THE BOILER MAKER

VOLUME XXX

JANUARY TO DECEMBER, 1930

PUBLISHED BY

SIMMONS-BOARDMAN PUBLISHING COMPANY

30 Church Street, New York, N. Y., U. S. A.

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The Boiler Maker

Name registered U. S. Patent Office

Volume XXX **January, 1930** **Number 1**

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

Chicago: 105 West Adams St. Cleveland: Terminal Tower
Washington: 17th and H. Sts., N. W.
San Francisco: 215 Market St.

H. H. BROWN, Editor
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WARNER LUMBARD, Associate Editor

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

Request for change of address should reach us on or before the first day 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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Boiler Failures

STATISTICS in themselves make dull reading but, when they constitute a record of improvement in operating conditions such as that shown in the annual report of the Chief Inspector of the Bureau of Locomotive Inspection, they become of vital interest.

One short paragraph of the report devoted to boiler explosions gives a striking picture of what the boiler makers and the inspectors have done in the past few years to lessen the number of failures and, in so doing, to bring about a decrease in the deaths and injuries that result from them. The report notes a decrease of 18 percent in the number of boiler failures as compared with 1928; a decrease of 35 percent in the number of persons killed, and 15 percent in the number of persons injured. As compared with 1923 the records show a decrease of 68 percent in the number of such accidents; 68 percent in the number of persons killed and 74 percent in the number of persons injured.

Since 1923 the steady improvement in inspection and maintenance of locomotive boilers has brought the fatalities lower each year and earnest effort on the part of all concerned will continue this good work in 1930.

A Friendly Chat

MANY times, sitting at a desk far removed from the atmosphere of the shop, grinding out material for THE BOILER MAKER, we wonder just what our readers think of us, and whether or not our stuff is getting across. Then again, when we have the chance to talk with you personally at the Master Boiler Makers' convention or in the shop when we are out gathering material, everyone seems to be greatly interested and willing to help the game along. In the course of the year, however, it is possible to meet only comparatively few of our readers, so from time to time it will be our purpose to use the editorial columns to get a message over to you.

The fundamental purpose of this magazine is to keep the men in the shops informed of new developments in boiler work and how they can best do any given job. If what is published does not accomplish this purpose, then you, as readers, should feel perfectly free to register a kick. If there are special subjects that you would like to see discussed, tell us about them. Other readers have done so, and we have been able to give them exactly what they wanted. If there is a problem on boiler or plate work of almost any kind that you have difficulty in solving, the Questions and Answers Department is a good place to have it worked out. Here again, men from all over the country and, in fact, from the far corners of the globe have used the service of this department to their own advantage. On the next page is an announcement of a new feature to be carried on in the magazine. Read it carefully and then write to us, giving your experience in repairing boiler cracks.

Think this over—

IN the November issue we published a letter requesting information on staybolt practice. The questions asked were too general in character to be dealt with in our regular Questions and Answers Department, and so our readers were invited to write to us giving their experience with the staybolt maintenance problem. In the December and now in this issue a number of letters explaining various phases of this subject from our readers have been published. The immediate response to this particular inquiry, and to others that have been published in the past, has led us to the conclusion that readers of THE BOILER MAKER would welcome an opportunity to discuss in our pages some of the practical boiler construction or maintenance problems which they have solved successfully.

To this end, we are publishing on this page a question that opens a broad field for discussion with an invitation to those who read the magazine, and to all others interested, but who may not be readers, to write to us on one or all of the questions asked giving their individual experiences on the repairing of cracks and patching of boilers. This is not in any way a contest — there are no rules, nor special requirements, except that the details given be accurate and that sketches be drawn so that they can be understood by our drafting department, which will prepare them for reproduction as illustrations.

What we are interested in receiving are the facts; so all that is necessary is to put these facts down as you would explain them to some visitor from another shop or to a man new on the job. We will do the rest in the office. If the story needs a little smoothing out, that will be our part of the job. The main thing is to tell us the story and in doing so you will help along the cause of better boiler work everywhere.

There is no one who will not admit the value of the exchange of ideas at conventions of the Master Boiler Makers' Association. Only a limited and favored few can take part in discussion at its meetings. What we are trying to do is to get everyone handling boiler work interested in this plan of interchanging ideas. If you are an apprentice instructor, here is an excellent opportunity for the boys under you to explain repair jobs as they see them. Make the writing of discussions of such work a special assignment for them and those turning in the best descriptions can have the satisfaction of seeing their own work in print. We want all foremen who can find time to discuss this question of boiler repairs to tell us how they do the work exactly as they would at the Master Boiler Makers' convention. Further, we solicit their co-operation in interesting the men in writing down what they know of the subject. And the men themselves can gain a tremendous advantage and a better understanding of their jobs, and, at the same time, receive a cash return for their effort, if they will put what they know in writing.

The length of the letter is immaterial. A short one, explaining some special job, or one covering the whole subject will be equally acceptable. Another way you can help is to send in questions of a general character that you would like to see discussed. Such questions should be on boiler practice where there are many ways of doing the same thing. Questions of detail and specific jobs will be handled in the regular Questions Department.

If the interest shown in this new feature of THE BOILER MAKER is sufficient as measured by the letters we receive, it will be continued regularly. It is our hope that a great many good ideas will be sent to us and that by their publication men all over the country doing boiler work will be able to do their job a little better, a little faster or a little easier.

How Do You Repair Boiler Cracks?

What has been your experience in patching cracks in the barrel of a locomotive boiler; in the firebox sheets; crown sheet; throat sheet; door sheet; roof sheet or dome?

In the stationary and marine fields, how have you handled repairs to cracks in boiler shells or sheets?

These practical questions come up every day in every shop and there are many different methods used to solve them. Our readers are invited to describe in detail the methods which they find successful in laying out and fitting up patches of all kinds and to illustrate them with sketches or photographs.

Such letters will be published as received if found to be accurate and will be paid for at our regular rates.

Communications

Enlarged Staybolt Holes

To the Editor:

In your November issue under the heading of communications I note an article from one of the readers in Canada in regard to enlarged staybolt holes.

I am at present employed by a large logging company in Washington and when I took charge of the present job, I had the same trouble to contend with. I overcame all this by countersinking all staybolt holes over 1⅛ inch in diameter on both outside shell and firebox side of the boiler, and by building up the holes with both the arc welding and acetylene processes and have found both highly satisfactory.

In countersinking holes be sure and get to the bottom of the hole as this insures a thread in the hole of the original thickness. In the arc-welding process I use a bobbing tool all around the weld and never have any pin holes, and in the acetylene process I smooth off the weld with the torch. In this manner I have reduced the staybolt stock to three sizes: i.e., 1 inch, 1$\frac{1}{16}$ inches, and 1⅛ inches, where previously we had to keep stock on hand up to 1⅜ inches.

Elma, Washington. C. A. May.

Staybolt Practice

To the Editor:

In answer to inquiry for information of staybolt practice (November issue), I find the following methods satisfactory: For gouged or burned holes have metal replaced by either welding process. Allow ⅛ inch increase put up size over original diameter. This will take care of all renewals on running repair. For general repairs and firebox application all oversize holes are countersunk and electric welded and redrilled. This gives the same uniform size as the original job.

For a better method, a general application of either threaded or welded sleeves by reaming out staybolt holes and applying sleeves makes a complete flexible installation.

To tap the crown of a new firebox when applying bolts, with both ends the same diameter, use a tap with a lead and shank a little longer than the water space so both the firebox sheet and the wagon top are tapped in one operation. For bolts of different diameters use a short tap with a long lead, tapping from both sides. This requires two operations.

Evansville, Ind. M. W. Smith.

Staybolt Breakage

To the Editor:

Referring to the communication of Joseph Smith of Lorain, O., on staybolt breakage in October, it is evident to this writer that the bolts were improperly applied. There is no question about the intent of the designer of the flexible staybolt, which was to overcome staybolt breakage of the old rigid bolt, and when properly applied will do so. We all know that expansion takes place before pressure when the boilers are fired up and, if the staybolt is turned back after being seated, that bolt will have a little breathing space, but if left tight in the seat it becomes rigid and does not function as intended, and will break.

Like Mr. Smith, this writer knows very little about the manufacture of the flexible stay, but like all bolts that are made on a bulldozer, there is a possibility that the material has been improperly heated, the fiber destroyed and the bolt defective before application. There is another cause of flexible bolt breakage, that is the accumulation of scale or mud in and around the bolt joint. This will occur in any bad-water district, even if the bolts are given proper breathing space by being turned back ⅛, ¼ or ½ turn according to the extremes of expansion. This gives the bolts the proper seating before pressure takes place and when it does, the bolts are then ready to bear it.

Pittsburgh, Pa. Flex Ible.

Lancashire Boilers Designed for Higher Pressures

An older-type British boiler brought up-to-date to meet modern requirements

By F. Johnstone Taylor

The term high pressure can in these day certainly be interpreted in a very wide sense, but values of 250 to 300 pounds per square inch are generally regarded as being on the high side for average work, and are certainly too high for firetube boilers of orthodox construction. Yet, with the modern trend towards steam-plant economy there is a good deal to be said for generating steam around 300 pounds per square inch and also in favor of the Lancashire boiler, for the average industrial plant, notwithstanding the very good designs of watertube boilers which are available at the present day for this and much higher pressures. The Lancashire boiler, though it is a very old type, is no longer built by the leading boiler makers to rule and thumb methods. It is a sound engineering product built of the best steel boiler plate with drilled rivet holes and to scientific design, which takes into account the all-important matter of expansion.

So far as the shell is concerned, this is a relatively simple matter even for boilers working at the highest pressures deemed suitable for boilers of this type, provided due care is taken in its fabrication. In the best work Siemens-Martin steel of 56,000 to 64,000 pounds tensile strength with an elongation of 20 percent in 8 inches is used for the shell plates, which are first marked out and then bent in rolls to the required diameter. For the average length of 30 feet, plates of sufficient width are used to enable the shell to be constructed in four rings so as to reduce the number of circular seams to the minimum. These rings are then placed in a circular turning machine which can trim the longitudinal edges and the circular ones at one setting which gives perfectly square and parallel edges. In the best work the rivet holes are drilled in position by multiple-spindle drilling machines, with a dividing attachment, which ensures absolute uniformity of pitch. After being drilled the shell rings are taken to a riveting tower where all the shell plates, butt straps, gussett angles, and back-end plates are riveted in position by hydraulic riveters, all of which makes for a shell of the soundest possible construction.

Coming now to the matter of the formation of the ends and the flues, it must always be remembered that the relatively long Lancashire boiler of 30 feet or so, expands lengthwise and circumferentially an appreciable amount when hot. In addition, the furnace tubes being hotter than the shell plates cause unequal expansion in that the fire tubes elongate more than the shell plates. Then the ever varying fire temperature has to be accommodated. That is to say, when the fire doors have been closed for some time on a good fire, the flue tubes are at their maximum length, whereas when the fires

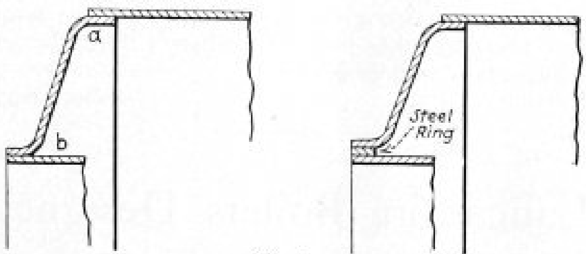


Fig.1

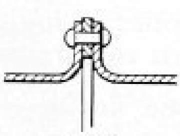


Fig. 2

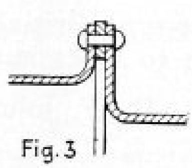


Fig. 3

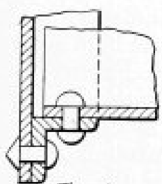


Fig. 4

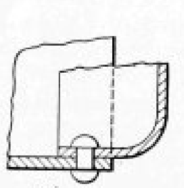


Fig. 5

Types of dished ends, flanged seams and flanged ends

have clinkered and are made up afresh they are at their shortest length. In addition, the flue tubes are hottest on the upper side owing to the increased temperature immediately over the fire. This condition, by causing unequal expansion and contraction, is the cause of curvature or "hogging" of the flues.

Grooving.—A well-known defect in the case of Lancashire boilers is that of grooving in the end plates due to the outward expansive movement which takes place. With low-pressure boilers, this trouble can to a great extent be minimized by using thin end plates, but for higher pressures this is inadmissible and the rigidity of relatively thick plates undoubtedly brings about grooving. In boilers of what may be classified as orthodox design, this trouble has to a certain extent been overcome by two different methods. One involves the substitution of the lowermost rivets of the gusset stays by "toe screws." These, formed with a rivet head at one end and provided with a nut at the other, are intended to allow a slight outward movement of the end plate of about 1/16 inch, the nut being arranged this distance clear of the flange of the gussett angle inside the boiler. The nut coming in contact with the angle when the permissible amount of movement has taken place prevents any further movement and allows a certain amount of "breathing" without weakening the stays.

Alternatively the holes provided in the gussett plates for the end plate gussett-angle rivets may be made elongated, the amount of elongation being gradually increased from a minimum in the uppermost holes to a maximum in the lowest to accommodate the increasing movement of the end plate towards the furnace tubes. Yet both these methods while effective are only suitable at relatively low pressures.

