properties such as impact values, endurance values and corrosion resistance show values which are also out of the ordinary for material of this analysis and structure. Here is a material in a condition which, by all the tenets of the usual metallurgy, should exhibit properties inferior to the product of the rolling mill.

It is believed that the seat of these extraordinary values lies in the extreme cleanliness of the weld metal as deposited by modern welding techniques which protect the fusion deposits from the atmosphere. The endurance value of this cast material, which should show directional weaknesses, is in the neighborhood of 30,000 pounds per square inch and this exceeds the values as exhibited by the product of the open hearth.

Some time ago, various specimens of steel were broken under the microscope, which specimens were purposely made with different degrees of oxide inclusions, and the mechanism of their failures was observed microscopically. It was interesting to note that the grains of the cleaner steels developed a marked number of slip bands under load before failure. In contrast, the more oxidized steels failed through the grain boundaries before the grains themselves developed any slip bands. The more finely divided oxides in the oxidized steels were found to have been excluded to the grain boundaries which effectively isolated the grain elastically to a point where the breaking load was not high enough to deform plastically the material in the grain. Some place in this conglomerate picture that modern weld metal presents would seem to be a clue that steelmakers could well afford to investigate in their search for better steels. Today, the situation presents a picture in which the modern fusion deposits which can be used for joining rolled steel products have characteristics and physical properties which are superior to the material they join.

To sum up, the physical properties of these modern weld metals with respect to the mild steels they join and, what is more important, to the higher strength alloy steels in conjunction with which they can be used, offer a challenge of considerable magnitude to the open hearth practices of today. Modern engineers, engineers with imagination, have at their disposal, if intelligently used, a material surrounded by a commercial technique which can sew together and integrate a mechanical structure from a series of composite pieces of rolled steel material to meet service conditions in accord with the next step in industrial revolution.

Material for Steam Boilers

The following abstract, compiled and translated by *Mechanical Engineering,* is one of a symposium of papers on the practical applications of recent research into the strength of materials, presented at a meeting of the Verein deutscher Ingenieure recently held in Essen, Germany.

The paper by Dr. of Engrg. E. Lupberger deals with the selection of material and wall thickness in steam boilers. Here again the opinion is expressed that the empirical methods now used cannot endure. But in order to replace them by really scientific methods one must above all know the spacial field of stresses at the critical locations in the boiler. They cannot be determined for practical purposes by mathematical methods. The solution of the problem can rather be found only by experiment. It is therefore the intention within a very short time to submit to elongation measurements the few typical parts which alone are of importance for the design of new boilers, and to determine in this way the distribution of stresses. These experiments are to be carried out as a community undertaking and the results are to be presented in a "Book of Types." The purpose of the new development is the creation of bodies that are as smooth as possible and have undisturbed flow of stresses and as uniform a distribution of strains as possible. In boiler construction only a few simple elements are really needed.

Measurement of strains can be carried out on a boiler only at static pressure and as a rule at temperatures of about 20 C (68 F.). In boiler operation, however, alternating forces are superimposed on static loads. Variations of steam pressure are of the very smallest importance as a source for the appearance of alternating strains, as the pressure variations in boilers while in operation seldom exceed ± 5 percent. The alternating stresses due to variations of temperature are much more important. This view is supported by the observation that in old boilers the formation of cracks is greatly accelerated by the installation of elastic firing. Therefore, in the design of boilers particular attention should be paid to the mobility of individual parts, such as may be due to the changes of temperature and to stresses generated in that way.

As regards the investigation that it is planned to undertake, it is stated that the classical science of strength of materials avoided the uncertainty as to the relation between simple tensile tests and the behavior of materials observed in practical operations, and it did it by the introduction of an "experience" or safety factor. All efforts of modern research in the field of strength of materials, testing of materials, and analysis of parts has not been able to eliminate completely this safety factor. This could be done only by making calculable in advance all the influences which necessitate its use.

The following of these influences are named here: (1) The difference between the behavior of material in a tensile test and its behavior under a spacial state of strain in a boiler. (2) Deviation of the properties of material as represented by a test bar from the properties in an actual construction which includes defects in manufacture, porosity, non-uniform heat treatment, etc. (3) Lack of precision in the computation of the strains occurring. (4) Differences between the properties of the material which are assumed in the computation of parts and the properties of the material when it undergoes actual strains. (For example, in test computations when dealing with the tensile strength and the elastic limit of materials, while in long-range straining the corrosion effect has to be considered). (5) Reduction of the resistance of material during operation because of corrosion, changes in the condition of surface, etc.

Fabricating Stainless Clad Steel

The first comprehensive guide to the fabrication of stainless clad steel has just been issued by the Ingersoll Steel and Disc Company, 310 South Michigan Ave., Chicago (division of the Borg-Warner Corp.). This 16 page booklet is entitled "Manual of Welding and Fabricating Procedures for IngAclad Stainless Clad Steel" and takes up, step by step, the various methods of welding, soldering, lock seaming, riveting, deep drawing, pickling, heat treating, etc., encountered in fabricating products of stainless clad steel. The manual contains many diagrams to guide the fabricator in working with the material.

Code Operation of the Boiler Industry

(*Continued from page 231*)

"I am concerned about the effect on the boiler manufacturing industry of the talk which has already taken place and the increasing intensity of that which is to come. It is more than likely that we are going to see an undermining of the morale of our industry and a tendency on the part of some of its members to have less respect for our Code. If this is not carefully watched, and if we do not begin now with a systematic plan for building up the industry from within in such a way that it will function as a unit whether N. R. A. exists or not, I feel that we shall witness a degree of backsliding that may wipe out the progress of the last year.

"It seems to me that the Code Authority of the industry has the responsibility of sensing these things and taking such steps as it can to guard against any influences, wherever they may be and whenever they may occur, which may tend to affect the unity of the industry detrimentally."

Very definitely the boiler manufacturing industry is interested in perpetuating the methods of conducting its business that have given evidence of progressiveness and have promoted harmony. For this reason concerted action to combat attempts towards a return to conditions of the past should be forthcoming from every concern doing business in this field.

Steel Plate Fabricating Industry Exemptions

The Code Authority for the steel plate fabricating industry has submitted a petition to the National Recovery Administrator asking for termination of the exemption contained in Administrative Order X-36, of May 26, 1934, as applied to its industry.

This order now exempts from contributing to the budget of the steel plate fabricating industry all members thereof whose principal line of business is embraced in a trade or industry subject to a code other than that of the industry mentioned.

Notice was given August 22, that any criticisms of, objections to or suggestions concerning this application for exemption must be submitted to Deputy Administrator Walter G. Hooke, Room 4033, Department of Commerce Building, Washington, D. C.

Exhibitors Advisory Council

The Pressed Steel Tank Company of Milwaukee, manufacturers of metal containers for gases, liquids and solids, and the 20th Century Machinery Company of Milwaukee, manufacturers of brewers and bottlers machinery, have become members of the Exhibitors Advisory Council of New York—a fact-finding co-operative group of leading industrial companies interested in the improvement of conditions relating to all types of industrial and trade shows and expositions.

Universal arc welders, electrodes and supplies, products of Universal Power Corporation, Cleveland, are, by recent appointment, being distributed in the New York Capital district by Larkin Equipment Company, Albany.

Service Bulletins

Many readers will find the information contained in the booklets listed of considerable value in their work. A request to the Editor of Boiler Maker and Plate Fabricator, 30 Church Street, New York, will assure your receiving copies of them.

The Shielded Arc

While many readers, both in the design and construction departments, of the boiler, pressure vessel and plate fabricating industries are constantly dealing with the shielded-arc process of welding, nevertheless the information concerning its characteristics and advantages as outlined in the service bulletin "The Shielded Arc," published by one of the leading manufacturers of arc-welding equipment, will be of value in developing a better understanding of the applications of this process. The foreword from this bulletin explains the purpose of this publication as follows:

The introduction of the shielded arc process of welding inaugurated a new era in welding. It has improved the construction of thousands of metal products and structures and at the same time lowered production costs. In many cases where the application of welding was formerly considered impractical the use of the shielded arc has made possible improved design, resulting in operating advantages for the equipment so built. It has assured the safety of welded construction for products whose failure might mean loss of human life. Typical of such products in which the shielded-arc process of welding is being used extensively in their construction are fired and unfired pressure vessels, naval and other types of ships and high-pressure piping. In such products it has successfully withstood the test of time and extensive service. Shielded-arc welding when done under proper procedure conforms to all requirements of the A.S.M.E. Boiler Code and insurance codes.

Arc Welding for Railroads

The economy of arc welding for railroad maintenance and construction has been definitely established. Recent innovations in this field have proved especially economical. This publication is intended to bring to the attention of railroad executives, engineers, and others interested, how the latest arc-welding equipment and methods are helping to reduce railroad maintenance and construction expense.

For ready reference, this publication is divided into three major sections:

1. Motive-Power Department.
2. Maintenance of Way Department
3. Bridge and Building Department.

The first section includes information on economical methods of maintenance and repair, on the fabrication of new locomotives and cars, and general information on the use of arc welding in the motive-power department. Special consideration is given to applications of boiler welding.

The second section outlines methods of repair and reclamation of worn and battered rails, switches, crossings, frogs, etc. It also contains information on equipment for the fabrication of steel ties.

In the third section proper, arc-welding methods and equipment for the erection and repair of buildings, bridges, and signal towers are described. The use of arc welding to strengthen existing structures.

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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Communications

Suggestions on Riveting Practice

TO THE EDITOR:

On page 226 of the August issue, I read with a great deal of interest the answer to the question, "What grade of steel should be used for locomotive boiler rivets?"

You have made absolutely the right answer; it is absolutely after my own heart, and I can conscientiously say this after an experience in this line for forty years. There is altogether too much carelessness in picking up any old kind of a rivet and driving it into the best firebox steel. Some fabricators think because a rivet holds its place for a reasonable time it is all right for the purpose intended, forgetting all about the sulphur content, which content they are not as particular about as they are for the firebox steel plates. You could not have expressed the answer any better, and I wish to compliment you.

There is one other point which I think would lead to better workmanship, and that is closer tolerances. There is no necessity of allowing $\frac{1}{16}$-inch clearance in firebox work; $\frac{1}{32}$-inch is much better, for it produces better workmanship. Of course, the rivets should be as round and true to size as the reamed holes into which they are driven. Such ideal conditions will promote high pressures, and add to the life of the structure.

Cleveland, O. D. J. CHAMPION

Railroad Men Have a Selling Job

TO THE EDITOR:

The railroad question, past, present and future, is or should be of grave concern to every man, woman and child, who resides in this great progressive country of ours, and especially to those who have spent a lifetime, or greater part thereof, working on railroads. There are also others who have only been working on railroads a few years, and these men must eventually replace the old-timers who have more than "made their mileage" in the life of an ordinary man.

To the comparatively new men and to those who are to follow, a few remarks here may be of some value; before many years the job of maintaining and operating the great working factors of this great industry will fall on their shoulders. Along with this responsibility will be the handicap of an already keen competition of other forms of transportation in their most progressive forms.

It will take the combined genius, experience and practical knowledge of every one of us to cope with such forms of competition. We must everlastingly study this problem to devise ways and means of making savings or improvements in every department. From laborer to president every man must do more than "his bit" to save every tack, nail, rail, spike, tie, wheel, frame, car and locomotive part that is serviceable (with the proper margin of safety).

We have more than our jobs to look after. We must prepare for the next step which we all hope to take some day, not too far off. Our next superior officer must move up soon, and who is to take his place. To the man who seriously studies his problems and is broad enough to visualize those of the men above him, that man will be offered the opportunity of advancement. The one who has a new practical, progressive idea will also receive consideration. It matters not what branch of service you may be in, the welfare of your provider, "the good old railroad" must be foremost in your thoughts, if we are to continue to pioneer in safe, sane and practical transportation, as we have been doing for over a hundred years.

Had it not been for the foresight and faith of our railroad forefathers, the western part and other parts as well of these United States would still be unexplored territory. Where on earth can a person ride with more ease, comfort and safety than on our air conditioned trains, with all modern equipment, meals, as good or better than can be found in any first-class hotel at much less than the price, clean courteous service, the atmosphere of the home, lounges, big comfortable chairs, radio, soft lights and sleeping car accommodations that rival anything in the world.

In addition to the above personal travel service, the giant locomotives of today are bringing your coal in trains 150 cars long with an average of 60 to 70 tons per car from afar and depositing it in your coal bins and power stokers, a few days, and in many cases a few hours after it is ordered.

There certainly can be no doubt of the value of the service of the railways to the welfare of the nation. The need is greater today than ever before for rapid, reliable service to meet the demand for quicker turnover of all raw material and perishables and food stuffs. Modern railway service is the answer to this need. It becomes every railroad man's duty to sell this service wherever he may go, and to continue to try and convert the skeptics to the safe, sane, practical and comfortable service which our employers have to sell at a bargain. This service is maintained under all conditions of weather—it is never too cold nor too stormy for this "steed of steel" to hit the trail. Be it 100 miles, 1000 miles, or across the continent you want to go or ship goods, this service goes on regardless of handicaps.

The railroad man's job is to make this service more attractive to the public and win back the patronage which rightfully is ours. In other words, keep on making "steel rail travel" so inviting that people who contemplate pleasant journeys, business men who must get there on time, and large industry and small as well, who must have merchandise and other commodities transported, will be truly aware of the fact that the safest, sanest and most economical way is by rail.

Grand Rapids, Mich. William N. Moore,
General Boiler Foreman,
Pere Marquette.

British Investigate Cracking of Boiler Plates

To the Editor:

Scientists from all parts of the world attended the annual inspection of the National Physical Laboratory, which has just been held at Teddington, England. Great interest was shown in the boiler plate exhibit.

It has become apparent during recent years that there exist many points of resemblance between certain types of boiler-plate failure and other service failures which have been traced to corrosion-fatigue. Fatiguing action in the boiler plate at the joint would be caused by variations in stress due to differences in steam pressure and also thermal stresses such as arise when the boiler is "let down" at intervals.

A machine, designed and constructed in the engineering department of the laboratory, was exhibited which can accommodate specimens of boiler plate, welded joints and riveted joints of ¼-inch plate, 12 inches wide by 27 inches long. The specimens are subjected to repeated straining actions, while immersed in a tank containing a boiler solution of caustic soda or various salts. The experiments on plates so far completed have yielded fractures of the corrosion-fatigue type only; no evidence of failure by caustic embrittlement has yet been encountered.

London, England. G. P. Blackall.

Review of "The Modern Coppersmith"

The author of the book "The Modern Coppersmith," L. A. Voss, is a practical coppersmith who has had an unusually well rounded experience in all branches of the art. The text comprises a complete treatment of the subject beginning with a detailed discussion and explanation of the materials, tools and equipment used. A minute description is given of all processes—joining, riveting, seaming, brazing, welding, forming and finishing, pipe fitting, reducing, bending, making dome shaped tops, cup joints, taking off branches, etc.

The text is profusely illustrated, with 160 illustrations, and useful tables, 370 pages, 4¾ by 7 inches, substantially bound in flexible fabrikoid. Price $5.00 postpaid.

The chapter headings are as follows: I. Introductory; II. Sheets, Tubes, Solders, Flux; III. Tools and Fixtures; IV. Joining; V. Copper Riveting; VI. Sheet Seaming and Brazing; VII. Varnish Kettle; VIII. Jacket Kettle; IX. Dome Shaped Tops; X. Expansion Joints; XI. Cone Shaped Air Chamber; XII. Bends; XIII. Ship Ventilator; XIV. Sheet Forming and Finishing; XV. Pipe Connections; XVI. Pipe Fitting; XVII. Copper Pipe Unions; XVIII. Cup Joints; XIX. Branches; XX. Pipe Reducing; XXI. Pipe Bending; XXII. Jacketed Pipe; XXIII. Assembled and Finished Work; XXIV. Working Various Metals.

This book is published by the Sheet Metal Worker, 45 West 45th Street, New York, N. Y.

Trade Publications

Electric Instruments.—A complete catalogue of electrical instruments manufactured by the General Electric Company, Schenectady, N. Y., has been issued. Detailed information on the uses, characteristics and the prices for General Electric products in this field are included in the catalogue.

Molybdenum.—The first of a series of folders having to do with molybdenum irons and steels has been issued by the Climax Molybdenum Company, New York. The purpose of these folders is to familiarize those interested with the better types of iron and steel in which molybdenum has improved the qualities. Suggestions are made of the use of molybdenum alloys where it is known that their merits are adequate to impart a saving and make a better product.

Monel Metal and Nickel.—A new booklet on the application of Monel metal, nickel, and nickel-clad steel has been issued by the Technical Service Department of the International Nickel Company, Inc., New York. It has been prepared especially for users of industrial processing equipment. Besides giving data on the physical and mechanical properties of these materials, the booklet contains considerable miscellaneous information including instructions on the selection of suitable welding rod and other fabrication details.

Testing Welders and Their Welds.—Anyone concerned with the hiring of welders will be interested in the recent publication by The Linde Air Products Company, 30 East 42nd Street, New York, N. Y., of a 24-page illustrated booklet entitled "The Testing and Qualification of Welders." The purpose of this booklet is to outline simple tests for measuring the ability of welders, the first of the six essential steps in every Procedure Control for oxy-acetylene welding. It is pointed out that welding technique differs somewhat with the materials to be welded and with the type of joint used, so that it cannot be assumed that a man who can weld excellent joints in aircraft tubing can also do as well in 20-inch steel pipe. Separate sections of the book discuss in detail the fracture test, the bend test, the tensile test, and the observation test. To round out the booklet, a summary of existing and pending qualification tests for welding steel plate and pipe is given. This includes: the A.S.M.E. Unfired Pressure Vessel Code for both Class 2 and Class 3 welded constructions, the A.S.A. Pressure Piping Code (unofficial) and the specifications and standards covering welding of steel and wrought iron pipe of the Heating and Piping Contractors National Association.

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

State Rules for Applying Boiler Patches

Q.—What do the various leading States recommend such as Massachusetts, Ohio, New York, California, Michigan, Pennsylvania and other A. S. M. E. Code States and National Board States sanction with regard to repairing, horizontal return tubular boilers which have been bulged, (bagged), necessary to install patch or patches. C. C. R.

A.—It is the rule of the majority A. S. M. E. Code States to have a duly authorized inspector make an inspection of the boiler previous to making any repairs, the inspector advising as to the proper method of making the repairs and approving same after the completion of the work, each case being treated separately. The following States of those mentioned in the question have rules for patching horizontal return tubular boilers, as follows:

California.—The method of designing patches for return tubular boilers in the State of California is illustrated in Fig. 1.

New York.—Similar to California.

Ohio.—Fig. 2 illustrates a properly designed patch for use in this State. The rules for computing the width girthwise based on the diameter and the horizontal length of the patch, also the method of computing the

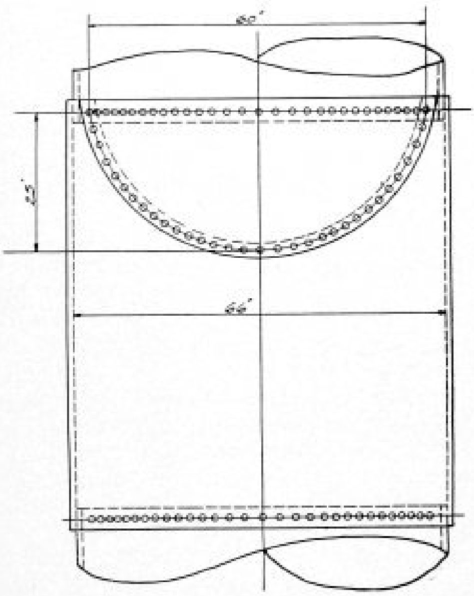


Fig. 2.—Properly designed boiler patch for Ohio

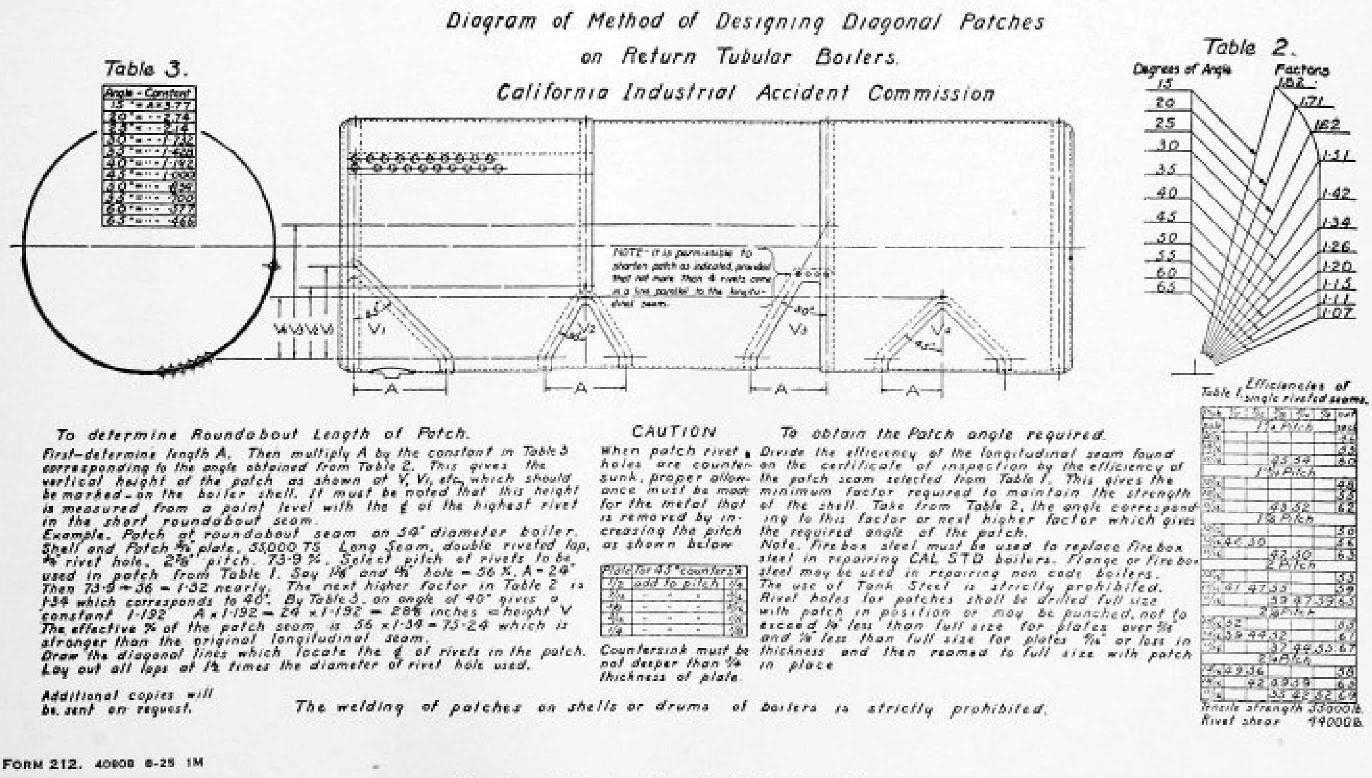


Fig. 1.—Methods of patch design in California

efficiency of the patch, are given in the Ohio Boiler Inspection Laws and Rules, and can be obtained by writing the Division of Boiler Inspection, Department of Industrial Relations, Columbus, Ohio.

Requirements for Boiler Patches

Q.—What does the A. S. M. E. Code Committee sanction in patching; maximum size, etc. Would like a sketch of a properly designed patch to meet requirements of the A. S. M. E. Committee. C. C. R.

A.—There are no rules in the A. S. M. E. Boiler Construction Code pertaining to patches, as they come within the classification of repairs. The scope of the A. S. M. E. Code Committee does not include repairing or repair items, and the Rules for that reason have not been extended to embrace repairs.

The parts of the code dealing with repairs in all cases leave the matter of repairs to a duly authorized boiler inspector, as follows:

Par. C-273. No repairs, other than those of a minor or routine character, shall be made upon a boiler except upon and in accordance with the advice of authorized boiler inspectors as required in Par. A-62 of the Appendix to the code.

A-62. Where repairs are necessary which in any way affect the working pressure or safety of a boiler, a State inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler-insurance business in the State in which the boiler is used, shall be called for consultation and advice as to the best method of making such repairs; after such repairs are made they shall be subject to the approval of a State inspector, municipal inspector, or an inspector regularly employed by an insurance company which is authorized to do a boiler-insurance business in the State in which the boiler is used.

C-277. The shell or drum of a boiler in which a typical "lap-seam crack" is discovered along a longitudinal riveted joint for either butt-seam or lap joints shall be permanently discontinued for use under steam pressure. By lap-seam crack is meant the typical crack frequently found in lap seams which extends parallel to the longitudinal joint and is located either between or adjacent to rivet holes.

C-278. Cracks caused by flexure of the metal shall be repaired by removing the part affected and replacing it with a new part as directed by an authorized inspector.

C-279. Where corrosion becomes dangerous or when cracks appear, the boiler shall be kept out of service until the affected parts have been repaired or replaced. No welding or patching shall be done except upon and in accordance with the advice of an authorized boiler inspector.

Working Pressure

Q.—What would be the working pressure on a flat head of a cylinder not taking into account the rivets or seam in any way for the following: Tensile strength of plate 50,000 pounds per square inch; diameter of head 32 inches; thickness of head 0.25 inch; factor of safety 0.5. R. H. L.

A.—Paragraph P-198 of the A. S. M. E. Boiler Code gives the following formula for computing the thickness of flat heads.

P-198. The thickness required in unstayed flat heads, which are unpierced and are rigidly fixed and supported at their bounding edges by riveted or bolted attachments to the shells or side plates, shall be calculated by the following formula:

$$t = a\sqrt{\frac{0.162\,P}{S}}$$

where t = thickness of plate in head, inches.

a = diameter, or short side of area, measured to the center of the inside row of rivets or bolts, inches.

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

S = allowable unit working stress, pounds per square inch $= \frac{TS}{5}$

TS = ultimate tensile strength, pounds per square inch, stamped on the plates, as provided for in the specifications for the material.

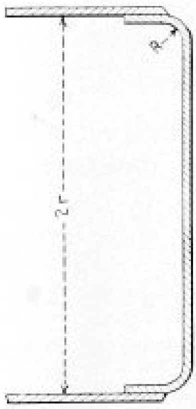


Fig. 1

The information given in the question does not clearly state how the head is applied to the cylinder. If the head is applied in accordance with the conditions of Par. P-198, the working pressure can be computed by transposing the formula for the value of P, as

$$P = \frac{S \times \left(\frac{t}{a}\right)^2}{0.162}$$

and substituting the values given in the question—$t = 0.25$, $a = 32$, $S = 10{,}000$—we have

$$P = \frac{10{,}000 \times \left(\frac{0.25}{32}\right)^2}{0.162}$$

$P = 3.76$ pounds working pressure.

Marks Engineering Hand Book gives the following formula for flat heads as illustrated in Fig. 1:

$$S\ \text{max.} = p\left\{K_1 \times \frac{R}{t} + K_2\left[\frac{r - 0.5\,R\left(1 + \frac{R}{r}\right)}{t}\right]^2\right\}$$

where

S max. = maximum stress, pounds per square inch.
R = radius of curvature of the flange, inches.
r = radius of head or attached cylinder, inches.
p = internal pressure, in pounds per square inch.
K_1 = 0.5 } For steel heads riveted to the
K_2 = 0.33 to 0.38 } cylinder.
t = thickness of plate in head, inches.

Transposing for (p) we have

$$p = \frac{S}{K_1 \times \frac{R}{t} + K_2\left[\frac{r - 0.5\,R\left(1 + \frac{R}{r}\right)}{t}\right]^2}$$

and substituting the values given in the question, assuming $R = 1$ inch, we have

$$p = \frac{10{,}000}{0.5 \times \frac{1}{0.25} + 0.38\left[\frac{16 - 0.5 \times 1\left(1 + \frac{1}{16}\right)}{0.25}\right]^2}$$

$p = 6.8$ pounds per sqtare inch allowable pressure.

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

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 — 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.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.
Executive Board — Charles J. Longacre, chairman, division boiler inspector, Pennsylvania Railroad, Baltimore, Md.

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, 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, O.

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

Cities

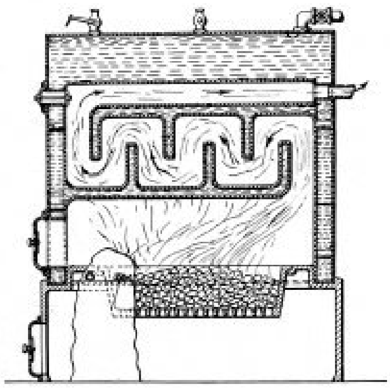
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,815,882. BOILER. LOUIS DAVIDSON, OF PHILADELPHIA, PENNSYLVANIA.

Claim.—A boiler of the character described, comprising sheet metal plates secured together in edge-to-edge relation to each other to form a chamber, sheet metal members located within and supported upon the said sheet metal plates, said members consisting of plates bent transversely

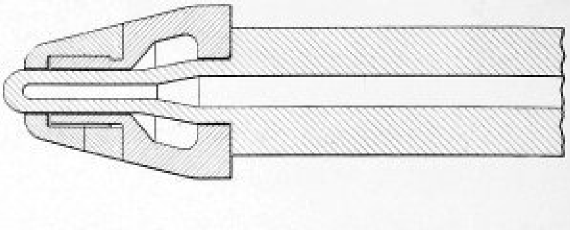


at an intermediate portion thereof, and the opposite sides of the said bent portions occupying positions in parallel spaced relation to each other and one of the sides of each of the said members being provided with hollow portions which project laterally therefrom, the spaces thus produced being adapted to hold a liquid and each of the said members terminating at one end in a depending flange and one of the said members having a horizontally extending portion located above and in parallel relation to the top side of the other of said members, the projections from the said members extending in opposite directions and in alternate spaced relation with respect to each other thereby forming a tortuous passageway through which the flames and the gases of combustion travel. Nine claims.

1,815,426. TUBE PIERCING AND EXPANDING PLUG. WILLIAM BARK, OF GARY, INDIANA, ASSIGNOR TO NATIONAL TUBE COMPANY, A CORPORATION OF NEW JERSEY.

This invention relates to expanding plugs for use in the manufacture of seamless tubes and has for its object the provision of a novel form of two-part plug designed so that the nose portion which receives the major portion of the wear may be readily replaced when worn.

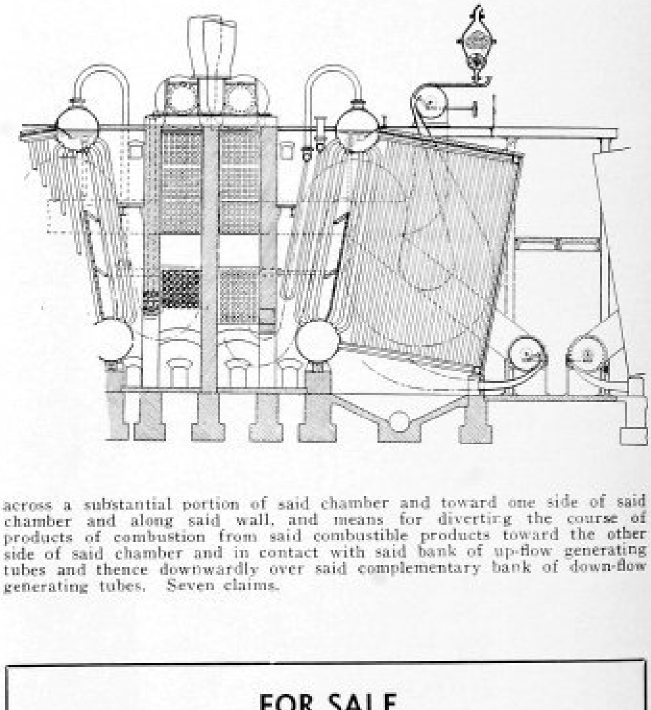
Claim.—1. The combination with a plug-bar for seamless tube machines having one end reduced forming a plug receiving shank terminating in a shoulder, of a plug mounted on said shank and abutting said shoulder,



said plug having its forward end reduced in diameter to receive a removable nose, bayonet-like slots formed in said reduced diameter end portion of said plug, and a removable nose member mounted on said reduced diameter end of said plug, said nose member being provided with lugs adapted to be locked in said bayonet-like slots by a rotation of said nose member.

1,815,086. STEAM GENERATOR. ALBERT C. WOOD, OF PHILADELPHIA, PENNSYLVANIA.

Claim.—A steam generator comprising a combustion chamber having a water cooled wall at one side thereof and a bank of up-flow generating tubes and a complementary bank of down-flow generating tubes at the other side thereof, means for discharging combustible products at an angle



across a substantial portion of said chamber and toward one side of said chamber and along said wall, and means for diverting the course of products of combustion from said combustible products toward the other side of said chamber and in contact with said bank of up-flow generating tubes and thence downwardly over said complementary bank of down-flow generating tubes. Seven claims.

Boiler Maker and Plate Fabricator

NRA
CODE
GRAPHIC ARTS INDUSTRY

A Convention Next Year

For several months consideration has been given to proposals for holding 1935 conventions of mechanical associations in the railroad field. The General Committee of the Mechanical Division, American Railway Association, at its meeting in June decided to hold a full membership meeting next year. This inspired the thought that because four years have elapsed since most department associations held their last conventions, every effort should be made to revive their activities and to obtain authority for holding meetings in 1935.

Efforts in this direction have finally materialized in action. On September 17 and 18, the International Railway Fuel Association and the International Railway General Foremen's Association held short meetings in Chicago. On September 18 representatives of the various mechanical associations, other than the Mechanical Division, A.R.A., including the Master Boiler Makers' Association, met at Chicago and decided to hold full membership meetings early next May, with a common exhibit of railway equipment and supplies.

Four of the associations, the Traveling Engineers, Air Brake, International Railway General Foremen and Car Department Officers, will hold individual, but simultaneous meetings on Thursday, Friday and Saturday, May 2-4. Four other associations, the International Railway Fuel, Master Boiler Makers, American Railway Tool Foremen and International Railway Master Blacksmiths, will meet on Monday, Tuesday and Wednesday of the following week. It was decided to hold these meetings in Chicago, with an exhibit under the direction of the Allied Railway Supply Association. The conventions are scheduled for early May, since that comes between seasons, at a time when the men can best be spared for the meetings. The central location will make it possible for a large number of members to attend the meetings with a minimum loss of time from their roads.

The assumption apparently has been that the Mechanical and Purchases and Stores divisions of the American Railway Association will hold meetings at Atlantic City in June, with an exhibit. Expressions from railway supply people rather question the desirability of putting on an exhibit if only a short meeting is to be held. There is a pronounced sentiment, also, that it might be better to hold the Mechanical Division meeting and the conventions of the other mechanical associations at the same place, so that one exhibit will suffice for all the conventions.

A number of railway supply men rather question the advisability of putting on an exhibit at a resort city, the feeling apparently being that it would cost less, both in the way of entertainment and setting up the exhibit, if it is held in Chicago, which is centrally located and where most of the railway supply companies have permanent offices or representatives. There is a question as to whether suitable quarters can be secured for such an exhibit in Chicago. These are some of the problems which must be threshed out before arriving at a final decision.

The important thing is that the various associations are taking steps to resume their activities. Changed conditions and the long lapse between meetings make it vitally important to stimulate the work of these associations and get them to function on a more constructive and aggressive basis.

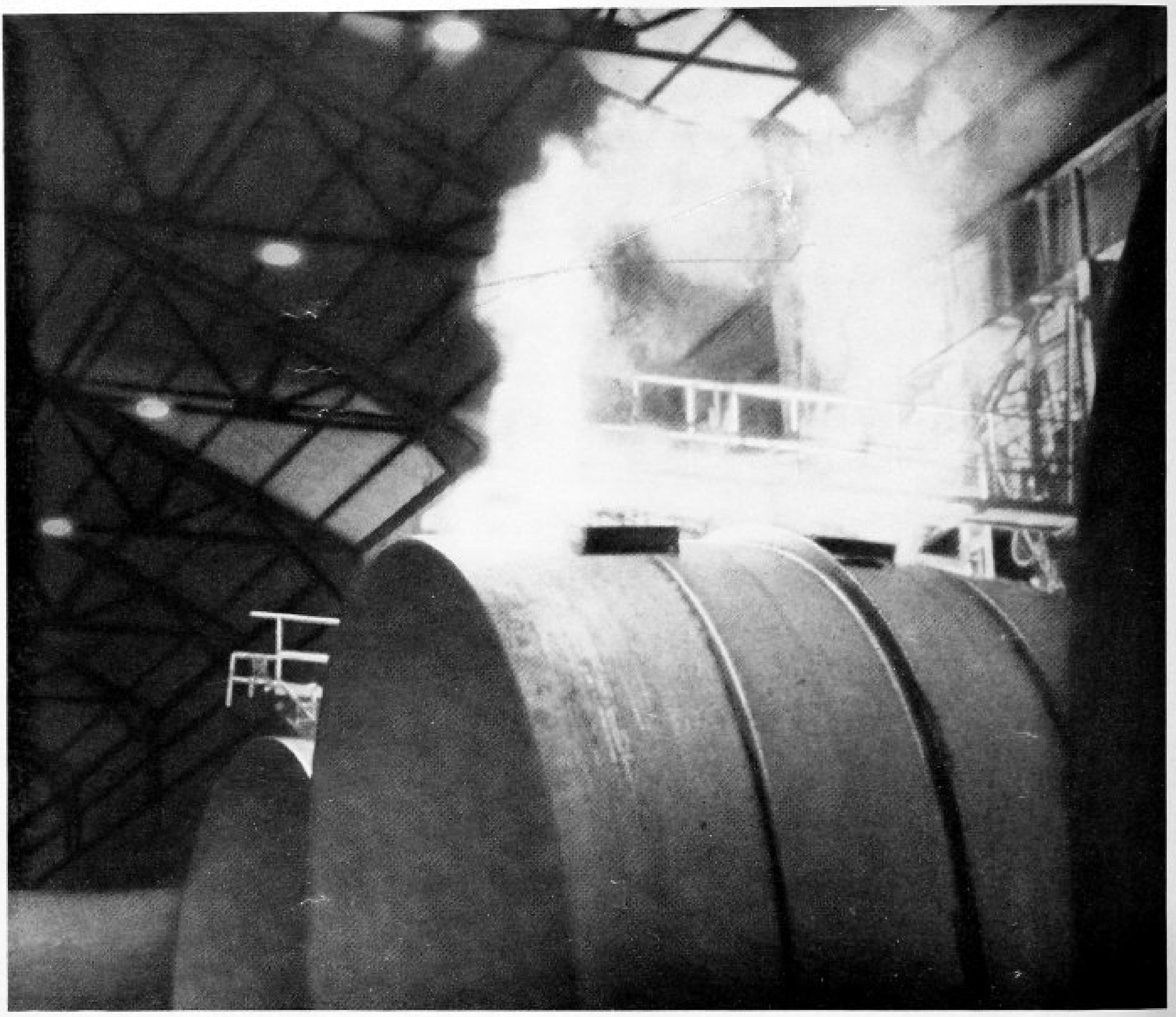
A Message to the Master Boiler Makers' Association

With a convention actually in prospect, officers and members of the Master Boiler Makers' Association should take new heart and look forward to a future of service that will be as fruitful for the organization and themselves as have the past thirty years of its history. The high state of development of the association has only been the result of the individual growth in prestige and standing of its members.

After a lapse of four years in which such tremendous changes have occurred in the industry, and because of hardships undergone by individuals of every rank, it would be strange if some difficulty were not experienced in reviving activities. Certainly conditions within the association are not as stringent as they were at the formation of the organization thirty-odd years ago. Now, while the membership may have shrunk to some extent, there is at least a favorable background on which to rebuild, that the founders did not have. In this thought should be the inspiration to go forward to greater achievements.

Every effort must be made by officers of the association to revive the morale of members who have been most seriously affected by conditions of the past few years. To this end all the influence that can be brought to bear should be exerted to insure attendance of those members who have been reduced in rank through force of circumstance. Returning business activity unquestionably will see their reinstatement and every possible encouragement should be given to them at this time.

Another matter of vital importance to the success of the 1935 convention is the arrangement of a comprehensive program of papers and discussions which will cover every phase of boiler shop, locomotive and equipment developments that have occurred since the last meeting. For this purpose committees should be appointed to work on the program and the subsequent reports at the earliest possible moment.



Development of A.S.M.E. Codes for

FUSION WELDING*

By Dr. D. S. Jacobus†

The art of fusion welding has advanced rapidly since the Boiler Code Committee of the American Society of Mechanical Engineers published Rules for Fusion Welding of Drums or Shells of Power Boilers in 1931, which rules were followed in the same year by its revised Rules for Fusion Welding of Unfired Pressure Vessels. The American Welding Society co-operated with the Boiler Code Committee in preparing these rules and continues to co-operate on all matters bearing on welding.

The formulation of rules to cover fusion welding was a long drawn out process. In March, 1920, the Council of the American Society of Mechanical Engineers requested the American Welding Society and the American Society of Refrigerating Engineers to appoint committees to co-operate with the Boiler Code Committee in the preparation of rules covering fusion welding, with the idea of incorporating these in the Boiler Code.

The question might be asked why the American Welding Society did not prepare rules independently of the Boiler Code Committee. The answer is a simple one,

* Address before local section of the American Welding Society on the West Coast.

† President of the American Welding Society and chairman of the executive committee, A. S. M. E. Boiler Code Committee.

namely, that the Boiler Code had been legally adopted by a number of states and municipalities and those in charge of its enforcement had jurisdiction over boilers and pressure vessels. Any welding rules relating to boilers or pressure vessels would, therefore, have to be passed on by the state or municipal authorities in charge of the enforcement of the Boiler Code, and as these authorities co-operate closely with the work of the Boiler Code Committee, the logical avenue of approach was through the Boiler Code Committee.

A public hearing was held by the Boiler Code Committee on December 5, 1921, at which a tentative Code was reviewed. At this meeting there were many different opinions expressed, some claiming that their welding processes were the best and the only ones that could be safely used. Realizing the need for further data before formulating rules, the American Bureau of Welding called a meeting on April 28, 1922, for the purpose of organizing the manufacturers of welded vessels to deal co-operatively with the situation. The report of the tests made at the Bureau of Standards was published in the May, 1923, issue of the *Journal* of the American Welding Society and was a most useful contribution. There, however, remained radical differences of opinion between the various interests and the Boiler Code Committee failed in its effort at that time to secure a general agreement.

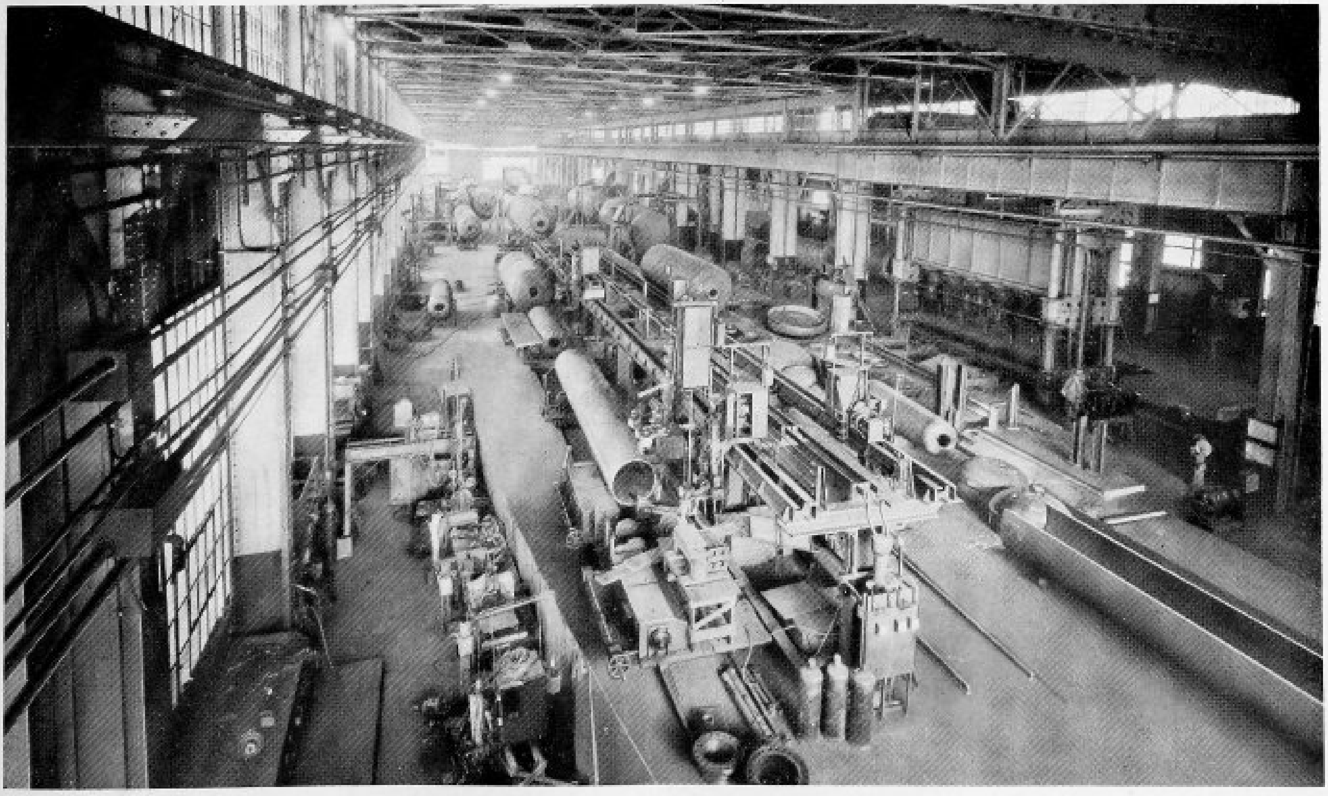
The first A. S. M. E. Boiler Code was published in 1914. This code sanctioned the use of fusion welding, then called autogenous welding, only where the stress or load was carried by other construction which conformed to the requirements of the code, and where the safety of the construction was not dependent upon the strength of the weld. From this time on the committee was urged to adopt more liberal rules, and it held a number of public hearings on the subject. The committee took the stand that it would adopt more liberal rules provided they were such as to insure safety, and asked for suggestions. As already stated, no feasible suggestions were forthcoming and there was a wide variation of opinion as to what the rules should be.

The committee was criticized by many interested in welding, including prominent members of the American Welding Society, for its conservative attitude, and it many times reiterated its statement that it would be glad to sanction more liberal rules provided they would insure safety. It finally became necessary for the Boiler Code Committee to prepare a set of rules for fusion welded unfired pressure vessels in order to check accidents which were occurring through the bursting of such vessels. Such a code was issued in 1927 without the approval of the American Welding Society. The maximum unit stress allowed, based on the thickness of the shell, was 5600 pounds per square inch, and the use of fusion welding was limited to the following vessels:

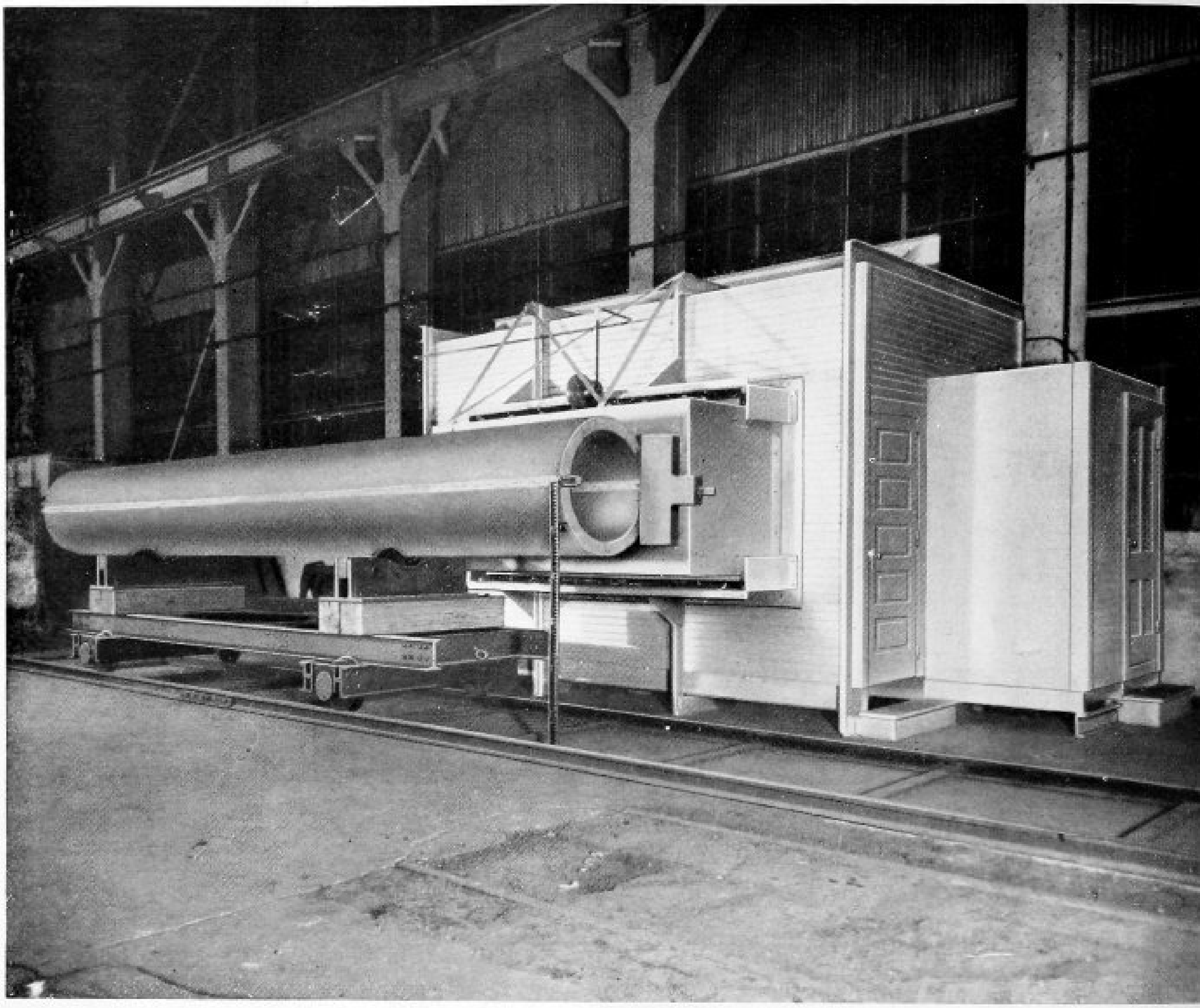
a. Air vessels, when the diameter does not exceed 20 inches, the length does not exceed 3 times the diameter, and the working pressure does not exceed 100 pounds per square inch.

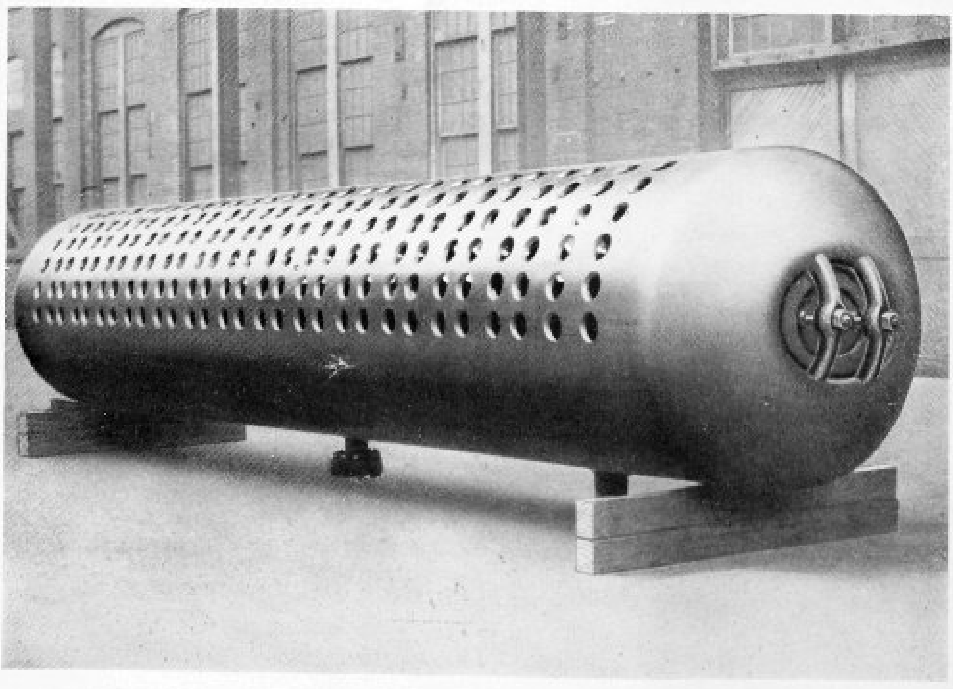
b. Other vessels, under these rules, in which the circumferential joints only may be welded, when the inside diameter does not exceed 48 inches, or 72 inches when at least 75 percent of the load on a flat head is supported by tubes or stays.

It is interesting to note that in the 1927 issue of the Unfired Pressure Vessel Code both the term "autogenous welding" and the term "fusion welding" are used. The term fusion welding was first used by the Boiler Code Committee in a program which listed certain matters for discussion which was prepared for one of the numerous hearings. In this program the Thompson process of electric resistance welding was referred to as a process of electric fusion welding. After the hearing some of those interested in what had been called autogenous weld-

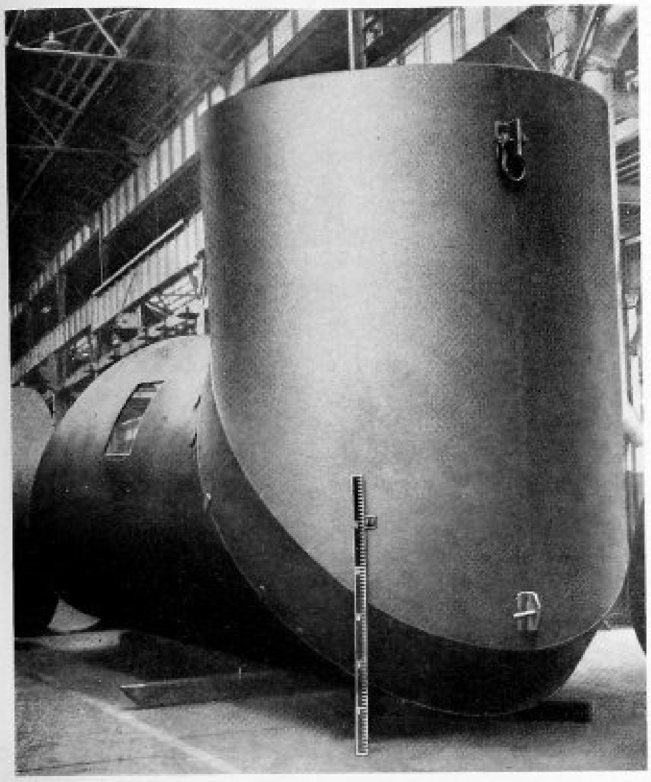


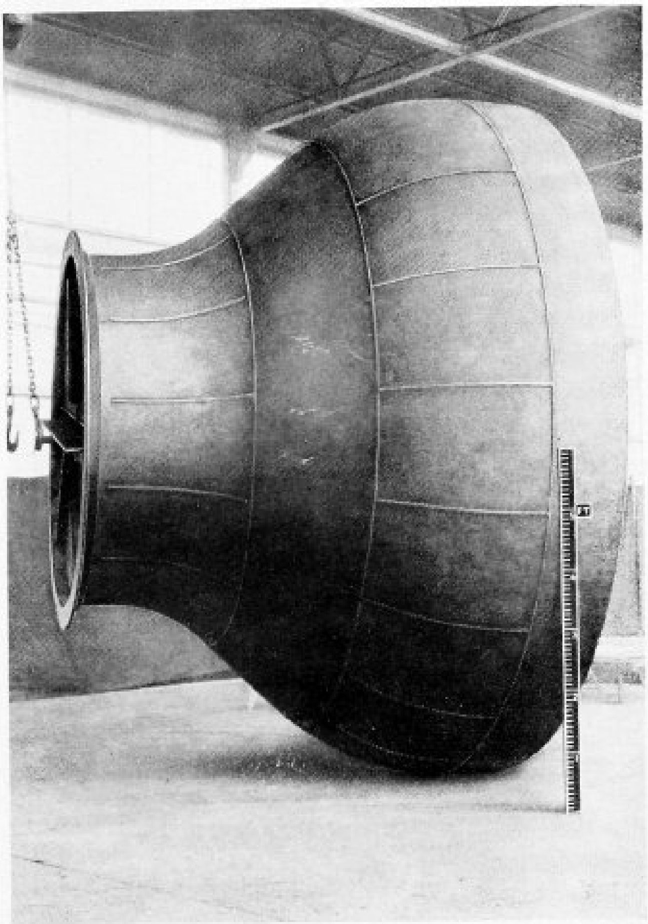
Barberton, O., plant of Babcock & Wilcox where pressure vessel welding is conducted



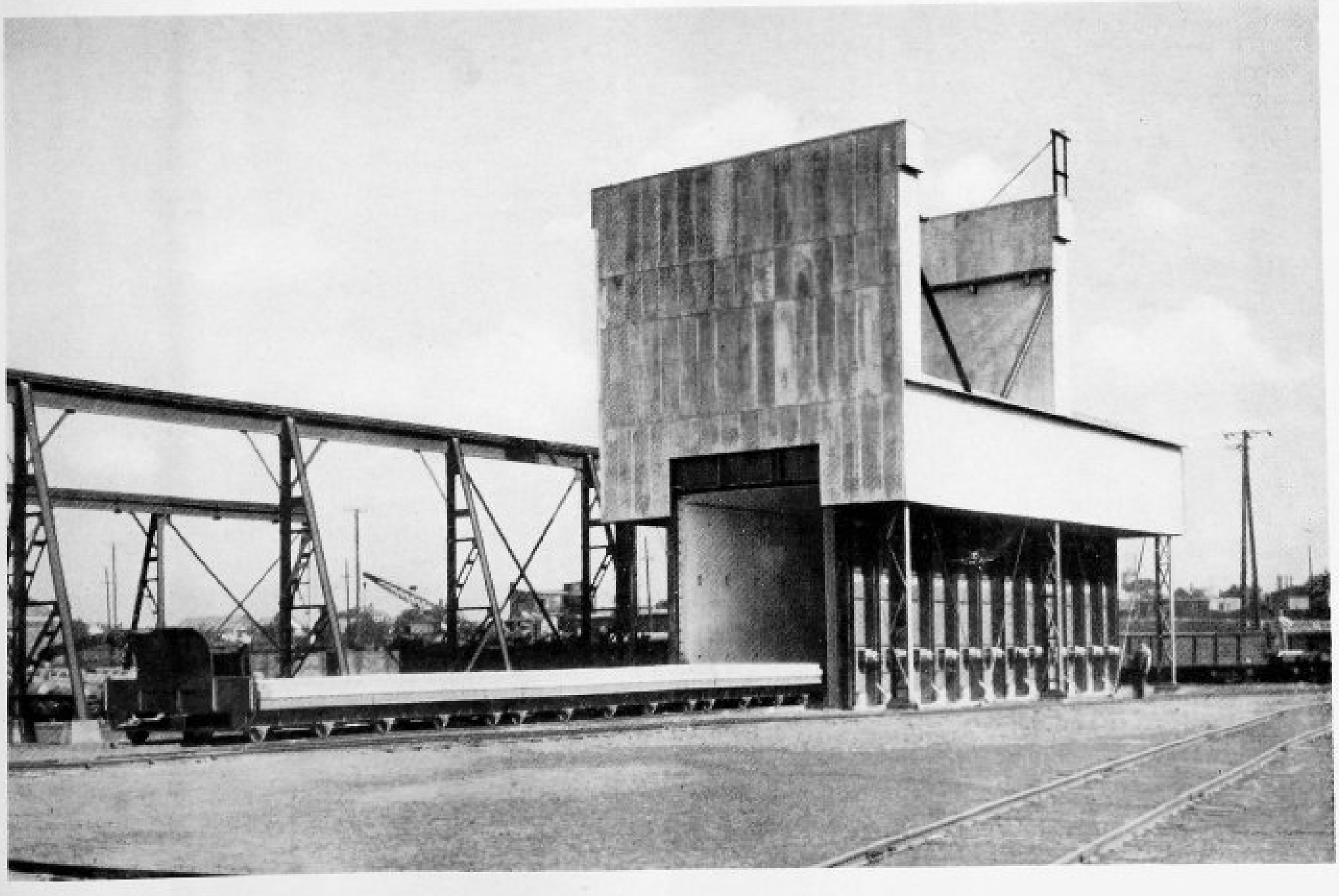


Above is shown X-ray equipment of 300,000 volts capacity, which will explore, on a production basis, fusion-welded seams up to 4¾ inches thick. At the left is a fusion-welded boiler drum





Two views of elements of a wind tunnel for aircraft experimental work. Below is the huge furnace at Barberton for stress relieving welded products



ing proposed that its name be changed to fusion welding, and this was agreed to by the Boiler Code Committee.

After the issuance of the 1927 edition of the Unfired Pressure Vessel Code, the committee continued to be criticized by many interested in welding for its conservative attitude, and it many times reiterated its statement that it would be glad to sanction more liberal rules provided they would insure safety. The welding interests failed to get together, however, and suggest any rules which were suitable for the purpose.

Those interested in welding in the State of California communicated with the American Society of Mechanical Engineers with the idea of inducing the Boiler Code Committee to allow higher stresses. After considerable discussion, during which a representative visited the Pacific Coast, the Boiler Code Committee sanctioned a set of stresses which were used in the Air Pressure Tank Safety Orders issued by the State of California, effective January 1, 1928. The stress for butt double-V longitudinal welds was 8000 pounds. The stress for butt single-V longitudinal welds for material of a thickness of less than ¼ inch was limited to 5600 pounds per square inch. The stresses agreed to between the Boiler Code Committee and the State of California were embodied in the Unfired Pressure Vessel Code in August, 1930, and the limiting inside diameter for air vessels with longitudinal seams was raised from 20 to 60 inches, and the pressure from 100 pounds per square inch to 200 pounds per square inch.

The use of air tanks over a number of years constructed as specified in the California Orders and in the A. S. M. E. Unfired Pressure Vessel Code has shown that the low stress values provide a safety element which was not foreseen, which is that the tanks will corrode through at local points and leak, and in this way fail without exploding. This is such an important safety element that it should be retained where air tanks are used under conditions which may lead to failures through corrosion.

The Boiler Code Committee was pressed harder and harder in the effort to obtain more liberal welding rules. In order to make its position plain, it prepared a statement in 1928, which was approved by the Council of the A. S. M. E., saying that the committee would be justified in publishing rules which would be generally applicable, even though they could be met only by a single manufacturer under some patented process, whereas it could not sanction the use of tanks made by any particular manufacturer to the exclusion of others except through a general rule of the sort. The statement emphasized the fact that any rule embodied in its code should be such that it would eliminate unsafe tanks.

At about this time representatives of the American Welding Society arranged for a conference with the executive committee of the Boiler Code Committee. These representatives said that they had become convinced that the conservative attitude of the Boiler Code Committee had been warranted, as most of the welding practiced at the time the rules were written was of a relatively brittle and uncertain nature. The use of more ductile and carefully controlled welding had resulted in far greater safety, and it was proposed that from then on the American Welding Society co-operate with the Boiler Code Committee in the formulation of more liberal rules. This offer was gladly accepted, and from that time to the present the American Welding Society has co-operated in the preparation of all welding rules.

One of the first undertakings was to recommend a series of tests to be made at the Bureau of Standards in Washington which, if met by fusion welded vessels, would convince the Boiler Code Committee that the welding could be used for such purposes as the drums of power boilers. The proposed tests included so-called breathing tests, where the vessels were subjected to intermittent pressures and other tests to demonstrate the integrity of the welds. After agreeing on the tests to be made it was found to be impossible to obtain the necessary subscriptions to defray the expense, and the project was therefore abandoned.

The Babcock & Wilcox Company finally decided to make tests along the lines of those which had been proposed for the Bureau of Standards. These tests were conducted at Barberton, O., under the direction of Professor H. F. Moore, of the University of Illinois. A preliminary report of these tests was published on September 5, 1929, and the complete results were presented at the semi-annual meeting of the A. S. M. E. in Detroit in June, 1930. These tests demonstrated the dependability of properly made fusion welds and established the working stresses which could be safely used. Several non-destructive tests of the fusion welds were investigated and the X-ray found to be the best for the purpose.

The results of these tests and a copy of specifications for Electric Arc Welding of Pressure Vessels proposed by The Babcock & Wilcox Company were transmitted to the Boiler Code Committee on September 17, 1929. On the basis of the test results and the proposed specifications and recommendations secured from a number of sources, and with the co-operation of the American Welding Society, the Boiler Code Committee published Proposed Specifications for Fusion Welding of Drums or Shells of Power Boilers in the March, 1930, issue of *Mechanical Engineering*, and shortly thereafter a complete revision of the fusion welding rules of the Unfired Pressure Vessel Code. In August, 1930, the Bureau of Engineering of the Navy Department issued specifications for fusion welded drums, including the requirement that all main seams be X-rayed, and a number of steam and water drums for boilers for marine service were constructed under them for the United States Navy. This gave an impetus to the use of fusion welded boilers, and from that time on the use of fusion welding has advanced so rapidly that practically all boilers which are now constructed for high pressures and high duty service are fusion welded.

The use of the X-ray examination in making non-destructive tests of welds was a turning point in the development of fusion welding, as it caused the safety of the welds to be less dependent on the human element. Experience has shown that one of the greatest assets of the X-ray examination is in helping the manufacturer to develop a technique which will assure sound welds and in keeping the work in his shop up to a high standard.

It will be evident on considering this brief history of the development of the Rules for Fusion Welding given in the A. S. M. E. Boiler Code that many took part in assisting in the preparation of a set of rules. This required over ten years, during which the art of fusion welding was rapidly advancing. The rules as they now stand are still incomplete, as they cover only drums or shells of power boilers and certain specific constructions sanctioned by the code. We should not lose sight of the fact that we still do not know everything about fusion welding, and we should all work together in an endeavor to make the rules more complete and inclusive.

The American Welding Society was requested by the Committee to Co-ordinate Marine Boiler Rules to prepare rules for fusion welding which would be particularly adaptable to marine service. The Committee to Co-ordinate Marine Boiler Rules was organized December 27, 1929, at the suggestion of the Hon. R. P. Lamont, then Secretary of Commerce, to harmonize the results of previous efforts toward the same end in order to serve as the basis of a revision of the Rules of the Steamboat Inspection Service and the American Bureau of Shipping.

On December 19, 1931, a subcommittee of the Committee on Welding in Marine Construction of the American Welding Society started the work of preparing a set of fusion welding rules for marine use which were based on those in the A. S. M. E. Power Boiler Code, and through the co-operation and a special action of the American Welding Society these rules were approved by its Board of Directors, January 5, 1932. This was certainly a record for speed in the preparation and approval of important rules of the sort, haste being necessary in order that they might be available for inclusion in the first report of the committee. The Rules for Fusion Welding given in the report of the Committee to Co-ordinate Marine Boiler Rules have been modified from those prepared by the American Welding Society in order to meet the requirements of the Steamboat Inspection Service, and the co-ordinating committee believes them to be the best available for the purpose.

Another set of welding rules is embodied in the A. P. I.-A. S. M. E. Rules for the Design, Construction, Inspection and Repair of Unfired Pressure Vessels for Petroleum Liquids and Gases, which are sponsored by the American Petroleum Institute and the American Society of Mechanical Engineers. The Joint A. P. I.-A. S. M. E. Committee was appointed in December, 1931. The welding rules in this code have been brought thoroughly up to date by making a study of all previous codes and a large amount of operating data and results of scientific tests contributed by the petroleum industry.

The reason for outlining the development of the Rules for Fusion Welding of Boilers and Pressure Vessels is to show the possibility of what can be done by all of us co-operating in the future. In the early days when the various interests were fighting each other no progress could be made. It should be borne in mind that we have only started on our way in the perfection of fusion welding and its use, and if we all work together from now on we can obtain that goal more quickly and thereby benefit the profession at large. For example, the question of what vessels or structures should be stress relieved after welding is still a controversial one, and much is being done in the way of research to determine the stresses at and near the welds. Again, new materials, such as alloy steels, are being developed, many of which are being welded, whereas there are no rules to cover the greater part of such welding. Some of these alloy steels are used to resist corrosive conditions, such as those encountered in chemical works and the like and under conditions where their high unit strength at high temperatures and lack of excessive brittleness at low temperatures makes them suitable for conditions which could not be met with plain carbon steel. The problem of lining vessels with corrosion-resisting metal is another one demanding attention. These are only a few of the problems confronting the welding engineer. We certainly, as already stated, have a lot to learn, and it has been said that progress in fusion welding has not advanced over 25 percent of what will ultimately be accomplished.

The only rules so far discussed are those bearing on the welding of boiler drums and unfired pressure vessels as covered by the A. S. M. E. Boiler and other Codes. These are not the only rules that have been and are being formulated, and they cover only a small part of the work that is being done. Rules are needed in other fields, such as in bridge, building, and ship construction, the replacement of castings by welded plates, the welding of piping, gas cutting, and many other developments. A great deal of work has already been done in preparing rules covering these fields, and a proposed American Standard Code for Pressure Piping which includes welding rules will shortly be issued by the American Standards Association.

Trained designers and inspectors are needed as well as trained men to do the welding. The procedure in welding should be carefully worked out by those in charge and not left to those doing the welding. The ease with which repairs can be made opens up a broad field, but unless the work is most carefully regulated accidents are bound to happen. There is a great need for standardizing the rules for tests to qualify operators of welding equipment, and our society is now working actively in an endeavor to formulate a set of such rules for universal use, in which it needs all the help that can be given by its sections and membership.

We are all vitally interested in solving the problems now at hand. One way of doing this is by inducing those interested in welding to join the American Welding Society to co-ordinate effort and assist in the work of developing standards. It has often been said that one cannot obtain any more benefit from a society than he is willing to contribute, and if we all work in this spirit we will do much in advancing our profession.

With the normal and expected general improvement in business conditions, and with the co-operation of the present membership of the society, its growth during the next year or two should be very large, but each member should remember that it is his society and that he has a real responsibility in helping to advance this growth. We have a golden opportunity; let us embrace it and make our society the world leader in everything that bears on welding.

Why Should Railroads Buy New Locomotives?*

With thousands of existing locomotives idle for lack of traffic or need of repairs, the query as to why railroads should buy new locomotives at this time is logical and entitled to an answer.

It is not generally appreciated that an abnormally high percentage of existing locomotives are physically old and economically obsolete.

About 59 percent of all locomotives on public service railroads are more than 20 years old. About 88 percent are more than 10 years old, and this proportion has been gradually increasing.

The period since 1920—and particularly the past decade—has been marked by the greatest progress in the development of locomotive design and manufacture. The outstanding characteristic of the modern locomotive is its sustained hauling power at speed, with economy of coal and water. At 30 miles an hour and up, the locomotive of today is capable of hauling approximately twice as much as locomotives of equal starting power built 10 to 15 years ago.

New locomotives should therefore be bought to secure, in much larger degree than at present, the advantages of the development of the locomotive art in recent years.

The high percentage of locomotives more than 10 years old has another drawback besides obsolescence of design. During the past three years we have analyzed the repair costs of more than 10,000 locomotives, covering more than 25,000 locomotive years. These studies

* Reprint of an advertisement which appeared in the Special NRA Supplement to *The United States News*, March 16, 1934.

show that there is an inexorably rising cost of repairs with the increasing physical age of locomotives. On a locomotive 20 years old the cost of repairs per unit of work done will be nearly twice what it would be on an identical locomotive only three years old, and more than four times what it would be on an identical locomotive just installed in service.

New locomotives should therefore be bought to hold down the cost of repairs and to increase the profit of railroad operation.

Changing traffic requirements have produced additional obsolescence. A general speeding up of railroad service has been going on for ten years, and the end is not yet in sight. The locomotive requirements for such service are high boiler capacity and big drivers. Many old locomotives may have the big drivers, but it is impossible to give them the necessary boiler capacity. Many newer locomotives have better boiler capacity, but not the large drivers required by present and future speeds.

New locomotives should therefore be bought to still further enhance the competitive ability of the railroads to furnish transportation at modern speed requirements.

The reported surplus of available locomotives on our railroads is largely illusory. The Federal Co-ordinator of Transportation had an examination made of the stored surplus locomotives reported available for service as of October 1, 1933. Out of a reported surplus of 5549 locomotives, 80.1 percent were more than 13 years old, and therefore lacked in various degrees the efficiency and economy of modern locomotives. Of this apparently large surplus, we estimate that only about 800 locomotives were capable of efficient and economical main line service under present conditions. A very moderate increase in traffic, or even a period of prolonged bad weather, could make the real locomotive surplus disappear in a short time.

In the year 1934 our railroads must spend considerably more money on locomotives than they did in 1932 or 1933. The only question is how it shall be spent.

Existing modern locomotives out of service because in need of repairs should be and are being repaired; but new locomotives should be bought instead of repairing physically old and obsolete locomotives.

The costs which revolve around the maintenance and operation of locomotives normally constitute at least one-third of railroad operating expenses. The economies of substituting new modern locomotives for old and obsolete ones are so great that new locomotives frequently pay for themselves in a very few years.

Few fields of investment for either public or private funds offer an equal certainty of more than paying their way.

We have confined our statements to locomotives; but in varying degree what we have said above is applicable to new railroad equipment generally.

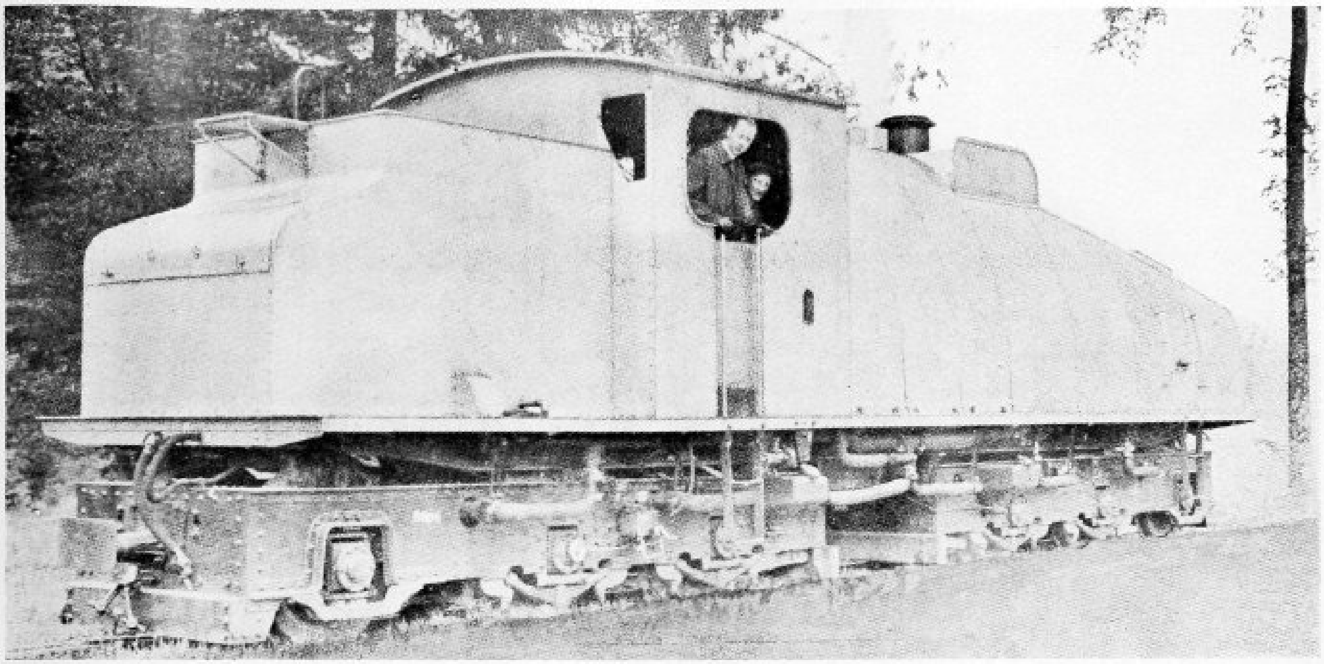
A Trend in Locomotive Development

It is probable that the German State Railways have had more experience in the operation of steam locomotives which depart radically from the time-honored type both as to boiler construction and in the method of converting the energy in the steam into useful mechanical work than have the railways in any other country. This experience has included turbine locomotives, high-pressure locomotives, and locomotives burning pulverized coal. Excepting the pulverized-coal locomotive, which included the conventional boiler, these developments all concentrated on improving the thermal efficiency. Parallel with these experimental developments has been a sustained development of standard locomotives of conventional type with a view to producing a locomotive of good operating characteristics rather than one of unusual heat economy.

It is, therefore, significant that the trend in thought with respect to locomotive development in Germany now appears to be swinging in the direction of intensive development of standard types of locomotives rather than the development of experimental types necessary for the high pressures and temperatures on which major improvements in thermal efficiency depend. Prof. H. Nordmann in a recent article in the *Zeitschrift des Vereines Deutscher Ingenieure*, reviewing a series of tests to determine the performance of the most modern standard locomotives and how far an increase in thermal efficiency can be carried within the limits of pressure and temperature associated today with the standard type of boiler construction, points out that the cost of fuel amounts to only about 21 percent of the total cost, including capital charges, repairs and wages. A further consideration which has detracted from the prospects of experimental types of locomotives has been the relatively low availability and the fact that engine failures are particularly undesirable at the present time in view of the keen competition offered by other means of transportation. For these reasons the author states that the attractiveness of radically new types of locomotives has decreased materially and, while such developments will not be discontinued completely, they have little chance to progress at the present time.

First cost and maintenance are items of such importance in determining the ultimate economic value of a locomotive that improvements in thermal efficiency and, hence, fuel economy, which effect major increases either in first cost or the cost of repairs, are looked at askance by railway men in America as well as in Germany. In the first place, there is the uncertainty as to whether a certain improvement in thermal efficiency will result in a corresponding increase in fuel economy under everyday operating conditions. Again, there is the uncertainty as to what maintenance costs will prove to be. Probably one of the strongest factors in causing hesitation to deal with locomotives in which radical departures have been made from conventional types of construction is the uncertainty as to reliability which is of no less importance in America than in Germany.

The changes which have been introduced in locomotive construction in recent years have been aimed as much, if not more, at effecting reductions in maintenance and increases in reliability as at improvements in thermal efficiency. American experience, indeed, has proved that practical fuel economy depends in as large measure on proper supervision of the selection, handling and firing of coal as on the thermal efficiency of the locomotive itself. As the result of the intensive campaign for fuel economy during the past twenty years the cost of fuel has become a relatively less important factor in the total cost of locomotive operation than has the cost of repairs. The present situation, therefore, would seem to call for concentrated attention on reducing the cost of repairs. This involves the design of locomotives, but it also calls for attention to organization, methods and facilities for economical repair processes as well.



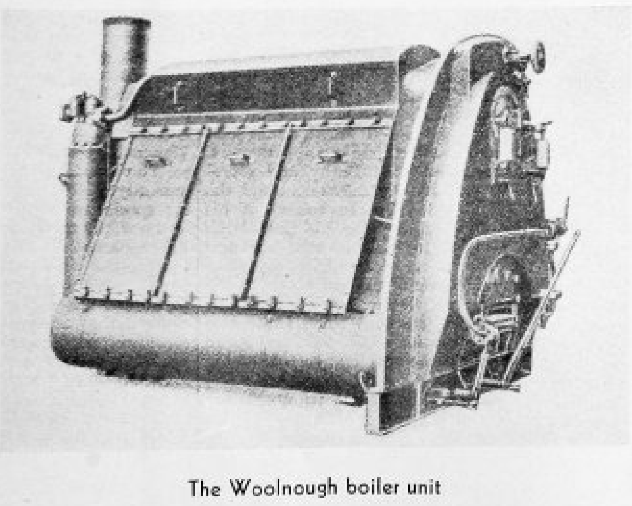
General view of the Sentinel locomotive

Multi-engined locomotive equipped with

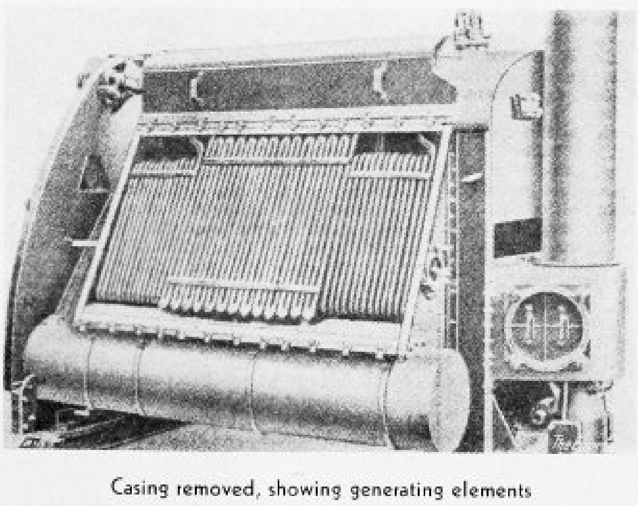
THE WOOLNOUGH BOILER

As a matter of interest, the development of an unusual locomotive design in England, featuring a Woolnough watertube boiler has been made available through information supplied by *The Engineer*. Three of these multi-engined locomotives have been built at the Shrewsbury plant of the Sentinel Waggon Works, Ltd., to the order of the Societé National de Chemins de Fer en Colombe, South America. These three locomotives, which are all precisely similar, are of exceptional interest owing to the departure that has been made from traditional locomotive practice. They are intended for heavy haulage work on a railway with steep gradients and curves of small radius, and are, we understand, to be the prototype of a number of similar locomotives on two, three, and four axles. For this reason the various parts have been standardized as far as possible.

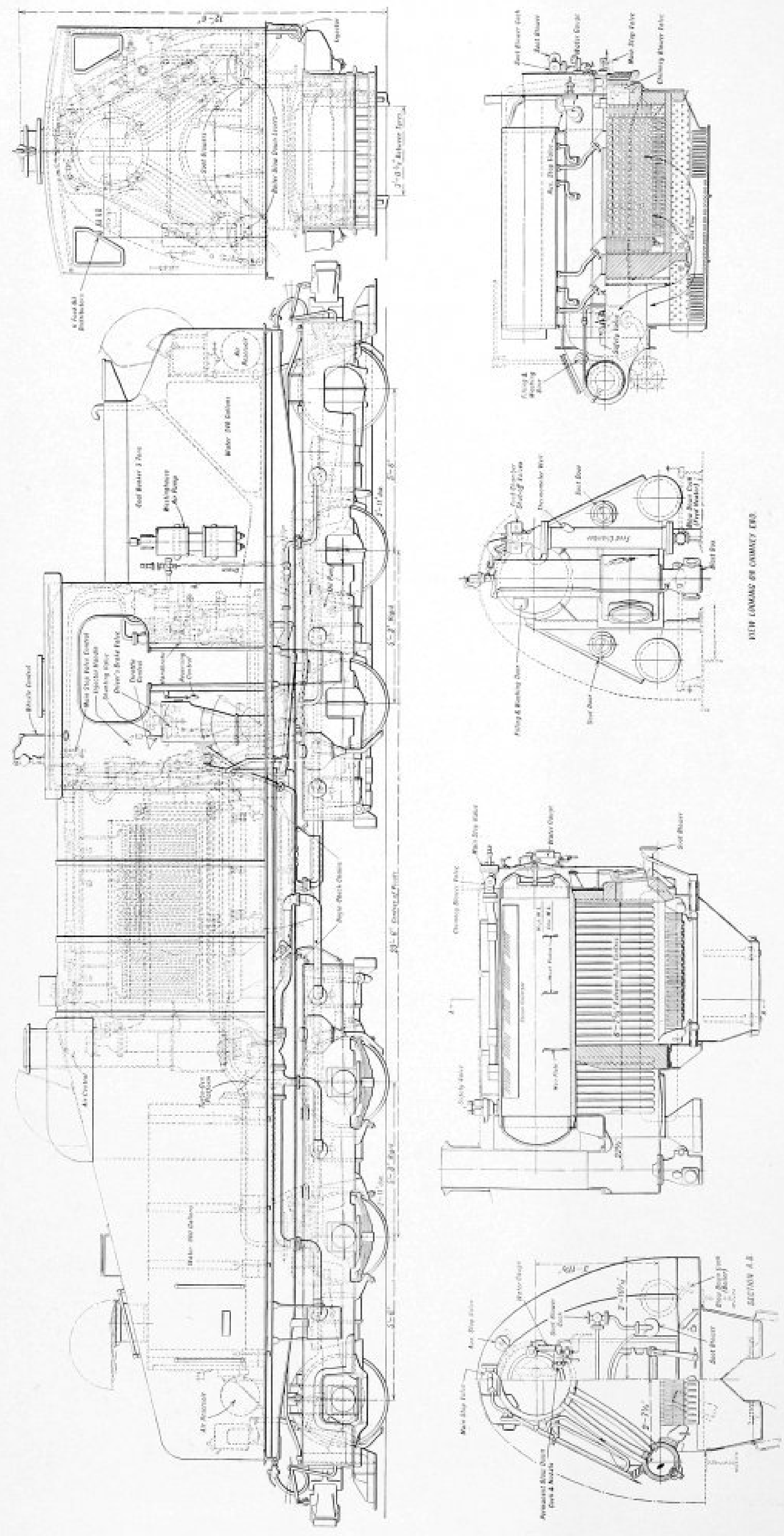
In this particular locomotive a six-axle arrangement was adopted for two reasons. The Colombian railways are built with light-gage rails, so that axle loadings must be kept down. At the same time, the severe gradients require that the locomotives shall be able to exert a high tractive effort. Since on these machines every axle



The Woolnough boiler unit



Casing removed, showing generating elements



Elevation and plan of Sentinel locomotive for Colombia

drives, a multiplicity of axles became desirable, not only to spread the weight, but also to obtain the high tractive effort. There are no coupled wheels; all the axles are accommodated in bogies; and visible cylinders and valve gear are conspicuous only by their absence. Moreover, the stack appears to rise from the very center of the boiler.

The illustrations indicate the wide departure from conventional design. The peculiar arrangement is made possible only by the unusual type boiler installed. As noted this is of the Woolnough water-tube type and, compared with the ordinary smoke tube locomotive boiler, is very short in length. Beyond it at the leading end of the locomotive there is space within the outer casing to accommodate a large water tank, and further forward still there is an air reservoir for the Westinghouse brakes, and parts of the sanding gear. The arrangement behind the cab is more normal. There is a coal bunker and another water tank. So much for the general features of the body. The boiler supplies steam to six high-speed double-acting compound engines mounted in the bogies beneath the frame, each driving one axle through gearing. The bogies have a three-axle arrangement and the leading axle of the front bogie and trailing axle of the rear bogie are carried in Bissel trucks, so that curves of small radius may be negotiated safely.

The Woolnough boiler has three drums. The two lower drums are disposed one on each side of the grate and are connected by banks of tubes slightly curved and inclined at a steep angle to a steam drum centrally placed above the grate. At a point about two-thirds along the length of the boiler a firebrick wall 9 inches thick closes the space between the three drums and the banks of tubes and so forces the products of combustion to travel outwards through the tube banks. In the space between the tube banks and the boiler casing the superheater tubes are so situated that, while they can freely absorb heat from the gases, they also protect the boiler casing from the heat. From this space the gases, having circled around the ends of the firebrick wall travel back through the tube banks to the smokebox, from which they are ejected up the chimney by the exhaust blast or the steam blower. The air for the combustion of the fuel is drawn in through balanced louvres in the partition between the smokebox and the front water tank and passes outside the boiler casing and within the external casing of the whole around the boiler to the ash pan. By this means the boiler casing is kept cool and the combustion air preheated, use being thus made of heat which would otherwise be lost by radiation. The balanced air louvres are arranged to open proportionately to the amount of vacuum induced by the blast and to close automatically when steam is shut off.

The grates are made in two similar parts, each of which is mounted on a longitudinally arranged trunnion. Each half is independently operable from the foot-plate and the arrangement allows the fire to be easily cleaned or dropped into the ashpan. Some general particulars of the boiler are as follows:

Heating surface:

Generating tubes	344 square feet
Superheater	145 square feet
Total	489 square feet
Grate area	16.6 square feet
Working pressure	550 lb. per sq. in.
Length of top drum	about 9 feet
Length between extreme tube centers	6 feet 7¾ inches
Height, centers of drums	3 feet 11½ inches
Diameter of steam drum, external	2 feet 3 inches
Diameter of water drums, external	1 foot 2 inches

In operation with hard feed water the greater part of the solids, it appears, is precipitated in the feed heater, which is of the Gresham and Craven type, and consists of two check valves for the injector and feed pump respectively, combined with delivery cones. Through these cones the feed water passes into a chamber connected with the steam space of the boiler and the force of the discharge is such as to mix the steam and water so intimately that the latter is heated up almost to the temperature of the former. Before entering the boiler proper the feed water is allowed to stand for a short while in a settling chamber, in which a large proportion of the solids is precipitated out. A blow-down cock is, of course, fitted to this chamber. All the solids, however, are not removed. The water enters the top drum of the boiler at the end remote from the furnace, and it is believed that a very definite circulation exists, the water traveling downwards from the back of the steam drum through the tubes around the smokebox, where the flue gases are coolest, and returning upwards to the top drum through the tubes surrounding the grate.

Certainly the rapid steaming qualities of the boiler suggest that some such active circulation exists. As a result of this circulation, which incidentally is encouraged by the provision of a weir plate in the top drum, those solids which have not already been deposited in the feed heater settling chamber are thrown out in the water drums at the end remote from the fire. It is recommended that the boiler should be blown down twice a day. If water containing nitrates must be used it is considered essential that the water should be treated either before the tanks are filled or alternatively actually in the tanks. Where less corrosive waters are concerned treatment is considered advantageous but not essential.

It is obvious that when a boiler is likely to be fired with several grades of fuel, some good and some bad, the amount of draft and combustion air required will vary. The amount of combustion air drawn in is automatically regulated by the inlet louvres according to the vacuum induced by the blast, while the size of the nozzle of the latter is variable and can be altered from within the cab. Steam soot blowers controlled from the cab are also provided for keeping the exterior of the boiler tubes clean.

First Stainless Steel Brew Kettle

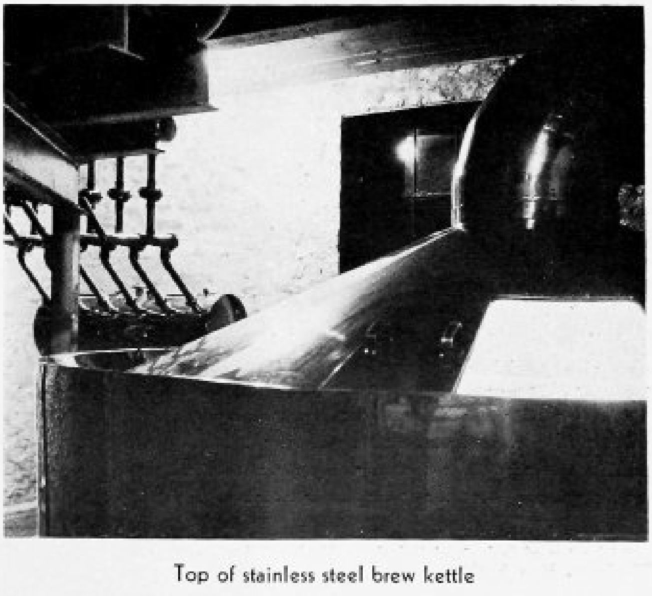
The stainless steel brew kettle in operation at Weber-Waukesha Brewing Company, Waukesha, Wis., is the most outstanding development in brew kettle construction since repeal, and is an important contribution to brewery sanitation. The first stainless steel brew kettle built in America, this unique vessel has attracted national attention.

Gleaming as lustrous silver, this kettle, highly polished inside and out, enhances the beauty of the brewery, and is Weber-Waukesha Brewery's guarantee of producing a clear, sparkling beverage free from contamination or impurities. Stainless steel imparts no off-flavor to beer, neither does it affect color, odor, or body. Interior of kettle is not coated. The mirror finish is permanent throughout the solid stainless steel.

More than eight months service has proven its superiority in efficiency and sanitation. Only one and one-half to two hours is required to complete the brewing operation, effecting an appreciable saving in fuel. The highly polished exterior surface has an extremely low coefficient of radiation which helps to reduce steam consumption.

Fabricated from No. 10 gage alloy metal (18-8) this stainless kettle is of all welded construction, insulated with magnesia block, and equipped with alloy metal fittings. The heating element consists of a three-ring, low-pressure stainless coil.

The Cream City Boiler Company, Milwaukee, Wis., fabricated the above equipment from Allegheny metal.



Top of stainless steel brew kettle

Eye Protection in Industry

*By Louis Resnick**

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 employees 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 employee'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 costs 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, employees 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.

What are the eye hazards of industry? Briefly, they are the accident hazards, the disease hazards and the hazards of excessive eye fatigue. The accident hazards are produced chiefly by flying chips of metal, wood, rock or other hard substances; by falling or throwing tools, raw materials and other large objects; by the splashing of molten metal or injurious chemicals. Disease hazards affecting the eyes with which industry is or should be concerned are the venereal diseases, trachoma, cataract, nystagmus and the general toxic effects of those poisonous chemicals commonly used in many industries which may affect the eyes as well as other organs. The hazards of excessive eye fatigue are those due to insufficient light, too much light (glare), flickering light, or too long neglect of eye conditions requiring refraction or other corrective measures.

The accident hazards are, of course, the most serious of all these. 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.

The National Society for the Prevention of Blindness has recently undertaken the formulation of a self-appraisal for safety engineers and other executives concerned with the conservation of vision in industry. This appraisal form may, in many plants, provide the basis of a program for 100 percent eye protection. Only the plant which can answer affirmatively each question in the self-appraisal pertinent to its line of operation can truly be said to be doing a thoroughgoing job of safeguarding the sight of its employees. Even these items, however, do not completely cover all that it is possible for an industry to do for the protection of the eyes of its workers.

Too often it is assumed in certain plants that if goggles have been provided, if signs and bulletins have been posted, if books of safety rules have been distributed and orders issued to foremen concerning their responsibility for accident prevention, the whole job of eye protection has been done. If the self-appraisal form does nothing more, it will at least show how far wrong this notion is.

This appraisal—especially when it incorporates the many constructive suggestions that are being made for its improvement—should enable the individual safety engineer or plant manager to find out exactly where his property stands in comparison with the ideal in the matter of protecting the eyes of the company's employees. It should enable those responsible for accident prevention to formulate immediately a program for thorough going eye protection.

The appraisal which is presented here is still in process of development. The National Society for the Prevention of Blindness welcomes the suggestions of all those directly concerned with eye protection in industry for the improvement of the form and for its ultimate utilization.

* Director of Industrial Relations, National Society for the Prevention of Blindness, New York.

A Self-Appraisal for Safety Engineers and Other Executives Concerned with Conservation of Vision in Industry

I. THE PLANT

Protection Against Accident Hazards

1. Are goggles, helmets and head masks available for each employee exposed to the danger of:
   (a) splashing of molten metal or injurious chemicals? .... ______
   (b) flying dust or particles of emery, metal, rock, wood or other hard substances?.... ______
   (c) falling or thrown tools or other large objects? .... ______
2. Do the goggles meet the required strength specified by the *National Safety Code for the Protection of the Heads and Eyes of Industrial Workers?* .... ______
3. Are the goggles or other protective devices the most comfortable that may be secured? ...... ______
4. Are goggles fitted to the individual workman? ______
5. Are emery wheels equipped with glass shields, metal hoods or other adequate protection?.... ______
6. Is some one person charged with responsibility for cleaning and replacing pitted or broken emery wheel shields? .... ______
7. Are emery wheels and other sources of dust or flying particles equipped with exhausts to draw off such particles?............ ______
8. Is there adequate provision for keeping tools in good condition:
   (a) by periodic inspection of tools for mushroomed or burred heads, for cracks or other defects?............ ______
   (b) through definite responsibility for dressing tools? .... ______
9. Are the points of operation of lathes, drills, punch presses and other high-speed machine tools protected by glass or wire mesh guards? ______
10. Is the general housekeeping of the plant such as to reduce to a minimum the possibility of:
   (a) workmen falling or stumbling?.......... ______
   (b) tools or other objects falling from high places? .... ______
11. Is there a properly equipped and staffed first-aid room? .... ______

Protection Against Health Hazards

1. Are there adequate facilities for washing—including hot water and soap—conveniently located and available to all workers without long waiting?............ ______
2. Are individual towels available? (Use of roller towels in public places is forbidden in most states as a precaution against the spread of communicable disease)............ ______
3. (a) Is each worker needing a head mask, helmet or goggles provided with such for his exclusive use? (The use of the same goggles by more than one person involves the danger of communication of disease)............ ______
   (b) Is there provision for approved sterilization* of eye protective devices turned in by one employee before they are issued to another?.. ______
4. Is adequate exhaust equipment provided to draw off poisonous fumes and gases?........ ______
5. Are respirators provided for all workers exposed to the dust or fumes of injurious chemicals? (Such exposure often leads to impairment of vision as well as other bodily injuries) .... ______
   Where respirators are necessary, is there provision:
   (a) for an individual respirator for each worker? .... ______
   (b) for sterilization of respirator turned in by one workman and handed to another?.... ______
6. Are plant layout and machinery arrangement such as to make it unnecessary for any employee to work in a strained position for long periods? (Subjection of the eyes to abnormal and unaccustomed motions may lead to serious eye disorders) .... ______
7. Is there adequate provision of proper goggles, masks and helmets to protect workers from injurious heat and light rays in occupations involving:
   (a) acetylene welding? .... ______
   (b) electric welding? .... ______
   (c) irradiation by ultra-violet light?......... ______

Protection Against the Hazards of Undue Eye Fatigue

1. Are prescription lenses provided for all employees with defective vision:
   (a) without charge to the employee?........ ______
   (b) employee pays half?............ ______
   (c) employee pays whole cost?............ ______
2. Does a foot-candle meter check of illumination in the plant show conformance with the minimum intensities of light recommended by the *Code of Lighting Factories, Mills and Other Work Places?* .... ______
3. Is illumination in the plant devoid of:
   (a) flickering lights? .... ______
   (b) sharply contrasted lights and shadows?.. ______
   (c) permanent or intermittent glare?......... ______
4. Is the plant arrangement such as to make unnecessary exposure of employees' eyes to:
   (a) glare of the sun?............ ______
   (b) unshaded filaments of electric light?.... ______
   (c) intense open fires or carbon lights?...... ______
   (d) reflection from polished surfaces? ...... ______

II. THE WORKER

1. Is good vision a prerequisite to employment in your plant? .... ______
2. Are the eyes of all workers examined at the time of employment? .... ______
3. Are the eyes of only skilled employees examined? .... ______
4. Is a report of the findings in such examination given to the employee or applicant for work? ______
5. Are employees' eyes re-examined:
   (a) at stated periods—biennially? annually? or semi-annually? (state how often)..... ______
   (b) only when symptoms of possible eye disorders appear? .... ______
6. Is there provision for general physical examination of employee:
   (a) at the time of employment? .... ______
   (b) at regular recurring intervals?.......... ______
   (c) when symptoms of disorders appear?.... ______
7. Are workmen with seriously defective vision or with disease involving the eyes referred to:
   (a) an oculist? .... ______
   (b) a general medical practitioner or family doctor? .... ______

III. THE JOB

Assignment of Work

1. Is the visual acuity of each employee taken into account in assignment of work?......... ______
   (a) Is it done through job analysis and test of vision with Snellen Letter Chart?.. ______
   (b) Is it left to the judgment of personnel manager, foreman or other supervisors?.. ______
2. Is there a periodic check of the relation of worker's vision to the character and quality of his job which will lead to the recommendation of change to a less hazardous occupation if necessary? (If so, state how often).......... ______

Safety Rules

1. Is there a mandatory rule concerning the wearing of goggles, masks or helmets in prescribed occupations and is this rule conscientiously enforced? .... ______
2. Does such a mandatory rule apply to foremen, other supervisors and plant visitors as well as to workmen? .... ______

Educational Activities

1. Are accurate records kept of:
   (a) number, nature and cause of eye injuries? ______
   (b) frequency and severity rate of such injuries? .... ______
   (c) compensation and other costs due to such injuries? .... ______
2. Is there a definite and permanent program of safety education, including instruction in protection of eyes? .... ______

* A method of sterilization used successfully by the Standard Oil Company of New Jersey consists of first soaking goggles or other eye protective devices for five minutes and then washing them in a 5% solution of Cresol, Lysol or similar phenol antiseptic. This solution will not corrode metal or injure fabric and is of sufficient antiseptic power to prevent transmission of infection from one individual to another.

ELEMENTARY PLATE LAYOUT—V

By George M. Davies

The next method of plate development to be considered is the radial line method of developing objects having conical shapes.

In geometry a cone is a solid figure described by the rotation of a triangle upon one of its sides as axis, or one which tapers uniformly from a circular base to a point.

A right cone is a solid figure described by the rotation of a right triangle about one of the sides adjacent to its right angle as an axis. The other side adjacent to the right angle generates the base, while the hypotenuse generates the sides of the cone, the apex of the cone being the point at the opposite end from the base.

In rotating the right triangle to form the cone, the hypotenuse of the triangle forms the surface of the cone and can therefore be considered as a surface line of the cone. The entire surface of the cone is composed of these surface lines, a selected number of which can be used for the purpose of mensuration.

This is more clearly illustrated in Fig. 28, in which *A-B-C* is a right angled triangle. The altitude *B-C* is the axis about which the triangle rotates and the base of the triangle *B-A* rotating about the axis *B-C* forms the base of the cone as A, A^1, A^2, A^3, A^4, A^5, A. The surface of the cone is made by the hypotenuse *A-C* rotating about the axis *B-C*. The side *A-C* in any position during the revolution, as A^1-*C*, A^2-*C*, A^3-*C*, to A^5-*C*, thus becomes the surface lines of the conical surface. The surface lines of a right cone are all of the same length.

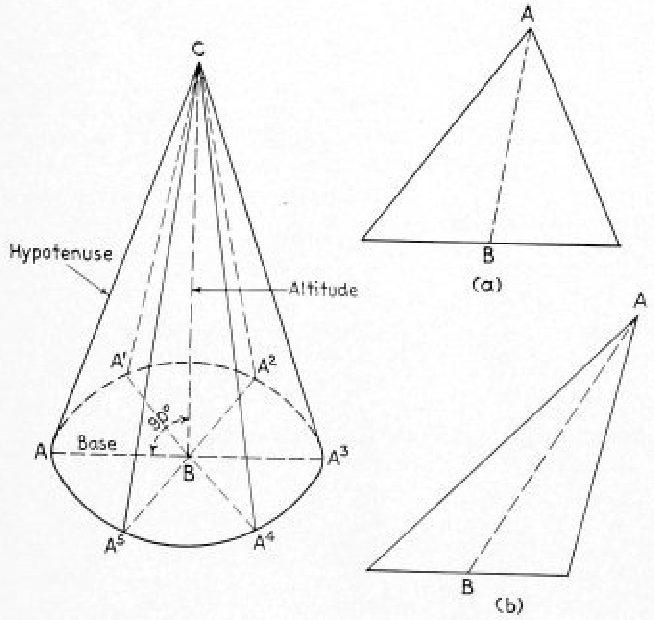


Fig. 28

A scalene or oblique cone is one in which the apex is not upon a line drawn vertically from the center of the base. It may be located over a point somewhere between the center of the base and its circumference as shown in Fig. 28 (a), or it may be over a point entirely outside the base as shown in Fig. 28 (b). The lines *A-B* of these two figures thus become the nominal axis, though they cannot be termed axis of revolution.

Development of Frustum of Cone

The simplest of all conical developments is the development of the frustum of a right cone as illustrated in Fig. 29.

When that part of a cone between a cutting plane and the apex is taken away, the cone is said to be truncated and what remains is termed the frustum of a cone. When the cutting plane is parallel to the base, the section thus produced is in the same shape as the base (round).

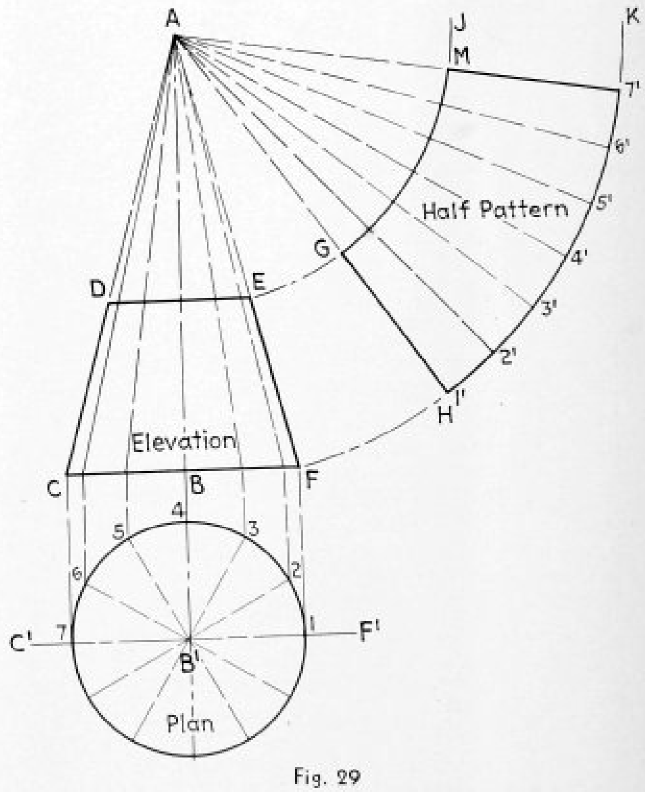


Fig. 29

To develop the frustum of a right cone, where the cutting plane *D-E* is parallel to the base, as shown in Fig. 29, first draw the elevation and plan views as shown. It will be noted that the line *C'-F'* of the plan view divides the frustum into two symmetrical halves and therefore a pattern of one-half can be duplicated for the other half, thus necessitating the development of a one-half pattern only.

With *A* as a center and with the trams set equal to *A-F* as a radius, describe an arc of indefinite length, as *F-K;* then with *A* as a center and with the trams set equal to *A-E* as a radius, describe another arc, as *E-J.* From any convenient point as *H* on the arc *F-K,* draw a radial line connecting with point *A,* cutting the arc *E-J* at *G.*

Next divide one-half the plan view into any number of equal parts, six being taken in this case; number the divisions from 1 to 7 as shown.

Then on the arc *F-K* from *H* step off the distances *1'-2', 2'-3'* to *6'-7'* equal to equal spaces *1-2, 2-3,* to *6-7* of the plan view. Having located the point *7'* of the pattern connect it with a radial line to the point *A,* cutting the arc *E-J* at *M,* completing the half pattern *H-7'-M-G.*

The next development to be considered is that of a frustum of a right cone where the cutting plane is taken at an angle with the base as illustrated in Fig. 30.

Draw the elevation and plan view, Fig. 30. *A-B-C*

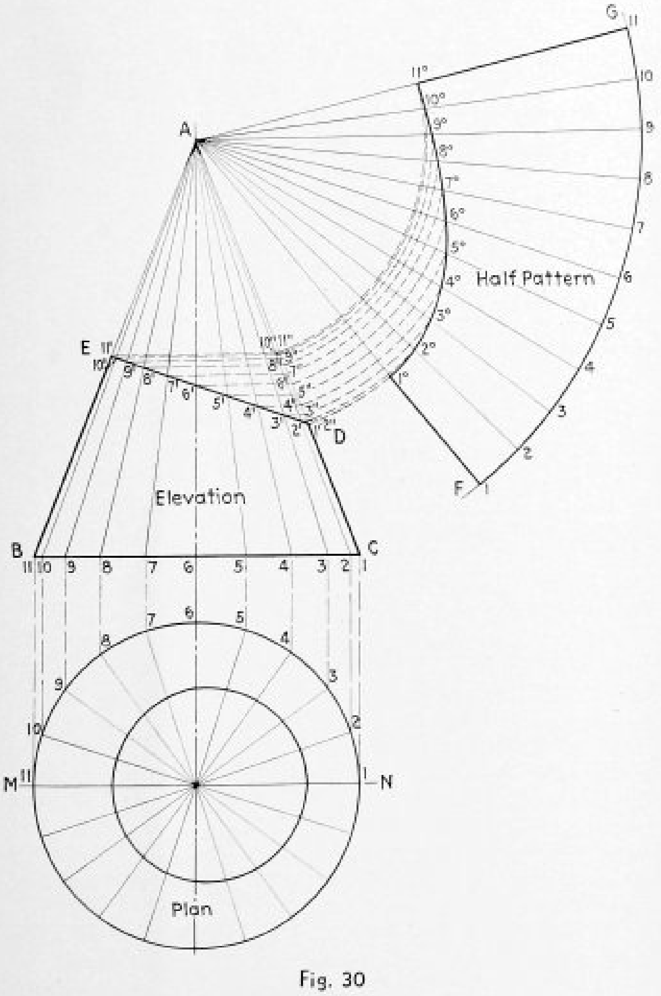


Fig. 30

represents a right cone with *D-E* the cutting plane at an angle with the base *B-C.*

It will be noted that the line *M-N* of the plan view divides the frustum into two symmetrical halves and therefore a pattern of one-half can be duplicated for the other half, thus necessitating the development of a one-half pattern only.