Dished ends.—From the design point of view, high-pressure Lancashire boilers are much more satisfactory when built with either dished ends or on the Adamson system, which will be discussed later. The virtue of the dished end lies in its elimination of all stays by reason of its being self supporting. As already pointed out, with a flat-end boiler with thin plates not too rigidly stayed, any freedom of expansion is largely dependent upon the flexibility of the end plate. One of the points formerly argued against the dished end boiler was that end plates of this kind would be far too rigid, but this contention, along with the fact that grooving would occur as the inevitable result of expansion and contraction has been proved a fallacy, provided a corrugated flue is used, such corrugations providing for all the expansion necessary. This supposed rigidity of the dished end plate does not really exist in practice. It has been proved by test that there is an expansive movement, though it is not very apparent owing to its being distributed over the whole area of the plate.

Dished ends with projecting furnace flanges are now made up to 12 feet in diameter in a single hydraulic press which dishes, flanges and bungs the plate, the ends and edges being turned for efficient fitting and calking. The ends being flanged, there is no need for any angle ring and as the rivets securing the end plates are all in shear there is no risk of leakage due to the springing of the plate as there is when the rivets are in tension. In Fig. 1, however, are shown two faults which became apparent with the earlier designs of these boilers. At the point *a*, for instance, there was a tendency for grooving to occur at the root of the radius of the end plate, too small a radius being the cause. At the point *b* overheating occurred due to the method of securing the flues to the end plate, but this can be overcome by the insertion of the steel ring as indicated, which makes for better water contact at this point. Properly designed and constructed the dished end Lancashire boiler with corrugated flues is a thoroughly sound proposition and quite suitable for pressure up to 300 to 350 pounds per square inch.

Flange seams.—The anti-collapsive flange seam and the absorber flange seam have been adopted for high-pressure work by the builders of the Adamson boiler. In the former as indicated in Fig. 2, it will be seen that between the flanges of the tubes there is a calking hoop, a simple but very effective item in that it strengthens the flue joints when under pressure, it eliminates rivets and joints in the flame space and in addition provides a large amount of elasticity in the flues, which can thus accommodate temperature differences in the same way as the aforementioned corrugated flue.

Fig. 3 shows the absorber flange seam by means of which some of the flue rings are made of larger diameter than the others so that some of the flanges are deeper. This provides considerable flexibility in the

(*Continued on page 25*)

Chief Inspector Reports

Locomotive Accidents for 1929

Accidents caused by boiler failures decrease eighteen percent as compared with previous year

THE following abstract of the Eighteenth Annual Report of Chief Inspector A. G. Pack of the Bureau of Locomotive Inspection to the Interstate Commerce Commission, covers locomotive accidents for the fiscal year which ended on June 30, 1929.

Summaries are given, by railroads, of all accidents, showing the number of persons killed and injured due to the failure of parts and appurtenances of locomotives, as reported and investigated under section 8 of the locomotive inspection law, and those reported to the Bureau of Statistics under the accident report act of May, 1910, and not reported to this bureau in accordance with the requirements.

The tables showing the number of accidents, the number of persons killed, and number injured as a result of the failure of parts and appurtenances of locomotives have been arranged to permit comparison with previous years as far as consistent. These tables also show the number of locomotives inspected, the number and percentage of those inspected and found defective the number for which written notices for repairs were issued in accordance with section 6 of the law, and the total defects found and reported. The data contained therein cover all defects on all parts and appurtenances of locomotives found and reported by our inspectors, arranged in order of railroads.

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

TABLE 1.—REPORTS AND INSPECTIONS—STEAM LOCOMOTIVES

	Year ended June 30					
	1929	1928	1927	1926	1925	1924
Number of locomotives for which reports were filed	63,562	65,940	67,835	69,173	70,361	70,683
Number inspected	96,465	100,415	97,227	90,475	72,279	67,507
Number found defective	20,185	24,051	29,995	36,354	32,989	36,098
Percentage inspected found defective	21	24	31	40	46	53
Number ordered out of service	1,490	1,725	2,539	3,281	3,637	5,764
Total number of defects found	53,998	85,530	112,008	136,973	129,239	146,121

All accidents reported to the bureau as required by the law and rules were carefully investigated and appropriate action taken to prevent recurrence as far as pos-

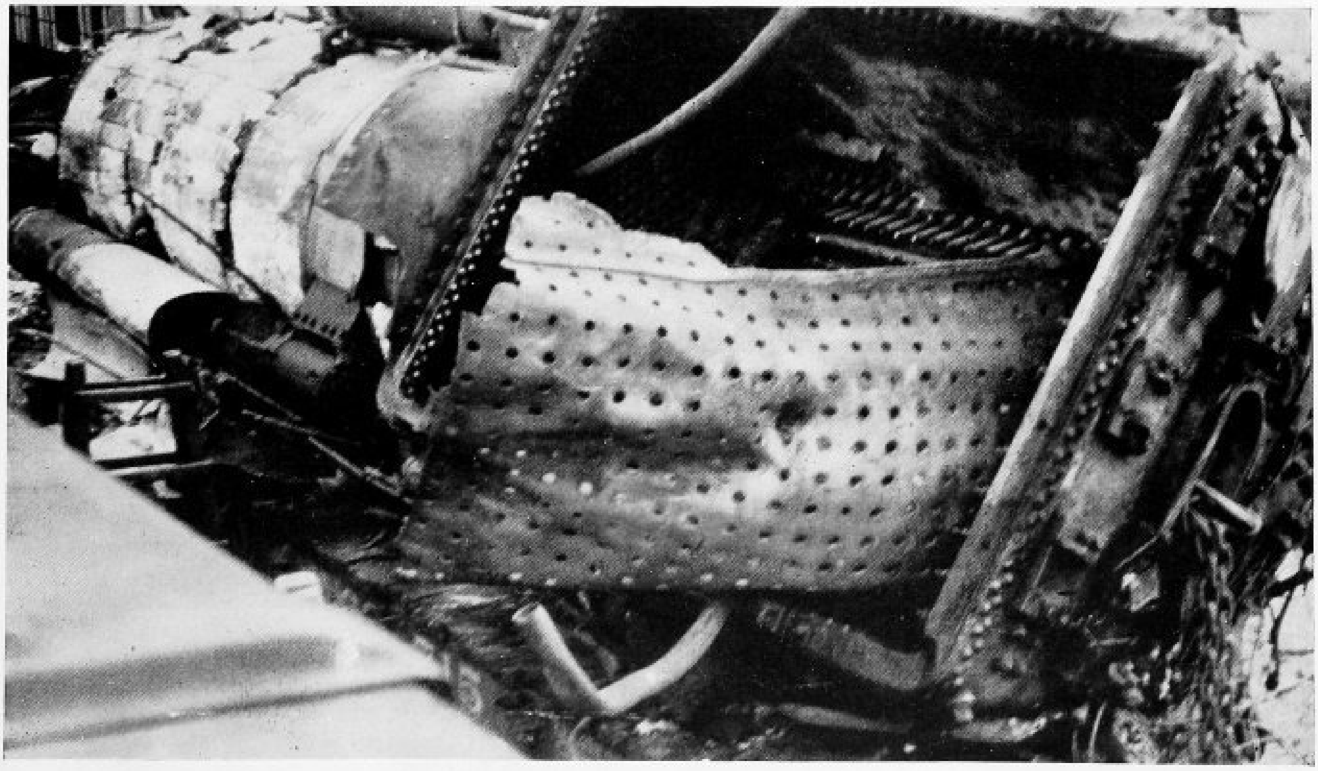


Fig. 1.—Crown sheet failures caused by low water

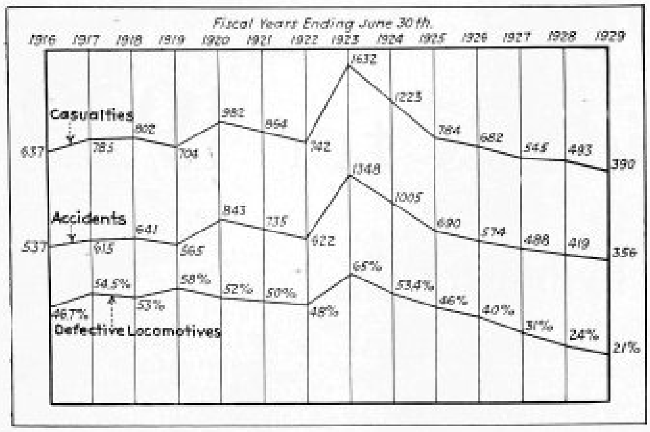


Chart showing relation of defective locomotives to accidents and casualties resulting from failures

TABLE 2.—ACCIDENTS AND CASUALTIES CAUSED BY FAILURE OF SOME PART OF THE STEAM LOCOMOTIVE, INCLUDING BOILER, OR TENDER

	Year ended June 30					
	1929	1928	1927	1926	1925	1924
Number of accidents	356	419	488	574	690	1,005
Percent increase or decrease from previous year	15	14.1	14.9	16.8	31.3	25.5
Number of persons killed	19	30	28	22	20	66
Percent increase or decrease from previous year	36.6	[1] 7.1	[1] 27.3	[1] 10	69.7	8.3
Number of persons injured	390	463	517	660	764	1,157
Percent increase or decrease from previous year	15.8	10.4	21.6	13.6	33.9	25

[1] Increase.

TABLE 3.—ACCIDENTS AND CASUALTIES CAUSED BY FAILURE OF SOME PART OR APPURTENANCE OF THE STEAM LOCOMOTIVE BOILER [2]

	Year ended June 30							
	1929	1928	1927	1926	1925	1924	1915	1912
Number of accidents	119	150	185	247	274	393	424	856
Number of persons killed	14	26	20	18	13	54	13	91
Number of persons injured	133	174	205	287	315	447	467	1,005

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

TABLE 4.—REPORTS AND INSPECTIONS—LOCOMOTIVES OTHER THAN STEAM

	Year ended June 30		
	1929	1928	1927
Number of locomotive units for which reports were filed	1,071	1,034	951
Number inspected	1,099	1,119	604
Number found defective	131	169	174
Percentage inspected found defective	12	15	29
Number ordered out of service	4	9	9
Total number of defects found	329	411	423

TABLE 5.—ACCIDENTS AND CASUALTIES CAUSED BY FAILURE OF SOME PART OR APPURTENANCE OF LOCOMOTIVES OTHER THAN STEAM

	Year ended June 30		
	1929	1928	1927
Number of accidents	1	4	5
Number of persons killed	..	1	..
Number of persons injured	1	3	5

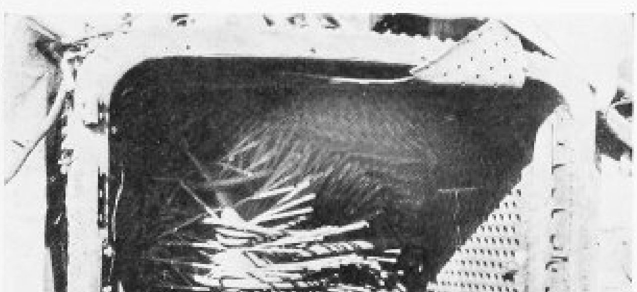


Fig. 2.—This disaster resulted in the death of two men

sible. Copies of accident investigation reports were furnished to parties interested when requested, and otherwise used in our effort to bring about a diminution in the number of such accidents.

The amendment of June 7, 1924, which authorized the employment of 15 additional inspectors with subsequent increased appropriations, has enabled the bureau to function more efficiently and to keep in closer touch with the general condition of locomotives, which is strikingly illustrated in the reduction of the number of accidents resulting in casualties to persons.

For instance, in 1923 we inspected 63,657 steam locomotives, of which 65 percent were found with reportable defects.

In 1929 we inspected 96,465 steam locomotives and 1099 locomotive units other than steam. Twenty-one percent of the steam locomotives and 12 percent of the locomotive units other than steam were found with reportable defects.

The number of locomotives ordered withheld from service also shows a marked and gradual decline. For

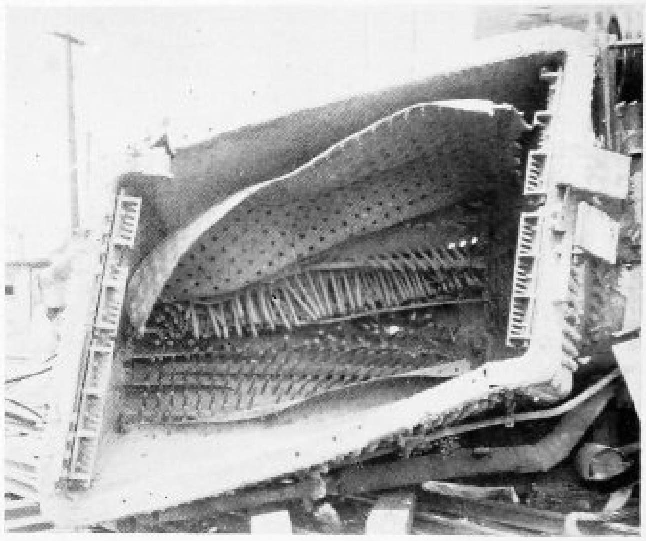


Fig. 3.—Failure of a five-piece firebox. Left side sheet seam failed for distance of 104 inches

instance, in 1923 there were 7075 steam locomotives ordered withheld from service because of being in distinct violation of the requirements, until they were put into serviceable condition as required by section 6 of the law. In 1929 there were 1490 steam locomotives and 4 locomotive units other than steam ordered withheld from service.

In 1923 there were 1348 accidents caused by the failure of some part or appurtenance of steam locomotives which resulted in the death of 72 persons and the serious injury of 1560 others. In 1929 there were 356 such accidents which resulted in the death of 19 persons and the serious injury of 390 others.