Divide one-half the plan view into any number of equal parts, ten being taken in this case. Number them from 1 to 11, as shown. Erect perpendiculars to the line *M-N* through the points *1* to *11,* extending them to cut the base line *B-C,* numbering the corresponding points from *1* to *11* as shown.

Connect the apex *A* with the points *1* to *11* on the base line *B-C;* these lines being the surface lines of the cone. Where these lines intersect the cutting plane *D-E,* number the intersections corresponding to the same numbers as used on the base line as from *1'* to *11'* as shown.

The surface lines *C-D* and *E-B* of the frustum are shown in their true lengths. In order to obtain the true lengths of the remaining surface lines of the frustum, they are projected to the line *A-C* by drawing lines through the points *2'-11'* parallel to the base line, cutting the line *A-C* at *2"* to *11"*; *2"-C* is the true length of the surface line *2-2', 3"-C* is the true length of the surface line *3-3',* etc.

Next with *A* as a center and with the trams set equal to *A-C* as a radius, scribe an arc of indefinite length as *F-G.* On the arc *F-G,* step off the distances *1-2, 2-3, 3-4* to *10-11* equal to *1-2, 2-3, 3-4* to *10-11* of the plan view. Connect the points *1* to *11* of the pattern with the points *A.*

Then with *A* as a center and with the trams set equal to *A-1'* of the elevation as a radius, scribe an arc cutting the line *A-1* of the pattern at *1°.*

Then with *A* as a center and with the trams set equal to *A-2"* of the elevation as a radius, scribe an arc cutting the line *A-2* of the pattern at *2°.* Continue in this manner, locating the points *3°, 4°, 5°, 6°, 7°, 8°, 9°, 10°, 11°* as shown, completing the half pattern.

(To be continued)

What to Weld—and How?

Railway locomotive and car maintenance practice, as well as reclamation work of all kinds, has been practically revolutionized in recent years by autogenous welding, the great bulk of which is now being done by the oxy-acetylene and the electric processes. The whole subject of welding is beset with a multitude of questions. Safety is the first requirement in railway operation and, therefore, the first question regarding any weld relates to its safety and reliability. The next question is economy, since many welds which would be permissible or desirable from a safety standpoint entail a greater cost for material and labor than would be required to buy a new part. Once the mechanical and economic practicability of individual welding jobs is conceded, the question arises regarding what type of welding will give the best results and what detailed method can best be employed in preparing parts for the welding operation and treating them subsequently, if necessary.

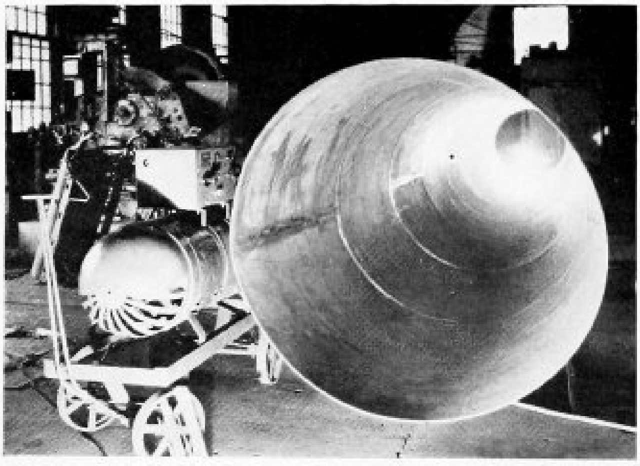
An observation of current practice leads to the inevitable conclusion that all kinds of welding, good and bad, too extensive and too limited, are found in railroad shops and engine houses at the present time. The final natural question, therefore, is: How can any railroad expect to achieve the best results with welding unless this important operation is put in charge of a specially trained general supervisor of welding who can co-ordinate the experience of mechanical supervisors on the entire system, check detailed welding operations with similar ones on other roads and with the most advanced methods in other industries, develop a standard welding practice folio for use at all points on the system, supervise the training of welding operators and see that periodic checks are made of their work?

Even a casual inspection of welding practice at many railroad shops and terminals indicates the widely divergent ideas regarding what can and cannot be done and emphasizes the necessity for a co-ordinated practice which will be well above present levels in many instances. Welding operations are being performed at some shop points which are said to be impossible by supervisors at other points. Sometimes this difference of opinion exists at a single repair shop. For example, a general foreman at a small railroad shop recently examined a particular job and expressed the opinion that it could be welded. On assigning the work to his welding foreman, however, the latter explained that a similar welding operation had been performed only the preceding week and proved to be unsatisfactory.

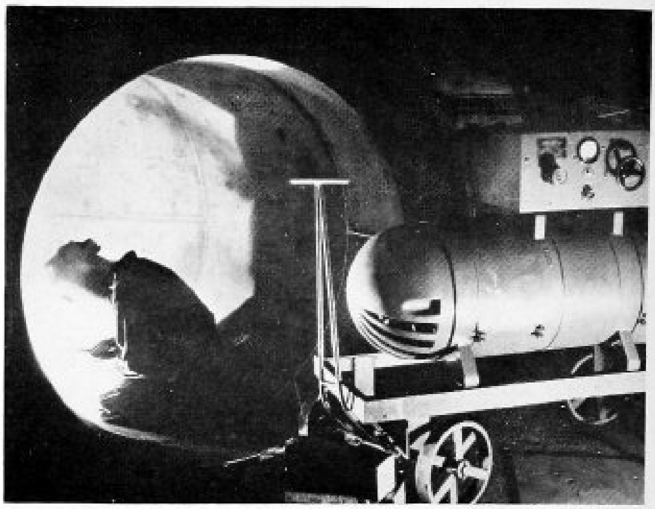
All kinds of welding operations, building up worn parts, and facing certain parts with hard metal to give increased wearing properties and service life, must be carried on daily at railway repair shops. It is futile to expect that the best results of these operations can be obtained without an expert knowledge on the part of the men who do the work, supplemented by general instructions from some central authority familiar with what can be done and how. As previously suggested, the training of welders and periodic checking of test welds, also, should come under this same central authority. Only a few of the larger railroads have in the past made a practice of employing a general supervisor of welding and some of these men have been reduced to the ranks or secured employment elsewhere, owing to retrenchment programs which have so greatly curtailed supervision in railroad mechanical departments. It can hardly be questioned that this policy is a mistake and costly in the long run, since the supervisor's annual salary can readily be lost by mistakes of omission or commission on two or three important welding jobs.

Large Stainless-Clad Pipe Is Arc Welded

The largest order for two-ply stainless-clad steel ever placed is being fabricated by arc welding into an 1800-foot pipe at Milwaukee, Wis.



Section of 1800-foot arc-welded pipe



Welding operations under way

This unusual pipe 2 feet to 5 feet in diameter, and 1/4 inch thick, will carry compressed air from rotary turbo-blowers to aeration tanks at the Milwaukee Sewage Disposal Plant on Jones Island. It is being built by the Cream City Boiler Company, Milwaukee, fabricators of alloy-metal equipment, who will also do the field welding. This is the first time that stainless-clad steel has been used for this type of work.

The pipe is a main air header which will convey air under pressure for activating raw sewage. Welded stainless steel construction was decided upon because of the low internal coefficient of friction which it provides and which will be maintained for life. Due to this low internal friction, the pipe was designed several inches smaller than cast-iron pipe for the same purpose. With this decrease in diameter, it is possible to install the pipe in existing structures. Cast-iron pipe would have required expensive changes to the buildings. Arc welding also proved the most economical and the fastest means of fabrication.

Most sections of the pipe are 54 feet long. These are made up of nine plates 1/4-inch thick. Each single plate is formed and placed in a special welding clamp for making the longitudinal seam. This is a plain butt weld, made with 18-8 stainless steel electrodes on the inside and with heavily coated mild-steel electrodes on the outside. Welding speed is about 50 feet per hour.

Nine of these plate shells are then welded together to form one section. The circumferential joints are butt welds. The plates have previously been sheared square and are placed with a 3/32-inch gap between the edges.

About 1325 feet of the pipe is 5 feet in diameter. The rest is 48, 36, 30 and 24 inches. The contract required the fabrication of several special elbows, T's and fittings.

Expansion joints are made of 10 gage solid stainless steel. All flanged connections are so made that only stainless steel is exposed to the action of the material carried by the line.

All welding of stainless steel inside the pipe is being done with 1/8 to 1/4-inch "Stainweld A" electrodes manufactured by The Lincoln Electric Company, Cleveland. Welding of the steel side of the pipe is done with 5/32-inch and 3/16-inch "Fleetweld" electrodes supplied by the same company. Four-hundred-ampere Lincoln Shield Arc welders supply the current.

Approximately 315,000 pounds of 1/4-inch two-ply stainless steel and 9000 pounds of 10-gage solid stainless steel are required for the project.

The total cost of the job is approximately $107,000. It is scheduled for completion by the first of December.

Uniform Cost Accounting System Proposed for Steel Plate Fabricating Industry

The Code Authority for the steel plate fabricating industry has asked NRA approval of a uniform method of cost accounting to be used in estimating the costs below which sales are forbidden. Communications of criticism of the proposed system were received by Deputy Administrator Walter G. Hooke, on October 3.

The headings of the proposed system are: Material and freight, drafting, labor, works expense and general overhead, erection labor, erection expenses and erection general expenses. Each of these headings is precisely defined in the proposed system, which follows:

Method for Estimating Costs

None of the members of the Code shall contract or offer to sell any product and/or do any erection work on any product (except to or for an affiliated company of such member not for resale) at a price which shall be less than the estimated cost to such member of such product and/or of such erection work as herein defined.

All estimates of cost shall include such elements of cost as the Code Authority shall from time to time prescribe and the allocation of overhead shall be on such basis as shall from time to time be prescribed by such Code Authority subject to the approval of the Administrator.

Such estimated cost shall include the following items:

F.—Fabrication

All estimates of labor cost in fabricating any product shall be based on not less than the actual rates of pay at the time in effect under the Code for the locality in which the plant of such member at which such product shall be fabricated is located; provided, however, that if such rates shall be less than the minimum rates of pay at the time in effect under the Code for the locality in which such product is to be delivered or erected, then such estimates of cost shall be based on the minimum rates of pay at the time in effect under the Code as provided in such latter locality. The average wage to be used in estimating shall not be less than 150 percent of the minimum rates of pay as used above.

FA.—Material and Freight

(1) Material. The estimated cost of shapes, plates and bars shall be $2.00 per ton (to cover handling charges) above the respective published base prices at the respective basing points therefor, nearest in terms of delivered prices to the place where the structure for which such shapes, plates or bars are to be used is to be erected, plus all published extras thereon and the all-rail published tariff freight charges thereon from such basing points to such place, or if such structure is to be erected at any such basing point, the published tariff switching charges, (if any), which are to be added to the base prices of such shapes, plates or bars at such basing point; provided, however, that the Code Authority may from time to time by regulations, copies of which shall be filed with the Secretary and mailed to all members of the Code modify the method of computing such estimated cost in order to conform to any changes which may be made in the methods of selling shapes, plates and bars by the producers thereof, in the above shall be included not less than 50 percent of the tabular allowances of the mills for overrun of weight in plates.

For all other materials entering into the estimate and bidding price, the estimated cost shall be based either on actual record of recent purchases or on bona fide quotations applicable to the structure for which bid is to be submitted, or, in case of material manufactured by the bidder, such as rivets, bolts, castings, welding rod, etc., at cost or the market value of such material whichever is lower.

(2) Shop Paint. Estimated cost of paint or other coating material only, the labor cost of applying to be included under labor (FC).

(3) Freight. Estimated cost of trucking fabricated material to be sold on delivered basis from works, railroad or dock to site; this should include only such amount as may be in excess of the freight included in (1) above.

FB.—Drafting

(1) Drafting Labor. Estimated wages of employees preparing detail shop drawings.

(2) Drafting Expense. This cost shall be computed at the rate of not less than 35 percent of the estimated drafting labor (as defined in 1 above) to cover the salaries of chief draftsman and his staff, and supplies and expenses incurred by the drawing room.

FC.—Labor

To include estimated cost of salaries and wages of employees at the works directly engaged in fabricating plus a percentage, not less than 25 percent, to cover other employees generally considered a part of the operating organization such as foreman, shop clerks, storeroom clerks, timekeepers, sweepers, etc. (the total constituting "Works labor"), but not including salaries and wages of employees charged to "Works Expense" as per items FD-1 (a) to (f) below, or included in "Material to be manufactured," such as rivets, bolts, castings, etc., to be included in item FA (1) above.

FD.—Works Expense and General Overhead

There shall be added to the estimated works labor as defined in FC above not less than 100 percent to cover the estimated cost of the following but in no case shall the gross of the items be less than 100 percent.

1. Works Expense

Salaries and wages of the following employees:

(a) Employees directly engaged on maintenance and upkeep of building and equipment.

(b) Employees of auxiliary departments, such as electric, hydraulic, pneumatic power, steam, water, yard switching, etc., watchmen and gatemen.

(c) Office employees, including accounting, shipping, steel order, telephone operators, janitors, etc., and employees located at the district managers' offices.

(d) Industrial relations representatives, first aid employees, doctors, nurses, etc.

(e) Inspectors checking shop and drawing room errors.

(f) Managers and superintendents.

Supplies and expenses:

(a) Materials for repairs and maintenance.

(b) Small tools, lubricants and miscellaneous supplies.

(c) Fuel, including coal, power and gas.

(d) Water.

(e) Office supplies and expenses at works and district managers' offices.

(f) Real estate and personal property taxes.

(g) Insurance (fire, workmen's compensations, etc.)

(h) Provision for contingencies (to provide for pensions, donations, etc.)

2. *General Overhead Expenses*

(a) Depreciation: Buildings and equipment at fabricating works (not including erection tools and equipment as defined under Erection), based on their use during a period of normal operation.

(b) Selling Expense-Salaries and expenses of employees in district and home sales offices, also office rent and the expense of maintaining such offices.

(c) Engineering and Estimating Expense-Salaries and expenses of employees in district sales offices and the home office engaged in engineering services, including the preparation of estimates for bidding purposes (except such expense applicable to the erection of structures, or designing of erection material and equipment), also office rent and expense of maintaining such offices.

(d) Administration and General Expense-Salaries and expenses of executive officers (president, vice-presidents, treasurer, auditor, and their respective staffs), also office rent and other expenses at administrative offices.

(e) Taxes: All taxes not included above except sales taxes. (Sales taxes, if any, shall be added to the sales price.)

E.—Erection

EA.—Erection Labor

To include the estimated salaries and wages of all employees engaged in the erection of the job in question.

EB.—Erection Expense

To include the estimated cost of the following:

(1) Field expense, including miscellaneous supplies and expenses including power and fuel, and in general all supplies which are consumed on the job.

(2) Transportation of men.

(3) Transportation of erection material and equipment.

(4) Hauling permanent material from railroad or wharf to site, if not included in shop cost (FA).

(5) Field paint (material only) or field paint and painting if sublet.

(6) Erection material and equipment of a special nature for the job in question and the cost of designing and shop fabrication of such equipment.

(7) Rental of miscellaneous equipment not owned.

(8) Insurance of all kinds.

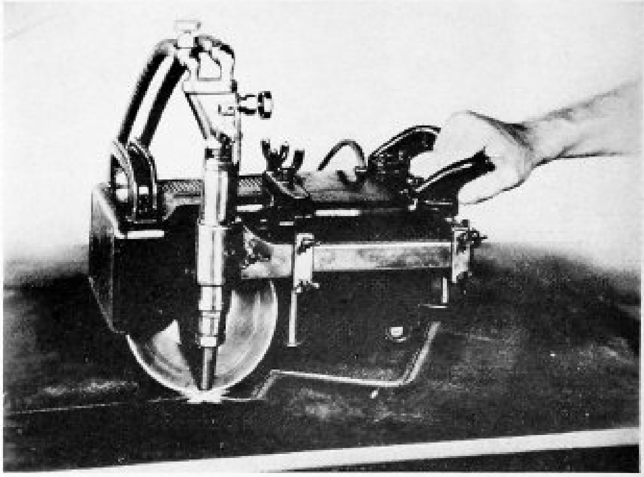
(9) Provision for depreciation of major erection equipment, based on its use during a period of normal operation.

(10) Estimated cost of maintaining major erection equipment, and the estimated cost of maintaining and replacing small erection tools such as snaps, hose, lines, cable, fitting-up bolts, washers, pneumatic hammers, chippers, etc., also expense at erection tool houses, including property taxes and fire insurance.

(11) Cost of bonds required if any.

EC.—Erection General Expense

This cost shall be computed at not less than 7½ percent of erection labor to cover salaries, wages and expenses at home and district erection offices and including engineering and preparing estimates applicable only to the erection of the job in question.



Tractograph in operation

The New Tractograph

The Airco-DB Tractograph, latest addition to the Airco-DB line of oxy-acetylene cutting machines, manufactured by the Air Reduction Sales Company, is said to provide a simple means for cutting steel plates and slabs accurately into shapes having straight, circular or irregular outlines and extending over practically unlimited areas. It is intended for the cutting of plates and slabs up to 2 inches in thickness.

It is a small, compact, motor propelled unit which can be quickly adjusted to travel at any speed from 2½ inches per minute. As it travels it is guided by hand along the desired contour laid out and scribed directly on the plate or slab.

An entirely new principle in cutting machine drive, combined with other features which enable the operator to change the direction of the machine with exceptional ease, make it possible to turn sharp corners and follow both simple and intricate contours with unusual accuracy.

The Tractograph will cut beveled as well as perpendicular edges. With the radius rod in place it will automatically cut arcs or complete circles. Circles or arcs of smaller radius than the minimum possible with the radius rod, can be cut with manual guidance. Also, it is capable of traveling up an incline of approximately ten degrees on ordinary hot rolled steel plate without slipping.

Once the operator has set the travel speed, lit the torch and pressed the starting switch, he can confine his attention to guiding the machine. Results, therefore, are dependent only upon the closeness of his attention to this duty, for it requires no special skill. The average mechanic with a little practice can follow a line with satisfactory accuracy and after he has become proficient, he can make cuts at much higher speeds than is possible with any of the hand torch cutting attachments commonly used. It is claimed that work done with the Tractograph will be of higher quality for the torch, in addition to being held always in correct position relative to the plate, is automatically moved along at a uniform speed throughout the extent of the cut. The experienced operator can make cuts with the Tractograph that are practically as smooth as those produced by a completely automatic gas cutting machine.

Measuring only 7¼ by 8¼ by 16 inches, and weighing but 48 pounds, the Tractograph can be easily carried about and used wherever 110 volts, alternating or direct current are available.

Fatal Boiler Accidents*

Seven recent power boiler accidents resulted in the death of seven men and women and injury to thirty persons, according to official city investigations or to newspaper accounts of the accidents.

A man and a woman were working in the office of a Texas auto supply house when, without warning, the 8-inch tile wall of the building was crashed in and a 1600-pound Scotch marine type boiler crushed the two workers as it passed on to the other side of the building. The woman was killed instantly and the man died later.

The boiler had come from a dry cleaning plant across an alley. There, as well as in the auto accessory store, it had reduced the equipment to debris. Four persons who were either customers or employees of one concern or the other were injured. Besides damaging the auto accessory store directly, the accident set fire to some paint and broke the sprinkler system, so that stock was damaged by fire and water.

An investigation was made of the exploded boiler, which had come to rest about 50 feet from its setting. It had ruptured in a small welded area in the lower sheet. A crack from the weld had extended 18 to 20 inches across the bottom, and the furnace of the boiler had collapsed. The boiler was rated at 15 horsepower and carried from 60 to 90 pounds of steam under normal operation. It was 38 inches in diameter and 7 feet 4 inches in length. A test made by railroad boiler men following the accident showed that the safety valve began to blow at 200 pounds instead of the 100 pounds at which it was supposed to work.

* * *

Two men died as the result of a boiler explosion at a grist mill near Murphy, N. C., on March 17, 1934. The mill was wrecked, and one of the men was hurled 75 feet from the boiler setting. The other suffered a broken arm and severe burns and internal injuries which led to his death the next day. Three other men were injured.

* * *

One man was burned fatally and three were injured, two seriously, on March 29, 1934, when a saw mill boiler exploded 15 miles south of Birmingham, Ala. Debris was scattered over a 300-foot area. The boiler itself was blown 180 feet.

* * *

A foreman at a Kansas oil lease was killed when a boiler in the engine house exploded on March 15, 1934, leveling the engine house and hurling the man's body more than 300 feet. Another man was hurt by flying timbers.

* * *

When the boiler of a saw mill operating at Baker, W. Va., exploded on April 27 one man was blown 200 feet and killed, and another man was injured.

* * *

Twelve men were injured, several seriously, by a boiler explosion on March 16, 1934, at a zinc mine near Caulfield, Mo.

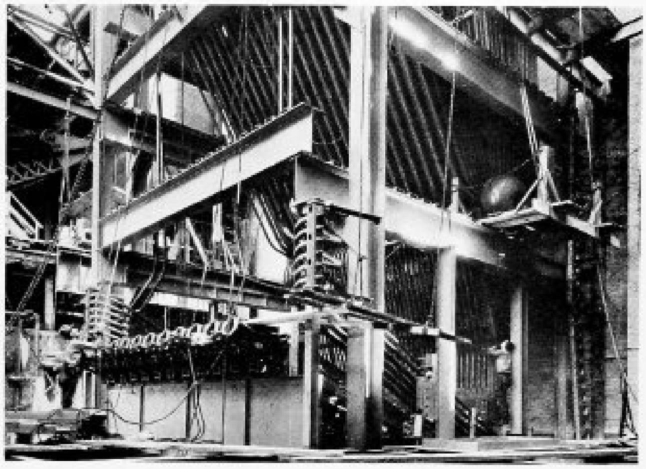
* * *

Six persons were injured on May 24, 1934, when a copper hot-water heater connected with an incinerator of a wholesale grocery concern in South Boston, Mass., exploded with such force as to wreck the rear of the building and damage several freight cars. The blast tore away the rear wall of the building, shattered a large section of the roof, knocked down a 40-foot chimney and broke many windows. It was attributed to an inoperative safety valve.

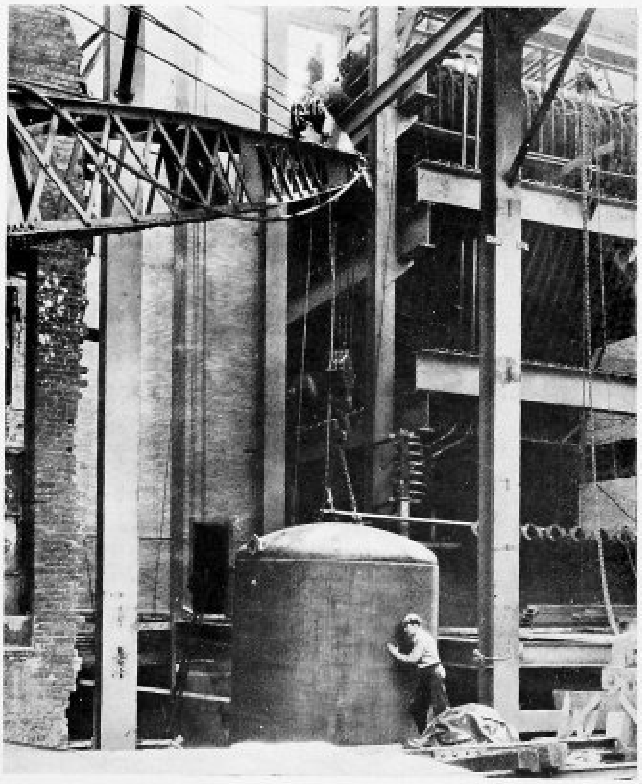
* From *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company.

Westinghouse Boiler Plant Under Construction

Construction on a new boiler house and the first of a group of four boilers is well under way at the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company. When completed this first 1600 horsepower boiler will be used for plant process and heating purposes and will be capable of operating at pressures up to 600 pounds per square inch. The building and boiler are being constructed at a cost of $400,000.



Generating elements of new boiler



Installing one of the drums

Boiler Equipment of the Steamship Queen Mary

By G. P. Blackall

The launching of the Cunard White Star liner *No. 534*, christened *Queen Mary*, at Clydebank recently was rightly regarded as an event of the very first importance in maritime history. The vessel will have a gross tonnage of 73,000, making her the largest liner afloat. She is 1018 feet in length overall, her height from keel to masthead is 234 feet, and her accommodation provides for 4000 passengers and 1000 crew.

Steam for propulsion is to be supplied by 24 water-tube boilers of the Yarrow type, at 440 pounds pressure and a temperature of about 700 degrees F. These boilers will be oil-fired, a feature which has much to do with the efficiency of the ship and the speed with which she can turn around at terminal ports.

Each of the four main boiler rooms is well over 60 feet in length by 80 feet in width. There are over 160,000 water and steam tubes in the 24 main boilers, and it is interesting to note that the actual delivery of the steam from the four main boiler rooms to the two main propelling machinery rooms is arranged in an ingenious manner which will place the chief engineer in the position of being able to rely upon keeping at least two of the four main engines running even in an emergency. All main steam lines are being installed with solid metal-to-metal joints and specially arranged expansion bends, thus ensuring entire freedom from the need for relying upon the tightness of packings or glands in the main supply.

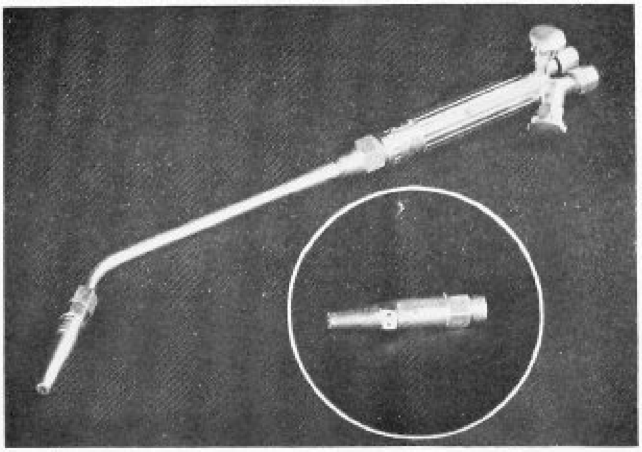
Blowpipe Head

The Linde Air Products Company, New York, has just announced a new welding head, known as the Multi-Flame Lindewelding Head, for use on W-17 or W-22 Oxweld blowpipes.

The Lindeweld process for pipe welding introduced about three years ago has been the means of greatly reducing pipe line installation costs, and the innovations incorporated in the new welding head will further reduce these costs by large amounts.

The head consists of a special chromium-plated stem and tip, available in three sizes, their use depending upon the pipe size. Its radical departure from other blowpipe heads is the design of the tip to give three flames; a main welding flame and two smaller auxiliary flames, the latter so positioned as to preheat both edges of the vee ahead of the point of welding.

Savings of more than 25 percent in rod and gases and 33⅓ percent or better in welding time are claimed to be possible with the new head employing the special manipulative technique recommended for its use.



Multiflame Lindewelding Head

Welding Clinic Planned

Completion of plans for the holding of a four-day welding clinic in New Orleans starting October 24 has just been announced by The Linde Air Products Company, distributor of materials and equipment for oxy-acetylene welding and cutting.

This will be the fourth large clinic of this type sponsored by this company this year, the others having been held at Birmingham, Alabama; Houston, Texas and Cleveland. The great success and popularity of these previous clinics led to the formation of the present plans, and no efforts are being spared to make the forthcoming clinic even better in every respect than its predecessors.

The purpose of this type of general clinic is to pass on to those interested in oxy-acetylene welding and cutting information on new developments in the industry; to assist those who have welding and cutting problems; to demonstrate and give instruction on new and old applications of the oxy-acetylene process; to afford a chance for discussion and interchange of ideas among those attending.

The New Orleans Clinic will be held at the Isaac Delgado Central Trades School, the officials of which are offering all the facilities of the school to take care of the large attendance expected from Louisiana and surrounding states.

Complete program plans will be announced later, but features will be demonstrations of several new developments in welding and cutting equipment, and of both usual and unusual applications of the oxy-acetylene process; instruction in all types of welding; informal discussions; motion pictures; exhibits of unique and standard welding and cutting jobs; and the testing of coupons welded by the guests.

Invitations have been sent out to a wide list including plant managers and superintendents, contractors, welding operators, and other interested persons, but everyone at all interested in learning more about the oxy-acetylene process is cordially invited to attend. Further announcements will be sent to anyone communicating with the New Orleans Office of The Linde Air Products Company.

Amendment to Boiler Manufacturing Industry Code

On August 28, Hugh S. Johnson, then administrator of the National Industrial Recovery Act, approved an amendment to the Code of Fair Competition of the Boiler Manufacturing Industry. In his report to the President, his findings covering the amendment were outlined as follows:

The Assistant Deputy Administrator in his final report to me on said amendment to said Code having found as herein set forth and on the basis of all the proceedings in this matter I find that:

(a) The amendment to said Code and the Code as amended are well designed to promote the policies and purposes of Title I of the National Industrial Recovery Act including the removal of obstructions to the free flow of interstate and foreign commerce which tend to diminish the amount thereof, and will provide for the general welfare by promoting the organization of industry for the purpose of co-operative action of labor and management under adequate governmental sanction and supervision, by eliminating unfair competitive practices, by promoting the fullest possible utilization of the present productive capacity of industries, by avoiding undue restriction of production (except as may be temporarily required), by increasing the consumption of industrial and agricultural products through increasing purchasing power, by reducing and relieving unemployment, by improving standards of labor, and by otherwise rehabilitating industry.

(b) The Code as amended complies in all respects with the pertinent provisions of said Title of said Act, including without limitation sub-section (a) of Section 3, sub-section (a) of Section 7 and sub-section (b) of Section 10 thereof.

(c) The Code empowers the A.B.M.A. Committee of Industrial Recovery to present the aforesaid amendment on behalf of the Industry as a whole.

(d) The amendment and the Code as amended are not designed to and will not permit monopolies or monopolistic practices.

(e) The amendment and the Code as amended are not designed to and will not eliminate or oppress small enterprises and will not operate to discriminate against them.

(f) Those engaged in other steps of the economic process have not been deprived of the right to be heard prior to approval of said amendment.

For these reasons, therefore, I have approved this amendment.

Amendment To Code of Fair Competition for the Boiler Manufacturing Industry

Delete the first sentence of Paragraph 1 of Article IX and substitute in lieu thereof the following:

"To facilitate the effective administration of this Code, and to provide the Administrator with requisite data as to the observance or nonobservance thereof, the A.B.M.A. Committee of Industrial Recovery is hereby designated as a Code Authority to co-operate with the Administrator in the enforcement of this Code; the said Committee to be hereafter elected by vote of the members of the industry in any fair manner approved by the Administrator."

Republic Steel Corporation in the Field of Safety

Activities of the Republic Steel Corporation in the fields of safety were indicated by the prominent part which the corporation's executives had in the National Safety Congress recently held in Cleveland.

J. A. Voss, director of industrial relations, was elected chairman of the Metals Section of the Safety Council. This is the oldest and one of the largest divisions in the organization.

J. D. Donovan, superintendent of maintenance, Central Alloy District, talked on "Safety Maintenance on Industrial Electrical Equipment." Five major points were considered as necessary for safe maintenance work on industrial electrical equipment. Effective accident prevention work when handling industrial electrical equipment depends on (1) good and approved equipment; (2) proper installations; (3) correct safeguarding; (4) good repair tools and equipment; (5) high type of men; (6) proper safety education. Mr. Donovan amplified these points in his address.

In discussing the maintenance of cranes, Frank W. Cramer, superintendent of electrical construction, Youngstown district, said:

"Safety in the operation of cranes requires more than mere operating rules. Care must be taken in the fundamental design of the crane and the building, and constant attention, inspection and maintenance of parts, are necessary for real safety.

"Lack of sufficient clearance between the building columns and the crane have sometimes forced crane builders to adopt forms of potentially dangerous freak design to allow for clearance. Even before a crane is put to work. conditions that will cause high maintenance and operating hazards may have been set up.

"The older type cranes are responsible for the impression that overhead traveling cranes need an army of men to keep them running. These present a real maintenance problem, as they use bolts and other parts that may work loose, antiquated electrical equipment and faulty bearings.

"A crane must have care and judgment used in its operation. Keep careful, keen cranesmen. Perhaps the biggest help they have is a book of rules of what and what not to do sponsored by the Safety department."

Mr. Cramer expressed confidence in the modern cranes, the standards for which are constantly being revised. Engineers are carefully incorporating many new ideas of materials and designs that make for sturdy, reliable and safe cranes.

Boiler Code Amendment Stayed

It is claimed in a petition for exemption, filed by the Wickes Boiler Company, of Saginaw, Michigan, that the provisions of Section 1, Article VIII of Amendment No. 1 to the Code of Fair Competition for the Boiler Manufacturing Industry is causing extreme hardship, and is tending to oppress small enterprises in the Industry.

Upon the showing made in said petition it appeared desirable that a stay of the provisions of said Section be had in order that an investigation might be made as to the merits of said petition and the ends of justice might thereby be served; and an Order (No. 38-11) to this effect was signed on September 27.

The Stay, as embraced in said Order, is as follows:

That the provision of Section 1, Article VIII of Amendment No. 1 to the Code of Fair Competition for the Boiler Manufacturing Industry be, and the same is hereby stayed for a period of sixty days, or until otherwise ordered, such stay to take effect fifteen days from the date hereof, unless good cause to the contrary is shown to the Administrator before that time and the Administrator issues a subsequent order to that effect.

Notice was given that any criticisms of, objections to or suggestions concerning said stay must be submitted to Deputy Administrator Beverly S. King, Room 3080, Department of Commerce Building, Washington, D. C., prior to Friday, October 12, 1934, and that such stay might become effective either in its present form, and/or in such form, wording, substance or scope as it might be modified and/or amplified on the basis of criticisms, objections or suggestions submitted and supporting facts received pursuant to this notice, or other considerations properly before the Administrator.

The amendment to the boiler manufacturing industry's code, requires the submission of reports on inquiries and copies of estimates and orders including prices and terms.

The stay was ordered after a petition asking exemption from the provision had been received from the Wickes Boiler Company, which claimed that the clause was causing hardship to small enterprises.

J. C. Lincoln Awarded Samuel Wylie Miller Medal

The American Welding Society, on October 1, awarded the Samuel Wylie Miller medal to John Cromwell Lincoln, chairman of the board, The Lincoln Electric Company, Cleveland, in recognition of his great contributions to the advancement of the science of electric fusion welding.

As one of the early pioneers of arc welding, J. C. Lincoln has devoted most of his life to research and development of the electric arc as an industrial tool. As a result the industry has achieved a remarkable growth, all of which has come about during the last quarter century.

Born July 17, 1866 in Painesville, O., J. C. Lincoln received his elementary education in the place of his birth, after which he attended Ohio State University, and received a degree in electrical engineering.

Joining the staff of Charles F. Brush, inventor of the arc light, in 1888, Lincoln early gained experience with the phenomena of the electric arc. Later he became affiliated with the Elliott-Lincoln Electric Company, one of the pioneer manufacturers of electric motors. In 1896 with this company as a nucleus, he formed the present Lincoln Electric Company.

Under his direction, this company produced in 1907 the first variable-voltage arc welding machine. Two years later as a direct result of Lincoln's efforts, the first re-design of a cast iron product for arc welded steel construction was made.

In 1916 Mr. Lincoln was the first to carry the electric arc into the structural field, where he directed the application of the process in the remodeling of an industrial structure.

A year later in conjunction with the U. S. Government, he established the first school for training welding operators. His company has conducted this school continuously since that time, and has given thorough instruction to many thousands of students in the application of the process.

Still another contribution to the ever-broadening field of application of arc welding was made in 1919 by Mr. Lincoln when the first motor was completely re-designed from cast iron to arc welded steel construction.

What is considered the greatest single advance in the art of welding was effected under Mr. Lincoln's direction in 1929 when his company introduced the first practical shielded arc for general industrial use. This greatly increased welding speeds and resulted in vastly improved physical properties of weld metal.

Since he introduced the first variable-voltage arc welding machine for the repair of faulty castings, J. C. Lincoln has seen the results of his numerous inventions in this field achieve a prominent position in the fabrication and maintenance of metal products.

Today not only have his research and developments saved industry millions of dollars, but they have been important contributing factors to the advancement of engineering progress.

Business and Personal

Michael Henry Broderick, founder and active president of the Broderick Company, Muncie, Ind., died in Muncie on September 1.

William E. S. Dyer has been elected president of the Edge Moor Iron Company, Edge Moor, Del. Mr. Dyer has been actively engaged in the consulting engineering field for nearly 30 years.

At a meeting of the directors of the Independent Pneumatic Tool Company on September 18th, W. A. Nugent was elected vice-president in charge of sales and Neil C. Hurley, Jr., was elected secretary. Mr. Nugent has been with the company for twenty years and during this period has served in various executive capacities. Most recently he has been the company's sales manager. Mr. Hurley has been in charge of the distribution of the company's electric tools.

James P. Roe, director of research and engineering of the Reading Iron Company, master of iron, died on September 14. Born in Consett, Wales, England, May 19, 1860, Mr. Roe began his business career at the age of 17 with the Consett Iron Company as an apprentice in mechanical engineering. In 1883 he came to the United States, accepting a position as mechanical engineer with the Pottstown Iron Company, Pottstown, Pa., which later failed. He joined the Glasgow Iron Company of Pottstown and by 1893 had worked his way to the position of general superintendent. In 1898, the Pottstown Company was leased by the Glasgow Iron Company and Mr. Roe put in charge. Up to exactly a week before his death he was in the various plants of the Reading Iron Company daily.

Trade Publications

Thumbs Down on Rust.—Under this title the Republic Steel Corporation, Youngstown, O., has recently issued a folder which explains three reasons for the high rust-resistance of Toncan iron and illustrates a number of typical installations of this long-lasting sheet iron.

Welding Set.—The general specifications for belted or direct-drive types SA300, SA400, SA600 electric arc welders have been issued by the Lincoln Electric Company, Cleveland, O. Complete details are given of the ratings, weights, power required, dimensions and the like.

Harnischfeger Anniversary.—In commemorating its 50th anniversary, the Harnischfeger Corporation, Milwaukee, has issued an attractive book entitled "The Fiftieth Year." The book tells the story of the organization from its early struggles, its pioneering of many types of equipment which play such an important part in the industry today and in general depicts the dramatic growth of the metal industry.

Tractograph.—A booklet describing the new Tractograph has been issued by the Air Reduction Sales Company, New York. This machine is a portable, motor-propelled, hand-guided oxy-acetylene cutting unit for cutting steel plates and slabs in simple or intricate shapes over extended areas. The booklet gives a clear picture of how this machine is operated and what it can accomplish, being greatly aided in this by numerous excellent illustrations of a Tractograph in operation.

Boiler Maker and Plate Fabricator

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Communication

New British Locomotives Have Interesting Boiler Features

TO THE EDITOR:

Interesting locomotive developments are now being carried out by several of the leading British railroads. The London, Midland & Scottish Railroad, the largest system in the United Kingdom, has recently introduced into traffic the first of a series of 70 two-cylinder six-coupled mixed traffic locomotives, which have been designed by the line's chief mechanical engineer, W. A. Stanier, for working both passenger and freight trains. Twenty of these engines are now being constructed at the L. M. S. works, Crewe, and fifty by the Vulcan Foundry, under the 1934 locomotive program.

Each locomotive is 63 feet in length and weighs 128 tons in full working order, including a six-wheeled tender. An interesting constructional feature of the boiler, which has a steam pressure of 225 pounds per square inch, is that a proportion of nickel steel plates has been used to save weight.

The London & North Eastern Railroad, second only in size to the L. M. S. system, has also placed an interesting locomotive order. It is for a steam locomotive of a new and unusual design, for use on branch line services, and will be the first of its kind to be employed in the United Kingdom. It will be mounted on two six-wheeled bogies and provided with a three-drum watertube boiler, having a working pressure of 56 pounds per square inch, from which steam is supplied to six separate compound two-cylinder engines, one engine being geared direct to each of the six axles. It is claimed for this locomotive that, in addition to economy in fuel consumption, steam can be raised in less time than with other types of locomotives now in use on the line.

London, England. G. P. BLACKALL.

High Cost of Caustic Embrittlement*

Caustic embrittlement has been discovered by "Hartford Steam Boiler" inspectors since January 1, 1930, in steam generating equipment with an estimated value of $4,000,000. Evidences of embrittlement have been found in 160 boilers and one kier in 58 plants scattered over 24 States.

The cost of replacement or repairs in these boilers following the discovery of caustic embrittlement is estimated at $750,000, the difference between this and the $4,000,000 figure being due to the fact that in some cases boilers worth as much as $500,000 have been repaired and have been continued in service with a careful watch maintained for any evidence of the disease extending its effects.

The boiler plants in which caustic embrittlement has been discovered since January 1, 1930, are scattered from Minnesota to Florida and from Washington to Maine as follows: Arkansas 1, Colorado 2, Connecticut 1, Florida 3, Georgia 1, Illinois 6, Indiana 1, Iowa 2, Louisiana 1, Maine 1, Massachusetts 2, Michigan 4, Minnesota 10, Mississippi 3, Montana 1, New York 5, North Dakota 1, Ohio 2, Oklahoma 2, Pennsylvania 1, Tennessee 2, Utah 1, Washington 1, Wisconsin 4.

In no case has embrittlement been discovered where there was a feed-water treatment record which indicated no departure at any time from the sodium carbonate to sodium sulphate alkalinity ratios at least as favorable as those recommended by the A. S. M. E. Boiler Code.

The feed water in a number of the plants affected was from deep wells and was untreated. In other plants base exchange type of water treatment was employed for the entire supply or for the make-up water. In still other plants soda ash and lime treatment was used, while at some the treatment consisted of secret commercial compounds. Changes in feed-water treatment and the absence of records in some plants make it difficult, if not impossible, to attribute the development of embrittlement to any one particular feed water.

Happily, the danger signs which pointed to the existence of caustic embrittlement were caught by the inspectors in each of the 160 boilers affected before there was an accident, so that a violent explosion with subsequent loss of life and damage to property did not occur.

* From *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company.

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

Working Pressure Allowed on Crown Sheets

Q.—If in order I would like to inquire as to the following formula which in part is not clear:
The formula in question Par. P-212 Page 35 sub paragraph (b) which applies to permissible working pressure on the crown sheet of a locomotive type boiler, radial stay section A. S. M. E. Code 1930. J. W. L.

A.—Paragraph P-212 (b) of the 1930 A. S. M. E. Code referred to in the question is as follows:

212-b. The maximum allowable working pressure for a stayed wrapper sheet of a locomotive-type boiler shall be determined by the two methods given above and by the method which follows, and the minimum value obtained shall be used:

$$P = \frac{11{,}000t \times E}{R - s \sum \text{sine } \chi}$$

in which

χ = angle any crown stay makes with vertical axis of boiler.

$\sum$ sine χ = summated value of sine χ for all crown stays considered in one transverse plane and on one side of vertical axis of boiler.

s = transverse spacing of crown stays in crown sheet, inches.

E = minimum efficiency of wrapper sheet through joints or stay holes.

t = thickness of wrapper sheet, inches.

R = radius of wrapper sheet, inches.

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

11,000 = allowable stress, pounds per square inch.

The above formula applies to the longitudinal center section of the wrapper sheet, and in cases where E is reduced at another section, the maximum allowable working pressure based on the strength at that section, may be increased in the proportion that the distance from the wrapper sheet to the top of the crown sheet at the center, bears to the distance, measured on a radial line through the other section, from the wrapper sheet to a line tangent to the crown sheet and at right angles to the radial line. (See Fig. P-9.)

Fig. 1 illustrates a typical example of a locomotive crown sheet layout giving the necessary data for illustrating the formula in Par. P-212b.

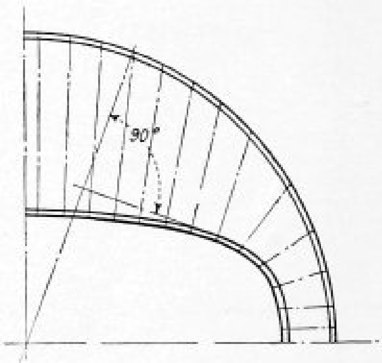

Fig. P-9

The first step is to find E, the minimum efficiency of the wrapper sheet through joints or stay holes.

Referring to Fig. 1, it will be noted that the three front rows of staybolts are flexible expansion stays and that the sheet is reinforced with a liner.

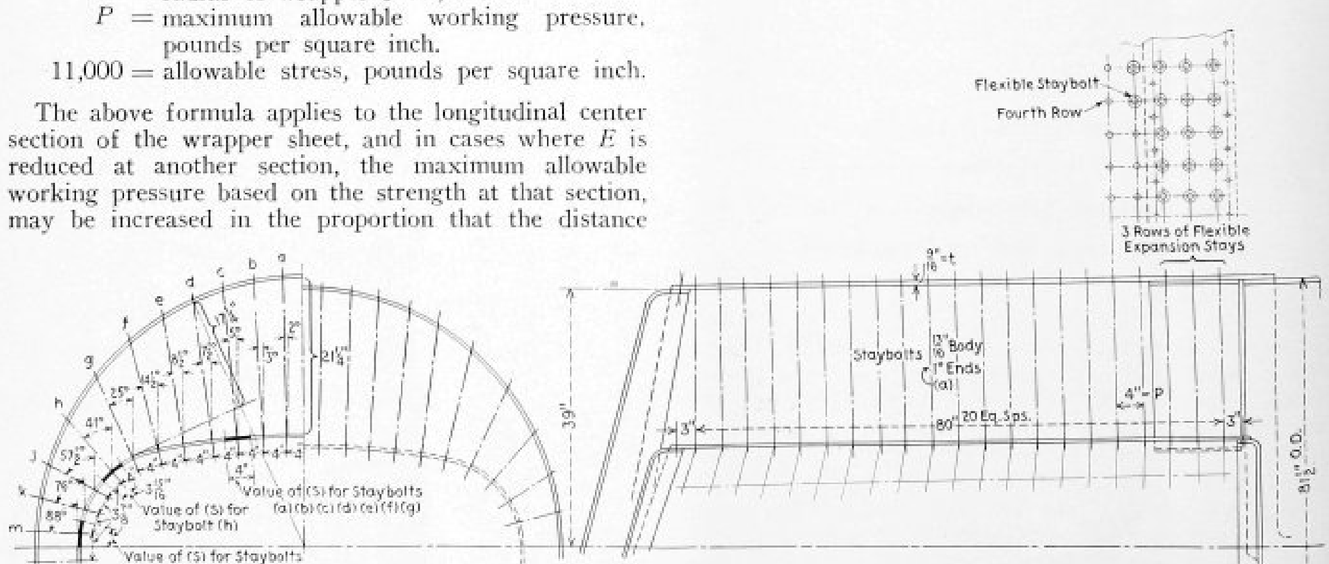

Fig. 1.—Stay arrangement in locomotive firebox

This condition will be considered later, for the present the efficiency will be taken for the radial stays having 1 inch diameter ends as shown in Fig. 1.

$$(1) \qquad E = \frac{p-d}{p}$$

where: p = pitch of staybolts in inches.
d = diameter of staybolts in inches.
p = 4 inches, D = 1 inch.

$$E = \frac{4-1}{4} = 0.75 \text{ or } 75 \text{ percent.}$$

The next step is to determine the value of $s \sum \text{sine } \chi$.

Where (s) is uniform for all the staybolts it is only necessary to add the sines of all the staybolts to be considered and multiply by the value of (s) as shown in the formula, but where the value of (s) varies as in the case illustrated in Fig. 1 each staybolt must be considered separately, multiplying the value of (s) for each staybolt by the sine of the angle of the staybolt separately and adding the total as follows:

Staybolt	Angle degrees	Sine	(s) inches	Sine χ (s)
a	2	.0349 ×	4	= .1296
b	3	.0523 ×	4	= .2092
c	5	.0872 ×	4	= .3488
d	7½	.1305 ×	4	= .5220
e	8½	.1478 ×	4	= .5912
f	14½	.2504 ×	4	= 1.0016
g	25	.4226 ×	4	= 1.6904
h	41	.6561 ×	3.9375	= 2.5833
j	57½	.8434 ×	3.875	= 3.2681
k	76	.9703 ×	3.875	= 3.7599
m	88	.9994 ×	3.875	= 3.8726
		Value $s \sum \text{sine } \chi$		=17.9767

All the values in the formula being known, the maximum allowable working pressure is found as follows:

where
$E = 0.75$
$R = 40.75$ inches
$t = 0.5625$ inch
$s \sum \text{sine } \chi = 17.9767$

$$(2) \qquad P = \frac{11{,}000 \times 0.5625 \times 0.75}{40.75 - 17.9767}$$

$P = 203.7$ pounds.

This will be the allowable working pressure based on the conditions found at the front of the crown.

The calculations should then be repeated in the same manner at the back of the crown sheet determining the value of $(s \sum \text{sine } \chi)$ for the conditions found there, in same manner as illustrated in Fig. 1 for the front of the crown sheet and using 39 inches for the value of R, obtaining the value of P.

This check calculation is important where the slope of the crown sheet is not the same as the slope of the roof sheet.

As a rule the application of a liner under the flexible expansion stays gives sufficient strength for the increase in size of the holes for the flexible staybolts, however the allowable working pressure should be checked at this point, obtaining the efficiency through these staybolts, and using 2¼-inch diameter of staybolt sleeve in sheet, and substituting in the formula; making

t = thickness of roof sheet plus the thickness of the lines.

R = Radius of roof sheet minus thickness of liner and solving for P.

Next it will be noted in the plan view of Fig. 1, starting with the fourth row, flexible staybolts are used with no supporting liner, thus changing the efficiency of the wrapper sheet at this point.

Assuming 2¼-inch diameter staybolt sleeve the efficiency at this point becomes,

$$E = \frac{4 - (1.125 + 0.5)}{4}$$

$$E = \frac{4 - 1.625}{4} = 0.593 \text{ or } 59.3 \text{ percent}$$

and solving for P we have;

$$P = \frac{11{,}000 \times 0.5625 \times 0.593}{40.75 - 17.9767}$$

$P = 161.1$ pounds

This pressure however can be increased in accordance with the second paragraph of P-212 (b) as follows:

Distance from the wrapper sheet to top of crown at vertical center line of boiler = 23¼ inches, see Fig. 1.

Distance measured on radial line to fourth row of staybolts from the wrapper sheet to a line tangent to the crown sheet and at right angles to the radial line = 17¼ inches, see Fig. 1.

The proportion would then be

$$161.1 : \times :: 17.25 : 23.25$$

$$\chi = \frac{161.1 \times 23.25}{17.25}$$

$\chi = 217.1$ pounds allowable working pressure,

which would be the allowable working pressure at this point.

The minimum allowable working pressure obtained from these calculations would be the maximum allowable working pressure for the boiler based on the strength of the wrapper sheet.

International Acetylene Association Meeting

Preparations are fast assuming final form for the annual meeting of the International Acetylene Association, which will be held at the William Penn Hotel in Pittsburgh on November 14, 15 and 16.

Acceptances to address the convention have already been received from Former Governor John P. Fisher of Pennsylvania, Dr. George T. Baker, President of the Carnegie Institute of Technology, Dean E. A. Holbrook of the University of Pittsburgh, Professor J. H. Zimmerman, Massachusetts Institute of Technology, A. R. Ellis, vice-president of the Pittsburgh Testing Laboratories, E. W. Smith, vice-president of the Pennsylvania Railroad, Dean R. L. Sackett of Pennsylvania State College, and E. F. Blank, Jones & Laughlin Steel Company.

The technical sessions of the convention will stress such important subjects as Oxy-Acetylene Cutting as Applied to Steel Mill Applications; the Metallurgical Aspects of the Oxy-Acetylene Welding Process; Pipe Welding and Testing; The Application of Welding to the Transportation Industries; and Education and Safety in Welding.

The association is meeting for the first time in the Pittsburgh area, and based on the interest already expressed in the association's convention, a record attendance is expected. The association's secretary is H. F. Reinhard, whose office is at 30 East 42nd Street, New York City.

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.

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.

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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.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.

Executive Board — Charles J. Longacre, chairman, division boiler inspector, Pennsylvania Railroad, Baltimore, Md.