These improvements have, without doubt, been made possible by the increase in the force of inspectors, the increased appropriation of funds, and by the earnest and helpful co-operation of railroad officials and employees, a large majority of whom are each year putting forth greater efforts to meet the requirements of the law. A review of the records, however, will show that there are some railroads that are falling considerably behind in their efforts to comply with the requirements, where a concentration of effort on our part may be required.

It should be borne in mind that the locomotive is the propelling power in the movement of trains and usually

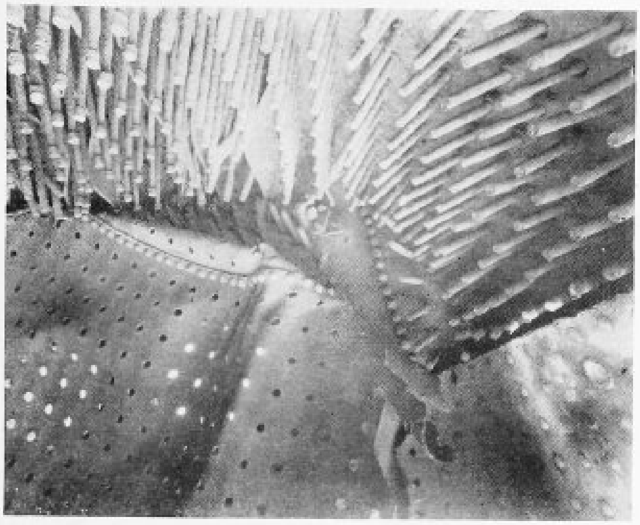


Fig. 4.—Both riveted and welded seams failed in this low-water explosion

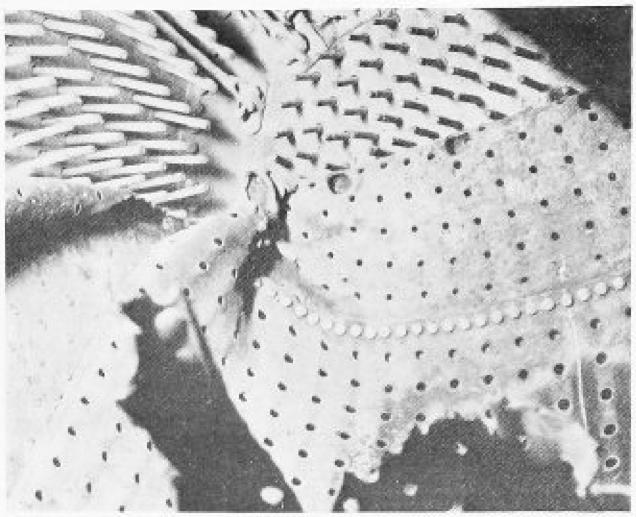


Fig. 5.—Crown sheet failure from low water caused by faulty water-glass cock

TABLE 6.—ACCIDENTS AND CASUALTIES RESULTING FROM FAILURES OF STEAM LOCOMOTIVES AND TENDERS AND THEIR APPURTENANCES

Part or appurtenance which caused accident	Year ended June 30														
	1929			1928			1927			1926			1925		
	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured
Air reservoirs	..	..	..	..	..	..	3	..	3	3	..	5	4	..	4
Aprons	2	..	2	5	..	5	6	..	6	11	..	11	4	..	4
Arch tubes	1	..	2	1	..	1	2	..	5	..	..	..	3	..	5
Ash-pan blowers	..	..	..	1	..	1	2	..	2	..	..	..	3	..	3
Axles	7	..	8	5	..	8	6	..	7	7	1	12	8	..	24
Blow-off cocks	7	..	10	7	..	7	10	1	9	10	..	10	13	..	13
Boiler checks	1	..	1	3	..	4	2	..	2	8	..	8	8	..	8
Boiler explosions:															
A. Shell explosions	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
B. Crown sheet; low water; no contributory causes found	11	11	12	15	16	25	14	14	14	22	11	33	9	5	18
C. Crown sheet; low water; contributory causes or defects found	6	2	8	7	4	12	5	3	12	15	6	30	13	5	22
D. Fire box; defective staybolts, crown stays, or sheets	1	..	3	..	..	..	..	..	..	..	..	..	6	2	9
Brakes and brake rigging	16	..	17	14	..	14	25	1	26	13	..	21	31	3	33
Couplers	5	..	6	13	1	14	15	..	16	15	..	19	21	1	20
Crank pins, collars, etc.	2	..	2	8	..	8	3	..	4	8	..	10	8	..	10
Crossheads and guides	3	..	10	3	..	3	7	..	7	5	..	7	3	..	3
Cylinder cocks and rigging	1	..	1	6	..	6	3	..	3	..	..	..	3	..	3
Cylinder heads and steam chests	4	..	4	1	..	1	4	..	4	9	..	11	2	..	2
Dome caps	..	..	..	1	..	1	..	..	..	..	..	..	2	..	3
Draft appliances	3	..	3	1	..	2	2	..	2	1	..	1	4	..	8
Draw gear	6	..	6	2	..	2	5	..	6	2	..	2	6	..	6
Fire doors, levers, etc.	4	..	4	8	..	8	6	..	6	11	..	11	12	..	12
Flues	7	1	7	17	..	21	23	1	26	26	..	31	36	..	42
Flue pockets	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Footboards	7	..	7	11	..	11	10	..	10	9	1	8	11	..	11
Gage cocks	1	..	1	..	..	..	..	..	..	..	..	..	2	..	2
Grease cups	5	..	6	1	..	1	1	..	1	3	..	3	7	..	7
Grate shakers	16	..	16	25	..	25	29	..	29	38	..	38	57	..	57
Handholds	10	1	9	12	..	12	12	1	11	14	..	14	13	..	13
Headlights and brackets	2	1	1	3	1	2	6	1	5	2	..	2	5	..	5
Injectors and connections (not including injector steam pipes)	6	..	6	7	..	7	12	..	12	19	..	22	20	..	20
Injector steam pipes	2	..	2	3	..	3	4	..	5	8	..	9	12	..	15
Lubricators and connections	5	..	5	8	..	8	7	..	8	12	1	11	16	..	16
Lubricator glasses	2	..	2	1	..	1	..	..	..	3	..	3	6	..	6
Patch bolts	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pistons and piston rods	4	..	4	2	..	2	4	1	3	3	..	3	4	1	4
Plugs, arch tube and washout	2	..	2	1	2	1	6	1	8	4	..	5	5	..	6
Plugs in firebox sheets	1	..	1	..	..	..	1	..	2	..	..	..	..	..	..
Reversing gear	23	..	23	35	..	35	30	..	30	37	..	37	49	..	49
Rivets	3	..	3	1	..	1	2	..	2	3	..	3	1	..	1
Rods, main and side	14	..	17	11	1	13	16	1	18	20	..	24	23	1	25
Safety valves	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..
Sanders	3	..	3	2	..	2	5	..	5	..	..	..	3	..	3
Side bearings	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Springs and spring rigging	10	..	10	10	1	11	14	..	18	16	..	16	25	1	26
Squirt hose	23	..	23	32	..	33	33	..	33	51	..	51	53	..	53
Staybolts	4	..	4	5	2	4	8	..	8	4	..	4	5	..	6
Steam piping and blowers	4	..	6	7	1	10	11	..	11	7	..	7	5	..	6
Steam valves	..	..	..	2	..	2	6	..	6	4	..	4	7	..	8
Studs	2	..	5	1	..	1	3	..	3	7	..	9	1	..	1
Superheater tubes	1	..	1	1	..	2	5	..	7	7	..	10	3	..	3
Throttle glands	..	..	..	1	..	1	2	..	2	..	..	..	1	..	1
Throttle leaking	..	..	..	1	..	1	..	..	..	3	..	3	2	..	2
Throttle rigging	2	..	2	3	..	3	6	1	6	12	..	12	10	..	10
Trucks, leading, trailing or tender	4	..	4	3	..	4	4	1	4	7	..	23	6	..	14
Valve gear, eccentrics and rods	14	..	16	8	..	9	22	..	23	13	..	13	16	..	16
Water glasses	18	..	18	13	..	13	10	..	11	12	..	12	8	..	8
Water-glass fittings	1	..	1	1	..	1	2	..	2	3	..	3	7	..	7
Wheels	8	1	16	5	..	13	5	..	6	6	..	7	7	..	10
Miscellaneous	71	2	69	84	1	87	69	1	68	81	2	82	101	1	101
Total	356	19	390	419	30	463	488	28	517	574	22	660	690	20	764

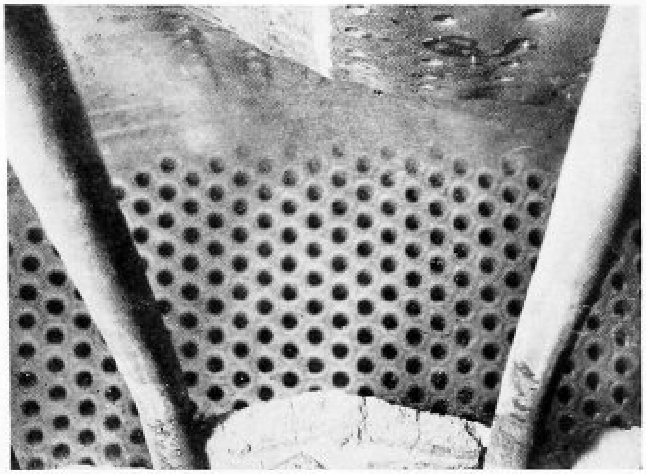


Fig. 6.—Pocket in crown sheet caused by overheating

in the lead, and that most frequently defects of an apparently insignificant nature may and do cause some serious accidents not only to the locomotive but to the train, and that an improper or unsafe condition of a locomotive is likely to distract the attention of enginemen from important duties and thereby cause serious oversights which may result not only in danger to life and limb but in damage to property and in inefficient performance. Therefore, it is in the interest of the carriers in the promotion of safety, efficiency, and economy of operation to put forth every reasonable effort in maintaining motive power in a high state of repair, as has been strikingly demonstrated during the past few years in the prompt, rapid, and dependable movement of traffic, as well as efficient and economical operation.

Table 6 shows the various parts and appurtenances of steam locomotives and tenders which through failure have caused serious and fatal accidents. If the information contained in this table is taken advantage of and proper inspections and repairs made in accordance with the requirements of the law and rules many accidents will be avoided.

The graphic chart shows the relation between the percentage of defective steam locomotives and the number of accidents and casualties to persons resulting from failure thereof, and illustrates the effect of operating locomotives in a defective condition from the viewpoint of safety.

As in former years, boiler explosions caused by crown sheet failures were the most prolific source of fatal accidents. Sixty-eight percent of the fatalities during the year were attributable to this cause as compared with

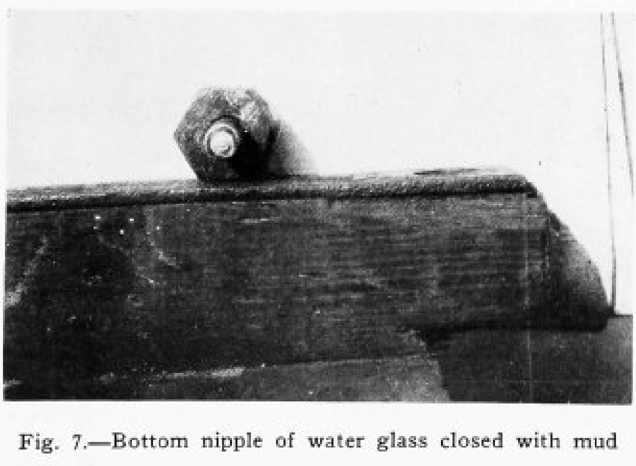


Fig. 7.—Bottom nipple of water glass closed with mud

67 percent in the previous year. However, there was a decrease of 18 percent in the number of such accidents, 35 percent decrease in the number killed, and 15 percent decrease in the number injured as compared with the previous year; and 68 percent decrease in the number of such accidents, 68 percent decrease in the number killed, and 74 percent decrease in the number injured as compared with the year 1923.

Careful study of the reports of investigation of boiler explosions caused by crown sheet failures as a result of low water indicates that the reduction in the number of such accidents has been largely, if not entirely, brought about through better maintenance, better water-indicating appliances—visibility of water glasses, proper and accessible location of gage cocks—and better and more dependable feed-water appliances—injuctors and feed-water pumps.

It is strongly urged, in the interest of safety, that all non-lifting injectors be equipped with a telltale device located in the cab of the locomotive that will give warn-

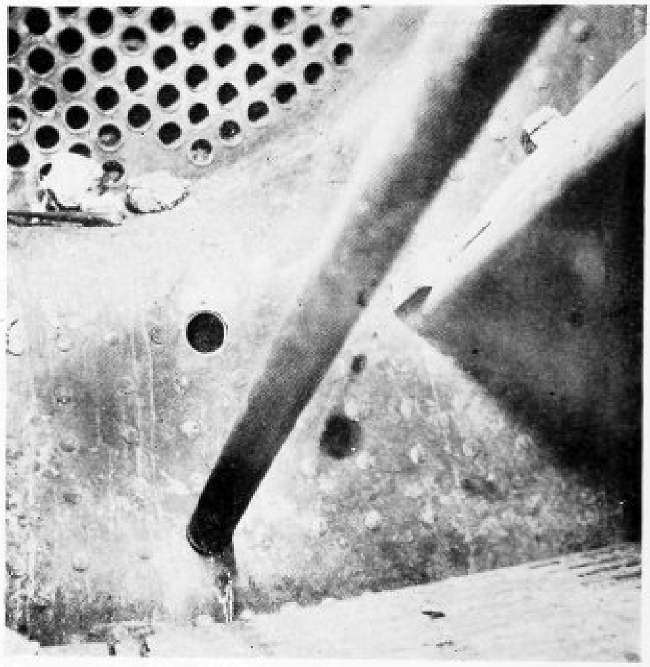


Fig. 8.—Arch tube which broke off on fire side of throat sheet

ing to the engineman in charge in the event of failure of the injector. Many such injectors now have these devices applied, which are comparatively inexpensive, both in application and maintenance.

The results of explosions from this cause illustrate the necessity for the application of all practical safeguards and the exercise of the best thought and effort of the various agencies concerned with design, construction, maintenance, and operation in order that this class of accidents may be reduced to a minimum.

Our records show that in the year 1927 there were 1760 locomotive fireboxes equipped with thermic siphons; during the year 1928 there were 595 additional equipments and during the year 1929 there were 645; or at the close of this year there were a total of 3000 locomotives thus equipped. During the year there were no accidents reported to the bureau where this equipment was in any way involved.

In my fifteenth, sixteenth, and seventeenth annual reports attention was called to the danger resulting from the use of reduced body staybolts having telltale holes which do not extend into the reduced section at least $\frac{5}{8}$ inch. Our investigation of reduced body staybolt breakage shows that failure most always occurs in the reduced body at or near the fillet between the body of the bolt and the enlarged ends, and that telltale holes which do not extend into the reduced section at least $\frac{5}{8}$ inch can not be depended upon to indicate broken bolts.

A great majority of broken staybolts are found by leakage through telltale holes, without the aid of hammer test; therefore, if the telltale holes do not extend into the bolts to or beyond the usual point of breakage, they are not only useless as a safety feature but become a distinct menace, because telltale holes are being depended upon to a great extent in determining broken and fractured rigid staybolts. Accidents resulting in serious and fatal injury continue to occur with this type of bolt because of the telltale holes not being of sufficient depth to perform the function for which intended.

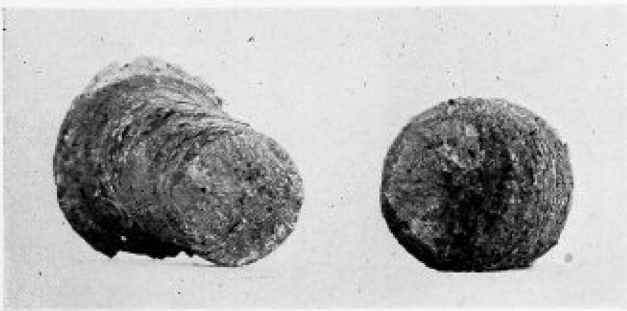


Fig. 9.—Ends of a broken reduced-body staybolt

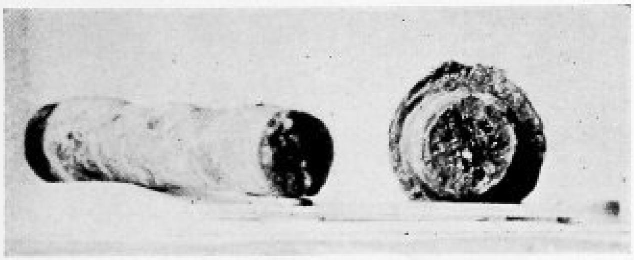


Fig. 10.—Radial staybolt, outer end of which blew out of wrapper sheet

Rule 26 requires that all rigid staybolts shorter than 8 inches shall have telltale holes $\frac{3}{16}$ inch in diameter and *not less than* $1\frac{1}{4}$ *inches* in depth in the outer end and that these holes must be kept open at all times.

A telltale hole that is not of sufficient depth to perform the function for which it is evidently intended can not be considered as meeting the requirements of the law or the rule referred to, which calls for a depth of telltale hole of not less than $1\frac{1}{4}$ inches.

Many such bolts are improperly applied, the reduced body of the bolts being too long to permit full engagement of the threads on the enlarged ends with the threads in the holes in the sheets.

Two hundred and forty-three applications were filed for extensions of time for removal of flues, as provided in rule 10. Our investigations disclosed that in 13 of these cases the condition of the locomotives was such that extensions could not properly be granted. Twenty were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. Thirty-nine extensions were granted after defects disclosed by our investigations had been repaired. Twelve applications were canceled for various reasons. One hundred and fifty-nine applications were granted for the full periods requested.

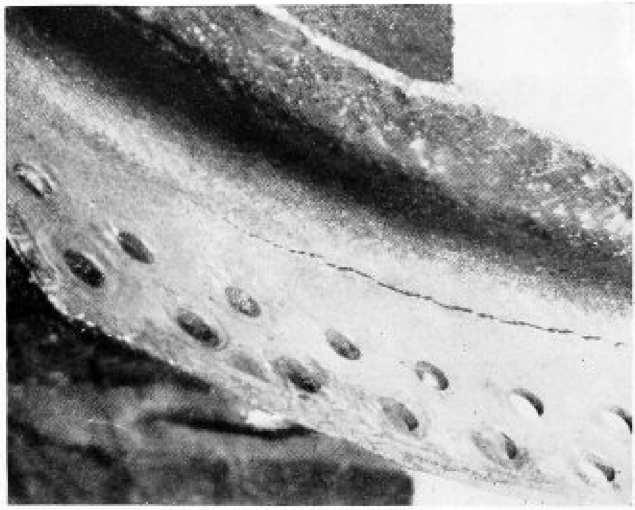


Fig. 11.—Crack in the flange of a rear flue sheet, in boiler equipped with watertube firebox

Under rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives, 913 specification cards and 8011 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, 134 specifications and 112 alteration reports were filed for locomotive units and 74 specifications and 11 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.

Typical Boiler Failures

Fig. 1 shows the result of a crown sheet failure caused by overheating due to low water, the explosion resulting in the death of the engineer, fatal injury to the fireman, and serious injury of the brakeman. The boiler was hurled from the frame and when alighting demolished a trestle about 155 feet ahead of the point of explosion. The line of low water was 3 inches below the highest part of the crown sheet. The firebox was originally of riveted construction but parts of the seams had been converted to welded seams. The illustration shows the failure of welded seam at front end of crown sheet and failure of the welded part of the left side sheet seam.

Fig. 2 shows the result of a crown sheet failure caused by overheating due to low water, the explosion resulting in the death of two and the serious injury of one employee. The force of the explosion tore the boiler from the frame, hurling it upward and forward, the boiler coming to rest 290 feet from point of accident. The firebox was originally of 3-piece construction but new side sheets had been applied with fusion-welded seams joining the side sheets and crown sheet and the side sheets and door sheet. The entire crown sheet was torn loose from the flue sheet, door sheet, and side sheets, and was blown down and out of the mud ring.

Fig. 3 shows the result of a crown sheet failure caused by overheating due to low water, the explosion resulting in the death of two employees. The force of the explosion tore the boiler from the frame hurling it upward and forward, the boiler coming to rest on an adjacent track about 600 feet from the point of accident. The firebox was of 5-piece construction with fusion-welded seams joining the side sheets and crown sheet. This illustration shows the left side sheet seam which failed for a distance of 104 inches.

Fig. 4 shows the result of a crown sheet failure caused by overheating due to low water which resulted in the death of two employees. The boiler was torn from the frame and finally came to rest 822 feet ahead of and 55 feet to the right of the point of the explosion. The running gear of the locomotive, the tender, and six passenger train cars were derailed and the roadbed badly damaged. Fig. 4 shows the failed fusion-welded seam of the left side sheet and the manner in which the crown sheet failed at the calking edge of the flue sheet seam which was of riveted construction with calking edge fusion welded.

Fig. 5 shows the result of a crown sheet failure caused by overheating due to low water which resulted in instant death of the engineer and fatal injuries to the fireman. The top water-glass cock, which had been applied seven days before the accident occurred, was of the gate-valve type. The operating handle required in excess of one full turn before the valve would open. Subsequent to the accident the operating handle was found to be three-fourths of one turn from the completely closed position. Tests made on another locomotive showed that with top cock closed water would remain trapped in the glass for approximately two hours with the water level blown down below the opening in the bottom cock.

Fig. 6 shows a pocket formed in a crown sheet caused by overheating due to low water; the accident resulted in the serious injury of two employees. Fig. 7 shows the bottom nipple of water glass of the boiler illustrated in Fig. 6. The opening through the nipple was entirely closed with mud which trapped water in the water glass resulting in a false indication of the water level.

Fig. 8 shows a failed arch tube which caused the serious injury of two employees. Tube broke off on fire side of throat sheet due to reduction in thickness of wall by excessive rolling.

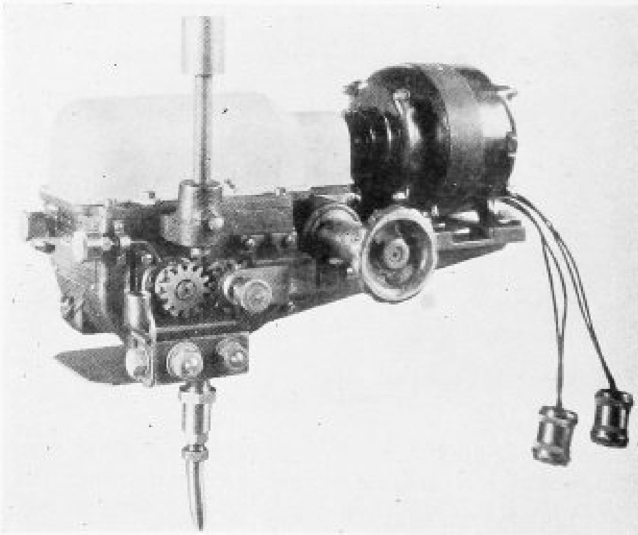
Fig. 9 shows the ends of a broken reduced body staybolt, the inner end of which blew out of firebox side sheet while the locomotive was in service, seriously injuring one employee. The bolt broke at the point most subject to failure, near the root of the fillet joining the reduced body and outer end; telltale hole was not of sufficient depth to serve the purpose for which it was intended—that of giving warning when staybolts are broken. The condition of the ends shows that the bolt had been broken for some considerable time prior to the accident, but this was not disclosed by the hammer test, which was made two days before the accident occurred. The bolt was of improper length when applied; an insufficient number of threads engaged the inner sheet, this resulted in leakage which eroded and practically destroyed the threads. The head had been excessively hammered and flattened in attempts to stop leakage.

Fig. 10 shows the ends of a reduced body radial staybolt, the outer end of which blew out of wrapper sheet, seriously scalding a boiler maker, while an attempt was being made to stop leakage. Threads on bolt and in wrapper sheet were in poor condition due to erosion caused by leakage and excessive hammering in attempts to stop leakage. The bolt broke at the root of the fillet joining the reduced body and outer end, where practically all breakage occurs with this type of rigid bolt. The bolt did not have a telltale hole in the outer end.

Fig. 11 shows a crack in the flange of a rear flue sheet of a boiler equipped with a watertube firebox. The crack opened while the locomotive was in service, the escaping steam and water causing serious injuries to three employees. The flue sheet had been applied with the flange extending inward with the rivets and calking edge on the water side. Fusion welding was applied on the fire side, joining the knuckle of the flue sheet and the inner circumference of the rear end of the barrel, for the purpose of sealing the joint. The crack developed from the water side, extending circumferentially around the sheet and in line with the edge of the fusion welding. Rear flue sheets applied in this manner to nine other locomotives developed similar cracks after being in service one year or less.

Electrode Feeding Device

THE General Electric Company, Schenectady, N. Y., has announced an improved feeding device on its automatic welding head to meet advances in the art of automatic welding which call for an increased use of high welding speeds requiring heavier welding currents and larger sizes of electrode wire than heretofore ordinarily used. This improvement consists of the addition of geared drive to what was formerly the idler roller in the feeding mechanism. In this way the large sizes of wire, which are stiff and hard to feed without excessive pressure on the driving rolls, are positively fed without slippage, at a regular rate and with only a moderate pressure between rolls.



Arc-welding head with driving gears for binding roller

This device also extends the uses for automatic welding by making it now possible to use curved nozzles so as to reach into otherwise inaccessible places, and to weld in abnormal positions. Such cases were formerly considered impractical if not impossible on account of the difficulty of conforming the heavier wires to any other shape than their natural curvature.

For the majority of applications the present practice in automatic welding requires electrode sizes from 1/8-inch to 1/4-inch diameter. The improved drive-roll gears furnished on heads for these normal applications will accommodate any size wire from 1/8-inch to 1/4-inch diameter without changing gears. Below 1/8-inch the gears are not needed and it is only necessary to remove one gear—that on the drive-roll shaft.

Proposed Welding Procedure for Pressure Vessels

Revisions and addenda to A.S.M.E. Boiler Construction Code recommended to establish the proper methods of fusion welding

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 on in the proper place in the code.

The Boiler Code Committee has received and acted upon a number of suggested revisions which have been approved for publication as addenda to the code. These are published below, with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticisms and comment thereon from any one interested therein. Discussions should be mailed 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.

After sufficient time has been allowed for criticism and comment upon the revisions as approved by the committee, it is the intention of the committee to present the modified rules as finally agreed upon to the council of the society for approval as an addition to the Boiler Construction Code. Upon approval by the council, the revisions will be published in the form of addenda data sheets, distinctly colored pink, and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type enclosed in brackets.