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

Cities

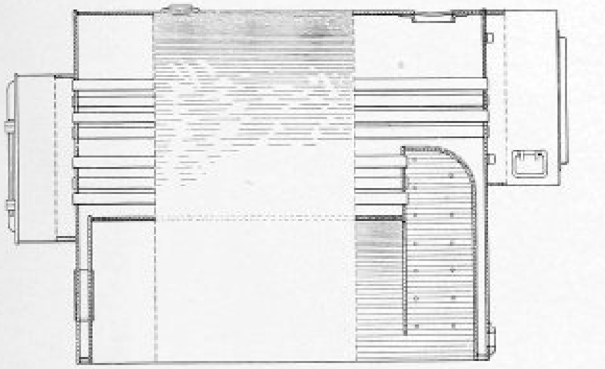
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,815,627. STEAM BOILER AND METHOD OF FORMING THE SAME. JAMES J. MAYS, OF OIL CITY, PENNSYLVANIA, ASSIGNOR TO OIL CITY BOILER WORKS, OF OIL CITY, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

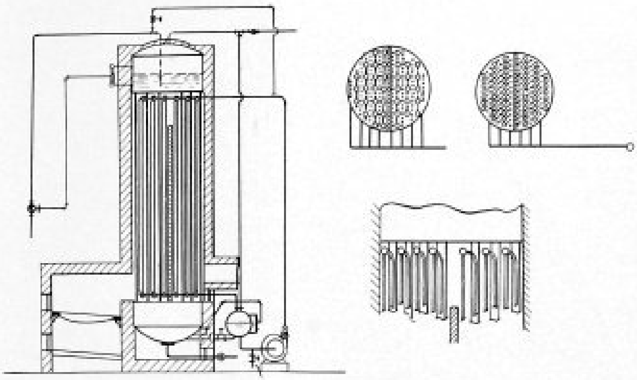
Claim.—The herein described method of constructing the main portion of a firebox structure of a boiler of the return tube type, embodying a main combustion chamber and an auxiliary combustion chamber located at one end of and being an upward extension of said main combustion



chamber, the component elements of which structure are, a plate to form the lefthand side wall and the corresponding half of the crown sheet of the firebox also the left hand side wall of said auxiliary combustion chamber, a plate to form the righthand side wall and the corresponding half of said crown sheet also the righthand side wall of said auxiliary combustion chamber, a rear wall for said auxiliary combustion chamber, and a front wall for said chamber which latter wall forms a tube sheet for one end of one set of tubes, said method consisting of the following steps, namely, cutting said first mentioned plate to pattern, forming the lefthand half of the crown upon said plate, cutting the second mentioned plate to pattern, forming the righthand half of the crown upon said plate. Four claims.

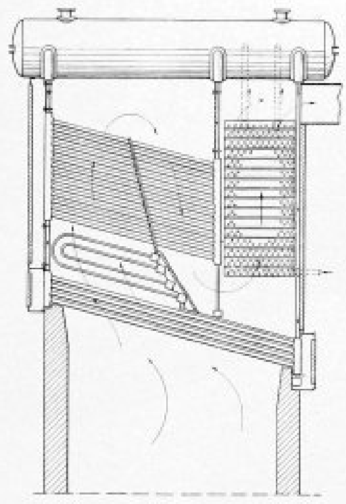
1,815,439. STEAM GENERATOR OR THE LIKE. WALTER DOUGLAS LA MONT, OF NEW ROCHELLE, NEW YORK, ASSIGNOR TO LA MONT CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim.—In steam generating apparatus, the combination with a boiler of the mass-boiling type and boiler heating means, of auxiliary steam generating tubes exposed to the heat of said heating means and connected at their respective ends to said boiler to form therewith an auxiliary water circuit, said tubes being arranged for gravitation of the water therethrough, means for positively effecting a circulation of boiler water through said auxiliary circuit and means for so restricting the input of water to the respective elements with relation to the total amount of water supplied to the elements as to properly apportion it to each element and through which restricting means the water is positively forced under action of the pressure generator. Fourteen claims.



1,854,704. WATER TUBE BOILER AND ECONOMIZER. CHARLES E. LUCKE, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim.—In a water tube boiler, a steam and water drum, two banks of inclined tubes connected to said drum having a plurality of gas passes



thereacross, an economizer located beyond the ends of the tubes of one bank and above the ends of the tubes of the other bank, said economizer being connected to said drum and headers for one of said banks of tubes constituting a portion of a baffle for the gas. Eleven claims.

Locomotive staybolt service is the severest service that metal must withstand. » » » They are constantly stressed in every direction. Every time the firebox breathes they must withstand bending, vibration and tensile all at the same time. » » » For more than 10 years Republic Metallurgists have been working with railroad men in different parts of the country on development of staybolt material that will successfully meet this service. » » » Agathon and Climax Staybolts have high tensile, coupled with shock toughness that safeguards against staybolt failure. » » » Staybolt renewals are expensive in labor alone, aside from delaying the engine. Agathon and Climax Staybolts reduce this expense and delay. » » » » » »

CENTRAL ALLOY DIVISION, MASSILLON, OHIO

Toncan Iron Boiler Tubes, Pipe, Plates, Culverts, Rivets, Tender Plates and Firebox Sheets • Sheets and Strip for special railroad purposes • Agathon Alloy Steels for Locomotive Parts • Agathon Engine Bolt Steel • Agathon Iron for pins and bushings • Agathon Staybolt Iron • Climax Steel Staybolts • Upson Bolts and Nuts • Track Material, Maney Guard Rail Assemblies • Enduro Stainless Steel for dining car equipment, for refrigeration cars and for firebox sheets • Agathon Nickel Forging Steel.

REPUBLIC STEEL CORPORATION

GENERAL OFFICES YOUNGSTOWN, OHIO

Boiler Maker and Plate Fabricator

NRA CODE GRAPHIC ARTS INDUSTRY

Mechanical Conventions Are Needed

Changing conditions in the railway field, as well as in our economic structure, and the possibility of improved business conditions in the not distant future, have been important factors in stimulating a strong interest in the revival of the work of the various mechanical-department associations, and the planning for conventions in 1935. Among the reasons why such activities should be resumed are two which, while of prime importance, are not generally recognized.

In the first place, it is now several years since conventions have been held by some of the organizations, and their activities have become almost dormant. In the meantime, because of death, retirement from service and in some cases, demotion, many changes have taken place in the members and officers of these associations. New men have come into supervisory positions, many of whom are very much in need of the sort of coaching and inspiration that they can get by mixing with their fellows from other railroads, exchanging experiences and making contacts which they can follow up to advantage in seeking information. Taking part in committee work and attending the conventions is not only valuable because of the actual knowledge gained and the contacts made, but such experiences are quite likely to prove of great importance in building up the morale and giving a supervisor that confidence which is so necessary in successful administration.

In the second place, the younger men have been largely overlooked in the depression years. Many of them have dropped out of service and little, if any, recruiting has been done. As business picks up it will be extremely important to remedy this deficiency. Meanwhile, many of the younger men who have been able to hang on, are badly discouraged and are wondering whether, after all, the future in railroad service is worth while. These young men have accumulated a considerable amount of experience and can be made very valuable to the railroads, with encouragement.

One mechanical-department executive is quite insistent that these young men be given consideration in arranging for convention attendance next year, since it may be the turning point in many instances in reviving their interest in railroad affairs and giving them a larger vision of the future possibilities. Certainly they would profit greatly from the experience of attending conventions and this is particularly true if exhibits are available which will permit them to get a good idea of some of the new devices and improved tools and equipment that are now available.

All arguments presented for the need of mechanical conventions in general apply with equal force to the Master Boiler Makers Association. In promoting a convention for this organization, it is absolutely necessary to work with all other railroad mechanical groups to this end. Unless all the associations involved hold meetings under the plan now proposed or some similar arrangement, the master boiler makers cannot hope to hold a 1935 convention.

It should be the object of the officers of this association to co-operate fully with committees of the other groups in preparing definite plans for the convention and to proceed with their own particular preparations so that when authorization is definitely assured, a convention of real practical value to members and to the railroads will result.

The entire future of this as well as a number of other mechanical associations will unquestionably depend upon what is done in the next few months to revive them after years of inactivity.

New Steam Locomotives

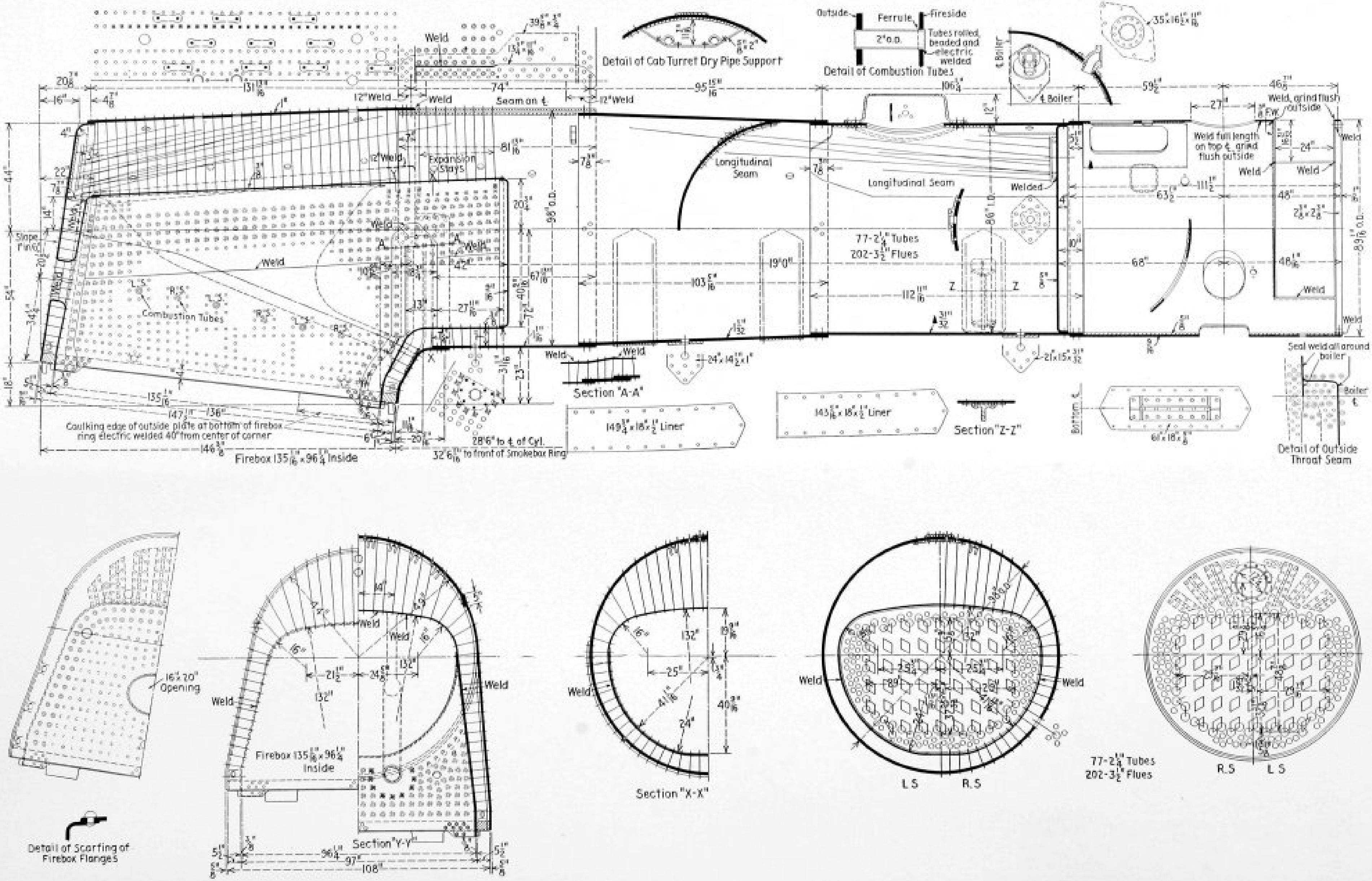
For the first time in several years, it has been possible to present to our readers, the description of a new locomotive, of which fifteen have been built or building for the Nickel Plate. While this 2-8-4 fast freight locomotive is not a new type, having been introduced in 1925, it does represent in its refinements completely modern steam locomotive practice.

With modern, efficient steam power on order for replacement of obsolete equipment, it is evident the dependence placed by the railroads on steam motive power has not been lessened. The only limitations on the volume of replacement orders has been due to lack of revenue. In the ten months this year, 27 steam locomotives have been delivered and 50 more are on order. The volume of rebuilt and reconditioned locomotives is not available, but it is becoming increasingly greater. With any appreciable gain in railroad earnings, the much needed replacement and modernization programs of power will go forward at a correspondingly greater pace. The need exists very definitely. Fulfillment will come with replenishment of funds.

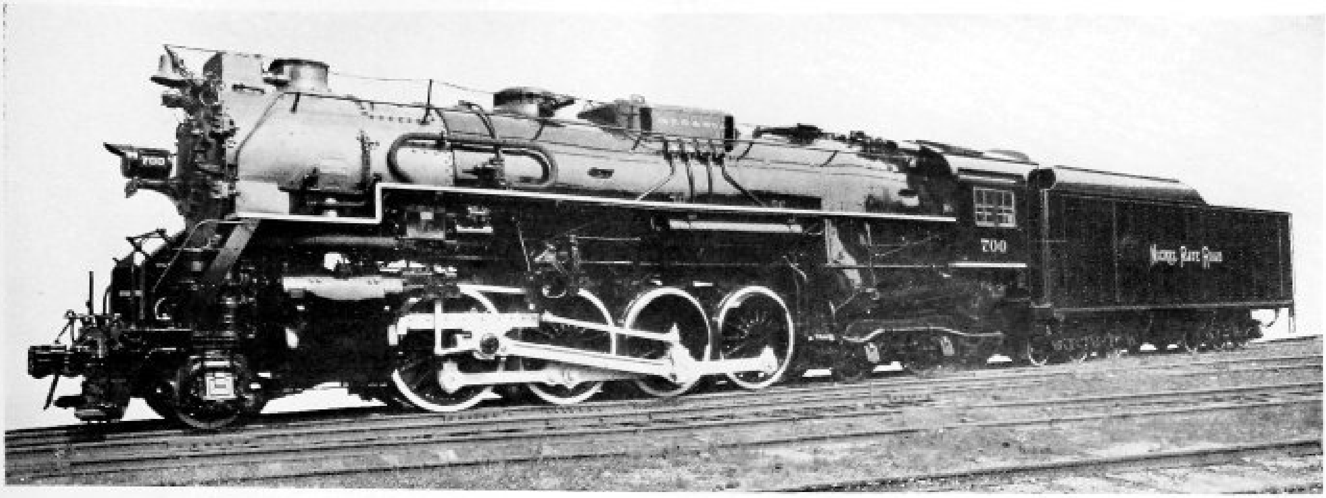
Elementary Plate Layout

The current series of articles on the subject of simple methods for laying out plate work concludes in this issue. While there has been one discrepancy noted in an early article, the reaction of our readers to this series has been most generally favorable.

If, however, any questions concerning the problems have occurred that require further explanation, the author, who also edits the Questions and Answers Department, will be very glad to answer such questions in our columns.



Longitudinal and cross sections of new Nickel Plate 2-8-4 type locomotive boiler with construction details



Nickel Plate 2-8-4 locomotive for freight service

Nickel Plate installs fifteen 2-8-4

FAST FREIGHT LOCOMOTIVES

The New York, Chicago & St. Louis is now receiving delivery of the first of 15 fast freight locomotives of the 2-8-4 type built by the American Locomotive Company. These engines, which are the first of this type to be placed in service by the Nickel Plate, are typical modern freight locomotives of what in the last few years has come to be recognized as good current practice. While of conventional design in so far as general appearance is concerned, they embody those details of design and proportions which are essential for the economical and expeditious handling of freight traffic in a relatively level territory.

The boiler is of generous capacity as it is now generally recognized that high sustained horsepower at speeds is dependent almost entirely on boiler capacity. The size of the cylinders, 25 inches by 34 inches with 69-inch drivers, is different from any previous locomotives of the 2-8-4 type. The rated tractive force with the 245 pounds boiler pressure is 64,100 pounds.

As many detail parts of these new engines as possible are interchangeable with similar parts of the Chesapeake & Ohio 2-10-4 type locomotives. It will be recalled that 40 locomotives of this type were built for the C. & O. in 1930 by the Lima Locomotive Works, Inc.

The 2-8-4 type was first introduced in 1925, and for new power has taken the place of the long popular 2-8-2 type just as some thirty years ago the Mikado type superseded the 2-8-0 or Consolidation type for freight traffic other than slow drag freight. Each step forward has been marked by larger wheels for increased running speeds and larger boilers required for sustained horsepower at high speeds as well as improvements for increased efficiency.

Including the Nickel Plate there are now 298 locomotives of this type on nine roads. This includes the following: 55 on the Boston & Albany, built by the Lima Locomotive Works in 1925, which weigh 389,000 pounds, have 28-inch by 30-inch cylinders, 63-inch drivers, 240 pounds boiler pressure, rated tractive force 69,400 pounds and 3726 potential boiler horsepower; 50 on the Illinois Central, built by the Lima Locomotive Works in 1926, which weigh 388,000 pounds, have 28-inch by 30-inch cylinders, 63-inch drivers, 240 pounds boiler pressure, rated tractive force 69,400 pounds, and 3966 potential horsepower; 12 on the Chicago & North Western, built by the American Locomotive Company in 1927, which weigh 397,000 pounds, have 28-inch by 30-inch cylinders, 63-inch drivers, 240 pounds boiler pressure, rated tractive force 67,200 pounds, and 3617 potential horsepower; 105 on the Erie, including four lots built in 1927, 1928 and 1929 by the American Locomotive Company, the Lima Locomotive Works and the Baldwin Locomotive Works, which weigh from 443,000 to 461,470 pounds, have 28½-inch by 32-inch cylinders, 70-inch drivers, 225 to 250 pounds boiler pressure, rated tractive force 70,000 to 72,000 pounds, and from 4206 to 4309 potential horsepower; 25 on the Boston & Maine, built in 1928 and 1929, by the Lima Locomotive Works, which weigh 393,000 pounds, have 28-inch by 30-inch cylinders, 63-inch drivers, 694,000 pounds, and 3923 potential horsepower; 2 on the Toronto, Hamilton & Buffalo, built in 1928 by the Montreal Locomotive Works, which weigh 383,000 pounds, have 28-inch by 30-inch cylinders, 63-inch drivers, 240 pounds boiler pressure, 69,000 pounds rated tractive force and 3712 potential horsepower; 30 on the Missouri Pacific, built in 1928 and 1930 by the American Locomotive Company and the Lima Locomotive Works, which weigh 404,000 to 412,200 pounds, have 28-inch by 30-inch cylinders, 63-inch drivers, 240 pounds boiler pressure, 69,400 to 70,500 pounds rated tractive force, and 3828 to 3944 potential horsepower. In all cases the tractive force given is that of the main cylinder. In most cases this is supplemented by a booster.

Table of Dimensions, Weights and Proportions of the N. Y., C. & St. L. 2-8-4 Type Locomotives

Railroad	N. Y., C. & St. L.
Builder	American Locomotive Co.
Type of locomotive	2-8-4
Service	Fast freight
Cylinders, diameter and stroke	25 in. by 34 in.
Valve gear, type	Baker
Valves, piston type, size	14 in.
Maximum travel	8 in.
Outside lap	1 11/16 in.
Exhaust clearance	1/16 in.
Lead in full gear	3/16 in.
Specified weights in working order:	
On drivers	254,000 lb.
On front truck	53,000 lb.
On trailing truck	109,000 lb.
Total engine	416,000 lb.
Tender	358,000 lb.
Wheel bases:	
Driving	18 ft. 3 in.
Rigid	18 ft. 3 in.
Total engine	42 ft. 0 in.
Total engine and tender	87 ft. 8¾ in.
Wheels, diameter outside tires:	
Driving	69 in.
Front truck	33 in.
Trailing truck	F. 36 in.—B. 43 in.
Journals, diameter and length:	
Driving, main	R. 12⅝ in. by 13 in. / L. 12½ in. by 13 in.
Driving, others	R. 11⅝ in. by 13 in. / L. 11½ in. by 13 in.
Front truck	6½ in. by 12 in.
Trailing truck, front	7 in. by 14 in.
Trailing truck, back	9 in. by 14 in.
Boiler:	
Type	Conical
Steam pressure	245 lb.
Fuel	Soft coal
Diameter, first ring, inside	86 in.
Firebox, length and width	135 1/16 in. by 96¼ in.
Height mud ring to crown sheet, back	68 in.
Height mud ring to crown sheet, front	92¾ in.
Combustion chamber length	42 in.
Tubes, number and diameter	77—2¼ in.
Flues, number and diameter	202—3½ in.
Length over tube sheets	19 ft. 0 in.
Tube spacing	F. ¾ in.—B. 11/16 in.
Grate type	Firebar
Grate area	90.3 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	343 sq. ft.
Arch tubes	19 sq. ft.
Syphon	100 sq. ft.
Firebox, total	462 sq. ft.
Tubes	857 sq. ft.
Flues	3,499 sq. ft.
Tubes and flues	4,356 sq. ft.
Total evaporative	4,818 sq. ft.
Superheating	1,992 sq. ft.
Comb. evaporative and superheating	6,810 sq. ft.
Tender:	
Style	Rectangular W.B.
Water capacity	22,000 gal.
Fuel capacity	22 ton
General data estimated:	
Rated tractive force, 85 per cent	64,100 lb.
Potential (boiler) horsepower	4,008 hp.
Speed at 1,000 ft. piston speed	36.2 m.p.h.
Piston speed at 10 m.p.h.	276.1 ft.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent.	61.0
Weight on drivers ÷ tractive force	3.96
Total weight engine ÷ comb. heat. surface	61.0
Boiler proportions:	
Tractive force ÷ comb. heat. surface	9.41
Tractive force × dia. drivers ÷ comb. heat. surface	649
Firebox heat. surface ÷ grate area	5.11
Firebox heat. surface, percent of evap. surface	9.59
Superheat. surface, percent of comb. heat. surface	29.2
Comb. heat surface ÷ grate area	75.4

Boiler of Generous Proportions

Special attention was given to the boiler design with a view of providing ample steam generating capacity at all times and for all services. It is of conical design, 86 inches inside diameter of the first course on which is mounted the steam dome and increased to 98 inches outside diameter in the third course over the combustion chamber. The total length of the boiler, including the smokebox, is 44 feet 8 7/16 inches.

The firebox is 135 1/16 inches long by 96¼ inches wide, with a combustion chamber 42 inches long. Outside measurements at the mud ring are 149 1/16 inches long by 109¼ inches wide. The firebox contains two thermic syphons and two arch tubes. The depth of the firebox from the top of the grate to the center of the lowest tube is 27⅝ inches and the height from the bottom of the mud ring to the crown sheet is 68 inches at the back and 92¾ inches at the front.

Boiler Equipment Applied on N. Y., C. & St. L. 2-8-4 Type Locomotives

Railroad	N. Y., C. & St. L.
Builder	American Locomotive Co.
No. ordered	15
Boiler:	
Boiler and firebox steel	Otis
Rivets	Champion—Victor
Brace rods	Ewald
Staybolts, flexible and rigid	Flannery
Tubes and flues (10)	National Tube
Tubes and flues (5)	Pittsburgh St. Products
Syphons, Thermic	Locomotive Firebox
Brick arch	Am. Arch—Security
Smokebox hinge	Okadee
Smokebox netting	Cleveland Wire Cloth—No. 398
Superheater	Superheater Co.—Type E
Throttle valve	American Multiple
Lagging (10)	Johns-Manville
Lagging (3)	Philip Carey
Pipe covering	Union Asb. & Rubber Co.—Insu-tape
Feedwater heater	Worthington—Type S
Feedwater check	Nathan
Injector	Nathan—Simplex NL
Injector check	Nathan
Blow-off cock	Wilson
Blow-off muffler	Wilson
Washout plugs	Huron
Arch tube plugs	Huron
Stoker	Standard Stoker
Firedoor	Franklin—No. 8
Grates	Waugh—Firebar
Grate pins	Am. Ry. Products
Safety valves	Coale
Steam gages	Star
Back-pressure gage	Ashton
Water column	Nathan—W.O.A. type
Water gage	Okadee
Gage cocks	Central Valve
Low water alarm	Nathan
Blower fittings	Barco
Turret valve	Nathan
Cocks and valves	Central Valve

The grate area is 90.3 square feet, the grates being of the firebar type. Three combustion tubes, 2 inches diameter, are provided on each side of the firebox together with suitable steam nozzles. The stoker was furnished by the Standard Stoker Company.

There are 77 2¼-inch tubes and 202 3½-inch flues, both tubes and flues being hot drawn seamless steel. For 10 engines they were supplied by the National Tube Company and for five engines by the Pittsburgh Steel Products Company. The length over tube sheets is 19 feet. The superheater is Elesco Type E and has an area of 1992 square feet heating surface. Flexible and rigid staybolts were supplied by the Flannery Bolt Company.

The evaporative heating surface totals 4818 square feet, of which 343 square feet is in the firebox, including arch tubes and syphons, and 4356 square feet in the tubes and flues.

The smokebox is 89 1/16 inches outside diameter and 116 inches long. The smoke stack, the top of which is 15 feet 8 inches above the rails, has a diameter of 21 inches. The exhaust nozzle is 8½ inches diameter. All auxiliary exhausts have been kept outside of the smokebox. This has the effect of keeping all water and condensation out of the smokebox and should improve the drafting.

A Worthington Type S feed-water heater is applied with hot and cold water pumps on the left-hand side and a Nathan Simplex NL injector on the right side. A Nathan low-water alarm is provided.

The blow-off equipment, including valves and muffler, was furnished by the Wilson Engineering Corporation, the centrifugal muffler being located on top of the boiler immediately back of the safety valves.

A 9½-inch dry pipe leads to the American multiple front end throttle. As will be noted from the illustrations, these locomotives present a particularly neat appearance. This is due partly to the fact that the piping has been placed under the jacket wherever possible. Another noticeable feature of the design is the large size sand box which has a capacity of 60 cubic feet. The customary pilot has been practically eliminated, but ample safety steps have been provided.

The cab is large and roomy and the location of all valves and fixtures has been worked out carefully to provide maximum accessibility and visibility. The cab is fitted with Prime clear-vision windows and windshields. The seats are of the Van Dorn pattern, two seats being fitted on the left side.

The chassis is of the built-up construction type. The cast-steel bar frames were furnished by the Ohio Steel Foundry Company and the frame cradle castings by the General Steel Castings Corporation. The cross-ties are of unusually rugged construction, the guide yoke cross-tie being of a heavy box-section design. Sliding shoe supports for the boiler are used at both front and back of the firebox. Particular attention has been given to the bolting of all parts, especially the cylinders which are of cast steel furnished by the Ohio Steel Foundry.

The tender is of large size, has a water capacity of 22,000 gallon, and a coal capacity of 22 tons. It is of the rectangular type with a cast-steel water bottom. Particular care was given to the design of the tank bracing. The trucks are of the Buckeye six-wheel type with 33-inch Davis steel wheels, 6½-inch by 12-inch journal axles and clasp brakes furnished by the American Steel Foundries.

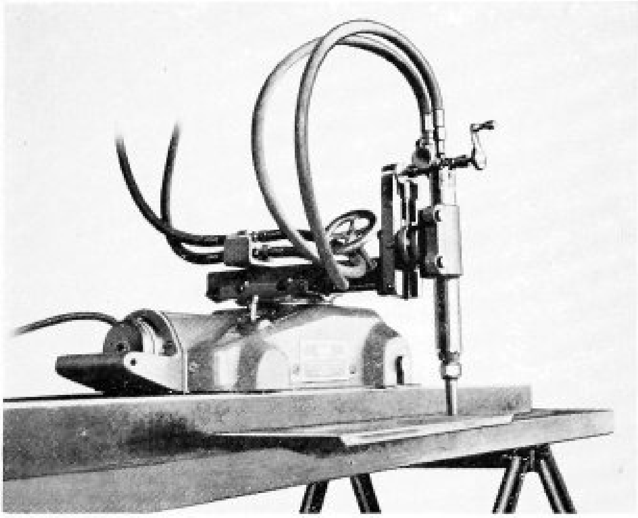
Oxweld Cutting Machine

The Linde Air Products Company, New York, has announced a new addition to its large line of oxy-acetylene cutting machines, The Oxweld Monitor or CM-8 Cutting Machine.

Every effort has been made to make the Monitor a perfect example of machine design. It is of extremely rugged construction, streamlined to facilitate both operation and maintenance. It is easily portable, and is adjustable through the entire range of oxy-acetylene cutting. All the working elements are enclosed in a double cover.

The Oxweld Monitor does automatic straight line cutting of practically unlimited length, straight bevel cutting, two bevels at a time if desired, plate edge preparation, circle or ring cutting of diameters up to 100 inches and the cutting of curved or irregular shapes.

One blowpipe, the Oxweld C-7, is supplied as standard equipment, thus permitting cuts up to 12 inches. The Oxweld C-22 Blowpipe may be substituted for heavier cutting and certain flame machining operations. Provision is made for the use of two blowpipes simultaneously. These can be mounted either on the same or opposite sides of the machine, and adjusted independently. The slide for the blowpipe holders is constructed so that it may be swung instantly into any horizontal position over a working arc of 250 degrees. Protractor scales gage the tilting of the blowpipes in either direction parallel to the side of the machine through 90 degrees, and up to 90 degrees at right angles from the side.



Monitor oxy-acetylene cutting machine

Special care has been given to speed control, and the sensitive indicators eliminate all guesswork. Merely by setting the indicator and shifting the gear lever any speed may be instantly obtained within the range of 2 to 48 inches per minute.

Reporting Locomotive Defects

Locomotive condition reports usually show the defects and work required, as reported by both enginemen and inspectors. While the reports of some enginemen reflect the true condition of the locomotives, these conditions being corroborated in every detail by the inspectors' reports, certain enginemen allow themselves to indulge in particular hobbies and, consequently, their reports can be forecast almost word for word and give little indication of the real conditions of the locomotives.

For example, as was pointed out at a recent meeting of the Pacific Railway Club, reports frequently include the following: "Engine not steaming," "Engine blows," "Oil engine truck, driver and trailer boxes." It is obviously of no help to the inspectors or the engine house supervision for enginemen to report work which will be taken care of normally as a routine operation. It is equally ineffective to concentrate on certain details at the expense of others which may be more important. Maximum benefit from the enginemen's records are secured only when they tell, as nearly as practicable, exactly what the defective conditions are and where they can be located. This is perhaps best illustrated in connection with the reports of engine blowing. When this condition exists, the engineman may just as well add "Examine admission rings (or exhaust rings, as the case may be) on the right valve"; or "Examine right (or left) cylinder packing."

Clear, precise reports by enginemen are extremely valuable to the engine house foreman who, in the last analysis, is the man who has to decide what work is non-essential, what can be postponed to some later time and what conditions must be corrected without fail before locomotives can be returned to service.

Combustible vapor as a cause of

AIR RECEIVER EXPLOSIONS*

By William D. Halsey†

So many conflicting theories have been advanced in an effort to assign a cause to the combustion explosions that occur in compressed air systems operating in the range of pressures upward of 80 pounds that no acceptable explanation has yet crystallized. The subject is still in the debatable stage, and in preparing this article the author does not assume to settle the question. However, he presents a line of reasoning which at some points is based on theory but which agrees closely with facts observed during investigations of exploded tanks. It is in accord, too, with the experience of many operators of air compressors that leaky discharge valves cause an abnormal rise in the temperature of the discharge air, and that vapor from the lubricating oil is the combustible substance to be contended with

The bursting of an air tank or of an air pipe system is, of course, due to the development of a pressure greater than the tank or pipe can withstand. This may result from a system becoming weakened through deterioration or because of the development of pressure beyond that which the system was intended to carry. Such over-pressure may build up gradually because of inoperative safety devices, or it may come about with extreme rapidity by reason of a combustion explosion within the system.

That such combustion explosions may and do occur has been shown on many occasions by clouds of smoke and flashes of fire at the time of the explosion; and the ruptured parts of vessels have frequently shown evidence of having been at a high temperature. The danger of a combustion explosion in compressed air systems is considered one of the greatest hazards in their operation, and these accidents have occurred with such frequency that considerable study has been given to their cause and to their prevention.

In any investigation of this subject these questions always arise: What is it that explodes when a combustion explosion occurs in a compressed air system; and what is there to ignite any combustible mixture that may be present? Neither question has ever been answered beyond argument; but it has been demonstrated by experience that failure to observe certain precautions has been followed by explosions, so it may be assumed that these known factors are responsible for accidents of this kind. For instance, if too much oil or an improper oil is used, if the intake air carries much dust or dirt, or if there is a failure of the cylinder cooling system, or if insufficient care is given the valve mechanism of the compressor, there is danger of explosions.

There seems to be no doubt whatsoever that the oil used for lubrication must form the basis for an explosive gas or vapor. However, the rate at which oil is ordinarily fed even with excessive lubrication would seem (when considered with the great amount of air passing through the cylinder) to be such as to form so weak a mixture of oily vapor and air that it would not ignite. This point will be considered again further along in the article. For the present we may assume that an explosive mixture can exist and confine our attention to finding out, if possible, how ignition takes place.

Compression of air is attended with a rise in temperature which primarily is dependent on the "ratio of compression," that is, the ratio of the final pressure to the initial pressure. It makes no difference what the initial and final pressures are. The important point is the ratio between the two. Thus if air is compressed in the simplest manner possible, or by what engineers call adiabatic compression, from atmospheric pressure or 15 pounds gage to 90 pounds gage, the ratio of compression is six and the rise of temperature will amount to 354 degrees. However, if the initial pressure had been 100 pounds it would have been possible to compress the air to 600 pounds before undergoing a temperature rise of 354 degrees. It has been pointed out on occasion that, as the flash and fire points of some lubricating oils are as low as 500 degrees, these oils may become ignited by the temperature ordinarily obtained by compression. However, this theory does not hold up when it is considered that the "flash point" of an oil is the lowest temperature at which, under definite specified conditions, the oil vaporizes rapidly enough to form above its surface an air-vapor mixture which gives a flash or mild explosion when ignited by a small flame; and the "fire point" is the lowest temperature at which, under definite specified conditions, the oil vaporizes rapidly enough to form above its surface an air-vapor mixture which burns continuously for at least five seconds when ignited by a small flame. It is important to note the words when ignited by a small flame. Oils do not flash nor take fire spontaneously in the atmosphere by merely raising them to their flash or fire point temperatures. They must be ignited by a flame. The ignition temperature of an oil or gas is a figure quite different from the flash or fire point. It varies for different oils or gases but in general it is in the vicinity of 1000 degrees F. at atmospheric pressure. This is very considerably higher than the temperature that could theoretically be obtained, at ordinary compression ratios, even by the poorest type of compression.

Viewed from the considerations given above it would

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† Assistant chief engineer of the Hartford Company.

appear to be impossible to obtain a temperature high enough to ignite such oil vapor mixtures as may be present in a compressed air system. Yet explosions do occur, so, obviously, ignition must take place.

It has been suggested at times that ignition may be brought about by a discharge of static electricity in the system. It is well known, of course, that if a jet of gas or vapor strikes an insulated object, that insulated object may become charged with static electricity and eventually discharge to some other object at a different potential. However, in a compressed air system there is metallic contact throughout and it is difficult to see how any one part of the system could attain a static potential sufficiently high to cause a static discharge. The theory of static discharge does not, therefore, seem tenable.

In considering the nature of a combustion explosion it must be borne in mind that it is merely the burning of a combustible mixture at such a rapid rate that the heat which develops cannot be carried away by the surrounding atmosphere or parts of the vessel in which the gas is contained, and that a sudden high pressure is thereby produced. To cause such an explosion the ratio of combustible and air must fall within a certain rather narrow and definite range. If the ratio is such that a mixture exists either leaner or richer than those within this narrow range, then a comparatively slow burning will take place, or possibly none at all.

As a matter of fact it has been noted on many occasions that fires do occur in compressed air systems. This has been evidenced at times by the discharge line from the compressor becoming red hot. Not infrequently compressed air receivers are found with the paint on them blistered, and at times there has been a discharge of flame from the safety valves. Furthermore, it has often been noted by operators of air compressors that the discharge line becomes excessively hot and when such evidence of high temperature appears, the remedy has been to overhaul the compressor—particularly the valve mechanism. The discharge valves have been found in poor condition, permitting leakage of air back into the compressor cylinder, and when such valves have been placed in proper operating condition the trouble from overheating has ceased.

A few years ago there was carried out, at the University of California, a test to determine the effect of a leaky discharge valve. Temperatures were taken of air at the two discharge ends of a compressor cylinder. In one end there was a leaky discharge valve made so by drilling a hole in it; in the other the valves were in good condition. Compression was carried to 90 pounds gage. The temperature of the discharge air in the end of the cylinder with good valves reached a value of approximately 235 degrees whereas in the end with a leaky valve the temperature rose to 330 degrees F. in slightly over 20 minutes.

Let us consider this condition of a compressor with leaky discharge valves. When a compression stroke has been finished, air at some temperature higher than the atmosphere has been discharged into the discharge line. On the suction stroke of the compressor the greater part of the air taken in will come through the suction valve, but with a leaky discharge valve some of the higher temperature air will slip back into the cylinder. As a result the next cylinder-full of air will start its compression at a higher temperature than the preceding one. Since this cylinder charge of air starts at a higher temperature it must necessarily finish at a higher temperature than before, and this repeated action will result in a cumulative increase of temperature until a point is reached where radiation from the cylinder and the surrounding pipes will exactly balance the amount of heat put in.

It has been claimed that when the heated air in the discharge pipe leaks back into the cylinder it expands and, therefore, cools. In this connection, however, it is well to note that as the air which expands into the cylinder may not do any work it is possible that the drop in temperature is not as great as it otherwise might be.

Whatever may be the real explanation the fact remains that the temperature of the discharge air will increase abnormally if the discharge valves do not close tightly.

In the University of California experiment an investigation was also made of the effect of throttling the intake air. Theoretically it would seem that this throttling should increase the ratio of compression and thereby increase the discharge temperature. This was found to be the case actually.

It appears then that the temperature of the discharge air may, under certain conditions, rise to somewhat abnormal figures although it is difficult to see how it could reach 1000 degrees F., which has been indicated as the ignition temperature of a number of gases. We must, therefore, look for another explanation.

The ignition temperature in the vicinity of 1000 degrees has been given as that which pertains to gases when they exist at atmospheric pressure. It is known, however, that a mixture of gasoline and air, when compressed in an engine cylinder, will give difficulty with knocking and pre-ignition if the compression pressure is raised much above 80 pounds per square inch. However, the temperature of compression at 80 pounds could hardly be much greater than 370 degrees. On the other hand it is only fair to assume that under compression (with the molecules of gas and oxygen crowded more closely together) the temperature required for ignition may be decreased.

An investigation along this line was conducted in 1924 by two Germans, Messrs. Tausz and Schulte. Their work has been reported in a publication of the National Advisory Committee for Aeronautics, Technical Memorandum No. 299. We find from their experiments quite definite indications that the ignition temperature is decreased by increase of pressure. For instance, a mixture of gasoline and air which under a pressure of 2 atmospheres ignited at 707 degrees F. required a temperature of only 464 degrees F. when under a pressure of 8 atmospheres. This series of experiments covered a number of different oils and it is interesting and also important to note that certain oils which have a comparatively low ignition temperature at atmospheric pressure may have a comparatively high ignition temperature when under a higher pressure. With other oils or gases the reverse is the case.

Messrs. Dixon and Higgins (*London Gas Journal*, Oct. 20, 1926) report a test indicating that a mixture of methane and air under a very slight pressure might show an ignition temperature of approximately 780 degrees whereas if carried to 7 atmospheres pressure it would have the ignition temperature depressed to 633 degrees.

While a number of experiments have been conducted by various investigators the results do not appear to be in complete agreement. However, it is very evident that increase in pressure may decrease the ignition temperature of vapor from some lubricating oils to the point where the abnormally high temperature caused by a leaky discharge valve would cause spontaneous ignition.

There is still another point to be considered in searching for an explanation of air receiver explosions, and that is: How may sufficiently rich mixtures accumulate to provide for a violent combustion explosion?

When a compressor is new and in good working order there is, of course, very little dirt in the system. With the passing of time some dirt is drawn in and there is likely to be in this dirt a considerable accumulation of insect life and vegetable matter. This foreign material is covered with oil in its passing through the compressor cylinder and adheres to the inside of the discharge pipe. Under the action of heated, high-pressure air such deposits may decompose and provide combustible gases. With further passage of time dirt begins to accumulate under the discharge valves and they become leaky. This brings about an increased temperature of the discharge air and this in turn favors more rapid decomposition of the oil-saturated animal and vegetable matter on the sides of the discharge pipe. Possibly this decomposition may result in the evolution of highly explosive gases. At first the mixture may be so lean as to simply burn but with the greater temperature thus developed a progressive action may take place with more rapid decomposition and breaking up of the oily discharge into still greater accumulations of explosive gases. These gases would be carried along by the air stream ahead of the flame into the receiver and accumulate there in what would be a highly explosive mixture. An explosion might conceivably occur when the flame reached this mixture.

This may or may not be the actual case. It is given merely as an imaginative picture of what may take place. But whether it is so or not it is well known that leaky discharge valves cause an increase in the temperature of the discharge air, that accumulation of an oily deposit of animal and vegetable matter will generate gases when subjected to air at a high temperature, and that the ignition temperature of such gases will in all probability be greatly depressed by the pressure under which they exist. Thus it appears quite probable that under some circumstances an explosive mixture may result and may be ignited through the combination of rising temperature of the air from the compressor and a decreasing ignition temperature of the gaseous mixture. Because of the fact that no exact figures can be given it would appear that what may cause an explosion in one case might not do so in another. It seems likely, too, that it would be difficult to duplicate results from time to time.

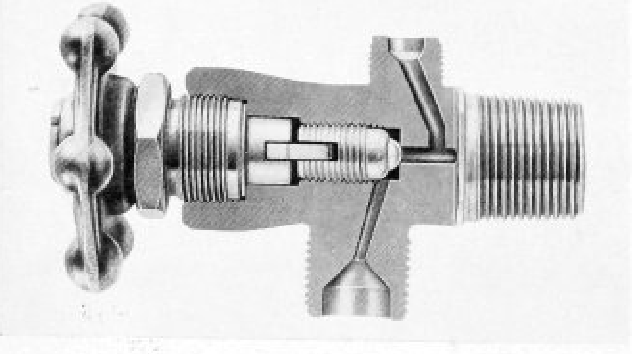
Airco Oxygen Cylinders Equipped with Ball-Seat Valves

In what is believed to be one of the most extensive efforts by any manufacturer to modernize and improve its equipment, the Air Reduction Sales Company has equipped more than 96 percent of all of its oxygen cylinders with valves having a stainless-steel ball seat.

While the valve proper closely resembles the older type valve in appearance, it differs in construction in that a hardened stainless steel ball forms the seat.

The valves not only open and close easily but they are said also to possess superior sealing qualities and they do not corrode or score and cause leaks.

For over three years similar types of hardened stainless steel ball valves have been used on all Airco-DB welding and cutting torches. Their use has demonstrated that torches so equipped rarely require valve repairs other than the occasional renewal of valve-stem packing.

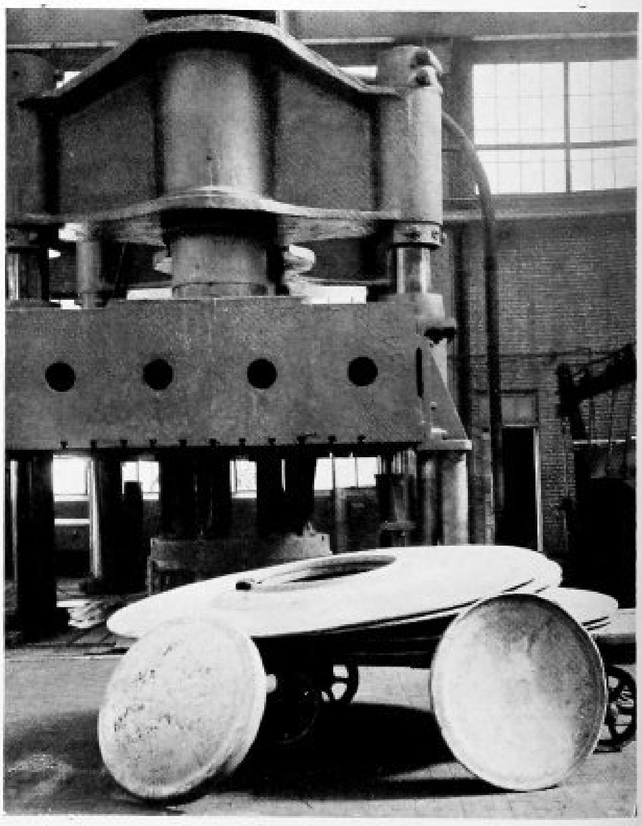


Oxygen cylinder valve with ball seat

Making Boiler Front Rings and Doors

Some difficulty has been experienced on the Illinois Central as well as other roads with cinder-cut boiler front rings and doors which wear thin and do not have the desired rigidity and length of service life. To meet this condition, it was decided on the I. C. to increase the thickness of these parts from 3/8 inch to 1/2 inch.

In making the heavier front rings and doors at the Paducah (Ky.) shop of the Illinois Central, 1/2-inch steel sheets of the desired size are cut to shape and formed in the Southwark 2100-ton flanging press, illustrated. In the case of the boiler front rings, the circular door opening is cut out with an oxy-acetylene torch and the ring formed hot in one operation of the flanging press. The front-end doors are also formed to the shape indicated and flanged in one operation of the press.



Southwark 2100-ton flanging press used at Paducah shops for forming boiler front rings and doors

Lloyd's Register of Shipping Adopts Tentative Requirements for Fusion Welded Pressure Vessels

The following rules tentatively adopted by Lloyd's Register of Shipping represent the first codification of regulations governing the fusion welding of pressure vessels in Great Britain. They should prove of interest to a large body of readers for comparison with American practice.

Definition of Fusion Weld

The term "Fusion Weld" is, for the purposes of this specification, applicable to all welded joints made by the oxy-acetylene or the oxy-hydrogen process, the metal-arc process with covered electrodes, or other electric arc process in which the arc stream and the deposited weld metal are shielded from atmospheric contamination.

Classification of Pressure Vessels

CLASS 1.—Fired pressure vessels and vessels subject to internal steam pressure above 50 pounds per square inch.

NOTE.—Class 1 vessels to be made by approved manufacturers only.

CLASS 2.—Pressure vessels not included in Class 1.

NOTE.—All vessels subject to internal pressure submitted for approval in accordance with these Requirements will be dealt with under one of the above classes, but in special cases some variation of the specified routine tests may be considered necessary.

Section I. Class 1 Pressure Vessels

1. QUALITY OF MATERIAL.—(*a*) The material used in the construction of a pressure vessel shall be mild steel made by the acid or basic Open Hearth Process. The finished material is to be free from cracks, surface flaws and lamination. It is also to have a workmanlike finish and must not have been hammer-dressed, but slight scale or shell may be removed by the use of the chisel, file, buff, or sand or shot blast.

(*b*) One tensile and one cold bend test shall be taken from each plate as rolled. For plates exceeding 2½ tons in weight, one tensile and one cold bend test shall be taken from each end.

(*c*) The tensile breaking strength of steel plates determined from the Society's Standard Test Piece A (Fig. 1) is to be between the limits of 26 and 32 tons per square inch, but a range of more than four tons per square inch will not be permitted in any one case. For plates intended for flanging, the tensile breaking strength is to be between the limits of 26 and 30 tons per square inch. The elongation measured on a gage length of eight inches is not to be less than 20 percent for material of 0.375 inch in thickness and upwards required to have a tensile breaking strength between the limits of 28 and 32 tons per square inch, and not less than 23 percent for material of 0.375 inch in thickness and upwards required to have a tensile breaking strength between the limits of 26 and 30 tons per square inch.

(*d*) Bend test pieces shall be sheared lengthwise or crosswise from plates and are not to be less than 1½ inches wide. The rough edge caused by shearing may be removed by filing or grinding, and test pieces 1 inch in thickness and above may have the edges machined but shall receive no other preparation. The test piece is to withstand, without fracture, being doubled over until the internal radius is equal to 1½ times the thickness of the test piece, and the sides are parallel. Bend tests may be made either by pressure or by blows.

(*e*) The tensile and bend test pieces shall not be heat treated unless the material from which they are cut is

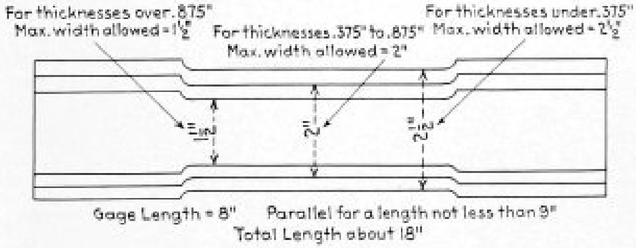


Fig. 1.—Standard test piece "A"

heat treated, in which case the test pieces of the material shall be similarly and simultaneously treated before test.

2. DESIGNS AND PERMISSIBLE WORKING PRESSURE.—(*a*) In all cases the designs for each pressure vessel are to be examined and the permissible working pressure is to be determined by the following formula:

$$WP = \frac{25.5 \times S \times (t - 2)}{D}$$

where WP is the working pressure in pounds per square inch,
S is the minimum tensile strength of the steel shell plates in tons per square inch,
t is the thickness of the shell plates in 32nds of an inch,
D is the internal diameter in inches.

(*b*) Where tube plates form portions of cylindrical drums, their thickness in way of the tube holes is to be calculated by the following formula:

$$t = \frac{WP \times C \times D}{S \times J} + 4$$

$$\text{or } WP = \frac{(t - 4)\ S \times J}{C \times D}$$

where D is the internal diameter of the drum in inches,
t is the thickness of tube plates, in 32nds of an inch,
S is the minimum tensile strength of the plate forming the drum, in tons per square inch,
J is the percentage strength of the plate through the tube holes, viz.: $\frac{p - d}{p} \times 100$ where p is the pitch of the tubes in inches, on lines parallel with the axis of the drum and d is the diameter of the tube holes in inches,
$C = 3$.

(*c*) Where the end plates are dished outwards to partial spherical form and not fitted with stays, the following formula is to be used:

$$WP = \frac{15 \times S \times (t - 1)}{R}$$

where WP is the working pressure in pounds per square inch,
t is the thickness of the end plate in 32nds of an inch,
R is the inner radius of curvature of the end, in inches, which is not to exceed the diameter of the shell,
S is the minimum tensile strength of plates, in tons per square inch.

The inner radius of curvature at the flange connecting the end to the cylindrical shell, is not to be less than four times the thickness of the end plate, and in no case less than 2.5 inches.

(*d*) Where the end has a manhole in it, ⅛ inch is to be added to the thickness of plate.

(*e*) Dished ends, concave to the pressure, which are to be inserted in a cylindrical shell, shall be driven in so that the outside fillet weld is clear of the knuckle.

Where a dished end plate is fixed by a butt joint, the flange shall form a continuous line at the outside, with the cylindrical shell plate. If the thickness of an end plate exceeds that of the shell, the end plate at the abutting edge shall be reduced to the thickness of the shell plate for a length not less than twice the thickness of the shell plate.

3. Welding.—(*a*) The welding of Class 1 Pressure Vessels is to be done only by firms who have demonstrated to the satisfaction of the Society's Surveyors that they are capable of making efficient welds consistently. For this purpose a Surveyor will make a preliminary visit to the works in order to inspect the welding plant, equipment and organization, also to arrange for the carrying out of a series of tests. Subsequently a Surveyor will report annually on the conditions which obtain at the works and if considered necessary, will carry out further tests.

(*b*) For the purposes of the initial series, three tensile and three bend test pieces are to be prepared and tested under the Surveyor's supervision. The preparation of the test specimens, the welding technique and the process are to be the same as normally used in the making of the longitudinal joints in pressure vessels. The tensile test pieces are to be taken across the joint, and the ultimate tensile strength of the weld is not to be less than the minimum allowed for shell plates, as per Section 1, clause 1 (*c*).

(*c*) The bend test pieces are to be capable of being bent without fracture through an angle of 180 degrees round a bar the diameter of which is not greater than twice the thickness of the test piece.

(*d*) The Surveyors are to select portions of the test plate to provide X-ray photographs of the weld and photo-micrographs of the weld metal, fusion zone and plate. The X-ray negatives and photo-micrographs are to be forwarded to the London Office for the purposes of record.

(*e*) Hardness tests are to be carried out on the parent metal, weld metal and in the vicinity of the fusion zone.

(*f*) Alternating fatigue tests are to be carried out on suitable specimens cut from the test plate.

(*g*) The welding plant is to be installed under cover, and is to be maintained in efficient working condition. The Surveyor is to be satisfied that the works are properly equipped for the welding of pressure vessels and that adequate supervision of the welding work is provided.

On satisfactory compliance with the foregoing, the name of the firm will be placed on a List of Manufacturers of Fusion Welded Pressure Vessels, which will be printed and circulated as an appendix to these Requirements.

4. Routine Tests for each Welded Vessel.—(*a*) Where possible the shell plates should be left long enough to accommodate the test specimens detailed below. Alternatively two test plates should be prepared for each vessel. They should be attached to the shell plate in such a manner that the edges to be welded are a continuation and duplication of the corresponding edges of the longitudinal joint. The welding process, procedure and technique are to be the same as employed in the welding of the longitudinal joint. Test plates are to be so supported during welding, that warping is reduced to a minimum.

(*b*) The test plates are to be straightened before being subjected to the same heat treatment as given to the vessel.

(*c*) Test plates need not be prepared for the circumferential seams, except in cases where a vessel has circumferential seams only, when two test plates are to be prepared, each having a welded joint which, so far as possible, is a duplication of the circumferential seams.

(*d*) The material for the test plates is to conform to the same specification as the shell plates of the vessel.

(*e*) The thickness of test plates is to be the same as that of the vessel.

(*f*) The test plates are to be cut up into test specimens as shown in Fig. 2. All the specimens are to be cut

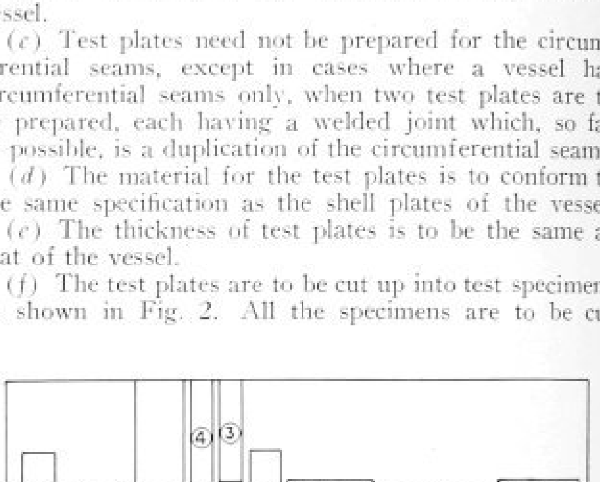


Fig. 2

from a plate of suitable length and are to comply with the test requirements detailed as follows:

(1) Tensile, all weld metal
(2) Bend
(3) Impact (Junction)
(4) Impact (Weld)
(5) Tensile (Joint)
(6) Density
(7) Micro and Macro

(*g*) Tensile Test for Weld Metal. Specimen No. 1.—Gage length = 8 × diameter.