PROPOSED REVISIONS

PAR. U-23 REVISED:

U-23. Pressures vessels shall not be fabricated by means of fusion welding under the rules given in Pars. U-67 to U-79 except:

a Air vessels, when the diameter does not exceed 20 in., the length does not exceed 3 times the diameter, and the working pressure does not exceed 100 lb. per sq. in.

b Other vessels, under these rules, in which the circumferential joints only may be welded, when the inside diameter does not exceed 48 in., or 72 in. when at least 75 percent of the load on a flat head is supported by tubes or through stays extending from head to head.

C WHERE THE VESSELS ARE FABRICATED IN ACCORDANCE WITH THE RECOMMENDED PROCEDURE FOR FUSION WELDING OF PRESSURE VESSELS GIVEN IN THE APPENDIX, THE LIMITING DIAMETER IN PAR. U-23*A* MAY BE TAKEN AS 60 IN. AND THE LIMITING PRESSURE MAY BE TAKEN AT 200 LB. PER SQ. IN., PROVIDED THE TEMPERATURE DOES NOT EXCEED 250 DEG. FAHR.

PAR. U-68 REVISED:

U-68. WHEN WELDED IN ACCORDANCE WITH THE RECOMMENDED PROCEDURE FOR FUSION WELDING OF PRESSURE VESSELS GIVEN IN THE APPENDIX, THE STRENGTHS OF JOINTS MAY BE CALCULATED ON A MAXIMUM UNIT WORKING STRESS (*S*), AT RIGHT ANGLES TO THE DIRECTION OF THE JOINT, AS FOLLOWS:

FOR BUTT DOUBLE V LONGITUDINAL WELDS .... 8000 LB.
FOR BUTT SINGLE V GIRTH OR HEAD WELDS .... 6500 LB.
FOR DOUBLE FULL FILLET LAP OR GIRTH WELDS .... 7000 LB.
FOR SPOT OR INTERMITTENT GIRTH OR HEAD WELDS .... 5600 LB.

UNLESS THE PROCEDURE FOR FUSION-WELDED VESSELS GIVEN IN THE APPENDIX IS FOLLOWED IN ALL PARTICULARS [when properly welded by the fusion process] the [strength of a joint may be calculated on a maximum] unit working stress (*S*) AT RIGHT ANGLES TO THE DIRECTION OF THE WELD SHALL NOT EXCEED 5600 lb. per sq. in. (see Par. U-20).

Recommended Procedure for Fusion Welding of Pressure Vessels

It is the purpose of this statement to outline such a course of procedure, embracing the essentials of proper fusion welding, as will not only insure sound and safe welded construction for pressure vessels, but will also enable such results to be duplicated at any place and at any time. This procedure outline is general in character and contemplates the use of any of the established methods of fusion welding, either hand or machine, for the construction of pressure vessels. The subject-matter is presented under the following subdivisions:

I Materials
II Design
III Construction
IV Qualification of Welders
V Supervision
VI Inspection
VII Testing

I—MATERIALS

Plate for Shell, Heads, etc. Steel plates for any part of a vessel that are subject to stress produced by internal pressure and are welded, shall be of good weldable firebox or flange quality conforming to the Specifications for Steel Plate of Flange Quality for Forge Welding, as given in Pars. S-264 to S-279, or to the Specifications for Steel Boiler Plate in Pars. S-5 to S-17 of Section II of the code.

Material for Manholes, Nozzles, and Other Connections. Material for manholes, nozzles, and other connections which are to be joined to the shell or heads by fusion welding, shall, when forged or rolled, comply with the specifications given for shell plate and heads as to chemical and physical properties, and be of good weldable quality. Steel castings and commercial nozzles may be used only when the material has been proved to be of good weldable quality.

Filler Material. Welding wire, rods, and/or electrodes must be smooth and free from scale, rust, oil or grease. In the hands of an experienced welder, the filler material shall demonstrate good weldability and shall flow smoothly and evenly without any unusual characteristics.

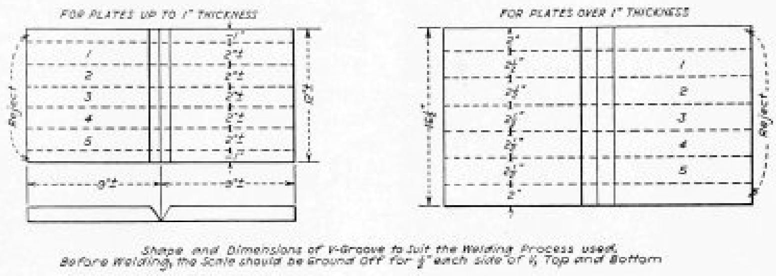
Electrodes for metal-arc welding of all kinds shall conform to the American Welding Society Specifications E1A or E1B.

Welding rods for gas welding shall conform to the American Welding Society Specifications G1A.

Other welding rods, wire, and/or electrodes may be used provided they give results equal to or better than those specified in Section IV.

II—Design

The design of all pressure vessels shall conform to the various requirements of the Code for Unfired Pressure Vessels. In applying the rules of this code, however, care should be taken to proportion and so place the constituent parts of the vessel that due consideration may be given to the requirements of the welded joint. In all cases where plates of unequal thicknesses are butted, it is desirable to reduce the edge of the thicker plate in some manner so that it is approximately the same thickness as the other plate; this is an exceedingly important element in obtaining complete fusion and should be treated as one of the factors contributing to a sound and safe welded joint. Furthermore, in the design of welded vessels care should be taken to so locate the welded joint that the bending stresses that are inevitable in certain shapes of structures will not be brought directly upon the welded joint; as an instance may be cited the case of dished heads on cylindrical vessels, in which the weld should not be applied directly at the knuckle of the head. Corner welds should in general be avoided unless the plates forming the corner are properly supported independently of such welds. Lap joints should be avoided for heavy stresses or for the joining of thick plates. In general, welds in tension or shear are much to be preferred over those subjected to other forms of stress. The design of parts of cylindrical vessels other than the shell should be so controlled that satisfactory welded design is assured and that the vessel will have uniform strength throughout; this applies particularly to large outlets and manhole openings.



Shape and Dimensions of V-Groove to Suit the Welding Process used. Before Welding, the Scale should be Ground Off for ½" each side of V, Top and Bottom

FIG. 1 QUALIFICATION TEST PLATES

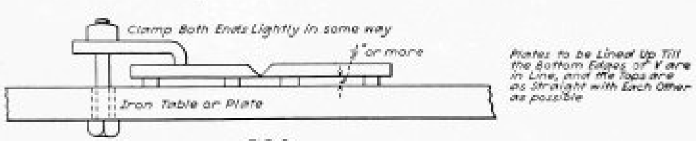


FIG. 2

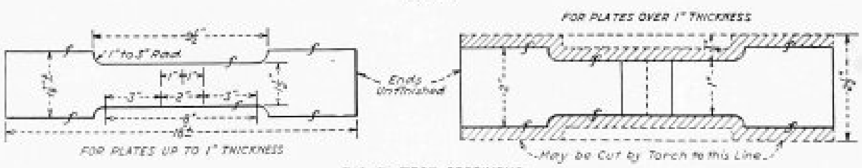


FIG. 3 TEST SPECIMENS

III—Construction

Preparation for Welding. The plates or sheets to be joined shall be accurately cut to size and formed. In all cases the forming shall be done by pressure and not by blows, including the edges of the plate.

Bars, jacks, clamps, or other appropriate tools may be used to hold the edges to be welded in line. The edges of butt joints must be so held that they will not be allowed to lap during welding.* For plates in excess of ¾-inch thickness, the offset must not be more than 10 percent (maximum ¼ inch) for girth seams. Where fillet welds are used, the lapped plates shall fit closely and be kept tight together during welding.

The surfaces of the sheets or plates to be welded must be cleaned thoroughly of all scale and rust for a distance of about ½ inch back from the welding edge. A steel-wire scratch brush may be used for removing light rust or scale, but for heavy scale, slag, and the like a grinder, chisel, air hammer, or other suitable tool should be used that will clean down to bright metal. When it is necessary to deposit metal over a previously welded surface, any scale or slag therefrom should be removed by a roughing tool, a chisel, an air chipping hammer, or other suitable means to prevent inclusion of impurities in the weld metal. In case there is grease or oil on the welding edges, it should be thoroughly cleaned with gasoline, lye, or the equivalent.

Welding Method. The application of this welding procedure is not limited to any method or process of welding or to any particular materials, but it is essential that the method or process shall be capable of effecting thorough fusion of the weld metal to the edges to be joined. There are no limitations as to the preparation of the edges to be welded except as provided in Par. U. 71 of the code that for the longitudinal joints of cylindrical vessels, double-V-type welds must be applied. It is here pointed out that while Par. U-71 requires for double-V welds penetrating half-way through from each side, a well-made single-V weld which is reinforced at its root is considered to be satisfactory. In cases when fusion at the root is irregular, the root of the weld shall be chipped out before reinforcing.

The dimensions and shape of the edges to be joined shall be such as to allow thorough fusion and complete penetration.

As full and complete penetration of the weld metal through the entire thickness of the plate is essential for safety, considerable precaution must be taken to insure this result. If the welding is stopped for any reason, extra care must be taken, when restarting, to get full penetration to the bottom of the joint and thorough fusion between the weld metal and the plates and to the weld metal previously deposited.

*Attention is called to the requirement in Par U-71 of the Code that stipulates that the sheet on one side of the joint must not be allowed to offset from opposite sheet by more than one-quarter of their minimum thickness.

In double-V butt welds the edges to be joined shall be so separated that the weld metal can penetrate to the root of the V.

Before welding the second side of the double-V, all scale and metal which has run through from the weld on the first side must be removed by some suitable method such as by chipping or grinding, and the rust removed from the adjacent surfaces for ½-inch back. Any suitable means such as a round-nosed chisel may be used to remove the metal from the V, and a portable grinder to clean the scale from the plates.

When single-V joints are used, particular care must be taken in lining up and separating the edges to be joined so that complete penetration and fusion at the root of the V will be assured, for in some instances it will be impracticable to eliminate any lack of fusion by reinforcement of the opposite side—for example, on head seams of tanks less than 3 feet in diameter and containing no manhole.

Particular care should be taken in the layout of joints in which fillet welds are used so as to make possible the fusion of the weld metal at the bottom of the fillet. Great care must also be exercised in the deposition of the weld metal so as to secure satisfactory penetration.

Reinforcement and Finish. The reinforcement of welds shall, in accordance with the requirement of Par. U-71 of the code, be built up uniformly from the edge of the plate to the maximum at the center of the weld. Particular attention is called, however, to the importance of the provision in that rule that there shall be no valley or groove along the edge or in the center of the weld, but that the deposited metal must be fused smoothly and uniformly into the plate edge at the top of the V.** The finish of the welded joint must be reasonably smooth and free from irregularities, grooves, or depressions.

If a cylinder shell shows irregularities after welding, it shall be rerolled to render it truly cylindrical, or the ends may be heated and shaped to come within the following limits:

> The edges of the plates at the seams shall not offset from each other at any point in excess of one-quarter of the thickness of the plate except for plates in excess of ¾ inch in thickness, in which the offset must not be more than 10 percent (maximum ⅛ inch) for longitudinal seams, or 25 percent (maximum ¼ inch) for girth seams.

If the thickness of a head to be attached to a cylindrical shell by a butt joint exceeds the shell thickness by more than 25 percent (maximum ¼ inch), the head thickness shall be reduced.

Heads concave to pressure and plate edges at girth seams to be attached by butt joints shall be lined up with the shell as true as possible, dividing up any offsets. If these are more than permitted by the above limitation, corrections shall be made by reforming the shell or head, whichever is out of true, until the errors are within the limits specified. The sheets at head and girth seams shall be kept so spaced that they shall be separated at the point of welding enough to insure thorough penetration of the weld metal.

Heads convex to pressure shall, as prescribed in Par. U-74 of the code, be prepared and applied with a length of flange of not less than 1 inch for shells not over 24 inches in diameter, but of not less than 1½ inches for shells over 24 inches in diameter. It is recommended in the code that this length of flange be made not less than 12 percent of the diameter of the shell.

IV—Qualification Test for Welders

The qualification test will consist of welding together in a flat position two plates of the same material and thickness as is to be used in the tank under consideration (see Fig. 1). Should the welder be required to make fillet welds, butt welds over ⅝-inch thick, or welds in other positions than in the flat, he shall qualify in that class of work. If a backing strip be used in practice for single-V butt welds, it may be employed in making the test specimens. After cleaning and straightening the plates and machining the edges to be welded, they shall be clamped down and the edges of the V lined up (see Fig. 2). It is important that the edges of the V shall not lap during welding and thus prevent full penetration. To this end the plates shall be so spaced before starting the weld that, at the point of welding, there shall be a slight distance between the edges of the V.

The test plates shall be cut up as shown in Fig. 1 by the dotted lines and the two outside strips rejected because they may not be truly representative of the weld. This cutting may be done with a gas cutting torch. Pieces 1, 3, and 5 shall be machined as shown in Fig. 3. The reinforcement should be ground or machined off both sides. The last grinding or tool marks should be parallel with the length, and not at right angles to it.

The test specimen shall then be tested in a tensile testing machine to determine the ultimate strength in pounds per square inch.