Diameter of test piece for plate thickness	½ in. to ⅝ in. = 0.356 in.
Diameter of test piece for plate thickness	⅝ in. to ¾ in. = 0.4375 in.
Diameter of test piece for plate thickness	above ¾ in. = 0.5 in.

Ultimate tensile strength of weld metal to be not less than minimum specified for plate.

Minimum elongation on gage length = 20 percent.

Minimum reduction of area = 30 percent.

The diameters of test pieces stated above are for guidance. Departure from these dimensions will be permitted, provided that the portion of the tensile specimen under test consists entirely of weld metal.

(*h*) Bend Test. Specimen No. 2.—Dimensions of specimen = ¾ inch wide by ⅜ inch thick. To be cut flush with the upper surface of the plate as shown in Fig. 3.

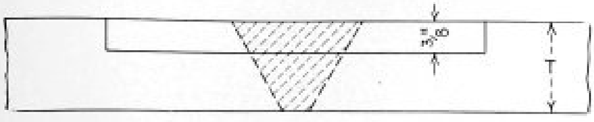


Fig. 3

To be bent cold through an angle of 180 degrees until the distance between the parallel sides is not greater than ⅜ inch. The sharp edges of the specimen may be rounded off before bending.

(*j*) Impact Test. Specimens Nos. 3 and 4.—Dimensions 0.394 inch square. One specimen to have milled V notch cut in the fusion zone and the other to have the notch cut in the center of the weld. Minimum Izod value = 28 foot-pounds.

(*k*) Tensile Test for Joint. Specimen No. 5. Dimensions (Fig. 4.):

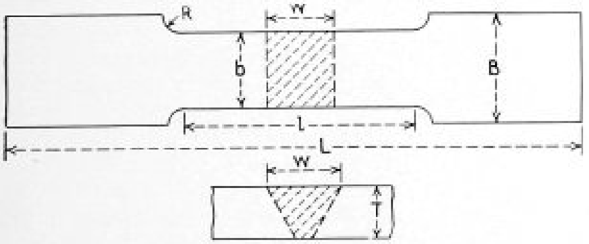


Fig 4

When T is less than 1 inch:

$L = 10$ inches.
$l = w + \frac{1}{2}$ inch. $R = \frac{3}{16}$ inch.
$B = 1\frac{1}{4}$ inches.
$b = \frac{7}{8}$ inch.

When T is greater than 1 inch:

$L = 12$ inches.
$l = w + \frac{1}{2}$ inch. $R = \frac{1}{4}$ inch.
$B = 1\frac{1}{2}$ inches.
$b = 1$ inch.

An equivalent form of test piece to the above could be accepted.

The weld is to be machined flush with plates on both sides.

Ultimate tensile strength of weld metal to be not less than minimum specified for plate.

(*l*) Density Test. Specimen No. 6. The dimensions of the specimen are to be such that the volume is not less than one half of a cubic inch.

Specific gravity of weld metal should be not less than 7.8.

(*m*) Micro and Macro Specimen. Specimen No. 7.

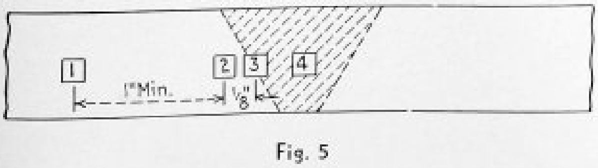


Fig. 5

The specimen is to be polished and etched and photo-micrographs, each of 100 magnifications, are to be taken at the positions indicated (1), (2), (3) and (4) in Fig. 5.

A photo-macrograph is also to be taken across a section of the welded joint.

The photo-macro and micrographs are to reveal a sound homogeneous weld and a normal refined and uniform grain structure.

(*n*) X-ray Examination.—X-ray photographs are to be taken of the entire length of each welded seam, both longitudinal and circumferential. The photographs are to be marked in such a way that the corresponding portion of the welded seam can readily be identified.

Defects revealed by the X-rays are to be cut out, re-welded and again X-rayed.

X-ray methods employed are to be sufficiently accurate to reveal a defect having a quantitative thickness greater than two percent of the depth of the weld, and the manufacturer is to furnish a negative defining this minimum homogeniety.

(*o*) Hydraulic Test.—For vessels intended for working pressures up to 100 pounds per square inch, the hydraulic test is to be twice the working pressure. Where working pressures exceed 100 pounds per square inch, the hydraulic test is to be 1½ times the working pressure plus 50 pounds per square inch.

While under this test the vessel is to be well hammered on both sides of, and close to, the welded seams.

(*p*) Heat Treatment.—Each vessel is to be efficiently heat treated before the hydraulic test is carried out.

The exact nature of the heat treatment is left to the Manufacturer who may be required to furnish a certificate stating the temperature at which the heat treatment was carried out, the soaking time and the cooling conditions.

5. Inspection.—(*a*) Before welding, the assembly is to be examined. The shape and size of the joints should be in accordance with the approved design and the preparation of the parts to be welded should be such as to reduce the shrinkage effects to a minimum.

(*b*) The attachment of branches should be examined before and after welding. In all cases more than one run of weld metal is to be deposited.

(*c*) During fabrication, the Surveyor should be provided with opportunities for seeing the actual deposition of weld metal. The joints are to be examined at various stages during construction. The stages to be arranged to suit the mutual convenience of the manufacturer and the Surveyor.

(*d*) On completion of the welding, the seams are to be thoroughly examined before being dressed or machined. Parts showing evidence of excessive under-cutting, blow-holes, slag inclusions, unsatisfactory penetration, porosity, or any other defect, are to be cut out and rewelded.

(*e*) The reinforcement of the welds should be removed, but, if it is not removed, the building up should be gradual and there should be no undercutting at the sides of the weld.

(*f*) Each vessel is to be calibrated for distortion. The calibration is to be made after the heat treatment has been carried out. The drum or shell is to be circular at any section within a limit of one percent based on the difference between the maximum and minimum diameters of any section.

Section II.—Class 2 Pressure Vessels

1. The following clauses of Section I of these Require-

ments are applicable to Class 2 Pressure Vessels:

Clause 1—(*a*), (*b*), (*c*), (*d*) and (*e*).

Clause 2—(*a*), (*c*), (*d*) and (*e*).

Clause 5—(*a*), (*b*), (*c*), (*d*), (*e*) and (*f*).

NOTE.—The permissible working pressure for end plates dished outwards to partial spherical form and not fitted with stays, is to be determined by the following formula:

$$WP = \frac{18 \times S \times t}{R}$$

S, t and R are as given in Section 1, clause 2 (*c*).

2. WELDING.—The welding of Class 2 Pressure Vessels is to be done only by firms who satisfy the Society's Surveyors that their works are properly equipped for the welding of pressure vessels.

The welding plant is to be installed under cover and is to be maintained in efficient working condition and adequate supervision of the welding work is to be provided.

3. ROUTINE TESTS FOR EACH WELDED PRESSURE VESSEL.—(*a*) Where possible the shell plates should be left long enough to accommodate the test specimens detailed below. Alternatively two test plates should be prepared for each vessel. They should be attached to the shell plate in such a manner that the edges to be welded are a continuation and duplication of the corresponding edges of the longitudinal joint. The welding process, procedure and technique are to be the same as employed in the welding of the longitudinal joint. Test plates are to be so supported during welding that warping is reduced to a minimum.

(*b*) The test plates are to be straightened before being subjected to the same heat treatment as given to the vessel.

(*c*) Test plates need not be prepared for the circumferential seams, except in cases where a vessel has circumferential seams only, when two test plates are to be prepared each having a welded joint which, so far as possible, is a duplication of the circumferential seams. The welding process, procedure and technique are to be the same as employed in the welding of the circumferential seams and the test plate material is to be of the same quality as that used for the shell.

Each test plate is to be large enough to provide one tensile and one bend specimen. The specimens are to comply with the test requirements detailed in clauses (*g*) and (*h*).

For small vessels, only one test plate need be prepared, provided that the welding of the circumferential seams is carried out to the entire satisfaction of the Surveyor.

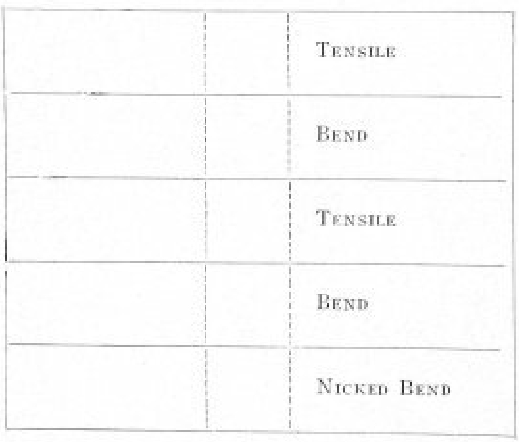


Fig. 6

(*d*) The material for the test plates is to conform to the same specification as the shell plates of the vessel.

(*e*) The thickness of test plates is to be the same as that of the vessel.

(*f*) The test plates are to be cut up into test specimens as shown in Fig. 6. All the specimens are to comply with the test requirements detailed as follows:

The choice of form of the test specimens is left to the manufacturer.

Specimens may be dressed in way of the weld and the sharp edges may be removed from the bend specimens.

(*g*) TENSILE TEST.—The ultimate tensile strength of the weld metal is to be not less than the minimum specified for the plate.

(*h*) BEND TEST.—The specimen is to be bent without fracture through 180 degrees round a bar the diameter of which is not greater than twice the thickness of the test piece.

(*j*) NICKED BEND TEST.—The specimen is to have a slot cut into each side of the weld. The specimen is then to be broken in the weld and the fracture is to reveal a sound homogeneous weld, substantially free from slag inclusions, porosity and coarse crystallinity.

(*k*) HYDRAULIC TEST.—For vessels intended for working pressures up to 100 pounds per square inch, the hydraulic test is to be twice the working pressure. Where working pressures exceed 100 pounds per square inch, the hydraulic test is to be 1½ times the working pressure plus 50 pounds per square inch.

While under this test the vessel is to be well hammered on both sides of, and close to, the welded seams.

(*l*) HEAT TREATMENT.—Vessels may require to be efficiently heat treated before the hydraulic test is carried out depending upon the service for which the vessels are intended.

The exact nature of the heat treatment is left to the manufacturer who may be required to furnish a certificate stating the temperature at which the heat treatment was carried out, the soaking time and the cooling conditions.

Recent Developments in Industrial Group Insurance

This book describes the growth in a little over two decades of the greatest structure of private industrial insurance anywhere in the world. Here, in the United States, a bulwark of protection for the worker against the ordinary hazards of life has been provided through the collaboration of employers, employees, and the large insurance carriers, and without compulsion by the government. The salient features of this insurance structure are:

$9 billion of group insurance outstanding, of which

$8.2 billion is in group life policies, and

$744 million in benefits for accidental death and dismemberment;

$16 million of weekly benefits for group accident and health insurance;

$8.5 million of monthly retirement incomes.

This study of group insurance is based upon the experience of the companies underwriting this vast fund and the many enterprises utilizing various types of group insurance.

The book is published by the National Industrial Conference Board, Inc., 247 Park Avenue, New York.

An Intimate Chat with a Division Superintendent*

There are, of course, all sorts of division superintendents—those on thickly congested trunk lines or at important terminals, and those on railroads serving large areas but with few trains and low traffic density. Or sizing up the situation from a different angle, we have the superintendent under the so-called divisional type of organization, in which he is more or less supreme on his division, the other departments reporting to him. As against this, we have the superintendent under the departmental system, where he deals more or less indirectly with the technical departments. The title does not mean a great deal until one knows more definitely the type of railroad and the nature of the traffic. In the last analysis, however, the division superintendents of all these different types have certain common responsibilities and common problems.

Embarrassing Details

"Do you have any special difficulties in dealing with the mechanical department?" I asked the Division Superintendent of a heavy traffic line—a man of long and successful experience, and a keen observer.

"We get along together very well," he replied, "but there is one thing that I have never been able to understand. Why is it that the mechanical department is so inflexible when it comes to correcting details in design which cause irritation in the operating department? True, many of these things are of comparatively minor importance, but why so much inertia and apparent lethargy? We have been pounding for many years to have some of these comparatively unimportant changes made, but for some reason or other, we don't seem to get much constructive action."

He was asked about certain of these details, but if he were quoted here it is quite probable they would be recognized and the Division Superintendent might be subjected to embarrassment. He made his point in a decided fashion, however.

"There is another thing," continued the Division Superintendent, "in which the mechanical department is more or less helpless, but which gives me a lot of concern, and that is the arch-bar trucks. I hope that the time will not be extended much further before all of these trucks will be taken out of service. An analysis of accident records indicates the seriousness of this hazard and certainly they do not help to make the life of the Division Superintendent any easier."

Personnel Problems

"How about the personnel of your mechanical department? Do you have difficulty in getting and keeping a high type of mechanical supervisors on your division?"

"We have done very well," replied the Division Superintendent; "indeed, much better than circumstances warrant. As you know, our mechanical department officers work under strenuous conditions, and more than that, there is often the question of legal responsibility if anything goes wrong. If you compare the conditions under which these men work and the salaries they receive, with the superintendents of small plants along the line, you will find that the latter operate under much easier and less exacting conditions and yet are much better compensated."

"Do you notice any adverse reactions because of this policy?" I questioned.

"Yes, decidedly so," replied the Division Superintendent. "There was a time when I could get high grade students from colleges to enter the service. In more recent years we have not been getting the pick of these men, although, of course, under present conditions we have no difficulty in getting all the help of this kind that we need. I anticipate a difficult time, however, in securing the best type of these men and even in holding the good men we have, when general business picks up."

Propinquity versus Ability

This led to some reminiscing and reviewing of past performances. The Division Superintendent frankly admitted that in a very large railroad organization men of lesser ability are sometimes put into important positions because the talents of men who are better adapted for these positions are not known to those who have the influence or authority to make the promotions. In other words, propinquity in some instances is a considerable factor in selecting the men for promotion.

"In light of these facts, what can the ambitious young man do to be sure that his talents are not overlooked and that he will not be lost sight of?"

"That is a rather difficult problem," replied the Division Superintendent. "Generally speaking, however, I would say that the young man must do everything he can to extend his contacts and in a diplomatic and tactful way get people to know of his ability. The trouble is, if one is too aggressive in pushing himself, that he may make enemies, or at least he may incur the displeasure of people who can interfere with his advancement. That is one reason why I feel strongly that real diplomacy and tact must be used in extending acquaintanceship and building up contacts, which may bring a capable young man into touch with those who may be in position to help in his climb up the ladder.

"Just one other bit of advice to the young men," he continued. "Tell them not to specialize too highly. This is quite likely to lead into a blind alley. If they do specialize, they should be sure that a way will be left open for advancement. My advice is, don't let your specialty be a hobby."

Help to Get More Business

"In what other way can the mechanical department employees co-operate with you to greater advantage?"

"By helping to sell the railroad to people with whom they deal, or with whom they come in contact," replied the Division Superintendent. "I do not mean that the employees should make a nuisance of themselves in trying to get business from people with whom they deal, but there are many ways in which, in a quiet, effective way, they can build up goodwill toward the railroad and get business for it. In this way they will really safe-

* One of a series of interviews with men outside the mechanical department, commenting in a constructive way on the possibilities of that department.

guard their own interests. The more business the railroad gets, the more men it will employ and the better wages it can pay."

"Specifically, just how can they help?"

"We have had very good results," replied the Division Superintendent, "where employees have tipped us off to the fact that certain of their friends were thinking of making long trips, or that new plants were being built in their neighborhood. The difficulty is that too frequently employees seem to think that the traffic and operating officers of a railroad receive this sort of information automatically; as an actual fact, in some instances employees have called our attention to new plants which were contemplated or being built, concerning which we were entirely unaware. It is better to receive too many tips about things of this sort than none at all, since it is important that our operating and traffic men follow up these leads promptly in the effort to secure business."

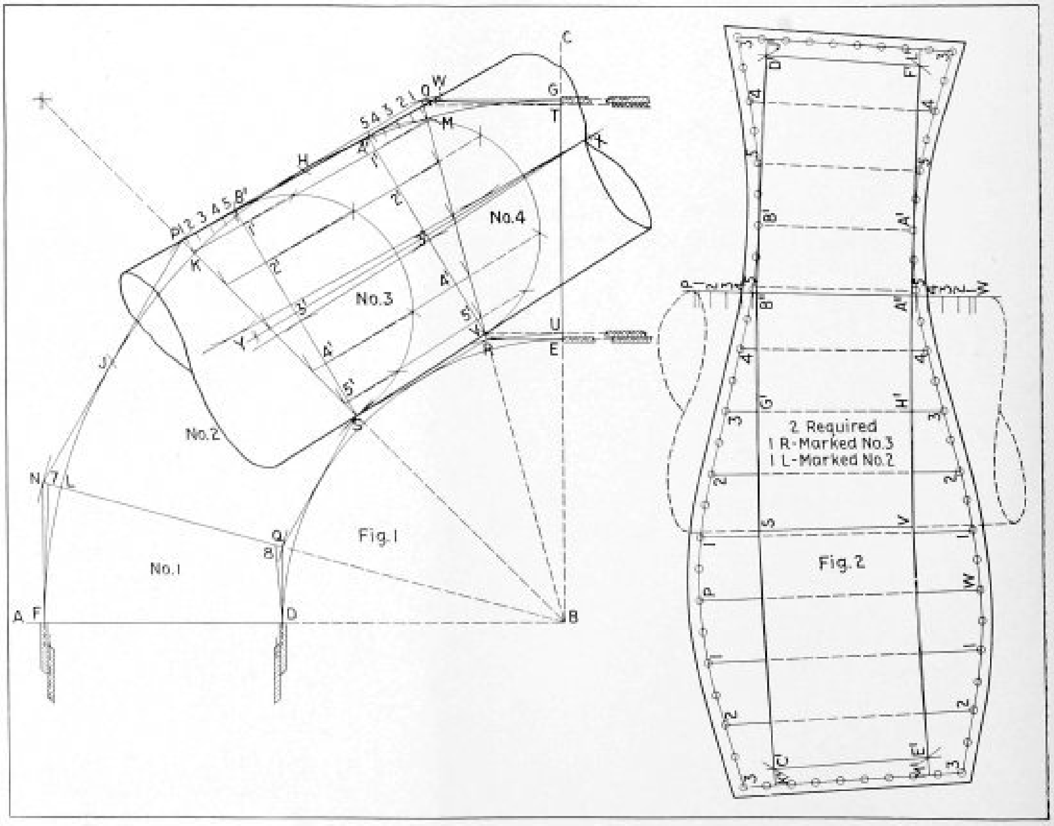
Development of a Four-Piece Ninety-Degree Elbow

By I. J. Haddon

In the development of the four-piece ninety-degree elbow, illustrated, first draw the line *A-B*, Fig. 1, and at *B* erect *B-C* perpendicular to *A-B*. Then with *B* as a center and a radius equal to the inside radius of the elbow, draw the quarter circle *D-E*. With the same center and radius equal to the outside radius of the elbow, draw the quarter circle *F-G*. From *F* and *G* respectively as centers and radius *B-G* or *B-F* cut the quadrant in *H* and *J*; bisect the arc *J-H* in *K*. With *J* and *H* respectively as centers and radius *J-K* cut the arc in *L* and *M*. Draw *B-L* produced, *B-K* produced and *B-M* produced. Draw *F-N* perpendicular to *A-B* to cut the line *B-L* produced in *N*. Draw *G-O* perpendicular to *B-C* to cut the line *B-M* produced in *O*. With *B* as center and radius *B-O* cut *B-K* produced in *P*. Join *N-B*, *P-B* and *O-B*.

Now draw *D-Q* perpendicular to *A-B* and *E-R* perpendicular to *B-C*; then with *B* as a center and radius *B-R* or *B-Q* cut the line *P-B* in *S*. Join *N-P*, *P-O*, also *Q-S* and *S-R*; then *F-N-P-O-G-E-R-S-Q-D* will be the elevation from which to lay out the four-piece elbow (development not shown) and *N-Q*, *P-S* and *O-R* will be the miter lines.

The lines represent the center of thickness of iron as



Details of method used in laying out a four piece ninety-degree elbow, showing overlaps for the riveting shown, and the joints are supposed to be butted for butt welding. The piece *N-P-S-Q* is exactly the same as *P-O-R-S*, and exactly the double of the piece *F-N-Q-D*, also of the piece *G-O-R-E*. Therefore in this elbow it is only necessary to lay out the pattern for the large piece, and one-half of the pattern does for the small pieces. These sections are all parallel pipes.

To develop the four-piece elbow when the ends have to fit into each other, overlaps, and riveted.

Set out the elevation exactly as already shown, then from *T* and *U* which indicates the small diameter, draw the lines *T-W* and *U-V* perpendicular to *B-C* and to meet the miter line *O-R* in *W* and *V*, as shown. Draw *P-W* and *S-V;* then *P-S* will equal the large end and *W-V* will equal the small end. From *P, W, V* and *S* as centers, and with a radius a little less than half of *W-V*, draw the arcs, as shown; draw tangents to these arcs as shown, to meet in *X*. Bisect the angle made by these two lines as at *Y;* then *X-Y* will be the center line of a cone whose sides are *P-W* and *S-V*, as shown. From *X* as a center, and with radius *X-V* cut the line *P-W* in *A'*; join *V-A'*. From *X* as center and radius *X-S* cut the line *P-W* in *B'*; join *B'-S*. Then *S-B'*, *V-A'* will be the frustum of a right cone, and *S-B'* will be parallel to *V-A'*.

Upon *B'-S* and *A'-V* describe semicircles, as shown, and divide each semicircle into six equal parts. From the points obtained on the semicircles, drop perpendiculars on to their respective bases, as shown in *1', 2', 3', 4'* and *5'*. Now draw lines through *1'-1', 2'-2'*, etc., to meet the lines *P-S* and *W-V*, as shown. Now these lines are generating lines on the cone, but not their true lengths, so from the points where they meet the lines *P-S* and *W-V* draw lines to the side of the cone parallel to *B'-S* and *A'-V*, as shown in *1-2-3-4-5* and *1-2-3-4-5*. (The miter lines do not alter in position.)

Draw the lines *V-A", S-B", S-V* and *B"-A"*, Fig. 2, exactly as shown in Fig. 1. Then with *V-B"* or *A"-S* as a radius, and with *V, S, B"* and *A"* as centers draw small arcs, as shown; then with *S-B"* as radius and *S* and *B"* as centers respectively, cut the arcs in *C'* and *D'*. From *V* and *A"* as centers respectively and radius *V-A"* cut the arcs in *E'* and *F'*. Join *C'-S, E'-V, C'-E', B"-D', A"-F'* and *D'-F'*. We now have three similar frustums laid out, as shown in the elevation, and as the apex of the cone will no doubt be unattainable, and there is very little rise in each frustum, curves must now be drawn through the points *C', S', B"* and *D'*, also through *E', V, A"* and *F'*, and each curve must be produced a little beyond *C'* and *D'*; also beyond *E'* and *F'*, as shown.

Bisect *S-B* in *G'*, also *V-A'* in *H';* draw *G'-H'* and produce both ways, as shown. Now measure carefully the length of the line *S* to *G'* and multiply this by 3.1416 and set out the length obtained by calculation, from *G'* *along the curve* to *J'* and along the curve to *K'*.

Calculate and lay out in a similar manner to obtain the points *L'* and *M'*. Join *M'-K'* and produce, as shown; also join *J'-L'* and produce. Produce the line *B"-A"* both ways, as shown, and step off on the line the distances, as shown in the elevation as *5-4-3*, etc., as shown in the development.

Now divide each *curved line* into twelve equal spaces and join them, and produce beyond, as shown. Then from the curved line, measure off the respective distances, as shown above and below the curved lines, and number them. Draw fair curves through these points to represent the center line of the holes. Mark holes on the lines intersecting the curves at *3, P, 3, B'* and *3;* also *3, W, 3, A'* and *3*. Pitch holes equidistant between each of these spaces to complete the layout of the holes on the miter lines. Lay out the holes for the seams at *3-K'-M'-3* and at *3-J'-L'-3;* allow a fair lap to complete the development.

This pattern will also do for No. 2, but must be rolled from the opposite side. No. 1 and No. 4 would have to be laid out separately on account of the overlaps all looking in the same direction. The pattern for No. 4 is developed from the elevation represented by the lines *O-T, T-U, U-R, R-O*, and for No. 1 by the lines *F-7, 7-8, 8-D, D-F*.

Metal Coating to Prevent Corrosion

Several years ago in an effort to reduce replacements and maintenance costs on metal parts the Western Union Telegraph Company tried to find some method of protection against corrosion which would be more permanent than that provided by paint or lacquer alone. In furtherance of this effort Dr. Leo P. Curtin, consulting chemist, was delegated to make a study of this problem.

As a result of this investigation there was developed a metal treatment that is simple to handle, inexpensive and positive in its action. The ingredients consist of a powder and a solvent used in water at a temperature of approximately 150 degrees F. This metal treatment has recently been made available to the trade under the name of "Loxal."

The treatment consists of dipping the metal parts to be treated into a solution made up of about 10 ounces of Loxal powder and 3 ounces of Loxal solvent per gallon of water. The parts to be treated are introduced into this solution in perforated iron baskets, racks or trays, and are held in this solution for a period of from one to five minutes and are then given a quick rinse in hot water, after which they are dried in open air or a warm air blast. Little preparation is needed before treatment. Removing oil or grease and sometimes a brief pickling treatment, followed by rinsing in hot water usually suffices. The equipment required is inexpensive and requires practically no maintenance. A metal tank of requisite size, fitted with steam coils to heat the solution to 150 degrees F. and with facilities for filling with water and for handling the material to be treated, is all that is necessary.

Iron and steel parts, cleaned by ordinary materials, are extremely susceptible to rusting after treatment and must be lacquered or otherwise finished within a few hours. When metals are coated with Loxal, such parts may be stored without danger of rusting, until used or until it is convenient to apply the finishing coat. Loxal coating also acts as a bonding coat, to which the finishing coat of paint, lacquer or enamel tenaciously adheres.

It is applicable to practically all types of iron and steel surfaces. The carbon content of the steel has no appreciable effect in retarding the formation of the coating.

There is a large coverage per pound of material and no appreciable loss as a result of precipitated sludge in the work-tank, since the addition of Loxal solvent to the bath converts any sludge into a clear solution which automatically becomes the active coating ingredient. Iron equipment is not harmed by Loxal, and there is no danger of leaks occurring in iron tanks in which it is used. As no chemical incrustation forms on the heating coils, whether made of iron or brass, high heating efficiency is maintained.

The material for this new process is being distributed by the Curtin-Howe Corporation, New York.

The importance of using the right

ELECTRODES FOR WELDING

By A. F. Davis*

The use of arc welding has become so wide today that there is scarcely an engineer or shop superintendent who has not had some experience with it.

The latest research and developments in actual practice show that welding economy is materially increased through the use of the proper electrodes. Research has shown that while the qualifications of the welder are important the difference between good and bad welds lies in the activity which takes place within the arc itself. To avoid a lengthy exposition of the matter we can state the case briefly. The molten metal under the arc attracts oxygen and nitrogen from the ambient atmosphere. The arc and the metal must therefore be protected from undesirable gases.

A good set up—intelligent preparation of the work before welding, capable operators and equipment that can supply current for the latest high-speed special electrodes—is all important, but, given these things, the success of arc welding is going to depend upon how carefully the metallurgical problems have been considered. There was a day when the operator had only mild steel uncoated electrodes and by trial and error learned what he could or could not weld successfully.

It is logical that if the specifications of the electrode are important so also are the specifications of the steel. Weld metal is the combination of the two. If little or no filler metal is used, the selection of the base metal is of prime importance. If the weld metal is supplied mostly from the electrode, the electrode is highly important.

Good electrodes are manufactured under the most exacting specifications and take into account all the chemical and metallurgical factors which affect weld metal.

Welding Mild Steel.—The greatest amount of arc welding is done on mild steel. For this purpose the shielded arc process was originally developed. It requires a steady welding current and a heavily coated electrode. This coating, of special composition, burns in the arc less rapidly than the electrode melts, protecting the arc for almost its entire length. The coating also gives off inert gases which shield the arc from the air and tend to improve the physical qualities of the weld metal. The residue from the coating forms an easily removable layer of slag which is further protection for the metal while cooling.

The chemical analysis of the steel used in a modern shielded arc electrode for metallic arc welding should be about as follows:

Carbon	0.13
Manganese	0.45
Silicon	0.01 maximum
Sulphur	0.03 maximum
Phosphorus	0.015 maximum

This steel will invariably be of the open or rimmed type.

The reasons for using this shielded arc electrode are simply that it permits much faster welding and, therefore, lower cost; that it results in welds with superior physical properties.

The tensile strength of welds properly made with this process is between 65,000 and 75,000 pounds per square inch, the ductility is 20 to 30 percent in two inches and the resistance to corrosion is better than that of mild steel. An example of these properties is found in Fig. 3.

Below is a table giving the properties of shielded arc

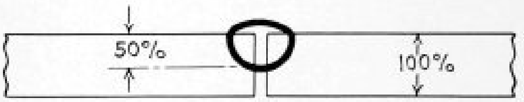


Fig. 1.—Plain butt weld where only 50 percent penetration is required. Most of the weld metal was supplied by the parent material

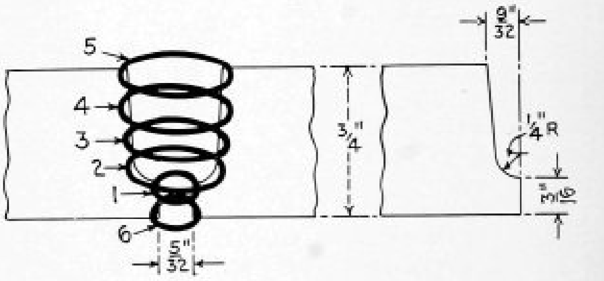


Fig. 2.—Butt weld in 3/4-inch plate in which six beads of weld metal are required. The joint is scarfed in preparation for welding and the weld metal is mostly filler material

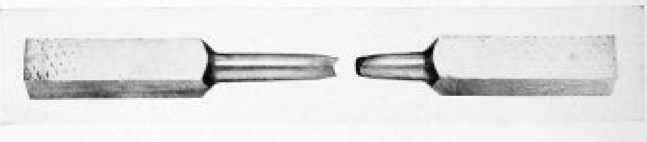


Fig. 3.—Typical tensile test specimen of shielded arc weld metal showed tensile strength of 76,100 pounds per square inch; elongation in 2 inches of 25.8 percent; reduction in area of 48 percent

weld metal as compared with mild steel and weld metal deposited with bare or washed electrodes.

PROPERTIES OF WELD METALS AND MILD ROLLED STEEL

Material	Tensile strength lb. per sq. in.	Ductility, percent elongation in 2 in.	Density, grams per c.c.	Fatigue resistance,† lb. per sq. in.	Impact resistance, ft. lb.
Weld metal made with bare or washed electrodes	40,000–55,000	5–10	7.5–7.7	12,000–15,000	8–15 (Izod)
Weld metal made with shielded arc	65,000–85,000	20–30	7.82–7.86	28,000–30,000	40–80 (Izod)
Mild rolled steel	55,000–65,000	20–30	7.86	28,000	40–80 (Izod)

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

† Maximum stress in outside fibres 10 million reversals without failure.

Because of these fine qualities, there is hardly a possible comparison between the shielded arc and the bare electrode methods. However, with bare electrode we made a single vee butt joint (beveled at 60 degrees) at the rate of five feet per hour on ½-inch plate. With the shielded arc the same weld is made at the rate of nine feet per hour, and with 100 percent penetration and 100 percent strength. The shielded arc is efficient, even on 2- and 3-inch boiler shells.

Similar advantages in speed and strength will be found on all applications.

The 18-8 Alloys.—A special shielded arc electrode is recommended for work on the 18-8 or "stainless" steel alloys. There are two considerations which must be kept in mind: First, this chrome-nickel steel has a coefficient of expansion some 50 percent higher than mild steel and the work must be set up to care for this; second, the work must be free from scale and carefully cleaned after welding in order to preserve the corrosion-resisting qualities. If these factors are considered, the special electrode which utilizes the shielded arc will produce the same fine physical characteristics.

High Carbon Steel.—Here is a type of steel generally used to resist wear, and due to its high carbon content a different electrode is used. If bare wire is used, there will be a "wildness" which makes welding difficult and there will also be a tendency toward boiling. Special analysis steel electrodes with another type of coating overcome "wildness" and "boiling" and help to control oxidation.

British Locomotive Fire Tube Inquiry

By G. P. Blackall

Last February the engineer of a London, Midland & Scottish railroad train was involved in an unusual mishap in which he was killed and his fireman incapacitated by a rush of steam and water through the fire door when a steel tube failed. The guard noticed that the train was running too fast as it approached Watford, so applied the continuous brake from his car, bringing the train to a stand.

An investigation of the accident was held for the British Transport Ministry, by Scott Main, whose report was issued recently. The steel tube which failed was in the center of the firebox tube sheet, just above the lower row of superheater tubes, of which there are 21 in three rows of seven. It was one of a complete set of 146 new tubes put into the boiler in December, 1931, which had been tested up to 1000 pounds per square inch. The tubes, cold drawn, are reduced in diameter from 1⅞ inches at a distance of 12¾ inches from the tube sheet to 1¾ inches, and then to 1½ inches, 2 inches from the tube sheet, but the thickness remains the same throughout.

The last examination of the boiler took place on September 8, 1933, when 45 of the lower tubes were drawn for cleaning and examination purposes. No wastage of the tubes was then observable. The tube adjacent to the one which failed had not suffered in any way, and the loss of section was negligible. The tube that collapsed showed that action had taken place on the outside, ½ inch from the outside of the tube sheet. The wastage was uniform all round and to a knife edge. Scale was in no way abnormal, and no other tube failed or deteriorated in that manner.

A chemical analysis of the tube shows that, compared with others in the boiler, in composition or structure it was normal. Photo-micrographs, however, revealed that not only had there been considerable grain growth in the affected portion of the tube, but the general structure of the tube itself differed appreciably from that of other tubes. Two alternatives are advanced by Mr. Main for the steel being in this state:

(1) That the tube was not annealed and that the swaged portion was in a state of stress owing to cold working. In that condition the steel would be susceptible to corrosive influences and, while corrosion had been progressing, grain growth had also proceeded slowly owing to the action of heat in service, thus relieving the metal of strain.

(2) During annealing the tube may have been left to soak for a long time at a rather low temperature, and grain growth took place during that period.

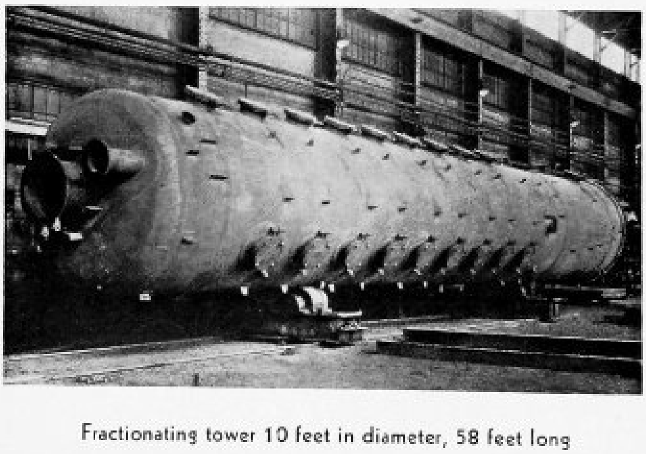
Mr. Main sums up by observing that these conclusions point to the fact that the tube was either not annealed or indifferently annealed prior to being placed in the boiler. The questions of annealing should, therefore, be gone into more carefully to ensure that a definite procedure is followed in the future. To make use of existing tube sheets it will be necessary for some time to use tubes which are reduced in diameter in a like manner. Mr. Main understands, however, that this design of tube is being discontinued and straight tubes substituted.

Incidentally, it is interesting to note that the question of boiler tubes is being exhaustively inquired into, and that their inspection has been arranged on a much more intensive system. It may also be remarked that water softening had nothing whatever to do with the condition of the tube in question, as the boiler had not been subject to treatment by that means since it went into service.

Large Fractionating Tower Built by Arc Welding

The huge fractionating tower shown is 10 feet in diameter and 58 feet high. It was completely arc welded by the Struthers-Wells Company using Fleetweld electrodes manufactured by The Lincoln Electric Company, Cleveland.

Shell thickness of the tower is ¾ inch while the heads are ⅞ inch. On completion of the welding the entire unit was heat treated. The column was shipped to Canada for oil refinery service in connection with the Dubbs cracking process.



Fractionating tower 10 feet in diameter, 58 feet long

ELEMENTARY PLATE LAYOUT—VI

By George M. Davies

The radial line method of development may be applied to regular tapering forms, where the profiles are of uniform shape but vary in size from one end of the object to the other.

The first development to be considered by this method is that of a 60-degree tapering elbow, as shown in Fig. 31.

In laying out a tapering elbow by the radial line method, the various sections are cut from the frustum of a right cone, thus the height *h* and the length *l* of the elbow as shown in Fig. 31(a) must cone what they will, based on the diameters of the elbow at the large and small ends and the height of the frustum of the cone from which the elbow is developed.

A-B-C-D, Fig. 31(b) represents the frustum of a right cone from which the three piece 60-degree elbow shown in Fig. 31(a) is to be developed. *A-B* represents the diameter of the small end, and *C-D* the diameter of the large end. Extend the sides *B-C* and *A-D* until they meet at the apex *E*. Draw the vertical center line *E-F* at right angles to *C-D* through *E*.

Next on the center line *E-F* draw the half profile Fig. 31(c) as shown. Divide the half profile into any number of equal parts, six being taken in this case; the greater the number of equal parts taken the more accurate the final development. Number these divisions from *1* to *7* as shown. Draw lines through the points *1* to *7* of the profile, parallel to the center line *E-F* cutting the line *C-D*. Number these points from *1* to *7* as shown. From these points draw the radial surface lines to the apex *E*, cutting the line *A-B* at *1°*, *2°*, *3°*, *4°*, *5°*, *6°*, and *7°*.

The elbow is to be made of three pieces and has an angle of 60 degrees on its center line. The miter lines are obtained as follows:

In a three-piece elbow there are two end pieces and one middle piece. The end pieces count as one each and the middle piece as two, thus we have $2 + 2 = 4$. The angle of the elbow 60 degrees is divided by 4 which is 15 degrees, the angle of the miter lines. Since four represents a three-piece elbow, divide the vertical center line of the cone frustum *A-B-C-D*, Fig. 31(b) into four equal spaces as *a-b*, *b-c*, *c-d*, and *d-e*.

Through the point *b* draw a line 15 degrees to the base line *D-C* as *f-g*, cutting the cone at *G* and *H*, thus obtaining the miter line *G-H*. Through the point *d*, draw a line 15 degrees to the top line *A-B* as *h-g*, cutting the cone at *K* and *J*, thus obtaining the miter line *J-K*.

Where the radial surface lines cut the miter line *G-H*, number the points from *1′* to *7′* and, where the radial surface lines cut the miter line *J-K*, number the points from *1″* to *7″* as shown. Parallel to the line *C-D* draw

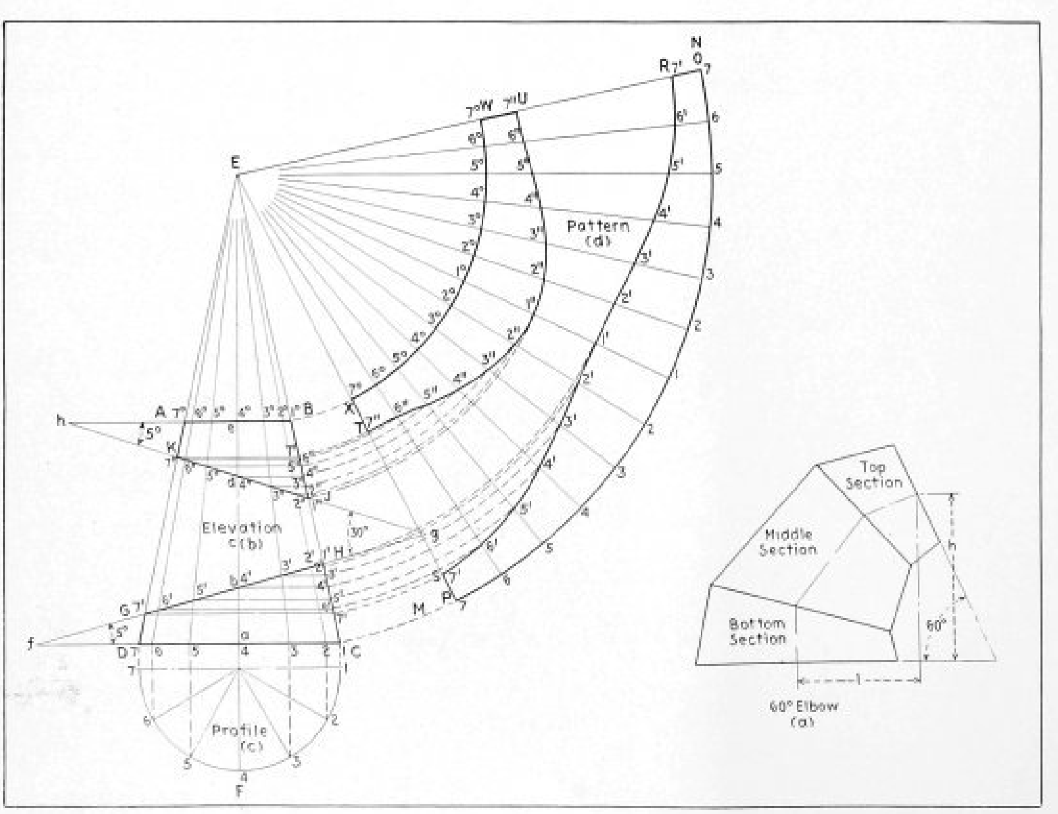


Fig. 31.—Radial line method of development used in the layout of a 60-degree tapering elbow.

lines through the points *1'* to *7'* and *1"* to *7"* cutting the line *B-C*. Number these intersections from *1'* to *7'* and from *1"* to *7"* as shown.

With *E* as a center, and with *E-C* as a radius, scribe the arc *M-N*. On the arc *M-N* set off from any point as *7* twice the girth of the profile, Fig. 31(c); number the points from *7* to *1* to *7* as shown, from which points draw radial lines to the apex *E*. Again using *E* as a center and with radii equal to the distances from *E* to the various intersections between *C-H* and *J-B* as *E-7"*, *E-6"*, *E-5"* to *E-1"* and *E-1'*, *E-2'* to *E-7'*, scribe arcs, intersecting correspondingly numbered radial lines in the pattern as shown, locating the points *7'* to *1'* to *7'*, *7"* to *1"* to *7"* and *7°* to *1°* to *7°* of the pattern Fig. 31(d). Connect these points with a curved line completing the patterns. Then *P-Q-R-S* will be the pattern for the bottom section, *R-S-T-U* will be the pattern for the middle section and *T-U-W-X* will be the pattern for the top section. The patterns make no allowance for joints, such allowance being added to the top, bottom and side of the pattern as required for the method of assembling used.

Intersection Between Cylinder and Cone

The next radial line development to be considered will be an intersection between a vertical cylinder and the frustum of a right cone as illustrated in Fig. 32.

Lay out the elevation and plan views as shown in Fig. 32(a) and Fig. 32(b). In Fig. 32(a), *A-B-C-D* is the frustum of a right cone and *F-G-H-J* the vertical cylinder intersecting the frustum, the center line of the cylinder being parallel to the center line of the frustum.

An inspection of the plan will show that the center line *M-N* divides the object into two symmetrical halves, consequently a pattern of one-half will serve as a pattern for the other half.

In laying out the elevation it is necessary to obtain the true contour of the miter line *J-H* as follows:

Divide the half profile of the cylinder in the plan as *K-L-P* into any number of equal parts, six being taken in this case; the greater the number of equal parts taken the more accurate the final development. Number these points from *1* to *7* as shown.

Next draw radial lines through these points from the center *E* of the plan extending this to the circumference of the base *R-Q-S*. Number these intersections corresponding to the numbers through which the lines were drawn as from *1* to *6* as shown.

Parallel to the center line *T-V* draw lines through the points *1* to *7* on *K-L-P* extending these down into the elevation. Then parallel to the center line of the frustum draw lines through the point *1* to *6* on the circumference *R-Q-S* extending them into the elevation cutting the base line *A-B* numbering these points from *1'* to *7'* as shown. Connect these points with the apex *E*. Where the line drawn from the apex *E* to the point *2'* of the elevation cuts the line drawn parallel to *T-V* through the point *2* of the plan locates the point *2"* on the miter line *J-H*. In like manner the points *1"*, *3"*, *4"*, *5"*, *6"* and *7"* are located. Draw a curved line through these points completing the miter line *H-J* in the elevation.

The pattern for the vertical cylinder is constructed using the parallel line method of development.

Extend the line *F-G* as *a-b* and on *a-b* step off the distances *1-2*, *2-3*, *3-4*, *6-7* equal to *1-2*, *2-3*, *3-4*, to *6-7* of the profile *K-L-P* of the plan. Erect perpendiculars to line *a-b* at the points *1* to *7*; then parallel to *a-b* draw a line through the point *1"* of the elevation, cutting the perpendicular to the point *1* just drawn at the point *1°*. In like manner locate the point *2°, 3°, 4°, to 7°*. Connect these points with a curved line completing the half pattern of the vertical cylinder, Fig. 32(c).

The pattern for the frustum is shown in Fig. 32(d). On any line as *m-n* with the point *E'* as a center and with a radius *E'-D'* equal to *E-D* of the elevation, scribe an arc and with *E'* as a center and with a radius *E'-A'* equal to *E-A* of the elevation scribe an arc as *A'-S'*. On the arc *A'-S'* lay off one-half of the girth of the base of the frustum as *A'-B'*. Connect *E'-B'*. Where *E'-B'* cuts the arc drawn through *D'* locates the point *C'*.

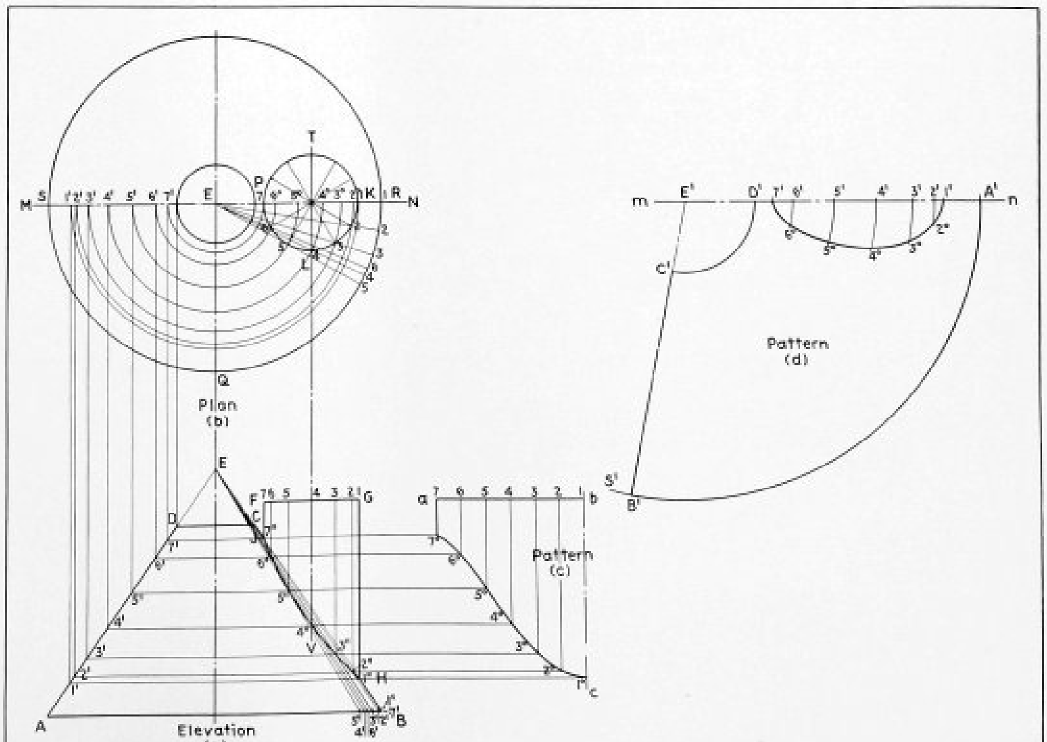


Fig. 32.—Radial line method of development in the layout of intersection of cylinder and frustum of right core

A'-B'-C'-D' is the half pattern of the frustum A-B-C-D.

The next step is to develop the opening in the pattern of the frustum for the vertical cylinder as follows:

In the plan view with *E* as a center and with *E-7* as a radius scribe an arc cutting *S-E* at *7'*; then with *E* as a center and with *E-6* as a radius scribe an arc cutting *S-E* at *6'*. Continue in this manner locating the points *5'*, *4'*, *3'*, *2'* and *1'* on *S-E*. Parallel to the center line of the frustum draw lines through the points *1'* to *7'* on *S-E* extending them to cut the line *A-E* at the points *1'* to *7'* as shown.

Then with the point *E'* of the pattern Fig. 32(d) as a center and with *E-7'* of the elevation as a radius scribe an arc cutting the line *m-n*. In like manner with *E'* as a center and with *E-6'*, *E-5'*, *E-4'*, etc., of the elevation as radii, scribe arcs cutting *m-n* as shown.

On the arc *E'-6'* step off from the line *E'-A'* the distance *6'-6°* equal to *6-6°* of the plan locating the point *6°*. In like manner on the arc *E'-5'* step off from the line *E'-A'* the distance *5'-5°* equal to *5-5°* of the plan locating the point *5°*.

In like manner locate the points *4°*, *3°*, *2°*. Connect these points with a curved line as shown completing the opening and the half pattern of the frustum.

(*The End*)

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. 781, 783, 784, 785, 786 and 787, as formulated at the meeting of September 14, 1934, 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 side 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).

Mistake in Testing Proves Quality of Weld Metal

While testing this arc welded brewery tank at the Kane Boiler Works, Galveston, Texas, 125 pounds pressure was applied instead of the required 25. The tank bulged, grew one foot longer!

Inspection revealed that despite five times normal testing pressure every weld was sound. Not a single leak or fracture developed. The tank was built by the

Tank that grew one foot in length under high pressure

Kane Boiler Works using the shielded arc process with Fleetweld electrodes manufactured by The Lincoln Electric Company, Cleveland.

Electrunite Boiler Tubes in Third Year of Production

Electrunite boiler tube has been produced by Steel and Tubes, Inc., for somewhat over two years. Tonnage has been and is constantly on the increase, until at present it has reached a point where it is a very important factor in the boiler tube field. During this two-year period thousands of tons have been placed in service in practically every type of boiler. Electrunite is indeed a fast growing baby of the depression.

These tubes differ from other types of tubes in many ways—in the manner in which they are made—in uniformity—in ease of installation—and in several other important features.

They are made from clean strip steel, cold formed to a perfect round, and welded by electrical resistance. There is no flux or other extraneous metal added during the welding process, and due to the full-normalize annealing which every tube receives, the weld has the same grain structure as the rest of the tube.

Steel and Tubes, Inc., announces that they will be glad to send detailed information upon request.

New York State Industrial Board to Amend Boiler Rules

The New York State Industrial Board held a public hearing on October 19, in New York City, on:

1. Proposed amendment of Rules Regulating Construction, Installation, Inspection and Maintenance of Steam Boilers.
2. Proposed amendment of Rules Regulating Fire Alarm Signal Systems.

The amendments to the boiler rules are designed to bring up to date the Industrial Board rules of 1926, particularly those regulating welding processes used in the repair of boilers, and to incorporate the latest rules adopted by the American Society of Mechanical Engineers.

The State Boiler Code applies to boilers operated at a pressure greater than 15 pounds per square inch. Since the original rules were adopted in 1918, there has not been one fatal boiler explosion in a plant under the jurisdiction of the State Department of Labor.

Richard J. Cullen, Chairman of the Industrial Board, presided at the hearing. The proposed amendments were presented by Referee George P. Keogh, of the Division of Industrial Code of the State Department of Labor. Mr. Keogh acted as Chairman of the Advisory Committee appointed by Industrial Commissioner Elmer F. Andrews to prepare amendments to the Boiler Code. The members of this Committee are: Mark A. Daly, secretary, Associated Industries of New York State, Buffalo, N. Y.; E. R. Fish, chief engineer, Boiler Division Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn.; Wm. H. Furman, chief boiler inspector, Inspection Division, Department of Labor, Albany, N. Y. (charged with enforcement of the Boiler Code); Charles E. Gorton, chairman, American Uniform Boiler Law Society, New York City; C. W. Obert, consulting engineer, Union Carbide and Carbon Research Laboratories, Long Island City; E. Mason-Parry, chief inspector, Hartford Steam Boiler Inspection and Insurance Company, New York City; James Partington, manager, Engineering Department, American Locomotive Company, New York City; E. J. Pierce, Industrial Code Referee, Department of Labor, New York City; C. George Segeler, industrial engineer, American Gas Association, New York City; James S. Shaw, chief engineer, Travelers Insurance Company, New York City; Norman S. Slee, Babcock and Wilcox Company, New York City.

Public hearings on the proposed amendments have also been held in Buffalo and Syracuse. The Industrial Board will take final action soon on both sets of rules.

Business Notes

R. R. Lally, who for several years has been manager of sales at New York, for the Globe Steel Tubes Company, Milwaukee, has just been made vice-president in charge of eastern sales.

James P. Roe, director of research and engineering of the Reading Iron Company, Philadelphia, Pa., died on September 14. Mr. Roe was born on May 19, 1860, at Consett, Wales. At the age of 17 he entered the service of the Consett Iron Company and had been connected with the iron industry since that time. He came to the United States in 1883.