The ultimate strength determined by tensile test will be the basis for the welder's rating. In order for him to qualify, the tensile--strength results should average at least 45,000 pounds per square inch, with no one test piece giving less than 42,000 pounds. If these results are not reached, the welder may be given a duplicate test. If the welder successfully passes this test, he shall be considered qualified.

The record of a welder's qualification test should contain complete information concerning the material of the plate welded, the filler metal used, the type of welding equipment, any pertinent particulars concerning its operation, and the quality of the weld not only as to completeness of fusion with the base metal but also as to completeness of penetration. Any peculiarities of the weld should also be noted such as finish and surface defects, style and amount of reinforcement, and appearance of weld on underside at bottom of V.

V—Supervision and Local Inspection in Shop

The welding supervision constitutes the system of oversight and shop inspection which insures that the provisions for proper Materials (1), proper Design (2), proper Construction (3), and properly Qualified Welders (4), shall so co-operate as to give sound and safe welded construction. It is the duty of the management of the welding shop to provide such supervision and local inspection as will make sure that the requirements of the Code for Unfired Pressure Vessels and also those of this Recommended Procedure will be carried out on any welded pressure vessels to be stamped as provided for in the code.

It is preferable, although not essential, that those who are charged with this supervision shall have a practical knowledge of fusion welding, particularly with the process that is employed. The supervisor shall provide and have readily accessible for purposes of record all necessary data concerning the material, designs, qualification of welders, etc. The assent to and signature upon the manufacturer's data report by the manufacturer's representative constitute a guarantee that the vessel conforms to the requirements of the Code for Unfired Pressure Vessels.

Any local inspection that may be provided in the man-

**If the reinforcement is built up so as to form a ridge with a valley or depression at the edge of the weld next to the plate, the result is a notch which causes concentration of stress and reduces the strength of the joint.

ufacturer's shop must be arranged to function without possible interference with the work of the authorized inspector from the outside and employed under the terms of Section VI. Such local inspection would obviously be operated as a service of the manufacturer to check the employees and make sure that they are carrying out all instructions and the details of this procedure.

VI—Inspection

The manufacturer shall arrange for inspection of the pressure vessels during construction, as provided for in Par. U-65 of the code. The inspector employed for this purpose shall not be in any way connected with the management of the shop performing the welding, but shall be a state or municipal inspector or an inspector regularly employed by an insurance company engaged in boiler or pressure-vessel inspection work.

It shall be the duty of the inspector to check the construction of the vessel to make sure that the provisions of this Recommended Procedure are carried out. He must arrange his inspections covering materials, design, and construction to conform to code requirements, and the qualification of welders to meet the convenience of the supervisor or other representative of the manufacturer, and be prepared to sign the data report furnished by the manufacturer. He must direct particular attention of the manufacturer to the requirements for testing of welded vessels in Par. U-78 of the code.

Inspection of Material. The inspector shall satisfy himself that all material used in the manufacture of a vessel is in accordance with the code requirements, and if he desires he may secure from the manufacturer a written statement to the effect that it is, to the best of his knowledge and belief, in accordance with the code. All parts shall be examined whenever possible before they are assembled as well as after they are applied. Material having injurious defects as referred to or defined in the code shall be rejected.

The inspector shall see that plates are properly stamped before being used. Should the identifying marks be obliterated or plates separated into two or more parts in the process of work, he shall see that such marks are properly transferred under code requirements.

All material shall be gaged or measured to determine whether the thickness meets with the code requirements, due allowance being made for code variations. During the process of manufacturing a vessel, the material shall be inspected for surface defects, cracks, blisters, pit marks, blowholes, or any other defects liable to develop in fabrication, and for excessive hammer marks. If defects are sufficient to materially impair the strength, the vessel shall not be stamped with the code marking. If depressions are found, careful measurement shall be made, and if by reason of the reduced thickness the plate is not weaker than where machined for holes or openings for connections and outlets, it may be accepted, provided that in no case shall a plate be accepted having a depression greater than 15 percent of its thickness and not exceeding 4 inches in its greatest length. Plates that are found laminated shall be rejected.

All cast parts when ready for use shall be carefully examined to determine that the walls are not less than the designed thickness, free from injurious defects, and annealed as required by the code. All lugs, brackets, nozzles, flanges, manhole frames, and other appurtenances shall fit snugly and conform to the curvature of the shell or surface to which they are attached.

After the shell is welded, the inspector shall inspect the welds from the inside and the outside of the shell and record their appearance. Before examining a weld, the outside and inside of the shell shall be struck all along the length of the weld with a hand hammer to break loose the scale. A wire brush shall also be used to clean the surfaces. Double-V welds shall be hammered the same as single-V welds.

In any case low spots in or at the sides of the weld may be filled up as in the case of pinhole repairs. If the low spots are not longer than four times the thickness of the plate, and if they do not go below the surface of the plate, they need not be repaired.

VII—Testing

After welding has been completed and the vessel has cooled and is ready for testing, it shall be given the hydrostatic pressure test as prescribed in Pars. U-65 and U-78 of the code. The water used for testing shall preferably be of a temperature not less than that of the surrounding atmosphere, or at least not under 70 degrees Fahr.

Care shall be taken in filling the vessel to set it up with one of the outlets on top and leveled so that all of the air therein can escape when it is filled with water. A test gage shall be connected to a suitable outlet on the vessel which shall preferably read to approximately double the maximum hydrostatic pressure. The connection to the gage should be fitted with a cock or valve so as to prevent the shock of hammer testing from being communicated to the delicate gage mechanism.

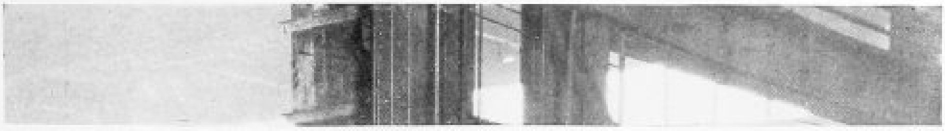
The pressure shall be slowly raised until it meets with the code requirements for the type of vessel under test, and shall be held there long enough to enable the inspector to examine all visible parts. If the tank is entirely free from leaks under these tests, it shall be accepted by the inspector, who shall certify thereto on the data report form. If leaks occur, they may be repaired in the following ways:

Pinholes, except on longitudinal seams, may be calked, filled with a plug not to exceed ¼ inch, or welded by the metal-arc process without preheating, or they may be melted out and rewelded by any process, provided the metal around the pinhole is preheated to a dull red for a distance of at least 4 inches all around it. Any preheating means may be used, such as a flange fire, gas or oil burner, or a welding torch. The preheating should be done slowly, so the heat will get well back into the plate and expand it thoroughly. After welding, the tank should be reheated in the vicinity of such weld until the heat has equalized in the dull red spot, and then slowly cooled.

Pinholes in longitudinal seams must be repaired only by cutting or melting out the defect and rewelding with the above precautions in regard to preheating and reheating, except that with metallic-arc welding, preheating and reheating are not required. Cracks in welds shall only be repaired by cutting out the weld and rewelding the entire seam.

After repairs have been made, the tank shall again be tested in the regular way, and if it passes the test the inspector shall accept it. If it does not pass the test the inspector can order supplementary repairs, or if in his judgment the tank is not suitable for service he may permanently reject it.

L. E. Fries has joined the sales force of the United States Electrical Tool Company, Cincinnati, O., as Cincinnati district manager succeeding R. H. Clare.

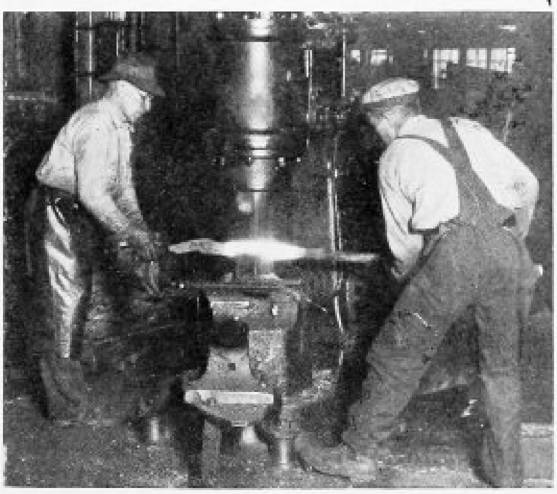


Installing Locomotive Boiler Braces

IN the construction of locomotive boilers, similar methods of procedure are generally followed in American boiler shops, but, depending upon the equipment of each shop and the plant layout, production methods require the most effective use of the machinery or skill available to insure economical and speedy manufacture. Such is the case at The Baldwin Locomotive Works, Eddystone, Pa., where among other buildings is located the world's largest boiler shop. For the past several months, THE BOILER MAKER has published a number of articles describing the layout of the boiler shop at Eddystone, and following the flow of materials through the shop, has given a general outline of the methods employed in the various departments contributing to the manufacture of locomotive boilers.

In the December, 1929, issue, the functions of the shell gang in bay No. 5 were outlined and the boiler barrel with the outside throat sheet and the crown and sides sheet attached was transferred to the finishing floor for completion.

The finishing floor occupies a space in the upper section of the boiler shop and covers three bays, Nos. 2, 3 and 4, and extends between panels 3 and 17 covering an area of 84,480 square feet. At the present time, only bays No. 3 and 4 are utilized for actual production work, bay No. 2 being held for reserve and used for the storage of finished boilers.

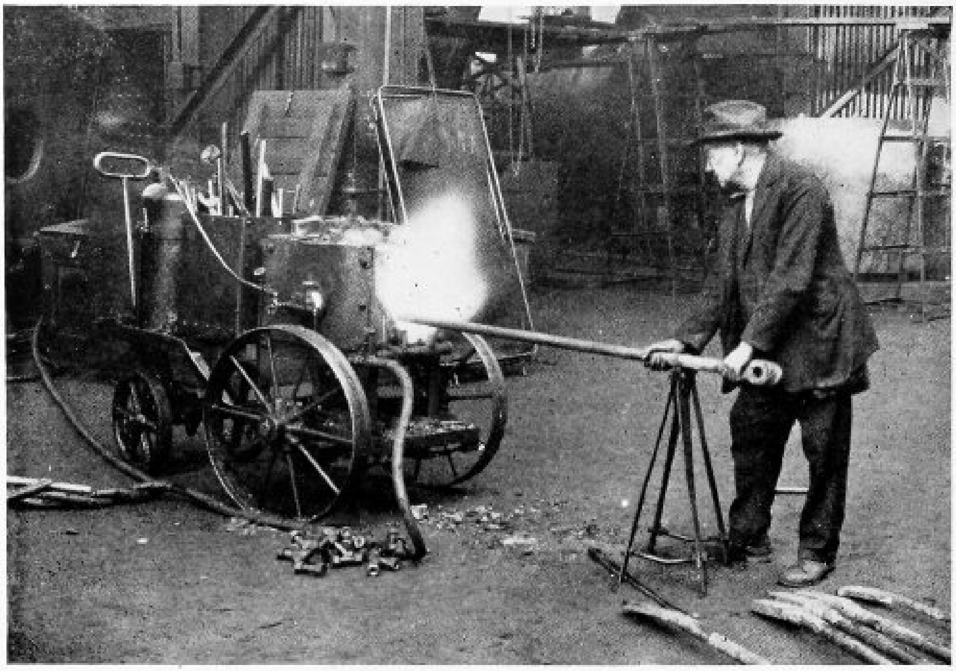


Welding brace ends

Material handling facilities for the finishing floor is of the extremely rugged type to handle the great loads that are required to be moved from place to place. Bays Nos. 2, 3 and 4 are each served by one 70-ton Morgan overhead traveling crane and one 120 to 80-ton Pawling & Harnischfeger crane.

When the boiler barrel arrives on the finishing floor, it is placed upright on steel and wooden horses in such a position that odd rivets in the boiler may be inserted by hand. Although it is desirable to insert all rivets with the aid of hydraulic bull riveters, these riveters have their limitations due to the depth of stake and the awkward locations of some rivets, particularly adjacent to butt straps. For this reason the rivets not applied by the previous departments are inserted by riveters employing hand-operated, pneumatic riveting hammers.

A gang of riveters on this work consists of three men; namely, a riveter, a holder-on and a heater boy. Generally, both the riveter and the holder-on use pneumatic guns but in some cases the solid dolly bar is held by the holder-on. The heater boy, heats the rivets to the proper heat and passes the rivet to the holder-on who inserts the rivet into the hole.



Heating brace ends in a portable oil furnace to facilitate fitting the braces to the shell or top sheet of the boiler. The opposite end of the brace is bolted

The type of rivet-heating furnace employed is of the oil-burning type which may be transported from one place to another. A small furnace of about two feet square and one foot high of refractory brick is mounted on a portable carriage. This carriage is made of angle iron and is mounted with two large wheels in the back and a small wheel in the front. A draw bar is fitted to the front axle to permit transportation. Compressed air from the main shop line is fed to a burner at the side of the furnace by means of the hose and the oil is sucked to the burner from a tank on the carriage beneath the furnace, by means of the compressed air. The oil is vaporized and mixed with sufficient air to cause good combustion.

In fitting backhead braces, two men work on the inside of the boiler and one on the outside applying assembly bolts

Prior to the application of the odd rivets, all rivet holes are reamed by means of pneumatic reamers operated by two men.

The staging employed in riveting and finishing work consists of steel plate, angle and rod horses over which planks are placed.

After the application of the odd rivets, all seams in the barrel and shell connections are calked both on the inside and outside. Round nosed tools in pneumatic calking hammers are employed for this purpose. Butt-straps, however, are not calked with a round nosed tool on the inside but are treated with a flatter tool to prevent the raising of the lap.