A. F. Stuebing has been appointed railroad mechanical engineer of the commercial office of the United States Steel Corporation, with headquarters at 71 Broadway, New York. Mr. Stuebing was born in Lewistown, Me., May 24, 1889, and received his education at Cornell University and the University of Illinois. He entered railway service in 1911 with the Boston & Albany, following which he was with the Pennsylvania, with the Chicago, Rock Island & Pacific and with the Simmons-Boardman Publishing Company, as associate editor of the *Railway Age* and managing editor of the *Railway Mechanical Engineer*. From 1923 to 1932 he was chief engineer of the Bradford Draft Gear Company and its successor, the Bradford Corporation, and since has been chief engineer of the Par Car Corporation. He is a member of the American Society of Mechanical Engineers and a past chairman of its Railroad Division. Mr. Steubing has been a frequent contributor to technical periodicals, and has presented numerous papers before engineering societies and railway organizations.

William E. Millhouse, president and treasurer of The Burden Iron Company, Troy, N. Y., who died on September 25, at his home in Troy, was born 70 years ago in London, England. Mr. Millhouse came to this country in 1870 and attended the public schools of Troy. In February, 1876, he entered the employ of The Burden Iron Company, and for more than 58 years had been affiliated with the company, having started work at the age of 12 years as a feeder on one of the swaging machines in its mill, and later working his way up to its presidency. He served in various capacities until 1897, when he was appointed head of the company's wages department. In May, 1907, he was appointed paymaster; two years later he was promoted to assistant secretary and the following year, assistant manager of its mill. On October 22, 1918, Mr. Millhouse was appointed manager of the company, serving in that position until June, 1932, when he was elected executive vice-president and since June of the following year was president of the company.

Boiler Maker and Plate Fabricator

VOLUME XXXIV NUMBER 11

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Communication

The "Take Up" On Thick Plates

To the Editor:

When bending steel plate of thicknesses commonly used in boiler shells, the neutral axis is so close to the middle thickness of the steel that the radius of gyration may be safely taken as one-half the thickness of the steel plate under fabrication. But, when plates of an inch or more in thickness must be bent to a certain radius, or steel bars are to be cut to length and bent to fit certain radii, there is liable to be found an error in the calculations which may sometimes be traced to the neutral axis of the steel being more or less distant from the center thickness of the steel shape.

Many boiler makers have expended much time and energy in trying to establish workable shop rules for determining where the neutral axis of thick plates or bars may be found, and how it may be located by means within reach of the boiler maker. There are so many "open questions" which must be considered when locating the neutral axis of thick sheets, that the worker must determine whether or not the radius of gyration remains the same when a plate is bent to different radii, and he must also determine for himself if different grades of steel do, or do not, disclose a varying radius of gyration. He is also to determine to his own satisfaction whether or not different metals of like thicknesses show like location of the neutral axis. That is, will a one-inch thick shell steel plate, a flange steel plate of same thickness, and a bar of one-inch machinery steel, all show that the neutral axis is located the same, relative to the center thickness of the material being bent? It also means, will the several materials show the same radius of gyration whether bent to a radius of four feet or more, or to a diameter as small as can be formed by the bending rolls.

By working according to the directions given below, the boiler maker may solve the above mentioned problems and he may do the work with tools—and "know how"—to be found in his own shop. While the results to be obtained from the following directions are not declared to be absolutely accurate, they are capable of yielding results which will guide the boiler maker toward working out for himself the "take-up" problems with which he may at the time be burdened.

Procedure for Bending Test Strip

Procure strips of the plate to be bent, either by shearing strips from large plates, or by ordering such strips from the manufacturer of the thick plates. Almost any length of test strip can be used which can be bent to the radius upon which the "take-up" has been queried, but it will be well, for future reference, to procure the strips several feet in length, in order that each strip may be bent to many different radii, thus permitting the movement of the neutral axis—if there be any—to be measured for different radii of bending. Thus, should a 10-foot test strip be procured, one end may be bent to a radius as small as the bending roll will form, while the remaining metal may be bent into a sort of hyperbolic curve, of large radius at the far end of the sample strip, thus permitting the consideration of radius of gyration location at many different radii, all in the same test piece.

Place each test strip in succession in the edge planer and plane one edge of each strip as square and as smooth as conveniently possible. Then, without removing the test strip from the planer, moisten a piece of blue vitrol—copper sulphate—and rub the planed edge of the strip thoroughly from one end of the strip to the other, keeping the piece of copper sulphate well moistened at all times. A thin deposit of metallic copper should cover the surface of the strip after the copper solution had become dry. Repeat the rubbing and drying operations until a fine, even coating of copper has been obtained—entirely covering the planed edge of the test strip.

Remove the tool from the edge planer and in its place put a well ground, sharp pointed tool, stiff enough not to spring badly, and with this tool scratch a fine line in the copper coating. Practice with the cross feed screw of the planer until you know how far to turn that screw to advance the scriber tool 1/16 inch, as exactly as possible, then scribe lines as exactly as possible 1/16 inch apart across the edge of the test piece. The lines may be made $\frac{1}{32}$ inch apart but they should not be farther than $\frac{1}{16}$ inch.

Proceed next to bend the test strip, giving one end a very long radius and constantly decreasing the radius until the other end of the test strip may possibly fit the bending roll!

Now, the test piece is ready for use. Cut from tin or other thin sheet metal, a segment having the radius it is desired to work with in testing the neutral axis. With this segment, locate the desired radius on the test piece and make a chalk mark at that point or, better yet, mark the test piece with steel figures which show the actual radius at that point. Next, with a small pair of draftsman's dividers, or with a finely graduated steel scale, measure the distance between the lines in the copper surface, at the required radius point. The lines may be found closer together on the outside of the bend and farther apart on the inside. Work patiently until two or three lines are found, probably near the middle of the strip width, which are neither wider nor narrower than the scribed lines before the test strip was bent. The neutral axis will be found between the mid-lines which have not been distorted. If there are but two lines the original distance apart, the neutral axis will lie between these two lines; should there be three undistorted lines, the middle one will probably indicate the neutral axis of the test strip for the stated radius! By searching the test lines at other radii it may be determined if the radius of gyration, which is the distance from the neutral axis to one side of the test strip, is the same or different, for varying radii.

Finding the Take-Up

Having thus located the neutral axis, with its position known, the "take-up" necessary may be found. Should the neutral axis be found near or practically at the center of the plate thickness, the amount of take-up may be calculated in the usual manner. But, if so, why not be a bit more exact and allow "$3\frac{1}{7}$ times" the plate thickness, thereby approximating more closely, "good old pi," the conventional 3.1416?

Possibly, the neutral axis may be found more or less out of center, and perhaps the strip itself is less than 1 inch in thickness, particularly when the bend has a very short radius. Suppose the neutral axis be found $\frac{7}{16}$-inch from one side of the test strip and $\frac{9}{16}$-inch from the other side? Mind, I do not say it will be found thus, only if! Use $\frac{7}{16}$ and $\frac{9}{16}$ for calculating the "take-up." Which one to use for the inside sheet and which one for the outside can be left for your own determination. Anyway, one of the products is to be "cut off" the inside course sheet, while the other "take-up" distance is to be cut "on" to the outside course sheet. As we are dealing with practically one-half the plate thickness, we will multiply, by $6\frac{2}{7}$, which is twice $3\frac{1}{7}$. The product of $\frac{7}{16}$ and $6\frac{2}{7}$, is apparently $2\frac{3}{4}$ inches, while $\frac{9}{16}$ inch being similarly treated approximates closely $3\frac{1}{2}$ inches.

Use the two quantities, $2\frac{3}{4}$ and $3\frac{1}{2}$ respectively, for the "cut-on," and the "cut-off" of the inner and the outer courses, but, which quantity to use for which course, I will leave for the deduction—or the intuition—of the boiler maker who is doing the job.

Take notice, please, that, as stated elsewhere, these deductions of take-up and neutral axis in heavy plate, are not given as an exact method of dealing with the knotty problem, but more as a way by means of which a boiler maker may perhaps help himself to "scratch his head in the right direction."

Indianapolis, Ind. James F. Hobart.

Erection of Youngstown New Rolling Mill

Contracts have been awarded for erecting the Youngstown Sheet & Tube Company's new cold rolling mill at Campbell, it was announced Friday by Frank Purnell, president of the company.

The mill contract was awarded to the Mesta Machine Company of Pittsburgh, and the steel will be erected by the Fort Pitt Bridge Company of Pittsburgh.

The new cold rolling mill, with a capacity of from 200,000 to 250,000 tons a year, will absorb a part of the production of the new continuous strip mill now being erected by the company at Campbell, which will have an annual capacity of from 500,000 to 600,000 tons of hot rolled strip. The cold mill will finish strip into sheets for automobile and other purposes.

A separate building, covering 216,000 square feet, will house the cold rolling mill equipment. The latter will include one 3-stand tandem 4-high finishing unit, and two single stand 4-high mills along with continuous annealing, pickling, shearing, and straightening machinery.

The cold mills will be capable of rolling down the unfinished hot strip to 26 gage in thickness and 84 inches in width.

The cold rolling mill is expected to be ready for operation by April 1, 1935. The continuous mill will probably be completed by February 1, 1935.

Trade Publications

Molybdenum Iron and Steel.—The Climax Molybdenum Company, New York, in a recent folder outlines the progress made on the adoption of molybdenum by the iron and steel industry since 1929. Alloys of molybdenum are particularly useful where exceedingly high temperatures are required.

Republic Steel at A Century of Progress.—Republic Steel Corporation, Massillon, O., has prepared a 12-page rotogravure tabloid depicting the part which the Republic products played in the recently closed Century of Progress Exposition at Chicago. Feature illustrations show the varied and wide use of Republic products in buildings and exhibits at the Exposition.

Switches.—The General Electric Company, Schenectady, N. Y., has issued bulletins for insertion in loose-leaf bindings of a number of switches and switchgear, including indoor disconnecting switches, high voltage magnetic switches, and indoor A-C. cubicle switchgear. These folders contain complete descriptions and specifications for each of these pieces of equipment.

Welding Machines.—The Air Reduction Sales Company, New York, has issued its first bulletin describing Airco-Wilson arc welders. It is a well-written booklet outlining the features and advantages claimed for these machines. A number of clear cut illustrations and a chart containing data from current range and revolutions per minute to maximum electrode sizes and approximate shipping weights combine to make this an interesting and informative booklet.

Milburn Products.—A complete catalogue of products of the Alexander Milburn Company, Baltimore, Md., has recently been issued. This catalogue will be of real service to those interested in oxy-acetylene apparatus for cutting and welding, paint spray equipment or portable carbide lights.

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.

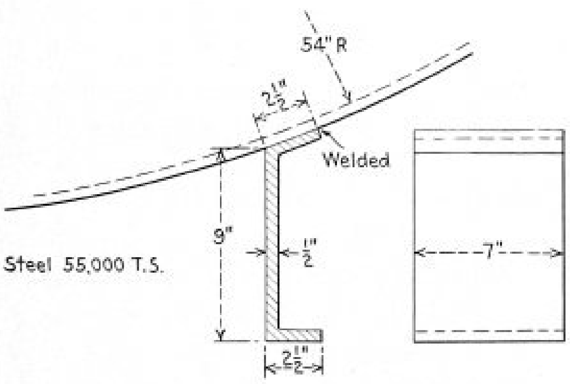
By George M. Davies

Safe Load for Tank Leg

Q.—Kindly advise through your Questions and Answers column in an early issue of BOILER MAKER AND PLATE FABRICATOR what safe load will the tank leg carry as per enclosed sketch. Give rule for figuring same. G. P. P.

A.—The tank leg submitted with the question is illustrated in Fig. 1.

Consider the tank support as a column with both



Problem of determining safe load on tank leg

ends fixed or resting on flat supports. The formula for ultimate load would be:

$$p = \frac{50{,}000}{1 + \dfrac{l^2}{36{,}000\, r^2}}$$

where

p = ultimate load in pounds per square inch
l = length of column or strut in inches
r = radius of gyration in inches

$$r^2 = \frac{\text{moment of inertia}}{\text{area of section}}$$

To find the safe load for a given section, multiply the value of p, as found from the above formula by the area of the section and divide by the factor of safety.

Substituting the values given in the question and solving for p we have:

$$r^2 = \frac{I}{A}, \quad I = \frac{bd}{12}, \quad b = 7 \text{ inches}, \quad d = \tfrac{1}{2} \text{ inch}$$

$$I = \frac{7 \times 0.5}{12}$$

$$I = 0.0729$$

$$r^2 = \frac{I}{A}$$

$$A = 7 \times 0.5 = 3.5 \text{ square inches}$$

$$r^2 = \frac{0.0729}{3.5} = 0.0208$$

$$p = \frac{55{,}000}{1 + \dfrac{(9)^2}{36{,}000 \times 0.0208}}$$

$$p = \frac{55{,}000}{1.109}$$

$P = 49{,}594$ pounds ultimate load.

Assuming a factor of safety of 5 we have:

$$\text{Safe load} = \frac{49{,}594 \times 3.5}{5}$$

Safe load = 34,715 pounds.

The tank leg could also fail in compression.

The formula for safe load under compression would be:

$P = S \times a$

where,

P = safe working load in pounds.

s = working stress in pounds per square inch with a factor of safety of

$$5 = \frac{55{,}000}{5} = 11{,}000 \text{ pounds.}$$

a = cross-sectional area, in square inches.

Substituting the values given in the question we have:

$P = 11{,}000 \times 3.5$

$P = 38{,}500$ pounds.

The minimum safe load obtained from these calculations should be taken as the safe load, 34,715 pounds, and this load would be a vertical load on the tank support.

Patch on Girth Seam

Q.—On page 255 of the September, 1934, BOILER MAKER AND PLATE FABRICATOR we note an article on rules for the design of patches on cylindrical shell boilers. Referring specifically to the patch on the second girth seam *V2*, please let us know if the measurement *A* shown on the sketch is correct. G. P. E.

A.—The measurement *A* for the second girth seam *V2* on the "Diagram of Method of Designing Diagonal Patches on Return Tubular Boilers" as shown on Page 255 of the September issue is incorrect.

A vertical center line should be drawn through the patch representing where the girth seam rivet line would come and the distance *A* should be taken from this center line to the rivet line of the patch in the same manner as taken for patch *V-4*.

The "Diagram of Method of Designing Diagonal Patches on Return Tubular Boiler" given in the September issue was taken from a plate in the California Boiler Code. I find that both the California and New York State Boiler Codes are in error in this particular.

Thickness of Plates for Oblong Tank Construction

Q.—We are occasionally called on to build square and oblong tanks for varying pressures, and we have not yet been able to locate a reasonable formula for figuring the thickness. Can you help us out in this? Your issue of December, 1925 (Vol. XXIV, No. 12), has an article on "Stresses in Flat Plates." We find a U. S. Government ruling on flat heads, but it applies only to 20 inches or less diameter. Our procedure heretofore has been to get at what seemed proper for thickness, complete the tank and pressure on it, and if the flat sides show bulging, to add outside stiffeners. But this is unsatisfactory. Just at present we are wrestling with specifications for an oblong tank, 18 inches wide, 36 inches deep, 72 inches long, to hold a working pressure of 100 pounds per square inch. It can have outside stiffeners, thereby reducing the thickness of the plate, although it is preferable to have plain sides. Your courtesy in this will be greatly appreciated. Possibly you can give us references to some publication that may have the information. J. F. W.

A.—The stresses imposed upon flat plates under pressure, as in the case of the tanks outlined in the question, have not yet been accurately determined, and this no doubt explains why so little data have been published bearing on this subject. Formulas have been developed which, while not theoretically correct, experience proves are sufficiently accurate for practical purposes.

The one most applicable to square or rectangular tanks is that derived by Unwin, which is:

$$L = 2t\sqrt{\frac{s}{p}}$$

where

L = length of square plate between stays in inches.
s = working stress in pounds per square inch.
p = working pressure in pounds per square inch.
t = thickness of plate in inches.

The formula is for square plates, firmly fixed around all four sides and uniformly loaded over the whole surface.

In practice the plate is held by rivets which are spaced more or less closely, depending upon whether they are in a seam which has to be calked or in a stay fastened to the plate. In the first case, the rivets are usually spaced sufficiently close to enable us to consider the plate as firmly fixed all along the riveted edge. In the second case, it is general practice to space the rivets quite far apart, too much so as to really fix the plate as called for by the conditions under which the formula was derived.

It is impossible to say exactly how much the stress is increased by a wide spacing of the rivets, but experience seems to show that the pitch of the rivets should never exceed six times their diameter and that little or nothing is gained by making the pitch less than four times the diameter of the rivet.

In the application of this formula to the tank sizes and pressures given in the question, it will readily be seen that in order to have reasonable plate thicknesses it will be necessary to use stiffeners. The size of the angle iron or tee iron bracing used can be determined by the following formula:

$$z = \frac{W \times L}{6 \times s}$$

where

z = section modulus of angle or tee.
W = total load on angle or tee.
L = length of angle or tee between supports in inches.
s = safe stress (10,000 pounds per square inch).

The size of the braces can be reduced by relieving the load from any given area by the use of cross-braces which have the required cross-sectional area in tension to support the load.

Conditions as outlined in the question are provided for in the A. S. M. E. Code for Unfired Pressure Vessels as follows:

"U-51. Where no rules are given and it is impossible to calculate with a reasonable degree of accuracy the strength of a pressure vessel or any part thereof, a full-sized sample shall be built by the manufacturer and tested in accordance with the standard practice for making a hydrostatic test on a pressure part to determine the maximum allowable working pressure, as given in the Appendix, or in such other manner as the Committee may prescribe."

Lectures on Boiler and Machinery Insurance

The second in the current series of lectures on Boiler and Machinery Insurance being conducted by the Royal and Eagle Indemnity Companies was held November 1, in the Lecture Room in the Companies' Head Office at 150 William Street, New York.

An instructive and interesting talk on the subject of Machinery Direct Damage Insurance was delivered by J. P. H. deWindt, manager of the Boiler and Machinery Department of the National Bureau. Following his address, Mr. deWindt conducted an informal discussion on many underwriting and sales problems arising in connection with this subject.

The meeting was attended by a large group of brokers and producers in the Metropolitan area who have enrolled for the series of lectures, which began on October 25 and are being held weekly for a period of five weeks. These interesting lectures, dealing with the various phases of boiler and machinery business, have been printed and copies will be supplied to anyone directing a request to the Production Department of either company.

INTERNATIONAL NICKEL COMPANY.—The district office of the development and research department of The International Nickel Company, Inc., moved on November 1, into larger quarters in the General Motors Building, Detroit.

According to E. J. Hergenroether, district representative, the move into larger quarters was made necessary by increased activity among these and other durable goods manufacturers in the middle west.

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

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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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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 — 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.

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Third Vice-President — Ira J. Pool, division boiler inspector, Baltimore & Ohio Railroad, Baltimore, Md.

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Fifth Vice-President — William N. Moore, general boiler foreman, Pere Marquette R. R., Grand Rapids, Mich.

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

Cities

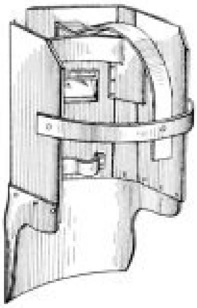
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

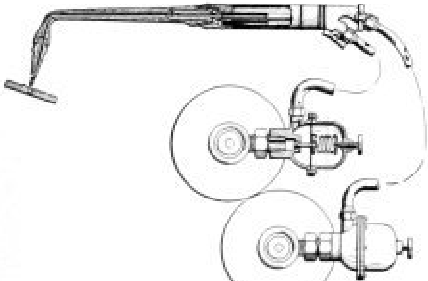
1,861,797. WELDING SHIELD. ROBERT W. HOLT, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO FRANKLIN M. WARDEN, OF CHICAGO, ILLINOIS.

Claim.—In a face shield for use in welding a relatively small stationary upper window through which the work being welded may be observed in the absence of an intense light at the location of the work.



1,865,033. METHOD OF PREVENTING POPPING OF TORCHES. CHESTER MOTT AND GERALD G. SPENCER, OF DENVER, COLORADO, ASSIGNORS, BY MESNE ASSIGNMENTS, TO UNION CARBIDE & CARBON RESEARCH LABORATORIES, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim.—A method of preventing popping in a torch which burns a combustible mixture supplied thereto from separate fuel gas and combustion-supporting gas sources.



STATEMENT of the ownership, management, circulation, etc., required by the Act of Congress of March 3, 1933, of *The Boiler Maker*, published monthly at Philadelphia, Pa., for November 1, 1934.

State of New York }
County of New York } 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 that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required 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 St., New York, N. Y.
   Editor, H. H. Brown, 30 Church St., New York, N. Y.
   Managing Editor, L. S. Blodgett, 30 Church St., 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, 1625 Ditmas Avenue, Brooklyn, 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.; B. L. Johnson, 105 West Adams Street, Chicago, Ill.; W. A. Radford, 407 S. Dearborn Street, 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 Kurk Beckers, Arthur H. Gilbert, all of 25 Broad Street, New York, N. Y. Percival Gilbert, William E. Stanwood, John T. Nightingale, all 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.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of the total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

H. H. BROWN.

Sworn to and subscribed before me this 28th day of September, 1934. H. D. NELSON.

[Seal] (My commission expires March 30, 1935.)

Boiler Maker and Plate Fabricator

NRA U.S. CODE GRAPHIC ARTS INDUSTRY

Annual Index

The annual index of Boiler Maker and Plate Fabricator for the year 1934 will be mailed without cost to each subscriber whose request for it is received at our New York office on or before January 15, 1935.

Demand for Steam Generators

Through the first ten months of the year a steadily increasing number of orders for new boilers was placed in the boiler manufacturing industry. For the period, according to the reports of the Department of Commerce Bureau of Census, a total of 4231 boilers were ordered having a heating surface of 3,822,066 square feet. In numbers this compares with 3493 units in 1933 and 3136 units in 1932.

Definitely the trend seems to have turned in this industry. With the potential demand as great as it is for new steam generating equipment to rehabilitate power stations and industrial plants, and for new construction of all kinds, the prospects for 1935 in the boiler manufacturing industry appear better at this time than for many years past.

Starting the year with heavy production in the steel plate fabricating industry, which fell off during the summer months, this field is now showing a slightly rising demand for its products. As a whole the year will be considerably better than last. The ten-month total, recorded for 1934, shows production of 198,209 tons in all classes as compared with 170,873 tons in the same period of 1933, and 144,418 tons in 1932.

Gains in the heavy goods industries as a whole will be reflected simultaneously in both the boiler manufacturing industry and that of plate fabrication.

Locomotive Boiler Patches

In the conduct of the Questions and Answers Department of Boiler Maker and Plate Fabricator, probably the most frequent of all inquiries received are concerned with methods of designing and applying boiler patches.

Some years ago a complete treatise on the principles of patch design was published, which subsequently constituted the basis of practice on many railroads. Recently numerous requests have been received for copies of the original article. It has been impossible to supply such copies and so for the benefit of our readers who have occasion to deal with locomotive boiler patches the article is being reprinted in this issue.

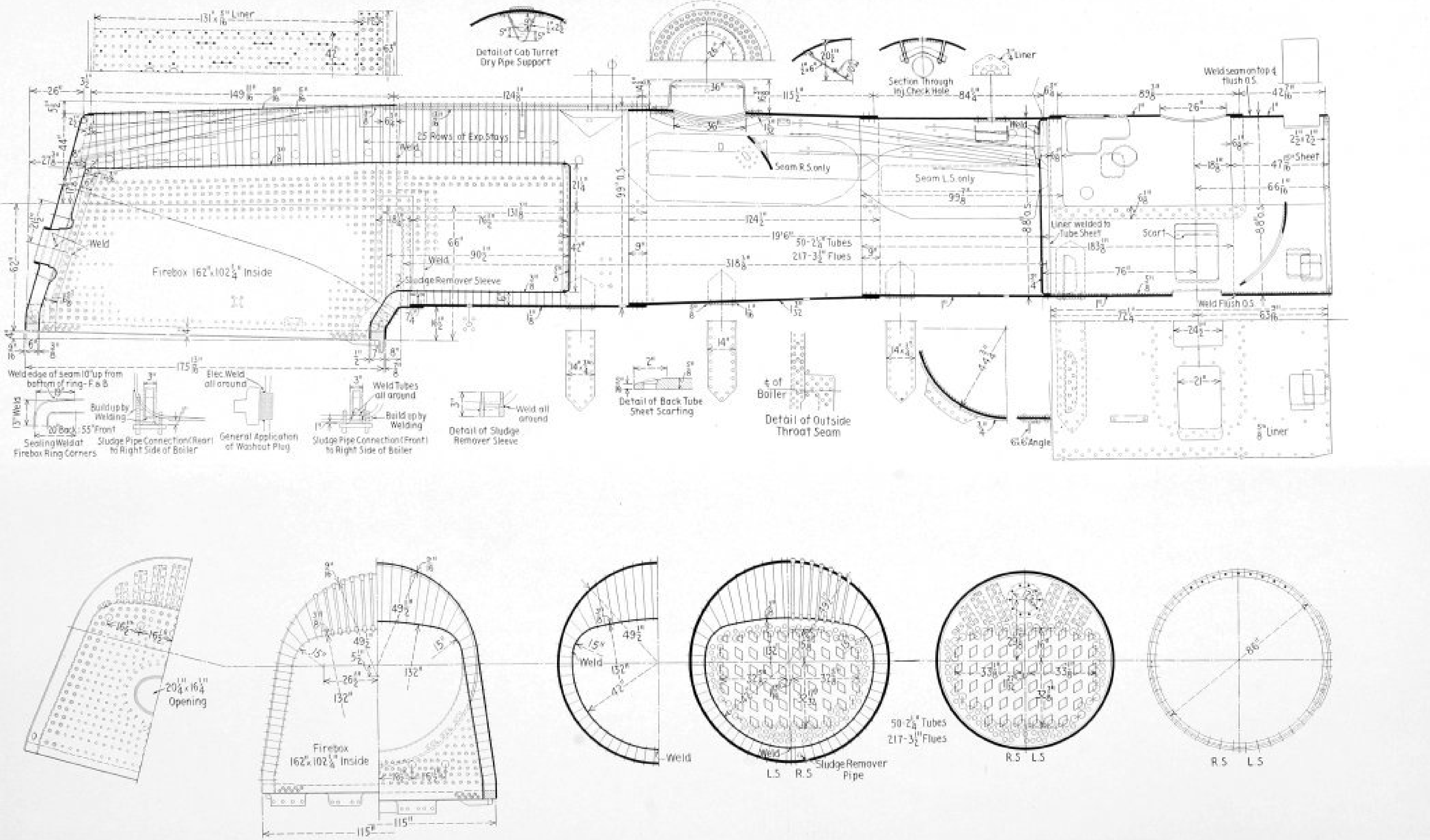
Possibly some will have methods of patching to suggest that will amplify the information contained in this article. Certainly through the depression, an unusual amount of experience in this work has been gained. Letters describing types of patches, methods of application and results attained will be accepted for publication in early issues of Boiler Maker and Plate Fabricator.

How Long Can the Railroads Hibernate?

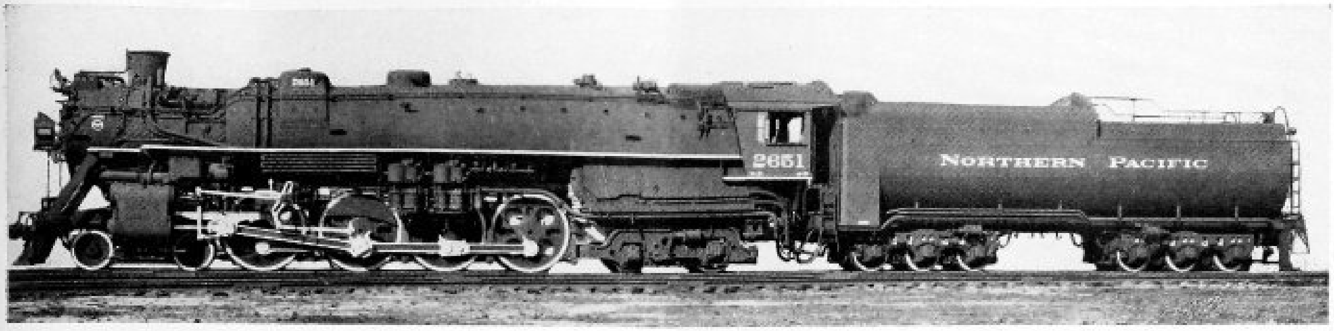
Certain animals, like the bear, go into retirement on the approach of the winter season, seeking refuge in some cave or den where they, in effect, "live on their fat" until the time comes when they can again make a more satisfactory living otherwise. They must accumulate and store away considerable surplus tissue each year, however, prior to embarking on this annual winter hibernation. Can you imagine a lean, hungry old bear, for example, coming out of his winter quarters all set for some nourishing food and suddenly being compelled to return for another protracted period of paw nursing. For how many years could he stand such a program?

The railroads are in much the same position as the animal mentioned. While not actually hibernating, they have been "living on their fat," in so far as equipment maintenance is concerned, for several years. Locomotive and car repair programs have been greatly curtailed, shops closed, personnel reduced, material stocks depleted, and repair parts taken from stored equipment for use of that which must be kept in service. The extent of under maintenance is indicated by the relatively much greater decline in repair costs than in mileage operated. In 1929, for example, equipment maintenance cost the railroads on an average about 101 million dollars a month, this figure dropping to 53 million dollars a month in 1934, or a reduction of 48 percent. In this same period principal and helper locomotive miles in freight service dropped from about 55 million to 37 million, or only 33 percent. Similarly, loaded car miles in freight service dropped from about 1.5 billion miles per month in 1929 to 0.9 billion in 1934, or only 40 percent.

For several years, now, locomotive and car miles have been run out much faster than they have been restored by repair programs and this trend cannot continue indefinitely. With few exceptions mechanical department officers are undoubtedly doing everything within their power to get ready for this increased maintenance program. But without more revenue there is no source from which to secure the means to increase maintenance expenditures. The fact that there has been so little actual decrease in the reliability and safety of railway service after four years of drastic retrenchments is a tribute to the self-reliance and resource of the foremen on whose shoulders has fallen the direct responsibility of keeping cars and locomotives in operation.



Longitudinal and cross sections of boiler on new Northern Pacific locomotives



Northern Pacific 4-8-4 type, Class A-2, heavy passenger locomotive

Heavy 4-8-4 Locomotives for the Northern Pacific

Ten passenger locomotives of the 4-8-4 type have been delivered to the Northern Pacific by the Baldwin Locomotive Works. These locomotives are among the heaviest and most powerful of the type yet built and the 77-inch driving wheels are one inch larger than the largest previously employed in locomotives of this type. With cylinders 28 inches by 31 inches and a boiler pressure of 260 pounds per square inch, these locomotives develop a rated tractive force, with 70 percent maximum cut-off, of 69,800 pounds. All the driving-axle journals are fitted with Timken roller bearings.

A prominent feature of the proportions of these locomotives is the firebox which has a grate area of 115 square feet. As in the case of other locomotives built for the Northern Pacific during the past six years, this is occasioned by the extensive use of Rosebud lignite coal in locomotive service. The heating value of this fuel is about 10,800 B.t.u. per pound. It has a moisture content of 11 percent, runs under 8 percent in ash, has 51 percent volatile and 30 percent fixed carbon, and is low in sulphur.

Dimensions of these new Northern Pacific locomotives are shown in the table page 318.

The boiler and firebox are constructed from plates of Lukens basic carbon steel and the boiler barrel has a diameter of 88 inches outside the first ring. The firebox is 162 inches long by 102¼ inches wide, which provides a grate area of 115 square feet and a ratio to heating surface of 1 to 43.16. The combustion chamber is 90 inches long, thus bringing the length of the tubes and flues down to 19 feet 6 inches.

Welding is used extensively to seal the firebox seams. The back tube sheet is welded, both inside and outside, after calking. The firebox door sheet is welded to the crown and sides, which are formed from a single sheet. The outside throat sheet is also sealed with electric welding after calking. Flannery telltale staybolts, with welded caps, are used for the full length of the combustion chamber, for the first three rows of roof stays back of the seam and in the breaking zone.

The staybolt installation includes 264 flexible crown stays, 1⅛ inches diameter, 396 rigid crown stays, 1⅛ inches diameter; 1367 flexible stays, 1 inch diameter; 126 flexible stays, 1$\frac{1}{16}$ inches diameter; 1213 hollow stays, 1 inch diameter, and 12 screw stays, 1⅛ inches diameter. A total of 500 expansion stays, 1⅛ inches diameter, was installed.

The tube installation included 50-2¼-inch outside diameter tubes and 217 flues 3½ inches outside diameter. The boiler tubes for all ten engines were supplied by the Globe Steel Tube Company, Milwaukee. This company also furnished superheater flues for six boilers, while the National Tube Company, Pittsburgh, furnished superheater flues for four boilers.

The firebox and combustion chamber provide 480.2 square feet of heating surface, arch tubes 62.6 square feet, tubes and flues 4421.5 square feet. The total evaporative surface is therefore 4964.3 square feet. The superheating surface is 2174 square feet, giving a total combined evaporative and superheating surface of 7138.3 square feet.

The brick arch is supported on five 4-inch tubes. The Globe Steel Tube Company supplied the tubes. The railway company has applied Security Arch brick, supplied by the American Arch Company. The boilers are fitted with Elesco Type E superhearters. Five of them are equipped with Worthington feed-water heaters and five with Wilson water conditioners. Coal is fed by a modified Type B Dupont-Simplex stoker with a capacity of 25,000 pounds of coal per hour. The front end is fitted with a Cyclone spark arrester.

Separate turrets are provided for superheated and saturated steam. The superheated-steam turret in the smokebox provides for the blower, air pumps, whistle, headlight turbo-generator and the stoker. The saturated steam turret in the cab provides steam for the injector, the feedwater heater, the power reverse gear, lubricator heaters, drifting valves, steam heat in the cab and train, and the coal pusher. The boiler has no auxiliary dome; the safety valves are screwed directly into the third boiler course back of the main dome. The whistle is mounted alongside the smokebox. The boilers are fitted with Wilson sludge-removers and air-operated blow-off cocks.

The locomotive is built on the General Steel Castings Corporation bed, with which are cast the cylinders, including the back heads, the air reservoirs and the inside cradle.

Table of Dimensions, Weights and Proportions of the Northern Pacific 4-8-4 Type Locomotives

Railroad	Northern Pacific
Builder	Baldwin Locomotive Works
Road class	A-2
Type of locomotive	4-8-4
Service	Passenger
Cylinders, diameter and stroke	28 in. by 31 in.
Valve gear, type	Walschaert
Valves, piston type, size	14 in.
Maximum travel	7½ in.
Crank throw	19½ in.
Steam lap	1 15/16 in.
Exhaust clearance	⅜ in.
Lead, constant	¼ in.
Cut-off in full gear, per cent	70
Weights in working order:	
Total engine	489,400 lb.
On drivers	279,800 lb.
On front truck	96,600 lb.
On trailing truck	113,000 lb.
Tender	387,600 lb.
Wheel bases:	
Driving	20 ft. 8 in.
Rigid	13 ft. 4 in.
Engine total	48 ft. 5 in.
Engine and tender, total	95 ft. 3 in.
Wheels, diameter outside tires:	
Driving	77 in.
Front truck	36 in.
Trailing truck	37 in. and 45¾ in.
Journals, diameter and length:	
Driving, main	13½ in.
Driving, others	12½ in.
Front truck	7½ in.
Trailing truck	7 in. and 8 in.
Boiler:	
Type	Conical
Steam pressure	260 lb.
Fuel, kind	Rosebud coal
Diameter, first ring, outside	88 in.
Firebox, length and width	162 in. by 102¼ in.
Height mud ring to crown sheet, back	79⅝ in.
Height mud ring to crown sheet, front	87¼ in.
Arch tubes, number and diameter	5—4 in.
Combustion chamber length	90½ in.
Tubes, number and diameter	50—2¼ in.
Flues, number and diameter	217—3½ in.
Length over tube sheets	19 ft. 6 in.
Grate area	115 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	480.2 sq. ft.
Arch tubes	62.6 sq. ft.
Firebox, total	542.8 sq. ft.
Tubes and flues	4,421.5 sq. ft.
Total evaporative	4,964.3 sq. ft.
Superheating	2,174.0 sq. ft.
Comb. evap. and superheat	7,138.3 sq. ft.
Special Equipment:	
Brick arch	Yes
Superheat	Elesco Type E
Feedwater heater (5)	Worthington 6-S-A
Feedwater conditioner (5)	Wilson
Stoker	Duplex-Simplex Type B modified
Tender:	
Style	Vanderbilt W.B.
Water capacity	20,000 gal.
Fuel capacity	27 tons
General Data, estimated:	
Rated tractive force (70 per cent cut-off)	69,800 lb.
Potential horsepower (Cook)	4,000 hp.
Speed at 1,000 ft. piston speed	44.45 m.p.h.
Piston speed at 10 m.p.h.	225.6 ft.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	57.2
Weight on drivers ÷ tractive force	4.0
Weight engine ÷ potential hp.	122.3
Weight engine ÷ comb. heat. surface	68.6
Boiler proportions:	
Tractive force ÷ comb. heat. surface	9.8
Tractive force x dia. drivers ÷ comb. heat. surface	753.0
Comb. heat. surface ÷ grate area	62.1
Comb. heat. surface ÷ potential hp.	1.78
Potential hp. ÷ grate area	34.8
Firebox heat. surface ÷ grate area	4.72
Firebox heat. surface, per cent of evap. heat. surface	10.95
Superheat. surface, per cent of comb. heat. surface	30.5

All driving axles are fitted with Timken roller bearings. These are provided with safety bombs—chemical cartridges inserted in the bearing housings—which warn against overheating by giving off visible fumes before bearing temperatures have reached a dangerous point.

The connecting rods are of annealed, open-hearth steel with solid ends. The front end of the main rod

Special Boiler Equipment Applied on Northern Pacific 4-8-4 Type Locomotives

Railroad	Northern Pacific
Builder	Baldwin Locomotive Wks.
Road class	A-2
Road numbers	4650—4659
Boiler:	
Boiler and firebox steel	Lukens
Staybolts	Ulster Special
Flexible staybolts	Flannery
Button-head radials (12 rows center of crown)	Agathon Nickel Iron
Brick arch	American—Security
Smokebox door hinges	Okadee
Spark arrester	Loco. Firebox—Cyclone
Blower nozzles	TZ
Smokebox blower fitting	Barco
Superheater	Elesco Type E
Throttle	American—Multiple
Steam dryer and shut-off valve	Tangential
Lagging	Johns-Manville
Feedwater heater (5)	Worthington
Water conditioner (5)	Wilson
Inspirator (1000 gal.)	Hancock—K.N.L.
Boiler checks	Hancock
Blow-off cocks (air operated)	Wilson—N.C.
Sludge remover	Wilson
Washout plugs	TZ
Stoker	Standard—Modified du Pont-Simplex
Firedoor	Franklin—Butterfly No.8
Grates (1 engine)	Firebar
Cabs, fittings, boiler mountings:	
Safety valves	Consolidated
Pressure gages	Ashton—Double dial
Back-pressure gage	Ashton—Duplex (with pulsation retarding device)
Speed indicator	Weston Electric
Water column	Edna
Drainpipe receptacles through cab floor	TZ
Low-water alarm	Barco
Valves, globe	Crane
Valves, globe on stoker	Hancock

is fitted with a solid brass bushing pressed in. The back end of the main rod and the side rods are all fitted with fixed bushings of Hunt Spiller gun iron, pressed in, and with floating bushings of brass.

The locomotive is equipped with an Alco power operated throttle lever, with provision for auxiliary manual operation, and with the American multiple type throttle. The dry pipe is fitted with the Tangential steam dryer and shut-off valve.

The tender has a General Steel Castings water-bottom underframe with a modified Vanderbilt type tank of welded construction. The water capacity is 20,000 gallons and fuel space is provided for 27 tons. The tender is carried on two General Steel Castings six-wheel trucks. The truck wheels are 37 inches in diameter and the axles are fitted with American Steel Foundries roller-bearing units. The tenders are equipped with track sprinklers.

The locomotives are equipped with the No. 6 ET brake applied to all driving, truck and tender wheels. Two 8½-inch cross-compound compressors are mounted on the left side of the boiler. Five of the locomotives have Pyle-National, and five Sunbeam turbo generators. Other accessories include the Franklin Butterfly fire door, Barco low-water alarm and a Hancock non-lifting inspirator of 10,000 gallons capacity.

These locomotives were designed for use in heavy through passenger service and for handling silk specials in continuous runs between Jamestown, N. D., and Missoula, Mont. The 904 miles of line between these points includes sections of rolling grade, water level grades, and heavy mountain grades. They will replace the 12 lighter 4-8-4 type locomotives of the first order, which have been assigned to other districts. The first of the locomotives, which was turned out of the Eddystone plant of the Baldwin Locomotive Works in September, was on exhibition at the Wings of a Century Pageant at the Century of Progress Exposition at Chicago from September 15 to October 5 before proceeding to its home rails to be placed in service.

Pressure vessel code requirements for

QUALIFYING WELDERS*

The A. S. M. E. Boiler Construction Code today refers specifically to four types of vessels; namely, those built in compliance with the Code for Fusion Welded Power Boilers, those built under the requirements of Par. U-68 of the Unfired Pressure Vessel Code (formerly known as Class 1 Pressure Vessels), those built in compliance with the requirements of Par. U-69 of the Unfired Pressure Vessel Code (formerly known as Class 2 Pressure Vessels) and those built in compliance with the requirements of Par. U-70 of the Unfired Pressure Vessel Code (formerly known as Class 3 Pressure Vessels). The Code for boilers and for U-68 vessels does not specify any exact procedure for determining the ability of the operators employed in welding the vessel. It is true that the Code does specify that a sample of welding must be made for each pressure vessel and this welding must be done by exactly the same technique as followed in the construction of the vessel. In most cases, weld samples must be made as a continuation of the longitudinal seam of the vessel. It also is true that the inspector may designate which operator, of those to be employed on the vessel, shall make the test weld and a recent interpretation case by the Boiler Code Committee stated that the inspector has the right to call for tests of any individual operator on a power boiler or U-68 vessel at any time. Aside from these provisions, however, the Code does not specifically state that all operators employed in the welding must be qualified by any set procedure. On the other hand, the Code does specify that all longitudinal and circumferential seams on power boilers and U-68 vessels must be radiographed and the soundness of the seams so examined must meet a certain standard.

In contrast to the above the Code requires that all operators of welding equipment to be employed in fabrication of U-69 or U-70 vessels shall make welds by the same process of welding to be used in fabricating the vessel and these test welds must meet certain requirements. Two types of tension tests are called for in addition to free-bend and nick-break tests. To qualify an operator a minimum of 8 and a maximum of 24 test specimens are required and plate thicknesses from ¼ inch to a maximum of 1½ inches.

In the construction of power boilers and U-68 vessels, all the welded seams must be fabricated by the same technique of welding as that used for the test plates and it is assumed that the physical properties shown by the test plates are representative of the physical properties of the welded seams provided those seams are free from defects. The fact that such seams are free from defects is determined by radiographic examination. For U-69 and U-70 vessels the Code states, in effect, that the technique of welding for any particular vessel must be determined upon in advance of welding that vessel, and the individual operators must then be tested to determine their ability to make a weld which will

By William D. Halsey†

meet the Code requirement for tensile strength, ductility and soundness, the latter quality to be determined by the nick-break method, although radiographic examination for the test plates may be used in lieu of the nick-break.

If we examine somewhat more closely the requirements of the A. S. M. E. Code for power boilers and U-68 vessels, it will be clear that the testing for tensile strength, ductility and specific gravity is done for the purpose of determining whether the process of welding used will produce satisfactory results. The acceptability of the welds on the vessel made by several individual operators is not specifically determined by such operators having previously demonstrated they could make a weld that would have the required tensile strength and ductility, but rather, the acceptability of the work of those men is determined by the radiographic examination. In other words, certain tests having shown that the welding process will produce a weld having proper tensile strength and ductility, all that is further needed to be known for each individual operator is that he has produced a sound weld.

The author has stated upon numerous occasions that quality welding depends upon two fundamental principles. First, a technique or procedure of welding that has been carefully tested to know that it will produce acceptable results and second, operators trained to exactly follow that technique of welding and subsequently tested to determine their ability to follow the procedure and to obtain results. We cannot require the most experienced operator to use inadequate equipment or improper materials and expect that he can obtain acceptable results nor can we place the most highly developed technique of welding in the hands of one who is wholly inexperienced in its application and expect to gain the desired end.

There has been in the past a most widespread practice to let each operator of welding equipment determine what materials he desired to use and determine how he would make a weld. If such methods are to be followed it is essential to know that every individual welder can by his pet procedure obtain welds that will have adequate tensile strength, in addition to ductility and soundness. On the other hand, if it can be definitely known that a certain exact procedure of welding will, within reasonable certainty, produce welds that have the desired characteristics, the only examination that need be made of individual operators is as regards their ability to obtain proper fusion and a clean weld.

The statement of the technique, specification or procedure for welding should cover exactly all variables which may have a bearing upon the physical properties of the welded joint. When such a specification for welding has been decided upon, numerous welds in various plate thicknesses should be made in accordance with that specification and such welds should then be tested. What those tests should be will depend largely upon

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the kind of information desired. They should include at least a determination of the tensile strength of the welded joint using the reduced section tensile test coupon, a determination of the free-bend ductility and a determination of the soundness either by nick-break methods or by X-ray examination. In addition to these tests it may be desirable to examine the tensile strength and ductility of the weld metal itself. Tests of specific gravity and impact strength may also be included. Macrographic and micrographic studies are undoubtedly of great value.

Having determined that a given fixed technique of welding will produce the desired results, it is then necessary to determine that the individual operators of the equipment are willing to and will follow the exact technique. If they are unwilling to do so, they should be shown wherein departures from the technique will produce poor results and, if there is an utter lack of desire to co-operate, their services should be dispensed with. When a welder has demonstrated that he can follow the technique of welding, some simple tests should then be made to determine his ability to obtain fusion with the base metal and also to obtain a clean weld.

While the free-bend test has been used primarily to determine the ductility of a welded joint, it is of value in examining an operator's ability to obtain fusion with the base metal and for that reason should be included in the tests for qualifying an operator of welding equipment.

The nick-break test has been used to determine the operator's ability to obtain a clean weld. However, the present type of nick-break specimen, while permitting an examination of the degree of porosity in the weld metal and the operator's ability to obtain a weld sound at the root, does not permit examination of the operator's ability to obtain thorough fusion with the base metal.

The author has examined numerous X-ray films of welded joints, and it is apparent that a common defect is a slag inclusion along the side wall of the joint. The author, therefore, suggests a new type of nick-break specimen in which the nick would be made along the line of fusion instead of at right angles to the plate surface and through the root of the weld. It is believed that such a test will prove of great advantage not only in testing the ability of an operator but also in showing him wherein it is necessary to keep his work clean and to follow the specified procedure for welding.

The author has made a number of nick-break tests with the nick on the line of fusion and has discovered defects which otherwise would not have been found except by X-ray examination.

In addition to the free-bend and the nick-break tests, a reverse bend test is of value. This is particularly true in the case of single butt welds in determining the operator's ability to obtain fusion through the entire thickness of material.

From the hundreds of qualification tests of operators that the author has made or reviewed, he is satisfied that an operator's ability may be satisfactorily determined by a test weld in the maximum plate thickness for which such operator is to qualify and subjecting this test weld to free bend, back bend, right angle and fusion line nick-break tests. Such tests require no elaborate equipment and can be made quickly at small cost. It should be clearly understood, however, that the author proposes this method of qualifying an operator only where an exact procedure of welding has been developed, proved and exactly followed in welding the test plate.

Whatever the author may have said in this paper regarding the A. S. M. E. Boiler or Pressure Vessel Code is not to be taken in any way as a criticism of that Code. It is best that such a Code be ultra-conservative and that it be rigid in its requirements. In adopting the procedure for qualifying an operator, as such procedure now appears in the Pressure Vessel Code, the Boiler Code Committee decided upon a method which seemed best suited for the purpose. However, the Boiler and Pressure Vessel Codes, while they are monuments of a great work, are not considered by the Boiler Code Committee to be so sacred and fixed that they may not be changed. The author had no small part in developing the methods of qualifying operators that now appear in the A. S. M. E. Code, and he is satisfied that the Boiler Code Committee will gladly listen to any suggestions for change, provided those suggestions maintain the high standards of safety desired.

Today there are almost as many methods of qualifying a welder as there are people who have given thought to the matter. It is the author's belief that in developing the various methods of qualifying an operator, the methods used have often been those for qualifying or testing a process of welding rather than qualifying an operator. Methods of investigating a process should be exhaustive. Methods of qualifying an operator who follows that process of welding may be rather simple.

It is the author's belief that the American Welding Society should be the authority to whom all can look for a statement as to what constitutes a qualified operator and the methods that should be used to qualify an operator, and he strongly recommends to the American Welding Society that consideration be given to this matter.

Reconstruction Finance Loans to Industry

In a statement recently issued, Jesse H. Jones, chairman of the board of the Reconstruction Finance Corporation, Washington, outlines the basis for loans to industry designed to tide companies in financial difficulty over the period of depression as a means for stabilizing and increasing employment. The statement follows:

Industrial concerns, eligible to borrow funds from the Reconstruction Finance Corporation for the purpose of maintaining and increasing employment, have not yet taken full advantage of the assistance which the Corporation is prepared to extend.

Congress provided that such loans might be made to industrial and commercial businesses subject to the following requirements:

(1) That the business must have been established prior to January 1, 1934.

(2) That such loans be adequately secured.

(3) That maturity of loan must not exceed five years.

(4) That borrower must be solvent at the time of disbursement of the loan.

(5) That credit at prevailing bank rates for loans of the character applied for not be available at banks.

(6) That reasonable assurance of increased or continued employment of labor be given.

(7) That the aggregate of such loans to any one borrower made directly or indirectly shall not exceed $500,000.

(8) That such other provisions as the Reconstruction Finance Corporation may impose be complied with.

The Directors of the Reconstruction Finance Corporation feel that these loans should be made in such a way that the available funds can be utilized as fully as possible for the advance of permanent business recovery. This objective can be accomplished best if the moneys loaned by the Corporation are used principally to supply funds for the payment of labor and the purchase of materials incident to the normal operation of the business, rather than for the payment of existing indebtedness, though in exceptional cases a small part of the loan may be used for payment of existing debts or for the financing of construction, improvements and/or repairs that do not materially increase capacity. When a loan is to be used primarily for labor and materials, a small portion of the loan may be applied to these latter purposes when necessary to assure ordinary and efficient operation.

The Corporation will make loans in co-operation with banks, or by the purchase of participations in loans made by banks. In cases of national banks, only the bank's participation in such loans, rather than the full amount of the loan, must be within the legal limit which may be loaned to any one customer, and accordingly this plan will allow substantially greater credit to be extended through such channels to borrowers who are already borrowing up to their legal limit.

The depression years have left many enterprises in very much involved and weakened positions, but our experience has led us to believe that where present creditors are willing to co-operate by a proper adjustment of existing debt structure, many such enterprises may be safely supplied with additional funds that will enable continuing operations on a sound basis.

Accordingly, we suggest to industrial concerns, to which credit at prevailing bank rates for loans of such character is not available but which can offer adequate security (even though such security may be frozen and therefore not generally acceptable to banks) and which can profitably use additional funds for labor and materials, that they communicate with the local loan agency of this Corporation serving the territory in which such concerns are located.

Each loan agency of the Corporation will, when requested, assist and advise with applicants in determining their eligibility and in the preparation of applications.

Trends in Motive Power

While purchases of locomotives and rolling stock have been insignificant since 1930, the inventory has not been standing still. Retirements of locomotives have been continued throughout the depression at rates not greatly below those prevailing before the depression. As a result there has been a sharp increase in the rate of decline in the number of units. The decline actually began in the middle 1920's, but until the sharp recession in equipment installations in 1931 it was causing little real change in the aggregate available capacity.

Installations of locomotives averaged 1405 units per year from 1925 to 1930, inclusive, and retirements were at the average rate of 2890 units per year. There was a decline from 63,974 locomotives owned by the Class I railways at the end of 1925 to 56,582 at the end of 1930. The aggregate tractive force, however, had declined only 60 million pounds from 2587 million pounds. At the end of 1933, after three years of installations at the average rate of 407 a year and retirements at 2599 a year, the number of locomotives had declined to 50,802. This decline is about three-fourths as great as that during the preceding six years, but the decline in aggregate tractive force was about 147 million pounds—nearly six percent in three years.

This represents a definite cleaning up of the inventory. The locomotives retired have been of types which have largely ceased to have any place except in light service. The retirements have little relation to the policies which the railways are developing with respect to the purchase of new equipment when a restoration of traffic and earnings permits them to take up seriously the question of major capital expenditures. They are evidence of a clear recognition of obsolescence at the bottom of the inventory, during a period when curtailed traffic has removed the immediate need for more aggregate equipment capacity and when vanished earnings and credit have made major capital expenditures impossible.

In the reports to Co-ordinator Eastman's Car Pooling Section, as of October 1, 1933, there were 1046 road locomotives having four-wheel trailer trucks, a characteristic which may be employed roughly to distinguish strictly modern locomotives from those not strictly modern in construction. In the middle group the numerically important freight types are the 2-8-2 and the 2-10-2, of which there are 9830 and 2054, respectively. The 4-6-2 and 4-8-2 types, of which there were 5528 and 1809, respectively, are the important groups of passenger power and are also used to a limited extent in freight service. It is locomotives from these groups which are being replaced in main line service by locomotives with the four wheel-trailers, which develop higher sustained horsepower and maintain higher sustained speeds than can be obtained from those now generally employed. There is little place, except on light branch lines, for the locomotives of 4-4-0, 2-6-0, 4-6-0, 2-8-0 and 4-8-0 types, but there were over 18,000 of these locomotives still carried in the property account at the time of the report—groups which have long ceased to be purchased and the average ages of which were from 26 to 34 years. To these may be added the 4-4-2 and 2-6-2 types, making a total of nearly 20,000 units. These are the locomotives which were the least used during the period studied by the Co-ordinator.

These figures, which are also set forth in the table, present a composite picture of a situation which varies

The Locomotive Inventory as of October 1, 1933

	No. locos.	Average age of groups, years	
		From	To
Strictly modern locomotives:			
2-8-4; 2-10-4; 4-6-4; 4-8-4	1,046	3.6	5.7
Principal active main-line types:			
2-8-2; 2-10-2; 4-6-2; 4-8-2	19,221	8.9	18.8
Articulated	1,619	3.0	23.0
Types generally obsolete:			
2-6-0; 2-8-0; 4-4-0; 4-6-0; 4-8-0; 2-6-2; 4-4-2	19,685	25.9	29.9
Types not classified (12 wheel arrangements)	1,051	...	...
Total road locomotives	42,622		

widely in its details on different individual railways. On some railroads the light character of the traffic may cause less obsolescence of the old, light types of motive power than must generally be charged against them. In any case, however, the advanced age of many of the units in types which average from 25 to 30 years of age is likely to make them expensive to maintain in relation to the amount of service they can render and in comparison with modern standards, they are likely to be very inefficient operating units.

When serious consideration can again be given to major capital expenditures by the railways the first interest will undoubtedly be in securing efficient and economical motive power for the main line services.

Methods of designing and applying

LOCOMOTIVE BOILER PATCHES

The following instructions for designing patches of various types for locomotive boilers have been widely used by mechanical departments and boiler shops throughout the country. They appeared originally in THE BOILER MAKER in 1917, in an article by William N. Allman. So many requests have been received for copies of these instructions, which in general cover all fundamental requirements of patch design, that a complete abstract of all essential information is being published as follows:

There are various defects which develop in boiler shells, such as pitting, grooving and cracks, which make it necessary to reinforce such parts in order to maintain the boiler in a safe and suitable condition for service.

In observing some applications of patches it will be found that where same has been left entirely to the shop man, that there are some cases of very poor design in the layout, and the strength of the boiler shell has been materially reduced through the application of poor patches. Some boiler makers go on the assumption that if they get enough rivets in the job to make it steam tight, that is all that is necessary, neglecting the fact that they are literally cutting the plate in half; then, very often, a lot of superfluous rivets are used, increasing the cost of repairs considerably.

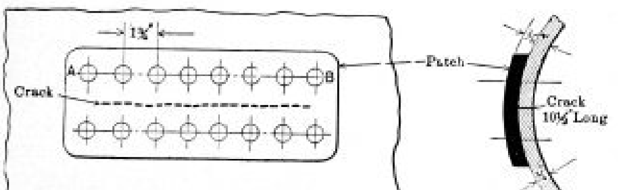


Fig. 1

As an illustration of an unsatisfactory patch, it will be noted from Fig. 1 that the patch plate is just one-half the thickness of the boiler plate, which is ¾ inch. It will also be noted that the rivet spacing is 1¾ inches, running longitudinally with the center line of the boiler, and which is necessary in order to provide a good calking edge for the thin plate.

A rule which is believed to be good practice is to make the patch plate the same thickness as the boiler shell plate to which it is applied. Referring to the patch in question, it will be found that it is weak along the line *A-B*; this condition would exist in this case even though the patch and the shell were of the same thickness, as the efficiency would be low, based on the tearing of the plate along line of rivets *A-B*. It would also be weak, based on the shearing of rivets. A patch of this character would not, therefore, provide sufficient strength under the rules covering the design and construction of boilers issued by the various State and Federal Commissions, from which will be seen that some other form of patch or reinforcement is necessary, as the factor of safety is reduced to such an extent the boiler pressure would necessarily have to be reduced.

In designing seams and patches it must be borne in mind that a longitudinal and circumferential seam of the same design have equal strength so far as the seam is itself, but the stress set up in the boiler due to the internal pressure is only one-half as great on the circumferential seam as on the longitudinal seam. This fact does not seem clear to a good many boiler men, and the following reasoning may make this point clear, if analyzed and studied carefully:

Let P = pressure in pounds per square inch,
D = the internal diameter of boiler in inches.

From this we find that the stress in a longitudinal seam per unit of length (considering a unit length of 1 inch) is:

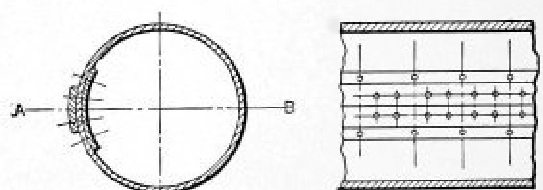


Fig. 2

$$(a)\quad \frac{D \times P \times 1}{2} = \frac{D \times P}{2}$$

By referring to Fig. 2 it will be evident why the constant 2 in the denominator is used.

The product of $D \times P \times 1$ equals the total load tending to part the boiler on line *A-B*, one-half of the load being carried at *A* and the other half at *B*. Therefore the stress at *A* is then represented by the formula (*a*).

Now referring to the circumferential seam the stress will be equal to the following:

This seam is subjected to the load on the boiler head, and neglecting the tubes and supporting value due to head braces, we have the area of the head in square inches multiplied by the pressure per square inch, which is represented by the following formula:

$$(b)\quad D^2 \times 0.7854 \times P$$

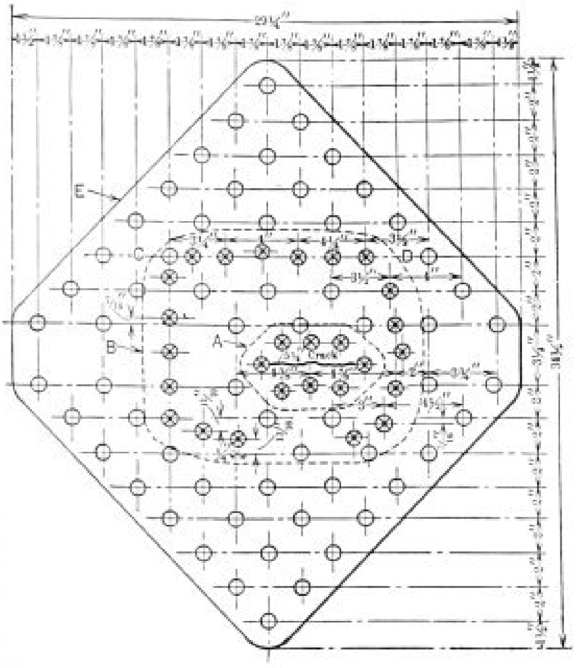


Fig. 3
Holes marked X in old patch, $\frac{3}{4}$'' boiler steel, $\frac{15}{16}$'' holes, $\frac{7}{8}$'' rivets

in which,

D = diameter of boiler in inches,

P = pressure in pounds per square inch.

The length of the circumferential seam is equal to $D \times 3.1416$, therefore the stress per unit of length is then equal to

$$(c)\ \frac{D^2 \times 0.7854 \times P}{D \times 3.1416}$$

which by cancellation reduces to

$$\frac{D \times P}{4}$$

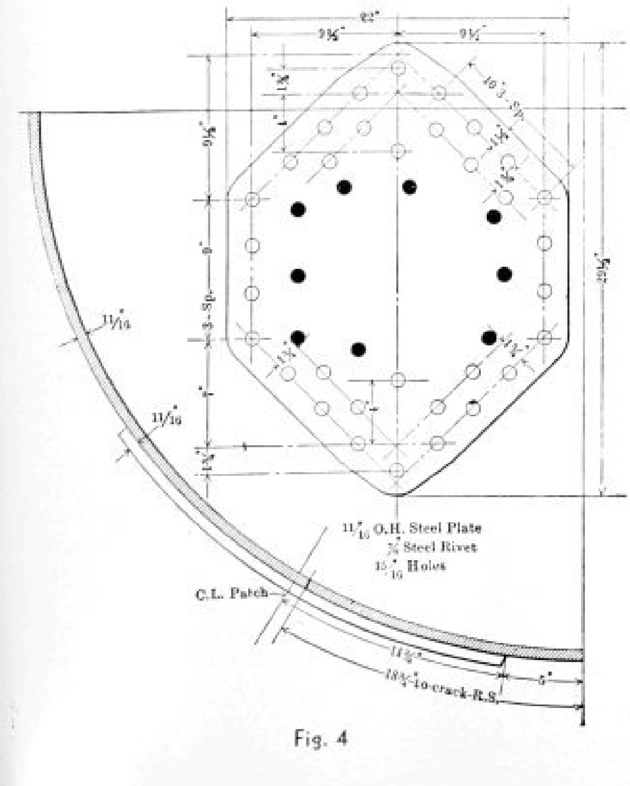


Fig. 4

and which is just exactly one-half the stress in formula (*a*) for the longitudinal seam.

Another illustration of a poorly designed patch is represented by Fig. 3. This patch was proposed for application to a boiler to cover a crack 5¼ inches long. When applying cover plates in the initial patch a small plate *A* was used on the outside and a larger plate *B* on the inside of the boiler. This made a weak point in the boiler plate along the line *C-D*, and in attempting to remedy this weak point another plate *E* was proposed to be applied by the shop man. While no doubt this would have been amply strong it will be noted that it was proposed to apply 61 rivets.

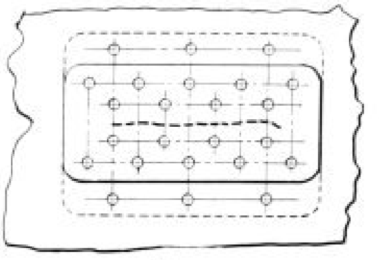


Fig. 5

After this proposition was given consideration by the drawing room a patch as represented by Fig. 4 was substituted and applied. In this case a reduction of 20 rivets was made without affecting the efficiency, as well as reducing the size of the patch and without reducing the strength.

In the opinion of the writer a diamond-shape patch consisting of a single plate is quite satisfactory for small cracks, and can be employed in reinforcing all cracks up to about 12 inches long. When the defect, however, assumes large proportions, an inside and outside cover plate should be used similar to that shown in Fig. 5, and the proportions of which should correspond to and be of equal

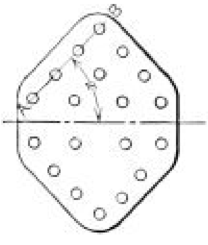


Fig. 6

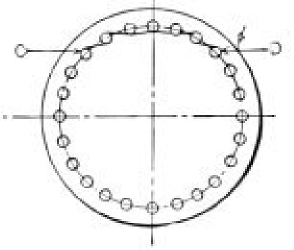


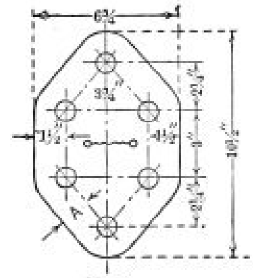
Fig. 7

strength as the longitudinal seam on the course to which it is applied.

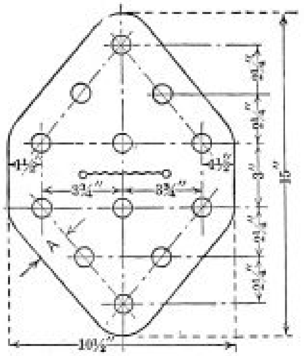
In considering the diamond-shape patch as shown in Fig. 4 it is necessary that care be exercised in the application of same, as, for instance, the efficiency may be greatly reduced if the angle *X* of the line *A-B* with the longitudinal center line of the boiler is less than 45 degrees, as shown in Fig. 6. It is, therefore, evident that the greater the angle *X* the more efficient the patch will be.

There have been a great many applications of circular patches, such as represented by Fig. 7. For cases of small reinforcements there seems to be no objection to the use of a circular plate, but there is a limit to this style of patch, as when it reaches a certain diameter the line of rivets as represented by *C-D* can be assumed to be a straight line, and on account of the close spacing of the rivets which is required in order to provide a calking edge, the factor of safety would be reduced, which would necessarily mean a reduction in the boiler pressure. It will, therefore, be seen that a large circular patch is not satisfactory and should not be used.

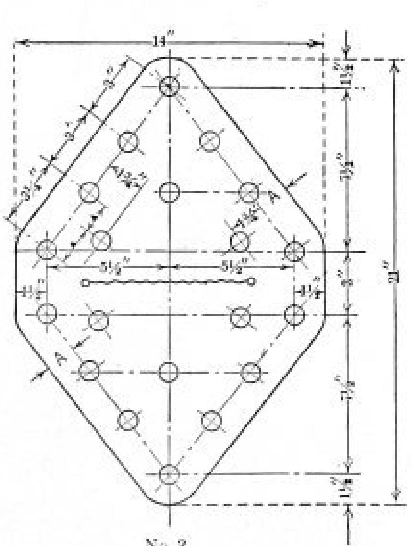
Very often a plate develops abnormal cracks due to crystallization. In such cases it is not good practice to



No. 1
Crack in Shell 2" and under.



No. 2
Crack in Shell 2" to 4" long.



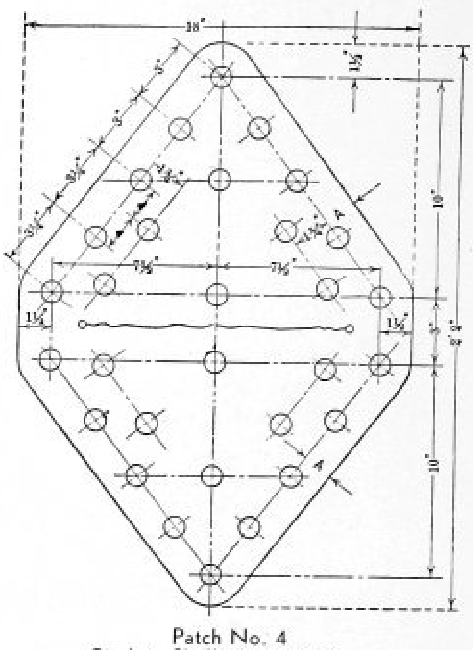
No. 3
Crack in Shell 4" to 8" long.

Fig. 8
Patches Nos. 1–3

patch the plates. The proper thing to do in such a case is to renew the whole or part of the plate, as patching under such conditions will not altogether correct matters, as the defective plate is bound to develop defects beyond the limits of the patch and give very unsatisfactory results.

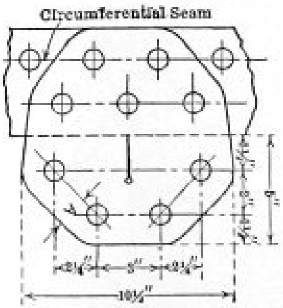
The writer is submitting a series of patches which it is believed will under ordinary conditions serve as a guide in the repairs to defective boilers, when such defects as cracks, pitted places, etc., develop. It will be seen that the patches are graduated for the limits of certain size cracks and the extent of defect due to pitting, grooving and cut-out portions.

In using the single thickness patch particular care must be exercised in keeping the pitch of rivets in the outer row so spaced that the efficiency is not reduced to such an extent that the factor of safety is lowered, which would consequently result in the reduction of the boiler pressure. It is, therefore, evident that a single thickness

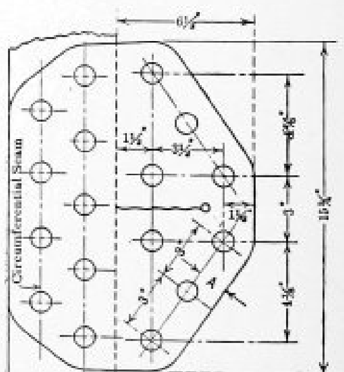


Patch No. 4
Crack in Shell 8" to 12" long

square or rectangular patch would not be sufficient beyond certain dimensions, as to get a good calking edge it would be necessary to space the rivets too close in order to get a good steam-tight job. This, of course, would lower the efficiency so far as the strength of the patch is concerned and result in a factor of safety below four.



Patch No. 5
Crack in Shell 2" and under

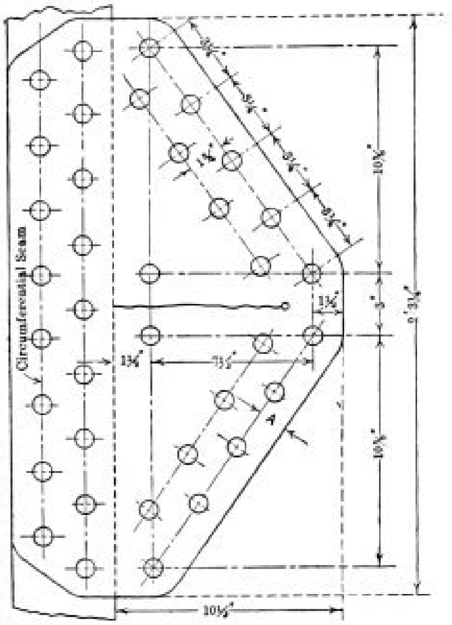


Patch No. 6
Crack in Shell 2" to 4" long

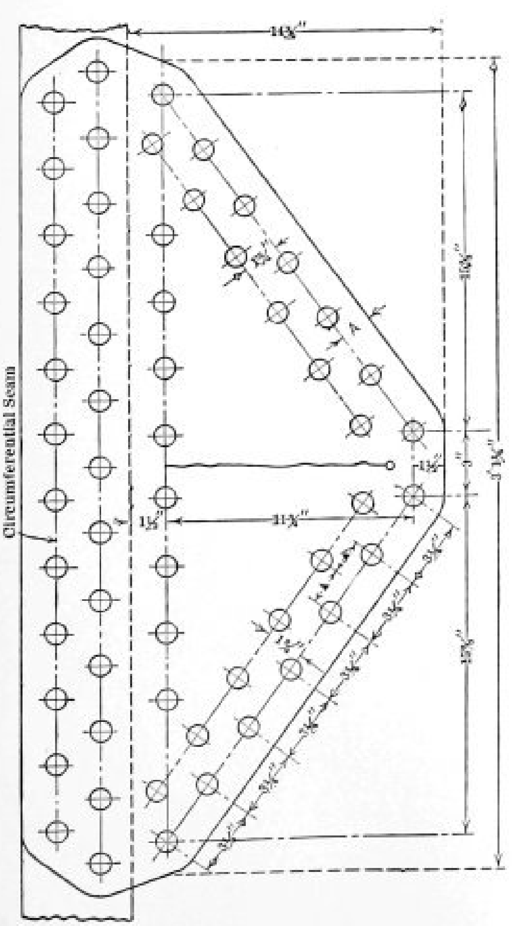
From the foregoing analysis it is evident that the only satisfactory single thickness patch would be the diamond-shape patch, and the next step to decide is what angle the line *A-B* should make with the longitudinal center line of the boiler as shown in Fig. 6, as the spacing of the rivets on the line *A-B* must be close enough to produce a good calking edge. This angle will vary with different conditions of service, depending upon the diameter of the boiler, thickness of the shell and the boiler pressure carried.

To determine the strength of diagonal seams on patches, Table 1 is given. From this it will be seen that as the angle X increases in Fig. 6 the greater will be the efficiency, as the line of rivets A-B more nearly approaches the conditions found in the circumferential seam, which is just twice as strong as the longitudinal seam of the same design. Of course the greater the angle X the longer will be the patch, from which it is evident that there are certain limits that should not be exceeded in order to provide for a good design of patch. The series of patches shown in this article will provide for a factor or safety of four or more if used in conjunction with the data covered in the table of size of rivets.

Objections have been raised in some instances to the use of patch bolts in the application of patches, and it is generally admitted that the best results are obtained from the use of rivets. In applying a patch with patch bolts it is generally the rule that internal examination is not made in connection with the defect and very often the crack assumes larger proportions than at first thought, as the full extent of the crack is not always visible from outside inspection. There may be cases where it is possible and satisfactory to use patch bolts in cases of emergency in order not to remove an engine from service and remove flues in order to apply a patch with rivets, but in such cases the patch bolts should be removed at the first opportunity and replaced with rivets. This means that in so doing it is necessary to ream out such holes and apply rivets that are much larger than required.



Patch No. 7
Crack in Shell 4" to 8" long



Patch No. 8
Crack in Shell 8" to 12" long

TABLE 1

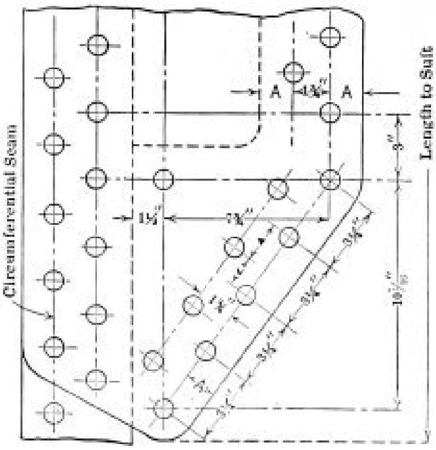
FACTORS FOR DETERMINING THE STRENGTH OF DIAGONAL SEAMS AND PATCHES ON LOCOMOTIVE BOILERS

Angle. Degs.	Sine of Angle.	Sine of Angle Squared.	Cosine of Angle.	Cosine of Angle Squared.	Factor for Strength of Diagonal Seams and Patches. When Angle is Measured with Circumferential Seam.	When Angle is Measured with Longitudinal Seam.
20	.3420	.1170	.9397	.8830	1.717	1.047
21	.3584	.1284	.9336	.8716	1.700	1.052
22	.3746	.1403	.9272	.8597	1.678	1.057
23	.3907	.1526	.9205	.8743	1.657	1.063
24	.4067	.1654	.9135	.8345	1.635	1.068
25	.4226	.1786	.9063	.8214	1.614	1.074
26	.4384	.1922	.8988	.8078	1.594	1.079
27	.4540	.2061	.8910	.7939	1.572	1.087
28	.4695	.2204	.8829	.7795	1.552	1.094
29	.4848	.2350	.8746	.7649	1.531	1.102
30	.5000	.2500	.8660	.7499	1.510	1.109
31	.5150	.2652	.8572	.7348	1.492	1.117
32	.5299	.2808	.8480	.7191	1.474	1.126
33	.5446	.2966	.8387	.7034	1.455	1.134
34	.5592	.3127	.8290	.6872	1.437	1.141
35	.5736	.3290	.8192	.6711	1.419	1.152
36	.5878	.3455	.8090	.6545	1.401	1.162
37	.6018	.3622	.7986	.6378	1.385	1.171
38	.6157	.3791	.7880	.6209	1.368	1.182
39	.6293	.3960	.7771	.6039	1.353	1.192
40	.6428	.4132	.7660	.5868	1.340	1.204
41	.6561	.4305	.7547	.5696	1.322	1.215
42	.6691	.4477	.7431	.5522	1.306	1.227
43	.6820	.4651	.7314	.5349	1.292	1.239
44	.6947	.4826	.7193	.5174	1.278	1.252
45	.7071	.5000	.7071	.5000	1.264	1.264
46	.7193	.5174	.6947	.4826	1.252	1.278
47	.7314	.5349	.6820	.4651	1.239	1.292
48	.7431	.5522	.6691	.4477	1.227	1.306
49	.7547	.5696	.6561	.4305	1.215	1.322
50	.7660	.5868	.6428	.4132	1.204	1.340
51	.7771	.6039	.6293	.3960	1.192	1.353
52	.7880	.6209	.6157	.3791	1.182	1.368
53	.7986	.6378	.6018	.3622	1.171	1.385
54	.8090	.6545	.5878	.3455	1.162	1.401
55	.8192	.6711	.5736	.3290	1.152	1.419
56	.8290	.6872	.5592	.3127	1.141	1.437
57	.8387	.7034	.5446	.2966	1.134	1.455
58	.8480	.7191	.5299	.2808	1.126	1.474
59	.8572	.7348	.5150	.2652	1.117	1.492
60	.8660	.7499	.5000	.2500	1.109	1.510
61	.8746	.7649	.4848	.2350	1.102	1.531
62	.8829	.7795	.4695	.2204	1.094	1.552
63	.8910	.7939	.4540	.2061	1.087	1.572
64	.8988	.8078	.4384	.1922	1.079	1.594
65	.9063	.8214	.4226	.1786	1.074	1.614
66	.9135	.8345	.4067	.1654	1.068	1.635
67	.9205	.8473	.3907	.1526	1.063	1.657
68	.9272	.8597	.3746	.1403	1.057	1.678
69	.9336	.8716	.3584	.1284	1.052	1.700
70	.9397	.8830	.3420	.1170	1.047	1.717

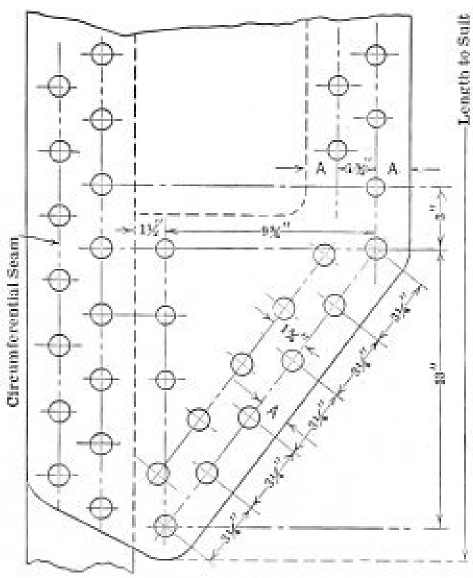
RULE.—To find strength of joint of patch, when at an angle with the longitudinal or circumferential seam multiply strength of corresponding long. seam or patch by factor in table opposite desired angle.

FORMULÆ FOR DETERMINING

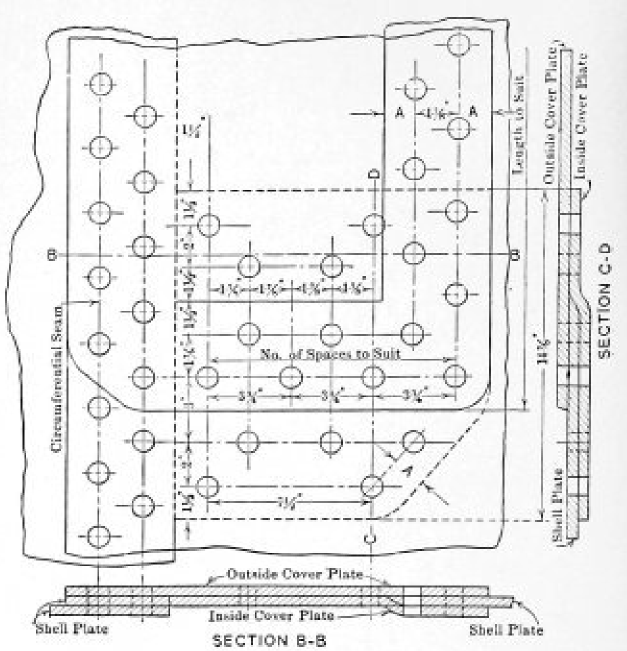
FACTORS $= 2 \div \sqrt{1 + 3 \sin.^2 Y}$ and $2 \div \sqrt{1 + 3 \cos.^2 X}$



Patch No. 9
Opening in Shell 6″ and under



Patch No. 10
Opening in Shell 6″ to 8″ long



Patch No. 11
Opening in Shell 8″ to 24″ long.
Cover Plates same thickness as Shell

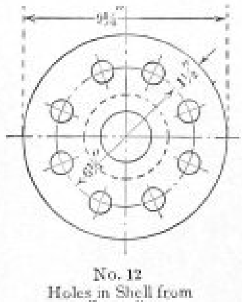
There seems to be a great diversity of opinion on this subject of boiler patches and one which no doubt has received much study during the past few years. From some of the applications which have been made in the past few years it is surprising to know that they have held up under the strains they are subjected to. Of course the margin of safety is about to the limit so far as calculations are concerned, but since the inauguration of the various codes and rules for the government of boilers, a much closer inspection and more rigid examination are given to such matters, and consequently better results are obtained in this regard, and the result is more satisfactory boiler conditions.

As an example for figuring the strength of a patch or a diagonal seam, let us consider a case such as follows:

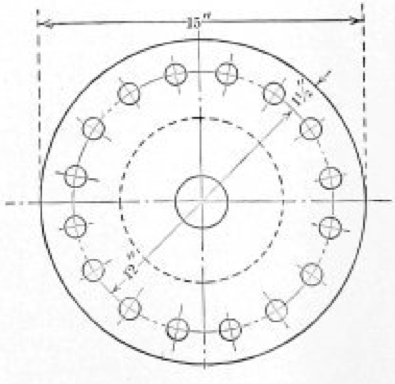
Diameter of boiler..................	70 inches
Boiler pressure......................	205 pounds
Pitch of rivets......................	3¼ inches
Diameter of driven rivet............	15/16 inch
Thickness of plate..................	11/16 inch

Patch applied as represented by Patch No. 4. Crack 12 inches long.

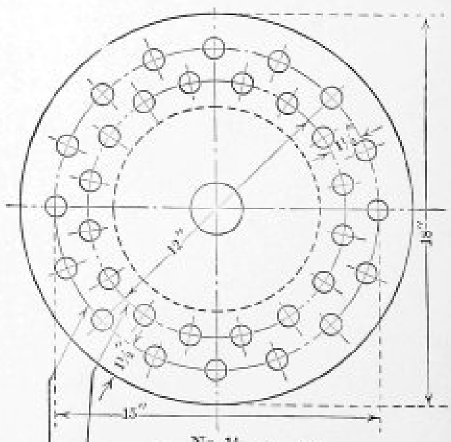
The first step is to consider the angle the patch makes



No. 12
Holes in Shell from 3¼″ to 3¾″ dia.
Holes less than 3¼″ dia. not required to be reinforced.



No. 13
Holes in Shell from 3¾″ to 7½″ dia.



No. 14
Holes in Shell from 7½″ to 9½″ dia.
Inside Row = ¾″ Rivets, 13/16″ Holes
Outside Row—See Table

Reinforcement for Washout Holes in Boiler with either the circumferential or the longitudinal seam. In this case let us consider the angle with the longitudinal seam.

In the right angle triangle shown in Fig. 9 the sides

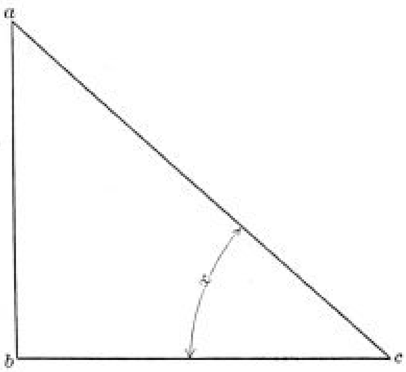


Fig.—9

a-b, b-c, are known, but it is necessary to determine the length of the hypotenuse a-c in order to find the angle X. This is, then, equal to

$$\sqrt{10^2 + 7.5^2}, \text{ or } 12.5,$$

and dividing the side opposite the angle X by the hypotenuse we then obtain the sine of the angle X, or 0.8000. Upon referring to table No. 1 this very nearly corresponds to an angle of 54 degrees, and the corresponding factor is then 1.401. In other words, the patch is 1.401 times as strong when making an angle of 54 degrees as when in a longitudinal direction.

$$\text{The efficiency of the plate} = \frac{3-15/16}{3} = 0.6875,$$

multiplying by the factor 1.401 we obtain $0.6875 \times 1.401 = 96.3$ percent efficiency.

In figuring the shell for the bursting strength:

$$P = \frac{T\,t}{r}\,e$$

where P = bursting pressure,
T = tensile strength of plate,
r = radius of boiler,
e = efficiency of seam or patch,
t = thickness of plate.

$$P = \frac{50{,}000 \times 11/16}{35} \times 0.963 = 945.6 \text{ pounds.}$$

$$\text{Factor of safety} = \frac{945.6}{205} = 4.61$$

so far as tearing plate is concerned.

The next point to consider is the shearing of rivets, or the number of rivets that is necessary to compensate for the 12-inch crack. Strength of solid plate then equals $12 \times 11/16 \times 50{,}000$, or 412,500 pounds. Fifteen 15/16-inch rivets (driven size) at a shearing value of 30,373 pounds per square inch, equals

$$15 \times 30{,}373 = 455{,}595 \text{ pounds.}$$

From this it will be seen that the rivets in shear have a value greater than the solid plate removed, or equivalent to an efficiency of

$$\frac{455{,}595}{412{,}500} = 114.04 \text{ percent.}$$

The bursting pressure in this case would then be equal to

$$\frac{50{,}000 \times 11/16}{35} \times 114.04 = 1119.98$$

Then the factor of safety at a boiler pressure of 205 pounds is equal to

$$\frac{1119.98}{205} = 5.45$$

By using patches represented by the examples covered by this article a factor of safety of four or more will be obtained in each case, as the patches are designed to take care of the worst condition for each thickness of plate.

In the formula for figuring the bursting strength, Table No. 2 will be found convenient for finding the value of the product of Tt or the strength of the plate multiplied by the thickness.

TABLE 2

STRENGTH OF STEEL BOILER PLATES, 1 INCH WIDE

Thickness of Plate.	Tensile Strength		
	50,000	55,000	60,000
1/4	12,500	13,750	15,000
9/32	14,062	15,469	16,895
5/16	15,625	17,188	18,750
11/32	17,187	18,907	20,625
3/8	18,750	20,625	22,500
13/32	20,312	22,344	24,375
7/16	21,875	24,063	26,250
15/32	23,437	25,782	28,125
1/2	25,000	27,500	30,000
17/32	26,562	29,219	31,875
9/16	28,125	30,938	33,750
19/32	29,687	32,657	35,625
5/8	31,250	34,375	37,500
21/32	32,812	36,094	39,375
11/16	34,375	37,813	41,250
23/32	35,937	39,532	43,125
3/4	37,500	41,250	45,000
25/32	39,062	42,969	46,875
13/16	40,625	44,687	48,750
27/32	42,187	46,406	50,625
7/8	43,750	48,125	52,500
29/32	45,312	49,844	54,375
15/16	46,875	51,562	56,250
31/32	48,437	53,281	58,125
1	50,000	55,000	60,000

Thickness of Sheets.	*Diameter of Rivets													Outside Row Only
	Patch No.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1/2"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	7/8"	3/4"	3/4"	3/4"
9/16"	3/4"	3/4"	3/4"	3/4"	7/8"	7/8"	3/4"	3/4"	3/4"	3/4"	7/8"	3/4"	3/4"	7/8"
5/8"	3/4"	3/4"	7/8"	7/8"	7/8"	7/8"	7/8"	3/4"	3/4"	3/4"	7/8"	7/8"	7/8"	7/8"
11/16"	3/4"	3/4"	7/8"	7/8"	15/16"	15/16"	7/8"	3/4"	3/4"	3/4"	15/16"	7/8"	7/8"	15/16"
3/4"	7/8"	7/8"	7/8"	7/8"	15/16"	15/16"	7/8"	7/8"	7/8"	7/8"	1"	15/16"	15/16"	1"
7/8"	7/8"	7/8"	15/16"	15/16"	1"	1"	15/16"	7/8"	7/8"	7/8"	1"	1"	1"	1"

* Diameter of rivet holes to be 1/16 larger than shown in above table.

Thickness of Sheets.		1/2"	9/16"	5/8"	11/16"	3/4"	7/8"
Diameter of Patch Bolts.	Patch No.						
	1	7/8"	7/8"	7/8"	15/16"	15/16"	1"
	2	7/8"	7/8"	7/8"	15/16"	15/16"	1"

In the example given, a tensile strength of 50,000 pounds has been used, as this is the maximum value generally used when authentic record of the plate is not known. The table, however, gives values for 50,000, 55,000 and 60,000 pounds.

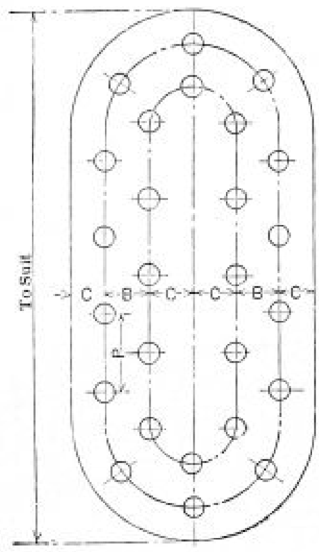
Instructions for Application of Patches

Use patches Nos. 1 to 8 for reinforcing cracks running lengthwise on boiler.

Use patches Nos. 9 to 11 for reinforcing openings in boiler or pitted sheets.

Use patches Nos. 12 to 14 for reinforcing washout holes in boiler.

Use patch No. 15 for reinforcing cracks running circumferentially around boiler. Also when it is necessary



Patch No. 15
Pitch P spacing B and C
Diameter of rivets same as in circumferential seam of boiler

to reinforce shell on account of grooving adjacent the circumferential seams. Dimensions shown at *A* must not be less than 1½ times diameter of rivet hole. Dimensions shown at *B* and *C* to be the same as in the circumferential seam in boiler.

When longitudinal cracks exceed 12 inches in length, single plate patches not to be used. Inside and outside cover plates must be applied with thickness of plates. Size and spacing of rivets the same as in the longitudinal seam of boiler.

Thickness of all single plate patches to be same as shell on which patch is applied. Steel rivets should always be used in applying patches or reinforcements to boilers.

Patch bolts are to be used only in cases of emergency for applying patches Nos. 1 and 2, and when used the material should be mild O. H. steel. Patch bolts should be removed at the first opportunity and replaced with steel rivets.

Small holes should be drilled at the ends of all cracks as indicated on patches, to prevent them from spreading.

When it is necessary to cut out a portion of the shell plate exceeding 24 inches in length, patch No. 11 should not be used. When this limit is exceeded a new course (or half course, according to the condition of the remaining portion of the shell plate) should be applied, using same thickness of plate, diameter and pitch of rivets, and design of seam as in shell of boiler.

Chemical Still Explosion*

The explosion of a still used at a chemical plant resulted some months ago in property damage exceeding $5000. The cause was the accidental blocking of the pipe connected to the pressure relief arrangement, and the subsequent building up of steam pressure in excess of that for which the vessel shell was designed.

As shown in the accompanying diagram, steam was supplied to a chest beneath the still proper at a pressure of about 150 pounds. Steam also was supplied to coils within the still, and through a third connection steam could be introduced to mix directly with the chemicals at such pressures and in such amounts as the operators deemed desirable. Due to the tendency of the chemicals to congeal at room temperature, it was customary, when starting, to admit steam to the shell as well as to the coils and the jacket in order to liquefy all of the still's contents. It was thought by investigators that the safety relief pipe was stopped up by the congealed material in the still at the time of the accident. In any event the safety relief failed to work and pressure built up within the vessel until the head gave away.

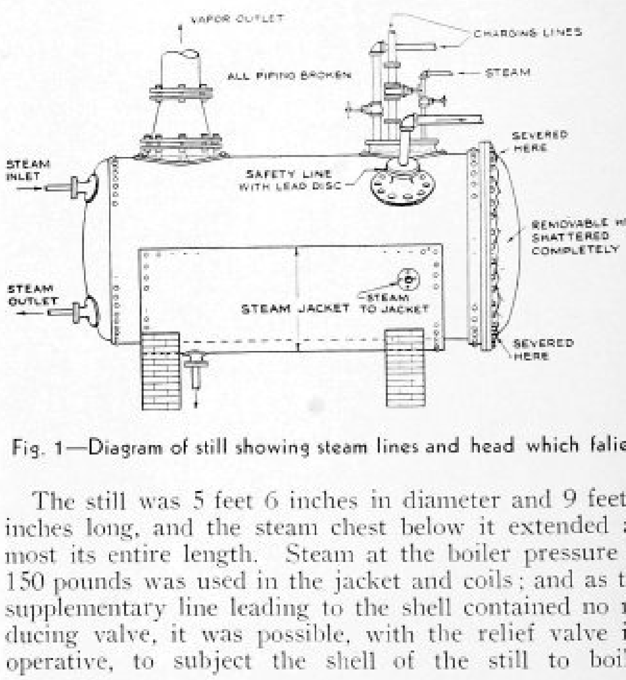


Fig. 1—Diagram of still showing steam lines and head which falied

The still was 5 feet 6 inches in diameter and 9 feet 8 inches long, and the steam chest below it extended almost its entire length. Steam at the boiler pressure of 150 pounds was used in the jacket and coils; and as the supplementary line leading to the shell contained no reducing valve, it was possible, with the relief valve inoperative, to subject the shell of the still to boiler pressure.

The force of the explosion shattered a removable cast iron cover at one end of the still and caused the rest of the vessel to leave its foundation and go hurtling across the plant. The connecting piping, which included a 10-inch diameter vapor pipe, was completely severed and the vessel itself passed through a brick wall where its progress finally was checked by a large storage tank. The parts of the cover were blown through the building, causing considerable damage.

The relief pipe on the still contained a lead disk which was expected to act as a safety valve. It was the opinion of investigators that the chemical mixture had congealed in this pipe as well as elsewhere in the still and had prevented the functioning of the emergency pressure-relieving disk. To minimize the risk of a similar accident in the future, it was deemed advisable that the safety relief pipe be installed near the steam inlet to the

* From *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company.

shell itself in order that steam would enter the still above the contents in such a way that the space under the lead disk would be kept clear. In addition, a safety valve and also a reducing valve set at about 30 pounds were recommended to be installed on the steam line to the still. This would make it less likely that boiler pressure would build up within the shell.

Comparative Study of Alternating and Direct-Current Arc Welding

By J. F. Lincoln*

The advantages and disadvantages of alternating and direct-current arc welding have been a subject of discussion among welding engineers for many years. Because alternating current is so generally used for light and power, some have felt that it should be advantageous to use alternating current welders. Why is it, then, that most arc welding is done with direct-current generator sets and the term "arc welding" as generally used, refers to direct-current arc welding?

The use by a large manufacturer in a welding job at Boulder Dam of alternating current on shielded-arc electrodes, with consequent publicity, has revived to a considerable extent the waning interest in alternating-current arc welding. The fact that under certain conditions with certain types of covering for shielded-arc electrodes, a less porous weld can be obtained with alternating current than with direct current, under the same conditions, has also tended to increase this interest.

A consideration of the fundamentals involved, however, does not indicate that there is going to be any extended use of alternating current for any type of arc welding. The facts involved are the following:

While it is theoretically possible to make a shielded-arc electrode which will work successfully on alternating current, it is not possible, so far as is known at the present time, to make such an electrode with as good results in its operation as is obtained with an electrode which is definitely made for either positive or negative operation. It is evident that if a rod will give better results working either positive or negative to the work, that when it is changed from positive to negative 120 times a second, the results obtained will not be as good as if worked on the proper polarity continuously. Since it is true that the best coatings known for shielded-arc rods will make the rod definitely either a positive or negative electrode, it is evident that operating on alternating current will not give best results.

The feature which has seemingly indicated that alternating current did have advantages over direct current in the arc is the fact that with certain electrodes under the condition of multiple passes in the same weld, less porosity is obtained with alternating current than with the proper single polarity. This is because alternating current will give somewhat less penetration into the metal already deposited than will the proper polarity on the same rod. The weld under these conditions will lose less carbon and manganese because of the less penetration and, therefore, it may have less porosity. If the same rod were used on the reverse polarity to that for which it was designed, less penetration would be obtained than with alternating current. Under these conditions still less tendency toward porosity would be observed although there would be a grave question whether proper uniting of the beads would be accomplished.

The obvious difficulty with alternating-current welding in addition to the one listed above is, of course, that it necessitates a very low power factor current from single phase, thus unbalancing the supply system and probably increasing materially the cost of power, but more important still is the fact that the arc characteristic is not good for the obvious reason that the heat distribution can never be anything else than practically equal between the two electrodes, and that an alternating-current arc characteristic is not nearly as good as a direct-current arc. Because of this, in all cases the designer of the rod must keep in mind first of all that he must overcome this arc operation difficulty, which is an added feature that must be included in his coating before he can design the coating to shield the metal. Since the two objects to be obtained are usually conflicting, he is no more successful in accomplishing his result than was the man written of by the prophet who attempted to serve two masters.

It has been definitely proved that under all conditions of welding better results can be obtained with a proper direct current than can be obtained with any alternating-current arc. The characteristics and results have been sufficiently studied so that the controlling factors are known.

* President, The Lincoln Electric Company, Cleveland.

Vertical Press Type Bending Brake

The Steelweld Machinery Company, Cleveland, manufacturer of all-steel welded bulldozers, bending brakes and similar metal working machines, announces a new design in vertical press type bending brakes, using box-type steel welded housings with deep throat, 18 inches being the standard, with flywheel mounted between the housings.

The manufacturers claim to have developed a bending brake which will not break down due to accidental over-

New bending brake with box-type welded housings load but will stall without damage to the machine. The deep throat not only enables the user to turn up much larger flanges than have hitherto been customary in this type of machine for the entire die length, but it also provides a means of giving the design a certain resiliency. Like the openside planer, it is an ideal jobbing tool. Work much longer than the normal capacity between housings can be handled with ease. Not only are the side sections box housings but the crown is also in the shape of an open box, reducing the height and tying the frame together very substantially.

All sizes are twin-gear driven and the eccentric shafts are solid forged, the eccentric coming immediately above the ball joint. The ball joint is a steel cylinder welded right into the ram, claimed by the manufacturers to be proof against damage. The flywheel is mounted on a type of roller bearing which eliminates danger of seizure should over-heating occur. The clutch and brake are both twin disk and are mounted on opposite sides of the housings to prevent overheating. The flywheel is also so drilled that it air-cools the clutch. The ram can be swiveled so that on a 10-foot machine, taper work up to ¼-inch taper per foot can be done. The ram swivels on the guide and does not cause any cramping action thereon. Only one guide is gibbed laterally to the housing, the opposite guide having clearance to prevent cramping in case the ram is tapered. The bending brake is provided with the customary micrometer dial gage to indicate settings, which has been a feature of all Steelweld brakes.

All bearings except the mains and slides are roller or ball bearings. The tool is designed so that no simple or compound stress in any member shall exceed 7500 pounds to the square inch and no bearings pressure shall exceed 2500 pounds. The tongue slot for bed and ram will be in alinement parallel and straight, within the limit of 0.002 to the inch in either bed or ram. The machine is equipped standard with removable clutch pedal to eliminate danger in re-setting dies and is attachable without the use of wrenches or other tools at a moment's notice at any position in the front of the bed. The raising and lowering mechanism for the ram is located in the back of the ram, out of harm's way. The worms are hardened and ground and running on ball bearings, operating in an all-enclosed case. The worm gears are high grade bronze, as are also the adjusting nuts.

The design is featured throughout with ruggedness for long service and simplicity.

Care and Operation of Unfired Pressure Vessels

By E. R. Fish*

With modern methods of manufacture there has arisen an increased demand for unfired pressure vessels of varying sizes and shapes, some of them subject to great pressure, to attack by acids or caustics, and to wear from stirring devices. The safe operation of such vessels depends on precautions which start at the time the vessel is designed and continue until it is relegated to the scrap heap.

Safe operation often depends upon using materials and methods of fabrication which will permit long life without the exasperation of leakage and other minor failures, not to mention more serious difficulty. Troubles because of improper material and workmanship may be largely avoided by purchasing such vessels from reliable makers.

The various indicating and control devices, with which practically all pressure vessels are provided, must not be neglected. These may include safety, relief, reducing, inlet and outlet valves, and instruments for recording pressures, temperatures, liquid levels, etc. Such devices are for the guidance of the operators who must understand their functions and know how to handle the vessel accordingly. Particularly in the case of the more dangerous processes is this important, for there an increased hazard to life and property is involved.

Deterioration of a once sound vessel may occur because of corrosion, erosion or "fatigue of the metal." Defects may develop and be hidden because of inaccessibility or the presence of rubbish in contact with the vessel. Some processes also lead to objectionable accumulations within the vessel.

Corrosion is most often caused by every-day rusting due to the presence of moisture in rubbish or dirt which may be allowed to accumulate against the vessel. Of course, there is internal corrosion in food packing and chemical processes, but this corrosion is or should be definitely anticipated. It is the unexpected corrosion due to poor housekeeping that is most likely to escape notice. Erosion is caused by internal rotating parts and sometimes by the rapid flow of liquids, especially when charged with suspended solid matter. The inherent dangers to specific vessels from erosion should place their operators on guard. Changes in pressure and temperature which take place many times in the life of a vessel produce weaknesses which are not easily detected by the operators.

Every part of an unfired pressure vessel should be accessible for inspection. Not infrequently parts of vessels are embedded in concrete as a convenient method of support. Because concrete and steel have different coefficients of expansion, space will develop between them and moisture and dirt will collect. Erection close to walls is another handicap to proper inspection of the exterior surface. Obviously the presence of rubbish in contact with such a vessel constitutes a hazard. With relation to accessibility, it is also necessary to provide one or more openings to the interior of the vessel in order to detect corrosion, erosion or the dangerous accumulation of process materials. Sometimes faulty erection results in this opening being obstructed in such a way as to render it useless. Where internal corrosion or erosion is noted, a trained inspector can direct the drilling of "telltale holes" from outside the vessel at points where the most serious weaknesses are suspected. Then, when the vessel has worn sufficiently from the inside it will cause leakage at the "telltale holes"—a signal that the vessel is nearing an unsafe condition. It should be emphasized that persistent leakage, the cause of which is not perfectly obvious and which does not yield to simple methods of repair, should be regarded as almost positive evidence of the presence of serious corrosion or cracks.

It is wise when unfired pressure vessels are required to:

1. See that they are properly designed.
2. Purchase them from reputable manufacturers.
3. Install them so they are accessible and free from deteriorating influences.
4. Entrust their care to competent operators.
5. Have all equipment inspected frequently by competent men.

* From *The Locomotive*, by the chief engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company.

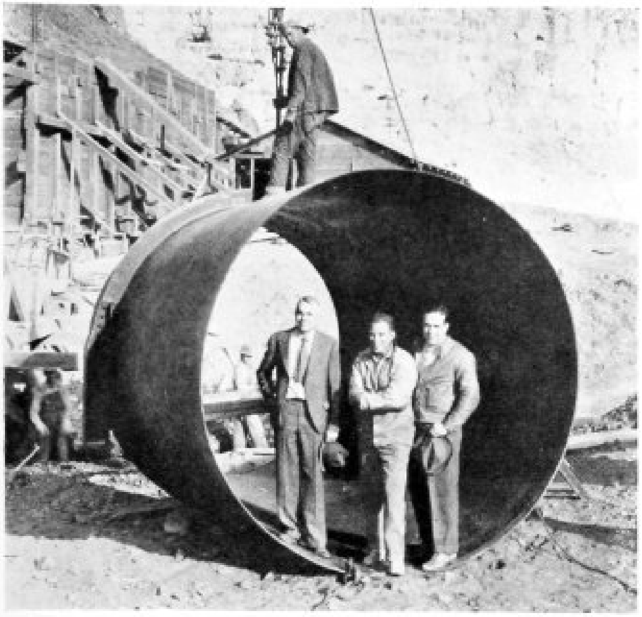


Fig. 1—Nine-foot siphon pipe

Fig. 2—Siphon 10 feet 6 inches in diameter

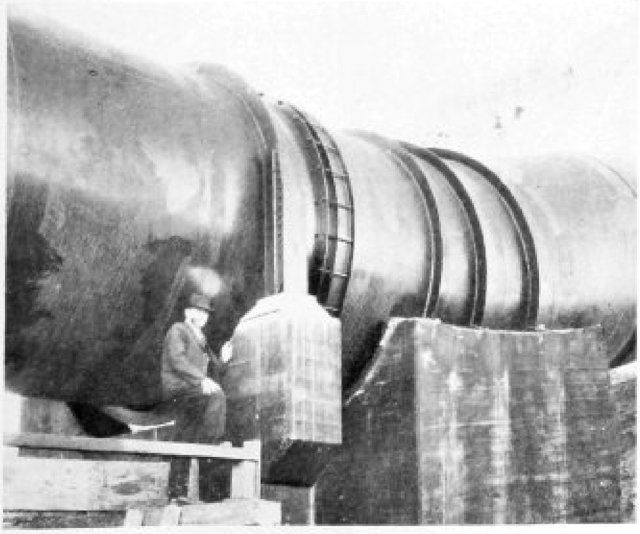


Fig. 3—Testing the Sniveley siphon

Arc Welding used in construction of two huge

SIPHONS

Two huge siphons, one 10 feet 6 inches, the other 9 feet in diameter, are being constructed by arc welding on the Owyhee River in Eastern Oregon for the Bureau of Reclamation. The 9-foot pipe is being welded into one solid tube 1630 feet long. The 10-foot 6-inch section is 900 feet in length. Both are being constructed of pipe and materials furnished by the Federal Government and are a part of the North Canal in the Mitchell Butte diversion of the Owyhee project.

The first pipe to be installed in the Owyhee siphon was placed in the bottom of the Owyhee Canyon June 1, 1934. This section of the project is 700 feet in length and constructed of 9-foot diameter pipe, fabricated from $^{3}/_{16}$-inch steel plate. This pipe is placed in a trench 29 feet deep and will be completely encased in concrete.

After the lower section was welded in place, heavy test heads were welded on each end and the line tested to 200 pounds per square inch for a period of 12 hours. Following this test, the same pressure as that effective when the siphon is placed in use, was held in the line during the time the concrete was being poured and for 10 days afterwards, making a total test period of approximately 30 days. There were no leaks whatever in the field welding of this section.

The field joints on the encased portion of the Owyhee siphon were butt vee type with no backing up strap, while the joints on the exposed section were butt vees with an outside butt strap ⅜ inch thick.

High mid-day temperatures (125 degrees in the shade) caused some difficulty in fitting the joints. In the case of the flat river section, after the string became more than 200 feet in length, it was found that the top of the pipe had a tendency to become longer than the bottom. A method was devised whereby the tops of the sections were secured by tack welding and the bottoms by pull jacks, leaving a gap at the bottom sometimes as much as ¼ inch greater than the top gap. The following morning with the temperature equalized, no trouble was experienced in bringing the pipe flush and tack welding.

The welding was accompanied by a thorough peening with pneumatic tools. Skilled pipe welders were qualified by test. Two-thirds of the joints required staging inside and out due to the steep grades. A total of 13 passes and 41 hours was required for each $^{13}/_{16}$ inch butt vee joint.

A trestle was used for diverting the Owyhee River while the pipe was being laid. After the job is finished, the river will be above the siphon.

At the present time the pipe on the two hillsides of the Owyhee siphon is being installed and is practically completed. The plate used on the hillsides ranges from $^{13}/_{16}$ inch to $^{3}/_{8}$ inch. Fig. 1 gives an idea of the size of the pipe. Just how steep the hillsides are is shown in Fig. 2, where the grade is 88 percent at the steepest point.

The pipe line shown in Fig. 2 is the Sniveley siphon, located about three miles from the Owyhee siphon, and a part of the same canal which goes through the Owyhee project. The pipe used in this part of the job is 10 feet 6 inches in diameter, ranging in thickness from ½ inch to ⅜ inch.