After calking, the backhead is installed; this is bolted in place to the top and sides sheet, reamed, riveted and calked. The riveting is done by hand as in the case of odd rivets and the calking is done on the inside flange only. The outside flange is calked after the mud ring is installed.

On completion of the backhead installation, the boiler is ready for the application of braces both to the backhead and front tube sheet. The backhead brace tie irons were previously fitted by the shell gang in bay No. 5 and the crown sheet brace rivet holes, having been previously laid out and drilled by the layout department and the multiple drillers in bay No. 12, are reamed to the required size by the finishing gang. Tee irons on the front tube sheet were fitted by the tube-sheet gang and the front-brace-shell rivet holes, having been laid out and drilled, are reamed by the finishing gang.

Braces, as installed at The Baldwin Locomotive works, are forgings, generally of wrought iron and are made in one, two or three pieces. In the case of the one piece brace or weldless brace, the wrought iron rod is forged in the blacksmith shop in one piece. This type of brace consists of a rod flattened at both ends and drilled with one hole at each end to take a rivet at one end and a pin at the other.

The greater part of the work of manufacturing braces is performed in the blacksmith shop and does not come under the direct control of the boiler maker. That work which is done in the boiler shop consists mainly of welding the various pieces making up the brace and drilling the ends. This work is performed in panels 16 and 17 of bays No. 3 and 4, a department which is equipped with four Nazel hammers, seven radial drills, four shears, one punch and six fires.

Forgings for the various types of brace ends, pads, eyes and jaws are made in the blacksmith shop and are transported to bay No. 4 where the ends are welded as required. Following the welding, the rivet holes, pin holes and bolt holes are drilled on one of the seven hammer sets. This type of machine is similar to the usual radial drills.

Welding as performed in one of the four Nazel-forging hammer is a self contained unit. A motor mounted on the machine drives an air compressor which in turn supplies air for the pneumatic operation of the hammer. Two men operate this machine and the accompanying fire, which is an oil burning furnace with two openings for the insertion of work. Welding consists principally of operations done in two heats. The forged end and the wrought-iron rod are placed in the furnace where the metal is raised to a welding heat. Where required the rod is first removed from the fire and upset by means of striking the end of the rod against a steel block firmly imbedded in the floor. On the second heat the welder takes the rod, the helper the forged end and the two pieces are welded together under the pneumatic Nazel hammer. This hammer has jaws or dies designed according to the desired radius of weld and the weld is finished to a smooth surface under this hammer.

This finishes the operations necessary for the manufacture of two-piece braces. Three-piece braces require four heats as the opposite end of the rod is joined to another forging in a similar manner to that described above. Following the welding operation, the pin, bolt or rivet holes are drilled.

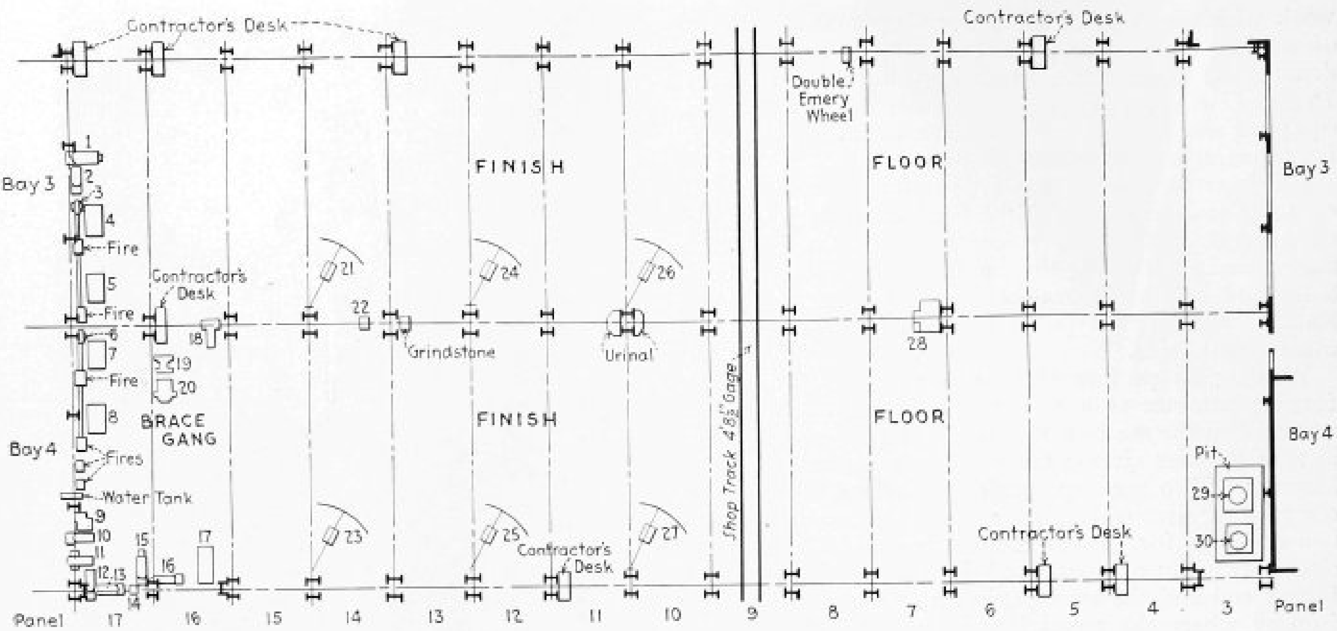
This department handles, in addition to the Baldwin-type brace rod, any that is specified by the various railroads. This gives the brace gang a wide variety of work.

The application of the Baldwin-type boiler brace is accomplished by a gang of three men. The boiler is placed on its side and, with the rivet holes drilled, the braces are ready for application.

In order to secure a perfect fit of the brace all parts which fit to the shell are heated to a red heat and are applied to the boiler. The heating is done in a special oil-burning furnace developed at the Baldwin Works and shown in the accompanying illustration. After heating, the heater-man passes the brace to one of the men inside the boiler who applies the jaw to the brace-tee iron in the backhead or tube sheet, and fits the bolt through the jaws and the tee iron. The other man on the inside fits the heated end of the brace to the shell, inserts the bolts through two of the rivet holes and drives the brace against the shell. The heater-man applies the nut to the shell-brace bolts and heats another brace for application. After bolting the backhead or tube-sheet end of the brace, a cotton pin is inserted in the bolt to

On receipt of the boiler, the odd rivets, which can not be fitted on the bull riveters, are driven by hand

General view of brace welding department showing Nazel hammers at right and radial drills in the background. This department welds, drills and applies braces



Machinery located on the finishing floor in the upper section of bays No. 3 and 4

1—Sellers 60-inch radial drill, motor on machine, direct drive.
2—Harrington 48-inch radial drill, motor on machine, direct drive.
3—No. 5 Sturtevant blower.
4—Nazel Engine & Tool Company No. 2 hammer, air drive, motor on machine.
5—Nazel Engine & Tool Company No. 2 hammer, air drive, motor on machine.
6—Sturtevant No. 6 blower, motor on machine direct drive.
7—Nazel Engine & Tool Company No. 2 hammer, air drive, motor on machine.
8—Nazel Engine & Tool Company No. 2B hammer, air drive, motor on machine.
9—Hilles & Jones No. 2 special shear, motor on machine, direct drive.
10—Harrington 48-inch radial drill, motor on machine, direct drive.
11—Harrington 48-inch radial drill, motor on separate stand, belt drive.
12—Harrington 48-inch radial drill, motor on machine, direct drive.
13—Harrington 48-inch radial drill, motor on machine, direct drive.
14—Hisey-Wolf 4-LA double emery wheel, motor on machine, direct drive.
15—Harrington 48-inch radial drill, motor on machine, direct drive.
16—Harrington 48-inch radial drill, motor on machine, direct drive.
17—Hilles & Jones No. 5, 54-inch punch, motor on machine, belt drive.
18—Hilles & Jones No. 2, 26-inch plate shear, motor on floor, belt drive.
19—Hilles & Jones No. 1 bar shear, motor on separate base, belt drive.
20—Hilles & Jones No. 2 bar shear, motor on machine, direct drive.
21—Baldwin 3-ton hand jib crane with Sellers hydraulic riveter, 21-foot reach.
22—Hisey-Wolf 6-LA emery wheel, motor on machine, direct drive.
23—Baldwin 3-ton hand jib crane with Sellers hydraulic riveter, 21-foot reach.
24—Baldwin 3-ton hand jib crane with Sellers hydraulic riveter, 21-foot reach.
25—Baldwin 3-ton hand jib crane with Baldwin hydraulic riveter, 21-foot reach.
26—Baldwin 3-ton hand jib crane with Baldwin hydraulic riveter, 21-foot reach.
27—Baldwin 3-ton hand jib crane with Baldwin hydraulic riveter, 21-foot reach.
28—Hilles & Jones special rivet shear, motor on machine.
29—R. D. Wood 14-inch by 14-foot hydraulic accumulator.
30—Baldwin 2000-pound hydraulic accumulator.

prevent the nut from loosening. On the shell end, the holes are reamed to size, burrs removed and the pieces riveted. This end is rigidly fitted and the snugness of the fit is such that a feeler gage can not be inserted between the brace and the shell.

Special braces are installed in various manners depending on the type of brace. Some railroads in this country often require the use of a gusset plate with angle connections to the shell and backhead instead of the usual brace rod.

Both fitting and manufacturing braces, with the exception of the blacksmith work, are under the charge of one contractor who orders material for each lot of boilers.

On completion of the installation of braces, the boiler is ready for the installation of the firebox, this process together with the application of staybolts and the smokebox will be outlined in the February issue of THE BOILER MAKER.

Scrubbing Acetylene Gas

"CANNED" acetylene gas comes fully cleaned and ready for use, but the shop-made article should be well washed before it is used in a welding torch. In some shops, the home-made gas is piped to the point of use and is there passed through a washing device before being permitted to go to the welding or cutting torches. This method requires the use of as many washing, or scrubbing devices as there are torches in operation and it is not a very economical method. It is far better to put in one larger washing device and cleanse the gas before it flows to the storage tank.

The Chicago headquarters of the American Cable Company have been moved to the recently completed Chicago Daily News Building, 400 West Madison street, Chicago, Ill.

Standardizing Boiler Tools*

Master boiler makers consider advantages of having uniform designs for taps, reamers, expanders and other small tools

As a general proposition, the results of standardization of boiler tools would be very beneficial, the benefits being two—namely, reduction in price by manufacturers due to being able to put the tools in quantity production instead of making special tools for various railroads and, secondly, in being able to procure the tools quickly in case of emergency as the manufacturers could stock the tools as they are unable to do at the present due to possibility of loss.

Beading Tools.—Beading tools can be standardized as there is so little difference in the many so-called standards. When beads are finished they are all similar, variations being only a sixty-fourth and thirty-second of an inch. In our opinion a standard tool for small tubes and one for superheater flues can be agreed upon which would meet general approval.

Fig. 1, represents one type used by one locomotive builder.

Fig. 2, is a type used by many class-one railroads,

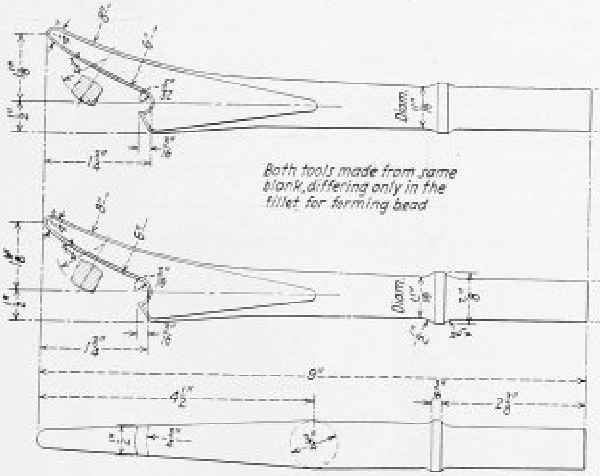


Fig. 1.—Beading tools for tubes and superheater flues

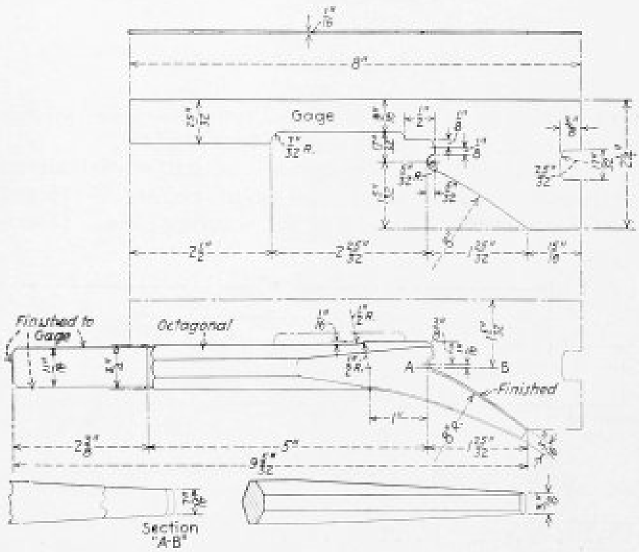


Fig. 2.—Broad heel beading tool and gage

and we believe it is the ideal tool, having a broad heel. There are many more types we might list but they are so nearly alike we considered it unnecessary.