The Sniveley siphon was started just after the lower crossing of the Owyhee siphon had been finished. This siphon is 900 feet in length.

Pipe was delivered in 20-foot lengths and placed by a crane where conditions permitted. On the steep slopes the pipe was slid over the piers on rails.

The pipe is entirely supported on rollers and anchors. The welded joints used in joining the pipe were similar to those used on the exposed portion of the Owyhee section; that is, butt vee with a ⅜-inch butt strap on the outside. Each joint required nine passes and 29 hours welding time.

A test of the Sniveley siphon revealed no leaks whatever in the field welding. Fig. 3 shows part of the Sniveley siphon, including expansion joints and anchors.

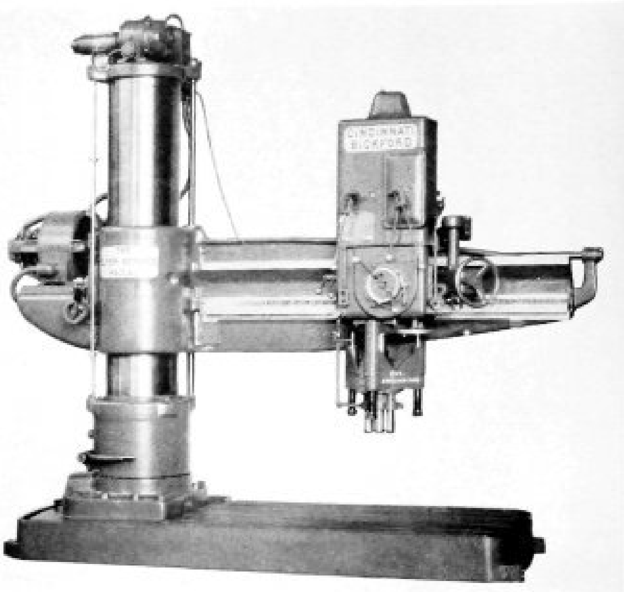
A crew of approximately 25 men and four arc-welding machines handled the placing of the pipe and the field welding on these two projects. The Olson Manufacturing Company, of Boise, Idaho, placed and welded the pipe under the direction of Hanford Haynes, superintendent. Two sizes of electrodes—$^{5}/_{32}$ and $^{3}/_{16}$ inch—were specified by the Bureau of Reclamation. These were supplied by The Lincoln Electric Company, Cleveland. The pipe was furnished by the Chicago Bridge and Iron Works.

Both of these siphons would have been completed in much shorter time had it not been for the fact that the Government decided to stress relieve the field welds. This was done by using an oil-fired portable ring furnace which heated the joint to 1100 degrees, at which temperature it "soaked" for about an hour and then was allowed to cool gradually. Temperatures were recorded by thermo-couples at eight points on the ring.

Multiple-Spindle Drill Heads Used on Radial Drills

Multiple-spindle drill heads for use on radial drills are a recent development of the Cincinnati Bickford Tool Company, Cincinnati, Ohio. A patented self-counterbalancing mounting bracket has been designed which provides rigid support, compensates for the weight of the drill head, and causes its quick return from the work. The multiple head and mounting bracket may be removed in a few minutes, thus quickly converting the machine to a standard single-spindle radial drill.

The illustration shows a 6-foot Cincinnati Bickford "Super Service" radial drill equipped with a fixed center, ball-bearing drill head to carry three 1¼-inch drills spaced on 2¾-inch centers and each spindle having vertical adjustment. Other drill arrangements may be provided as desired, also provision for supplying cutting lubricant to the drills.

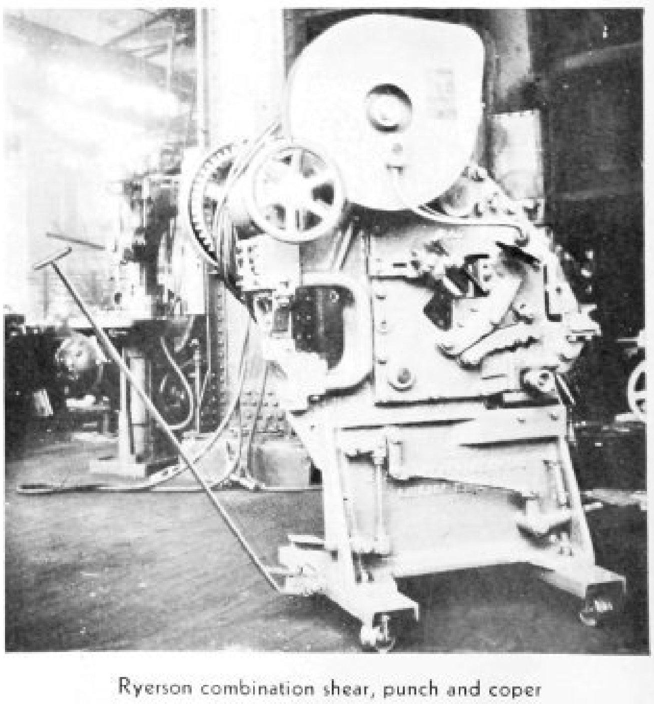


Cincinnati Bickford "Super Service" radial drill with multiple-spindle drill head

The drill head shown has the spindles in line, but other types of drill heads are equally applicable. Bolt circle drilling of several diameters may be handled on a Super Service radial with an adjustable center distance drill head. The use of a multiple-spindle drill head causes no sacrifice in drilling efficiency or in ease of handling.

Portable Combination Shear, Punch and Coper

Ryerson has announced a new full-size, fully portable combination shear, punch and coper which has all the standard features of the cast-steel combination machines which the Ryerson Company has been selling for several years. Better to meet requirements in certain fields, a


Ryerson combination shear, punch and coper

ball-bearing caster and steel channel mounting has been arranged so that the machine can be easily pulled anywhere about the shop. A 50-foot extension cable provides motor connection to most any location. An extension lamp assures proper working light in dark places. The handle for pulling the machine can be quickly connected at either end so that it is not even necessary to turn the machine completely around to run it in the opposite direction.

The frame is a one-piece alloy steel casting with the various attachments built in at the proper working heights. The machine handles punching, plate and bar shearing, angle and tee cutting, angle mitering, coping and notching. Can be furnished in various sizes and capacities. Complete information can be obtained by addressing Joseph T. Ryerson & Son, Inc., Chicago.

Southwark Heavy Duty Plate Planer

The Southwark Division of Baldwin-Southwark Corporation, Philadelphia, which for many years has been the designer and builder of special tools and machinery for shipyards, boiler shops, etc., has just completed a plate planer having several unique features. The machine is arranged to handle heavier plate with a deeper scarf than any built heretofore.

It will plane the edge of a 36-foot long by 4.7-inch thick plate and make an 18-inch scarf or slope on the edge of the plate.

The cutting speed is variable from 15 to 45 feet per minute and cuts are made in both directions of travel of the tool holder. The tool feed is from $\frac{1}{128}$ inch to 1 inch per cut. Maximum vertical adjustment of the tool is 10½ inches and the maximum horizontal adjustment is 24 inches. The drive screw is 7 inches in diameter by 58 feet long, has a quintuple thread and runs in roller bearings. As may well be imagined the cutting of this screw presented problems of no mean size to the shops of Southwark. They were successfully solved and a very fine screw produced.

A 50-horsepower motor drives the machine, all controls being operated from the tool carriage on which the operator rides from end to end of the plate.

Pneumatically operated hold-downs grip and clamp the plate with a load of 120 tons.

Pressure lubrication is used, many wearing surfaces being of hardened steel. Machine and operator are fully protected by safety devices.

This Southwark plate planer is to be used in edge planing and scarfing of plates for some of the new vessels of the United States Navy.

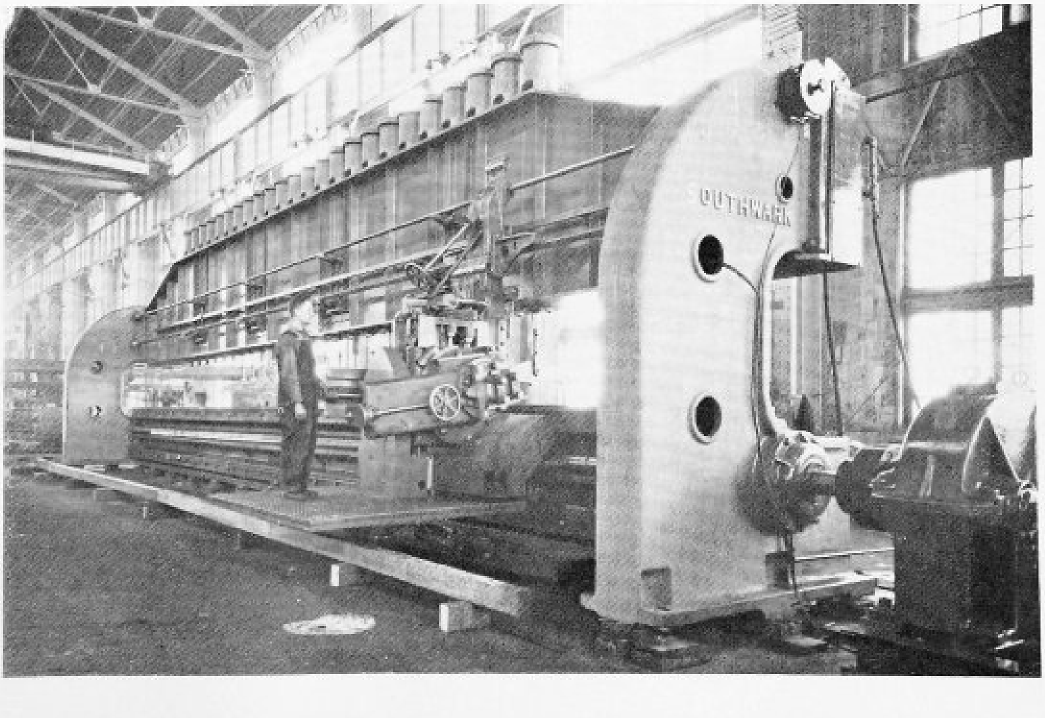
Huron Washout Plugs on Nickel Plate Locomotives

When the description of fifteen new 2-8-4 Nickel Plate locomotives was published in the November issue, information concerning the washout and arch tube plug installation on these engines was not available.

All fifteen of these locomotives were fitted with Huron washout and arch tube plugs and bushings, supplied by the Huron Manufacturing Company, Detroit.

The Huron plug has been installed on the vast majority of all locomotives built in the United States for the past thirteen years, and nearly 90 percent of those under construction and on order at the present time will be so equipped. Huron plugs are being installed on ten Boston & Maine locomotives, five of which are being built by the Baldwin Locomotive Works and five by the Lima Locomotive Works.

Charles H. Reinert, formerly superintendent of the Brooklyn plant of Steel and Tubes, Inc., has become assistant superintendent of the electric weld tube mill of the company at Youngstown, O. M. B. Steel, until recently a sales engineer working out of the Cleveland office of Steel and Tubes, Inc., is now assisting E. T. Glass, sales manager of the New England division, at Boston, Mass.

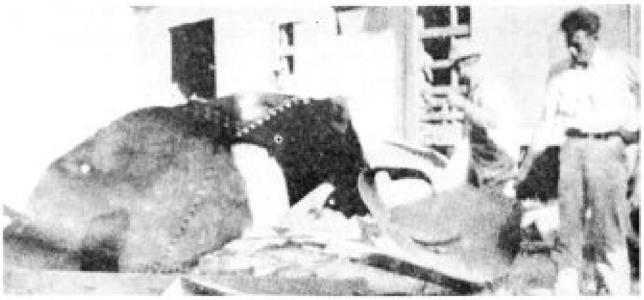


Heavy-duty plate planer for the boiler shop. Capacity of this machine is 36-foot length of 4.7-inch thickness plate

Boiler Explosions Kill Seventeen Persons*

Five accidents during the summer to cotton gin or sawmill boilers brought death to 17 persons, injury to a number of others, and serious damage to property. Two explosions occurred as the operators were preparing to start the season's ginning operations.

The most severe of the accidents occurred at Neal, Ga., in Pike County, on September 7, 1934. Eight men



Above—Middle and rear courses of Neal, Georgia, boiler
Below—Where eight were killed in cotton gin boiler explosion

were killed as they were working around a cotton gin, or were watching the start of work on the 1934 crop. The gin structure was destroyed, and the bodies of two of the victims were hurled several hundred feet. The front tube sheet of the 54-inch horizontal tubular boiler landed 600 feet from its former location and other parts were widely scattered. It was not determined what caused the accident, although it was evident that there was considerable pressure in the boiler when the failure occurred.

A similar scene was enacted in Waltham County, near Gratis, Ga., where two persons, a man and a woman, were scalded by steam when a cotton gin boiler exploded on August 30. They were visiting the gin as the season's operation began.

Three men were killed and seven persons, including two children, were injured when a fire-tube boiler of the stationary locomotive type exploded at a semi-portable sawmill installation in the Allenstown district of New Hampshire on July 3. Fragments of the boiler were found 500 feet from the wrecked mill. The crown sheet collapsed because of overheating.

At a combination sawmill and cotton gin operated at Trotville, N. C., three men were killed on August 14, when the mill building was destroyed by a boiler explosion.

One man met his death and eight were injured on June 29, when a sawmill boiler exploded on Marrowbone Creek near Williamson, W. Va. The man who was killed was crushed beneath the falling walls. Those who were injured were working nearby and all were scalded. Parts of the boiler were hurled through the air and buried in a hillside several hundred feet away.

* From *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company.

New Alternating Current Arc Welder

The Lincoln Electric Company, Cleveland, O., has announced a new alternating-current welder which will be known as the Lincoln "Shield Arc AC." This new welder is of revolutionary design and is of the motor generator type which takes 2-phase or 3-phase alternating current of standard voltages and frequencies and converts it into alternating current of lower voltage and at that higher frequency most suitable for arc welding with either heavily coated or washed electrodes in all positions. This principle, exponents of alternating-current welding say, is an innovation which makes the new type of machine the most commercially practical type.

For this equipment, the manufacturer claims the following advantages over the usual alternating current transformer type of welder:

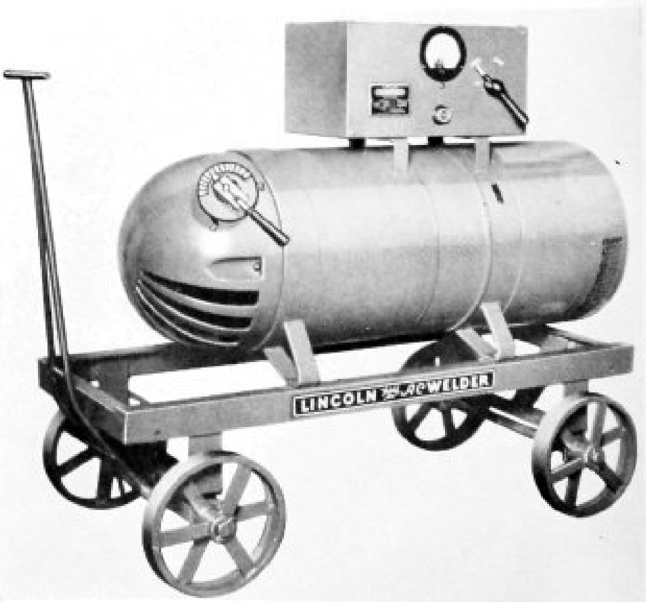
(a) Improved arc characteristics due to the higher frequency such as more stable arc, less magnetic blow, easier starting of arc.

(b) Improved weld metal since there is less spatter loss and in multiple pass welding greater density.

(c) Better power characteristics from the line. Since the machine takes power from all phases instead of from one phase, unbalancing of phases is eliminated and a power factor of approximately double that of the transformer type is obtained.

Since this type of welder draws from the line balanced power at lower amperage and higher power factor, the regulation of the transmission equipment is materially improved over that of the usual transformer type.

The new Shield Arc AC welder is built in portable and stationary alternating-current motor-driven models in two sizes. The smaller capacity machine can be used for continuous welding with electrodes of $^3/_{32}$ inch to



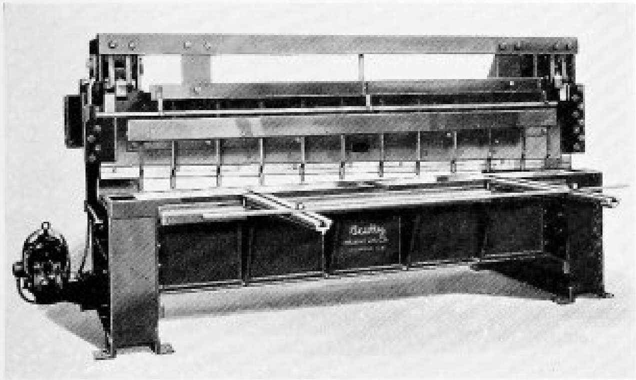
Lincoln alternating-current arc welder

$\frac{5}{16}$ inch in size; the larger capacity welder handles electrodes from $\frac{1}{8}$ inch to $\frac{3}{8}$ inch in size. These machines are wired for 220, 440 or 550 volts, alternating current supply, 2 or 3 phase, 50 and 60 cycles. In appearance, size and weight the Shield Arc AC is almost identical with its companion, the Shield Arc machine for direct-current welding.

The manufacturer also claims that according to actual test the current drawn from the line by this machine is no more than that drawn by the usual direct-current motor generator type and is a fraction of that drawn by the transformer type.

All-Steel Totally Enclosed Shear

An outstanding development in plate shears is announced by the Beatty Machine & Manufacturing Company, of Hammond, Ind. The shear is of all-steel construction with all working parts fully enclosed. In addition to the unique arrangement and complete housing-



Beatty plate shear

in of the working parts, the shear provides instantaneous cutting action at the touch of a button, for single-piece cutting or for continuous cutting. This assures faster cutting since there is no waiting for the flywheel to build up energy and there is no loss of power due to idling motors between operations.

As is seen by the illustration, no flywheel is employed. The simple push-button has also eliminated the use of a foot treadle. Thus safety is an outstanding characteristic. The Beatty type 4-S shear has also eliminated such old-fashioned shear disadvantages, as moving and waving counterweights and noisy clutch. Another feature is the fact that the gap or throat of the shear cannot expand during splitting operations. No vertical deflection is possible inasmuch as all vertical strains are transmitted to the ram and cannot be borne by the throat. In this shear the vertical thrust is taken by a heavy pin and is located behind the gap or throat of the shear instead of directly over it. Transverse deflection is also impossible.

Another advantage is the clear view of the work which the shear affords. Large or small sheets may be sheared within full view of the operator at all times, and an adjustable rear squaring gage is provided with a range of two inches from the blade to any specified width.

Through the use of rolled steel welded construction, together with steel castings and the elimination of delicate working parts, this shear gives the sheet metal working industry an effective means of lowering operating costs and meeting present-day competitive demands. This shear is built in a number of sizes. Complete description, specifications and capacities may be obtained by addressing the Beatty Machine & Manufacturing Company.

Heine Boiler Reorganization Completed

The Heine Boiler Company, St. Louis, which has been in receivership since 1930, has now been reorganized as a subsidiary of Combustion Engineering Company, Inc., New York.

The Heine Company was founded in 1879 by the late Colonel E. D. Meier and rapidly became one of the leading boiler manufacturers. A boiler built in 1882 now forms a part of the permanent exhibit in the Ford Industrial Museum at Dearborn, Michigan.

Subsequent to Colonel Meier's death in 1914 the company continued under the control of his sons until 1927 when it became a manufacturing division of the predecessor of Combustion Engineering Company, Inc. The present plant was built in 1910 and there is now being installed a large stress-relieving furnace which will improve its facilities for doing all classes of fabricated plate work, tanks, vessels, etc., of either riveted or welded construction, in addition to the boiler work. Fred O. Pahmeyer long associated with the Heine Boiler Company will continue, with the title of superintendent.

Ryerson Expands Milwaukee Plant

Ryerson Company is now completing an extension to their Milwaukee plant at 244 S. 19th Street, Milwaukee, which will almost double the former warehousing capacity of this plant.

The plant proper has been extended to almost twice its former length. A section of the old warehouse has been insulated and rebuilt with a new central heating system for the storage of special steels. A new two-story modern brick office building with sound deadening ceiling and other improvements has also been erected.

The new heating system will provide proper distribution of heat to prevent any condensation of atmospheric moisture spoiling the quality and finish of the special sheets, cold finished bars, tool and alloy steels, etc., that are being added in stock. Many new sizes of structurals, bars, plates and heavy sections are also included.

These increased stocks and facilities together with arrangements for overnight shipment of almost any product, in any quantity from the Ryerson Chicago Steel-Service Plant assures the Milwaukee district excellent service on any requirements.

Other Ryerson plants are located at Chicago, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, and Jersey City.

Development and Service Metallurgist Appointed for Lukens Steel Company

Thomas T. Watson, who joined the Metallurgical Department of Lukens Steel Company, Coatesville, Pa., in August, 1931, has been appointed development and service metallurgist. He will be engaged principally in service and sales work in connection with Lukens Nickel-Clad Steel.

Mr. Watson was born in Scotland thirty-five years ago and graduated in 1923 from the Royal Technical College in Glasgow with the degree of Associate of the R. T. C. Until 1925 he was assistant metallurgist at David Colville & Sons, the largest iron and steel manufacturer in Scotland. He then became metallurgist at the Clyde Alloy Steel Company, serving there for two years under Dr. A. McCance, managing director. From 1927 to 1930 he was assistant metallurgist at Dorman Long & Company, one of the largest iron and steel manufacturers in England. He came to this country in 1930 and engaged as a consulting metallurgist in New York until he joined the Lukens organization in 1931.

Simplified Practice Recommendation Covering Steel Horizontal Firebox Heating Boilers

A proposed simplified practice recommendation covering steel horizontal firebox heating boilers has been mailed to all interests in the industry by the division of simplified practice of the National Bureau of Standards for their consideration and written approval.

This recommendation, which was approved at a general conference held in Cleveland, June 5, 1934, lists 19 sizes of boilers ranging from 1800 to 35,000 square feet of steam radiation and from 2880 to 56,000 square feet of water radiation for hand firing. Nineteen ratings are also given for these boilers mechanically fired ranging from 2190 to 42,500 square feet of steam radiation and from 3500 to 68,000 square feet of water radiation. The recommendation also includes heating surface and grate area for each size of boiler. Other information includes furnace volume for oil, gas fired, or bituminous coal stoker fired boilers, together with size of outlets and number and size of safety valves.

The recommendation, if approved by the industry, will be issued as simplified practice recommendation R157 and will be effective from July 1, 1935.

C. E. Davies Appointed Secretary of American Society of Mechanical Engineers

C. E. Davies, since 1931 executive secretary of the American Society of Mechanical Engineers, was appointed national secretary of the society. He succeeds Dr. Calvin W. Rice, whose death in October of this year terminated *27* years of active service as national secretary.

Mr. Davies, a member of the staff of the society since 1920, was born in Utica, N. Y., and received his early education at the Utica Free Academy, from which he was graduated in 1907. In 1910 he entered Rensselaer Polytechnic Institute, Troy, N. Y. He was elected to the honor societies of Tau Beta Pi and Sigma Xi. He received the degree of mechanical engineer from the Institute in 1914.

Mr. Davies began his professional career in the production department of the Smith Premier Works, Syracuse, N. Y., of the Remington Typewriter Company. Here he came in contact with Henry L. Gantt, one of the pioneers in industrial management.

During the war, as first leutenant and later as captain, Mr. Davies served in the Ordnance Department, U. S. Army. At the close of the war, Mr. Davies returned to the Remington Typewriter Company at the works in Ilion, N. Y., and later at the Syracuse works.

In 1920 he became associate editor of the American Society of Mechanical Engineers, and in 1921, managing editor and assistant secretary of the society. Under his supervision were the activities of society administrative committees responsible for the meetings and publications of the society. Mr. Davies was placed in charge of the administration of the headquarters office and in 1931 was appointed executive secretary.

Code Authority Additions for Steel Plate Fabricating Industry

The National Recovery Administration recently announced additions to membership of the Code Authority for the Steel Plate Fabricating Industry as follows: J. H. Brillhart, Fort Worth Structural Steel Company, Fort Worth, Tex., and William S. Wheeler, Pennsylvania Engineering Works, New Castle, Pa., to represent those not members of the Steel Plate Fabricators Association.

New Officers of the American Society of Mechanical Engineers

At the annual meeting of the American Society of Mechanical Engineers held in New York City, December 4 and 5, the following officers were elected for the coming year: President, Ralph E. Flanders, president of Jones & Lamson Machine Company, Springfield, Vt.

Vice-presidents include: James H. Herron, president of the James H. Herron Company, Cleveland, O.; Eugene W. O'Brien, editor of the Southern Power Journal, Atlanta, Ga.; Harry R. Westcott, president of Westcott & Mapes, Inc., consulting engineers and architects, New Haven, Conn.

New managers include: Bennett M. Brigman, dean of the Speed Scientific School of the University of Louisville; Jiles W. Haney, professor of mechanical engineering at the University of Nebraska; Alfred Iddles, vice-president of United Engineers & Constructors, Inc., Philadelphia.

Linde Issues Booklet on Safe Practice for Gas Welding

A new and completely revised edition of "Precautions and Safe Practices" is now being offered by The Linde Air Products Company, 30 East 42nd Street, New York.

Since the original publication of this booklet several years ago, it has come to be accepted as the standard reference work on this important phase of safety in industry, as attested by the thousands of copies that have been distributed. While the subject of safety is well standardized, and therefore subject to but little change, the advances in the oxy-acetylene process itself, and its widening use during recent years, have shown where additional emphasis in safety precautions is needed, and have necessitated some new suggestions. All of this has been incorporated in the new edition of this valuable booklet, to fill the demand for a more up-to-date handbook on this subject. Many provisions in the test have been regrouped to form a more co-ordinated whole, and considerable amplification of ideas can be noted throughout.

Everyone responsible in any way for the storage, care or handling of oxy-acetylene welding and cutting equipment should have a copy of this booklet for careful study and constant reference. All those having copies of the previous edition should provide themselves with the revised edition to become familiar with the new recommendations.

Boiler Maker and Plate Fabricator

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

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Code Authority Members for Steel Tubular and Firebox Boiler Industry

The National Recovery Administration has announced he following Code Authority members for the steel ubular and firebox boiler manufacturing industry:

C. N. Tull, Spencer Heater Company, Williamsport, Pa., Homer Addams, Fitzgibbons Boiler Company, New York City; J. R. Collette, Pacific Steel Boiler Corporation, Detroit, Mich.; C. L. Crouse, National Radiator Corporation, Johnstown, Pa.; R. B. Dixon, Kewannee Boiler Corporation, Kewannee, Ill.; J. T. Dillon, Jr., Titusville Iron Works, Titusville, Pa.; J. F. Johnston, Johnston Brothers, Inc., Ferrysburg, Mich.; F. B. Metcalf, International Boiler Works, East Stroudsburg, Pa.; and J. Harry Stiteler, Orr & Sembower, Reading, Pa.

Trade Publications

Centrifugal Blast Cleaning Machine.—A folder describing a new centrifugal blast cleaning machine, which cleans various size and shape castings without the use of compressed air has been issued by the Pangborn Corporation, Hagerstown, Md.

Electric Drills.—A recent circular entitled, "A Step Ahead in the Design of High Frequency Electric Portable Tools," describes a new Hercules high frequency electric drill. Hercules products are manufactured by the Buckeye Portable Tool Company, Dayton.

Abrasives.—The history and development of abrasives as used in all industries have been made the subject matter of a booklet issued by the Norton Company, Worcester, Mass. The physical characteristics of all types of modern abrasives are included.

Alloy-Steel Boiler Plate.—Specifications for chrome-manganese silicon alloy steel boiler plate are given in the reprint from the 1934 addenda to Material Specifications Section, A.S.M.E. Boiler Construction Code, being issued by the Lukens Steel Company, Coatesville, Pa.

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.

Sheet Iron.—The fifth edition of "Sheet Iron—A Primer," issued by the Republic Steel Corporation, Massillon, O., contains 64 illustrated pages, which tell, in simple, non-technical language, the step-by-step story of modern manufacture of sheet iron. Production is traced from the ore mine to the final inspection of the completed sheet. The booklet also contains gage tables and a glossary of metallurgical terms.

Chrome Manganese Silicon Alloy Boiler Plate.—Specifications covering chrome manganese silicon alloy steel boiler plate, reprinted from the 1934 addenda to the Material Specification Section of the American Society of Mechanical Engineers Boiler Construction Code have recently been issued by the Lukens Steel Company, Coatesville. This specification covers the material marketed under the trade name of Lukens' Cromansil steel.

Robertson Protected Metal.—The H. H. Robertson Company, Pittsburgh, has issued a new copper covered protected metal which is described in a folder issued by the company. This new product is in addition to the standard line of Robertson protected metals. The feature of the product is the addition of a durable Anaconda electro-sheet copper on the outside. This is a relatively new product which the American Brass Company is introducing to the market.

Accounting Policies.—The Policyholders Service Bureau of the Metropolitan Life Insurance Company, New York, has recently completed a survey of the accounting policies of 34 prominent companies with reference to inter-company sales and transfers. The findings are presented in a report entitled "Accounting Policies in Inter-Company Sales and Transfers" which gives a detailed account of the practices of each of six of the 34 companies mentioned, as well as a brief tabular resumé of the basic policies of all the companies.

Questions and Answers Pertaining to Boilers

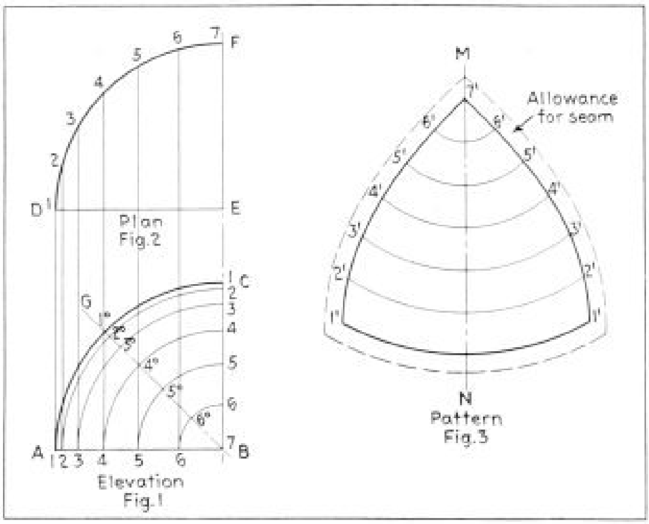
This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor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

By George M. Davies

Laying Out a Quarter Sphere

Q.—I would like to have a copy of the "Diagram of Method of Designing Diagonal Patch." Which is the best way to lay out approximately a quarter of sphere 30-inch radius, steel ½ inch? I know I cannot do that exactly, but I would like to know approximately the dimensions of the plate required for this work. J. E. R.

A.—The note "additional copies will be sent on request," on the Diagram of Method of Designing Diagonal Patches on Return Tubular Boilers, in the September issue, was copied from the original plate as found in the California Boiler Code; additional copies can be obtained



Approximate development of quarter sphere

by writing the Industrial Accident Commission, State of California, Department of Industrial Relations, State Building, San Francisco, California.

The development of a quarter sphere, as outlined in the question, can only be approximate as the surface of a sphere or any other arched construction has a double curvature.

To make an approximate development of a quarter sphere, lay out the elevation and plan views as shown in Figs. 1 and 2. This work is laid off to the neutral layer of the metal. By working to the neutral layer of the plate no further allowances are necessary for the forming process.

First divide the arc *D-F* of the plan into any number of equal parts, the greater the number of equal parts taken the more accurate the final development, six being taken in this case. Number the points from *1* to *7* as shown.

Draw lines parallel to *F-B* through the points *1* to *7* of the plan, extending them into the elevation, cutting the line *A-B*. Number these points from *1* to *7* corresponding to the points in the plan view.

Next with *7* as a center, Fig. 1, and with the distance *7-6* on the line *A-B* as a radius scribe the arc *6-6* as shown; in the same manner draw the arcs *5-5*, *4-4*, *3-3*, *2-2*, then draw *B-G* which bisects the angle *A-B-C*.

To construct the pattern draw the center line *M-N* and with any point on *M-N* as *7'* as a center, and with the trams set equal to *7-6* (measured on the arc) of the plan view scribe an arc, then with *7'* as a center and with the trams set equal to *7-5* of the plan scribe an arc, and in like manner scribe arcs using *7-4*, *7-3*, *7-2*, *7-1* of the plan as radii.

On the first arc drawn step off each side of the center line *M-N* a distance equal to *6-6°* of the elevation, locating the points *6'-6'* of the pattern. On the second arc step off each side of the center line *M-N* a distance equal to *5-5°* of the elevation, locating the points *5'-5'* of the pattern. Continue in this manner locating the points *4'-4'*, *3'-3'*, *2'-2'* and *1'-1'*, completing the pattern.

Combustion Chamber Fireboxes

Q.—As a 10 years subscriber to The Boiler Maker, I would esteem it a great favor if you would help me over a slight difficulty. A number of Mikado and Pacific-type locomotives are operating in North China, built by the American Locomotive Company. These locomotives are equipped with boilers having combustion chamber fireboxes. Many fireboxes have had to be renewed here and flanging had to be done by hand, as we had no suitable flanging blocks. (We have a hydraulic flanger.)

Our chief difficulty was:

1. Rolling the wrapper plate.
2. Laying out and fabricating the throat sheet.

Are there special rolls or an attachment to the horizontal rolls for rolling these wrappers?

What sort of flanging block is used for the throat sheet?

Can you supply a sketch and also give method of layout?

Have found many helpful articles in The Boiler Maker, so I hope you will now be able to assist me solve the above problems.

We have all Chinese boiler makers, who can soon grasp our western methods. F. T.

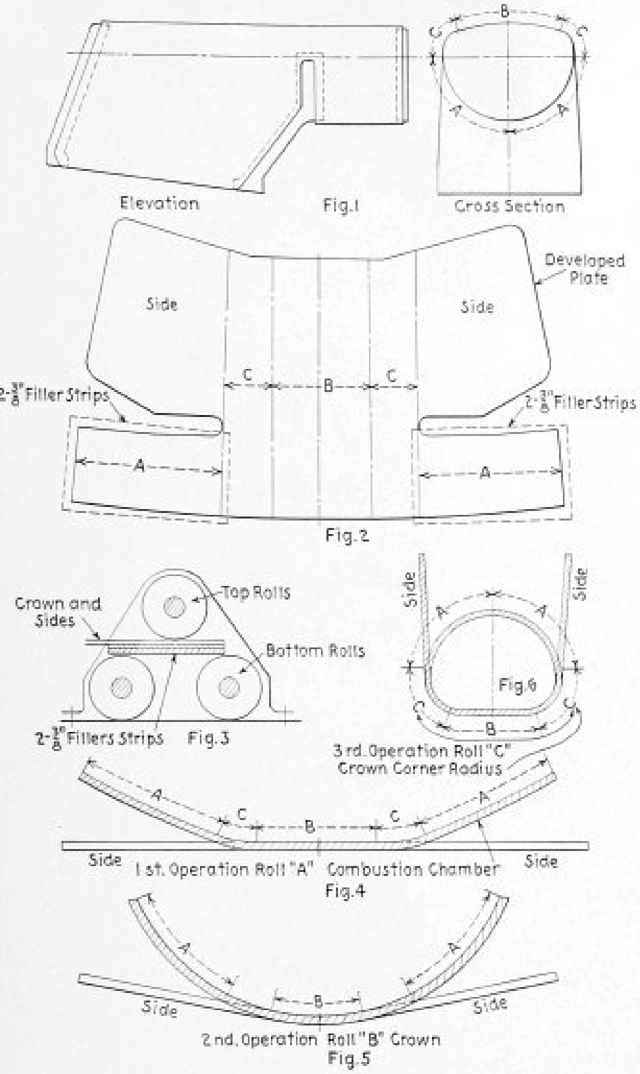
A.—The following method is used in rolling the crown and sides of fireboxes having combustion chambers:

Fig. 1 illustrates the elevation and cross-section of a typical combustion chamber firebox.

Fig. 2 shows the crown and sides in the flat ready to roll; the dotted lines in *A* show filler plates under the plate at *A*.

Fig. 3 illustrates the position of the plate in the rolls.

To fabricate the plate, place it in the rolls as illustrated in Fig. 3, and bend section *A-A*, Fig. 4, to the same radius as *A-a* in cross-section Fig. 1. This is done with the use of filler strips as illustrated in Figs. 2 and 3. The filler strips are generally ⅜ inch thick and a



Figs. 1–6.—Method of rolling crown and side sheets

sufficient number used so that the crown and sides will pass freely through the rollers, the filler strips and combustion chamber portion being rolled to the desired diameter.

Next, bend *B*, Fig. 5, to the radius of the top of the crown *B* in cross-section, Fig. 1; then bend both top corners *C-C*, cross-section Fig. 1, completing the job.

Laying Out a Throat Sheet

The method of laying out a throat sheet of a locomotive boiler is shown diagrammatically in Figs. 7, 8, 9 and 10.

Fig. 7 shows a flanged throat sheet and Fig. 8 a developed throat plate. These two diagram figures give all the necessary information for determining the outline and allowances for wide firebox sloping, inside and outside throat sheets.

Figs. 9 and 10 give similar information for narrow firebox boilers with straight throat sheets.

The brace or tie piece shown across the top of the throat sheet development, Fig. 8, is necessary to keep the plate from drawing together at the top, when the plunger die performs the second operation in pushing down the front flange of the plate. The back flange is the first operation.

When a one-operation die is used for flanging a wide firebox throat sheet the tie piece is not required.

Flanging Throat Sheets

Fig. 11 is a typical throat sheet die used in flanging these sheets. The die consists of a male die, a female die, a plunger, and a tie clamp. This type of die flanges throat sheets in a single heat with two operations.

The female die is bolted to removable leg supports on the lower table; the heavy plunger die is bolted to a support from the top ram, while the male die and tie clamp are bolted to removable legs on the top table.

The cold developed plate is laid on the die to determine the correct flanging position.

Due to throat sheets having the center portion cut out,

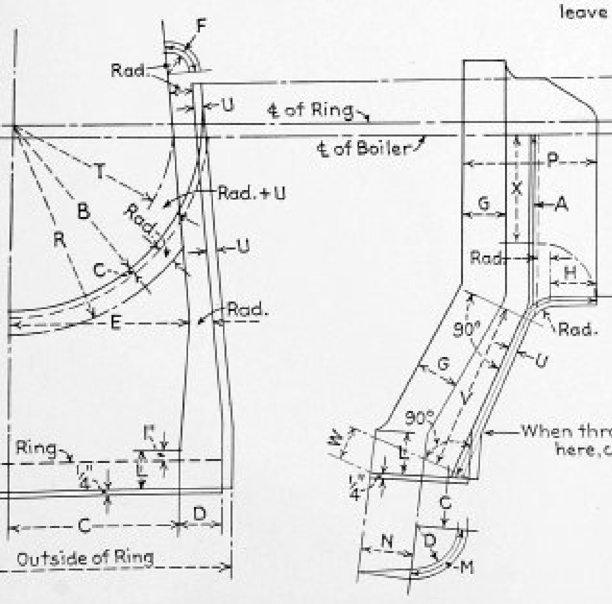


Fig. 7.—Flanged plate

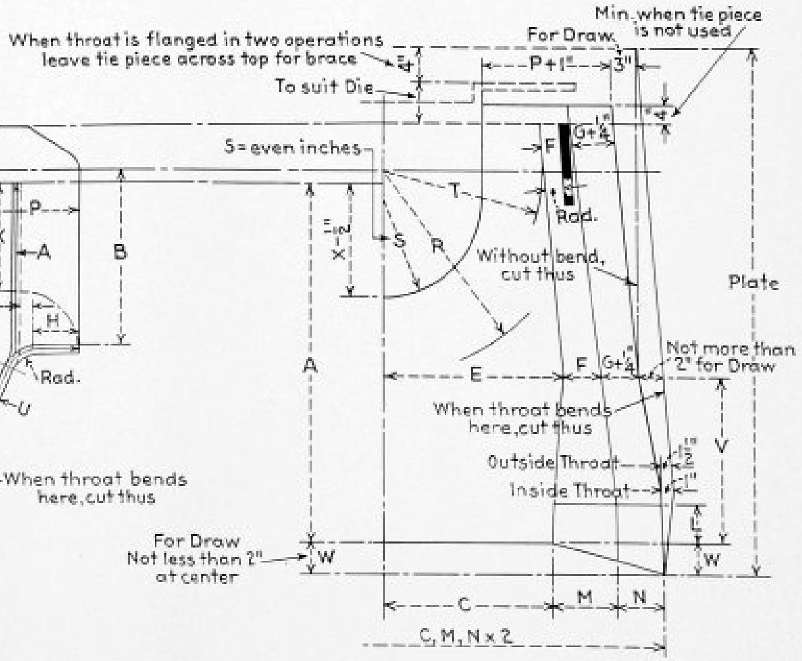


Fig. 8.—Developed plate

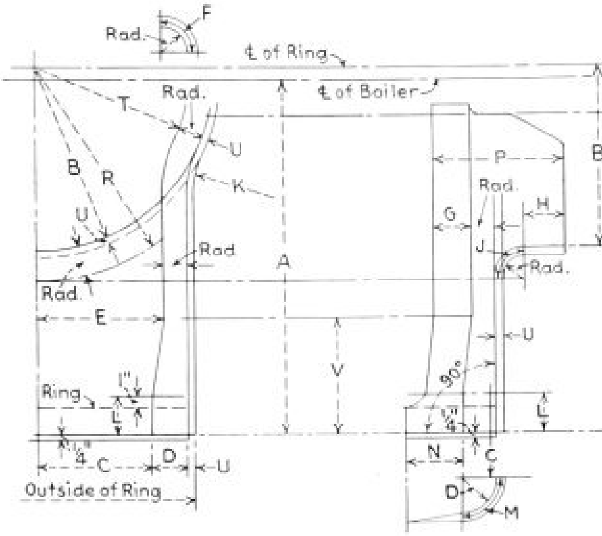


Fig. 9.—Flanged plate

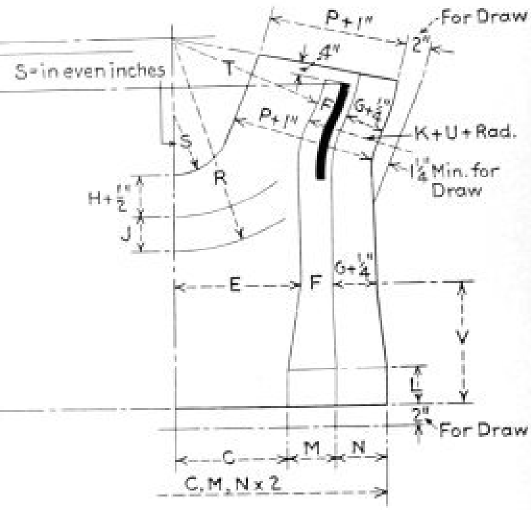


Fig. 10.—Developed plate

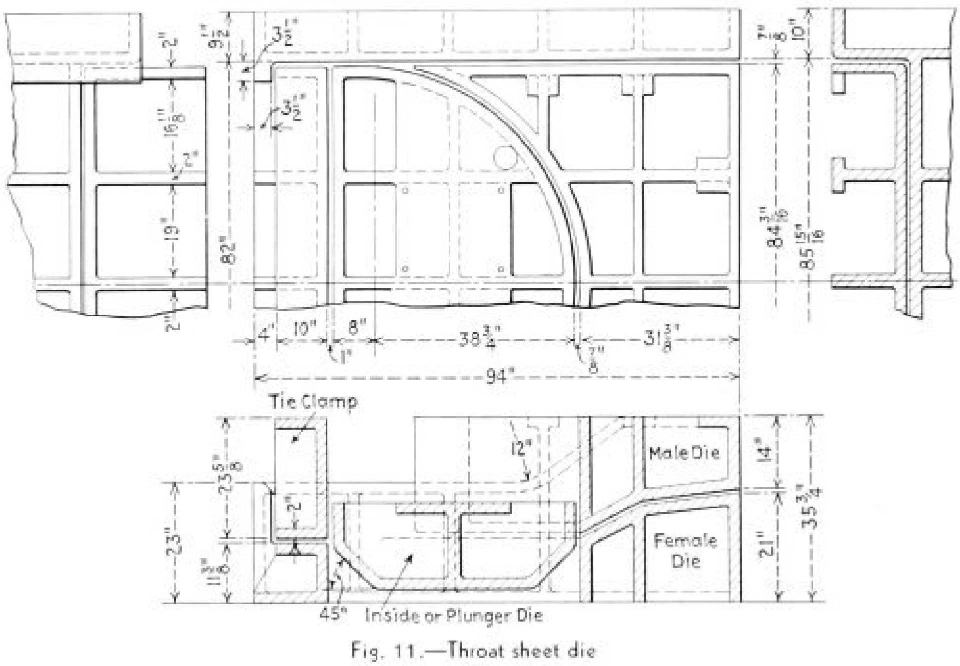


Fig. 11.—Throat sheet die

which will permit a better circulation of heat about the plates, two or three of these plates may be put in the furnace at one time, providing the size of the plates does not make the load too great to draw from the furnace. However, as the top outer part of the wings is not flanged, this portion has to be kept from getting too hot by placing a piece of plate over these portions.

The hot plate is placed on the female die and lined up with the soap stone guide marks previously made on the die. The back or side flanges are now formed by raising the lower table to bring the female die, the plate, the male die and tie clamp die together. The dies are held intact. The top ram is now lowered with the plunger die, turning the throat or front flange. The lip on the tie piece, which acts as a guide for the plunger, is also turned in this operation.

The tie piece serves to keep the wings on top of the throat sheet from drawing down out of shape.

The dies are now separated for a few minutes to allow examination of the flange and also to permit the plate to contract, cooling a little.

In removing the flange sheet from the die, the table is again raised and the plunger die lowered below the bottom surface of the plate. Bars are held on top of the plunger to strike the edges of the wings of the sheet when the plunger is raised and the table lowered simultaneously. The power thus applied, of course, draws the sheet out of the female die.

The flanged sheet is first wheeled and otherwise gaged and measured for size, after which it is placed on an open blast coke and bituminous coal fire. The side flanges are first made correct; retaining the tie piece serves to facilitate this operation, after which the plate is allowed to cool and the tie piece removed with a burning torch.

The throat flange and the lower offset leg of the throat are next corrected. Flat bar templates, shaped to the inside of the sheet, are made for the center and the side shape of the offset. The radius of the throat flange is also checked, with a thin metal template. The straightening work is done by pounding the flanges with mauls, flattening tools and sledge hammers on a surface block, completing the job.

N. J. Clarke, vice-president in charge of sales, Republic Steel Corporation, Youngstown, O., has announced the appointment of Steel Products Company, McKees Rocks, Pa., as warehouse distributors of Republic's Toncan Iron sheets in the Pittsburgh area. Appointment of three new warehouse distributors of Enduro Stainless Steel was also announced by Mr. Clarke. The new distributors are: Buhl Sons Company, Detroit, Mich.; F. W. Heitmann Company, Houston, Tex.; and The Woodward Company, Albany, N. Y.

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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

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Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
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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	Missouri	Pennsylvania
California	New Jersey	Rhode Island
Delaware	New York	Utah
Indiana	Ohio	Washington
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	Michigan

Cities

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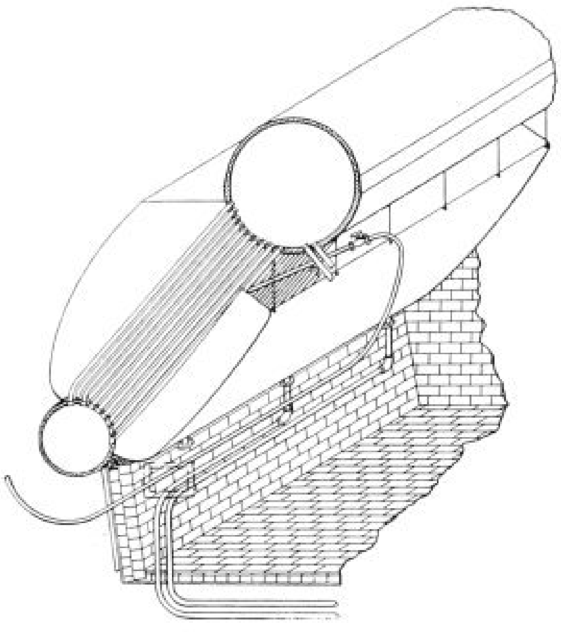
Kansas City, Mo.	Philadelphia, Pa.	Tampa, Fla.
	Parkersburg, W. Va.	

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.

1,815,993. APPARATUS FOR CLEANING BOILERS. BERIAH M. THOMPSON, OF CHEYENNE, WYOMING.

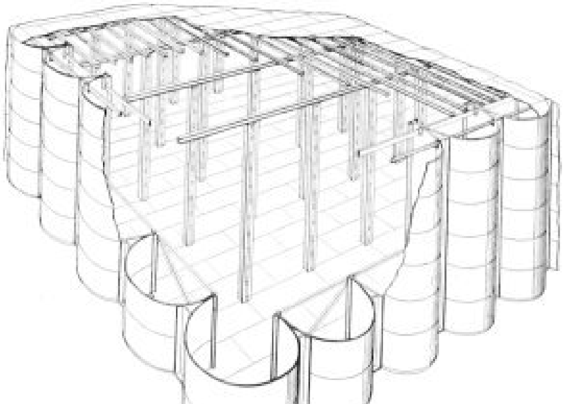
Claim.—In a boiler cleaning apparatus, the combination of a boiler having tubes subject to accumulation of combustion deposit, a metallic



member, a flexible shield secured to said member and means for mounting the shield and said member below the tubes of a boiler, and means for passing within the boiler and applying to said deposit a fluid. Twenty-two claims.

1,864,931. TANK CONSTRUCTION. CLIFFORD M. PRITCHARD, OF TULSA, OKLAHOMA.

Claim.—A tank having straight opposed walls, each wall comprising a series of connected substantially-vertical elements having a curvature



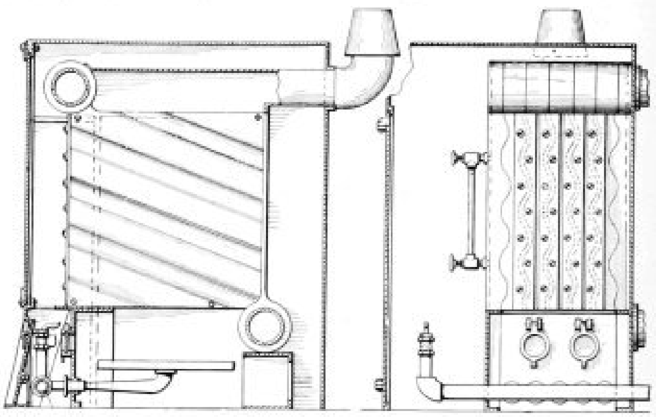
in horizontal cross section sufficient to impart to the element a substantial amount of transverse rigidity, and tie means operatively interposed between and across the tops of said walls, the curved form of the vertical elements combining with the cross top tie to brace the tank as a whole. Four claims.

1,864,600. METHOD OF FORMING WALL PLATE STRUCTURES FOR FURNACES. HUGH C. LORD, OF ERIE, PENNSYLVANIA, ASSIGNOR TO ERIE CITY IRON WORKS, OF ERIE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

Claim.—The method of making furnace walls of metal plate, which consists in forming on a main plate a top and depending sides; forming a flue sheet by shaping the same with its lower edge conforming to the rear end of the top of the main sheet, and bending the ends of the flue sheet rearwardly to provide sides for a return projection of the furnace chamber, bringing the lower edges of the bent ends into joining relation with the sides of the main sheet; forming a rear plate by shaping a rear plate to conform to the rear edges of the furnace sides, bending said rear plate forwardly to conform to the upper edges of the rearwardly bent portions of the flue sheet and shaping the forward edge of said forwardly bent portion to conform to the upper edge of the flue sheet; assembling the sheets by joining the bottom edge of the flue sheet and the lower edges of the rearwardly bent ends with the rear end and sides of the main sheet, and the rear plate with the rear ends of the sides of the main sheet, the top edges of the rearwardly bent ends of the flue sheet and the top edge of the flue sheet; and welding the plates along the joined edges. Three claims.

1,863,476. BOILER. GEORGE WILLIAM FRANZHEIM, OF CLEVELAND, OHIO.

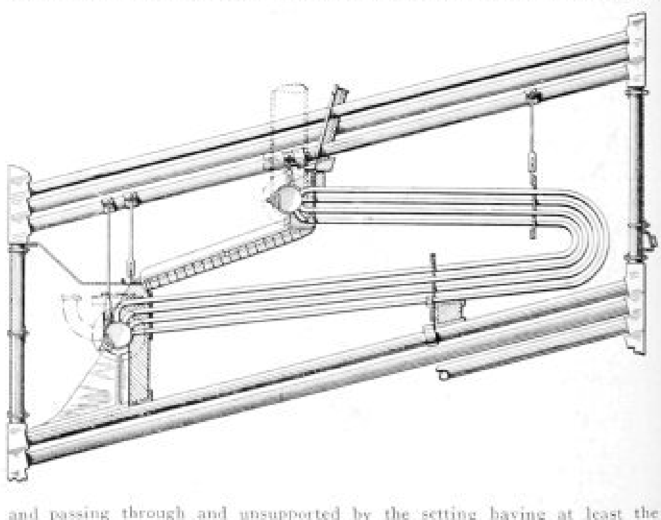
Claim.—The combination with a boiler having flues, a burner thereunder, means for conducting products of combustion from the boiler flues, and a jacket extending over the boiler having an inlet at one end, said



jacket constituting means for conducting fresh air to the burner, of a rotatable valve for controlling the flow of fuel to the burner, a tiltable damper in the inlet of the jacket normally held open by gravity, and means rotatable with the valve for engaging the damper when the valve is closed to close the damper, said damper being movable to closed position independently of the valve. Three claims.

1,863,055. SUPERHEATER BOILER. HOWARD J. KERR, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim.—A steam boiler and its setting having banks of water tubes connected to water chambers with a space between the banks, and a tubular superheater including headers extending transversely between said banks



and passing through and unsupported by the setting having at least the major portion of its tubular heating surface within said space, said superheater being supported solely on locally adjacent parts of the boiler. Fifteen claims.