A great many railroads are welding all flues in fireboxes. This will have a tendency to bring about a standard for this class of work. We believe that 5/32-inch radius for small tubes and 3/16-inch radius for superheater flues is good practice.

Flue Rollers.—Flue rollers of the self-feed design with 1½-inch reach to insure the complete setting out of the flue back of the heaviest sheet is proper. At present manufacturers are making almost uniform rollers with the exception that some are still making short-reach rolls. The collar roll is one most generally used. Where rolling of back end is desired a roller expander to recess flue is used by many. Our recommendation for this tool is as above stated, long-reach, self-feed roller.

Expanders.—Expanders at present are made unless otherwise ordered, with little variation by most all manufacturers in this line of work. A standard for this tool can be worked out very easily we believe, with the exception of reach, where the thickness of the tube sheet would govern.

The eight sections for small tubes, and twelve sections for superheater flues with the eight and twelve flat-sided pin to insure equal distribution of sections on flue is, in our opinion, the correct type of expander for general use. In connection with this we believe the quick-action knock-out tool should be mentioned, as this saves time and also the tool.

We believe that a suitable expander for setting copper ferrules in tube sheet is worthy of mention. We are submitting in Fig. 3, an expander which has been used by one member of your committee for several years and we think it is the correct tool for properly setting ferrules. Note please, when copper is set and expanded, it is not over-worked and is ⅛-inch larger at receiving side of ferrules than flue fit, this securely sets copper in counterbore in sheets on both sides and it is almost impossible to move copper in sheet.

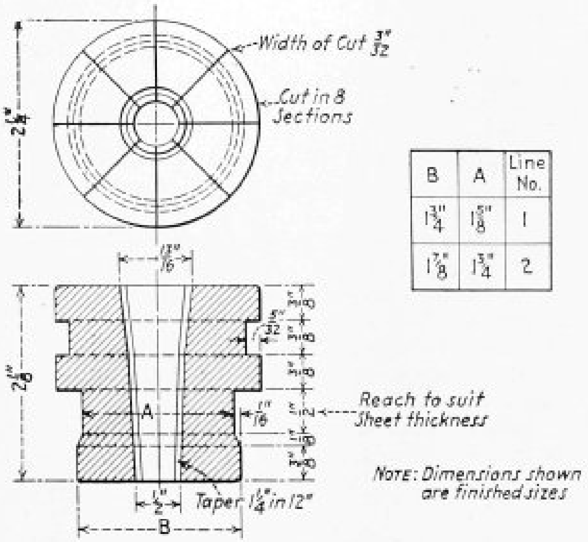
Taps.—Staybolt taps are now made almost uniform in length, flutes and tolerance unless otherwise ordered. Types of thread being U. S. Standard, Whitworth or V thread. While all are in general use throughout the country, we believe that the U. S. S. type of thread is ideal for boiler work, as it is sharp enough. Other types have their merits, but we believe the sharp V and the dull Whitworth are the extremes and the U. S. S. the correct medium. Maximum tolerance should be 0.003 over and none under. Reliable tap and bolt gages should be used to insure standard sizes.

Lengths of popular demand are 20 inches, 24 inches and 27 inches. For ordinary staybolt application we

* Report presented at the twentieth annual convention Master Boiler Makers' Association.

believe that approximately 24 inches is correct length.

For flexible application we are showing in Fig. 4, one style tap used by several railroads. Some builders use similar taps. For tapping through sleeves, a brass collar can be used which insures perfect alinement of bolt threads. As to spiral or straight flutes we see very little choice except the straight flute is easier to make up and also to grind. In several tests they have proven about equal, with the spiral leading slightly.



B	A	Line No.
1 3/4"	1 5/8"	1
1 7/8"	1 3/4"	2

Fig. 3.—Sectional expander

Fig. 5, shows the pilot-radial and half-radial tap or wagon-top tap. This tap has been recently developed with 3/8-inch pipe thread teet for securing pilot. This is an improvement over the standard thread teet which always held pilot rigid and when tap was dropped or received a sudden jar, teet broke off making tap useless. With 3/8-inch pipe thread an ordinary straight 3/8-inch pipe coupling and pipe to suit, makes this an ideal tap for wagon-top tapping, and tap will never be scrapped on account of broken teet.

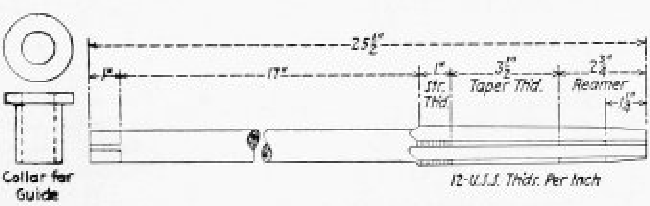


Fig. 4.—Flexible staybolt tap in common use

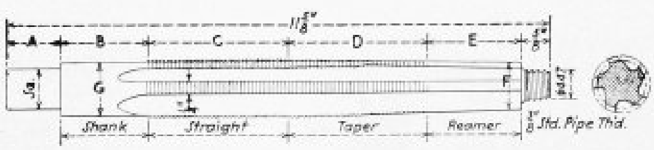


Fig. 5.—Wagon-top pilot radial tap

TABLE OF WAGON-TOP PILOT RADIAL TAP SIZES

Size	Square	A	B	C	D	E	F	G	No. flutes
1"	5/8"	3/4"	2 1/4"	2"	4"	2"	13/16"	7/8"	5
1 1/16"	5/8"	3/4"	2 1/4"	2"	4"	2"	7/8"	7/8"	5
1 1/8"	3/4"	1"	2"	2"	4"	2"	15/16"	1"	5
1 3/16"	3/4"	1"	2"	2"	4"	2"	1"	1"	5
1 1/4"	3/4"	1"	2"	2"	4"	2"	1 1/16"	1"	5
1 5/16"	7/8"	1 1/8"	1 7/8"	2"	4"	2"	1 1/8"	1 3/16"	5
1 3/8"	7/8"	1 1/8"	1 7/8"	2"	4"	2"	1 3/16"	1 3/16"	5

Figs. 6 and 6A, show a combination radial and staybolt tap where combination radial and staybolt application is desired. This table shows variations to suit application.

Fig. 7, shows the 1½-inch taper-crown radial tap, where 1½-inch taper driven crown radials are to be applied, (and we believe they are proper for locomotive boilers). By use of this tap all sizes on all engines can be made from this one type of tap, as it taps all holes from 1⅛-inches to 1 7/16-inches. A suitable reamer can be made from worn out taps which will make an ideal reamer to accomplish tapping by simply grinding off thread which is dull and worn, or the high-speed reamer shown may be used.

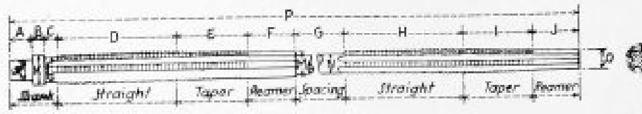


Fig. 6.—Combination radial staybolt tap

TABLE OF COMBINATION RADIAL STAYBOLT TAP SIZES

Size	Square	No. flutes	A	B	C	D	E
1" x 1 1/8"	3/4"	5	1"	1/2"	1/2"	5"	4"
1 1/16" x 1 3/16"	7/8"	5	1 1/8"	1/2"	3/8"	5"	4"
1 1/8" x 1 1/4"	7/8"	5	1 1/8"	1/2"	3/8"	5"	4"
1" x 1 1/8"	3/4"	5	1"	1/2"	1/2"	5"	4"
1 1/16" x 1 3/16"	7/8"	5	1 1/8"	1/2"	3/8"	5"	4"
1 1/8" x 1 1/4"	7/8"	5	1 1/8"	1/2"	3/8"	5"	4"
1" x 1 1/8"	3/4"	5	1"	1/2"	1/2"	5"	4"
1 1/16" x 1 3/16"	7/8"	5	1 1/8"	1/2"	3/8"	5"	4"
1 1/8" x 1 1/4"	7/8"	5	1 1/8"	1/2"	3/8"	5"	4"

Table continued

F	G	H	I	J	K	L	M	N	O	P
2"	0"	5"	4"	2"	1 1/8"	1"	1"	7/8"	7/8"	24
2"	0"	5"	4"	2"	1 3/16"	1 1/16"	1 1/16"	15/16"	15/16"	24
2"	0"	5"	4"	2"	1 1/4"	1 1/8"	1 1/8"	1"	1"	24
2"	6"	5"	4"	2"	1 1/8"	1"	1"	7/8"	7/8"	30
2"	6"	5"	4"	2"	1 3/16"	1 1/16"	1 1/16"	15/16"	15/16"	30
2"	6"	5"	4"	2"	1 1/4"	1 1/8"	1 1/8"	1"	1"	30
2"	12"	5"	4"	2"	1 1/8"	1"	1"	7/8"	7/8"	36
2"	12"	5"	4"	2"	1 3/16"	1 1/16"	1 1/16"	15/16"	15/16"	36
2"	12"	5"	4"	2"	1 1/4"	1 1/8"	1 1/8"	1"	1"	36

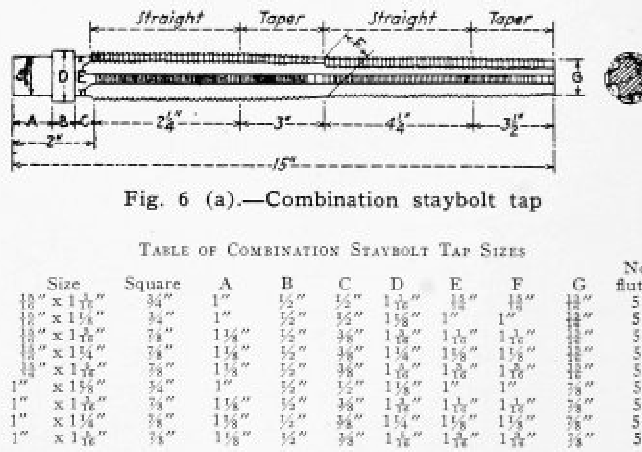


Fig. 6 (a).—Combination staybolt tap

TABLE OF COMBINATION STAYBOLT TAP SIZES

Size	Square	A	B	C	D	E	F	G	No. flutes
15/16" x 1 1/16"	3/4"	1"	1/2"	1/2"	1 1/16"	15/16"	15/16"	13/16"	5
15/16" x 1 1/8"	3/4"	1"	1/2"	1/2"	1 1/8"	1"	1"	13/16"	5
15/16" x 1 3/16"	7/8"	1 1/8"	1/2"	3/8"	1 3/16"	1 1/16"	1 1/16"	13/16"	5
15/16" x 1 1/4"	7/8"	1 1/8"	1/2"	3/8"	1 1/4"	1 1/8"	1 1/8"	13/16"	5
15/16" x 1 5/16"	7/8"	1 1/8"	1/2"	3/8"	1 5/16"	1 3/16"	1 3/16"	13/16"	5
1" x 1 1/8"	3/4"	1"	1/2"	1/2"	1 1/8"	1"	1"	7/8"	5
1" x 1 3/16"	7/8"	1 1/8"	1/2"	3/8"	1 3/16"	1 1/16"	1 1/16"	7/8"	5
1" x 1 1/4"	7/8"	1 1/8"	1/2"	3/8"	1 1/4"	1 1/8"	1 1/8"	7/8"	5
1" x 1 5/16"	7/8"	1 1/8"	1/2"	3/8"	1 5/16"	1 3/16"	1 3/16"	7/8"	5

Fig. 8, shows ¾-inch taper 12-T thread boiler taps for general work of sturdy design from ⅝-inch to 1¾-inches. Sixteenth and thirty-second-inch sizes can be developed if required, but all sizes can be worked from figure shown.

Flexible staybolt taps and reamers are at present pretty well standardized. Fig. 8, shows type of taps in general use. As many roads are now applying the welded sleeves, these tools will give way to special tools of new design of high-speed steel for reaming, countersinking and welded application.

Washout plug taps are shown in Fig. 9. These are the individual taps, one for each plug. The advantage of this is that each tap is worn out individually all the way; as with the ordinary tap having three and four sizes on it, usually one size is worn out then the tap is scrapped. Three-quarter inch taper is correct for washout plugs.

Fig. 10, shows standard spindle tap. This tap is so familiar to most that comment is unnecessary.

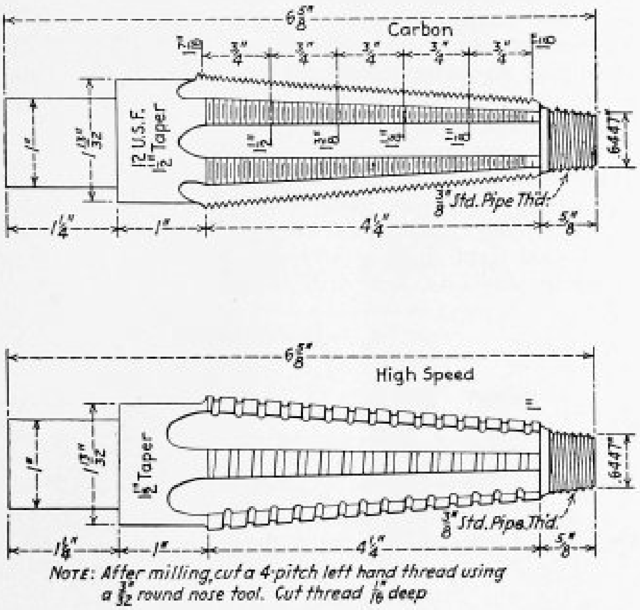


Fig. 7.—Taper-head radial tap and reamer

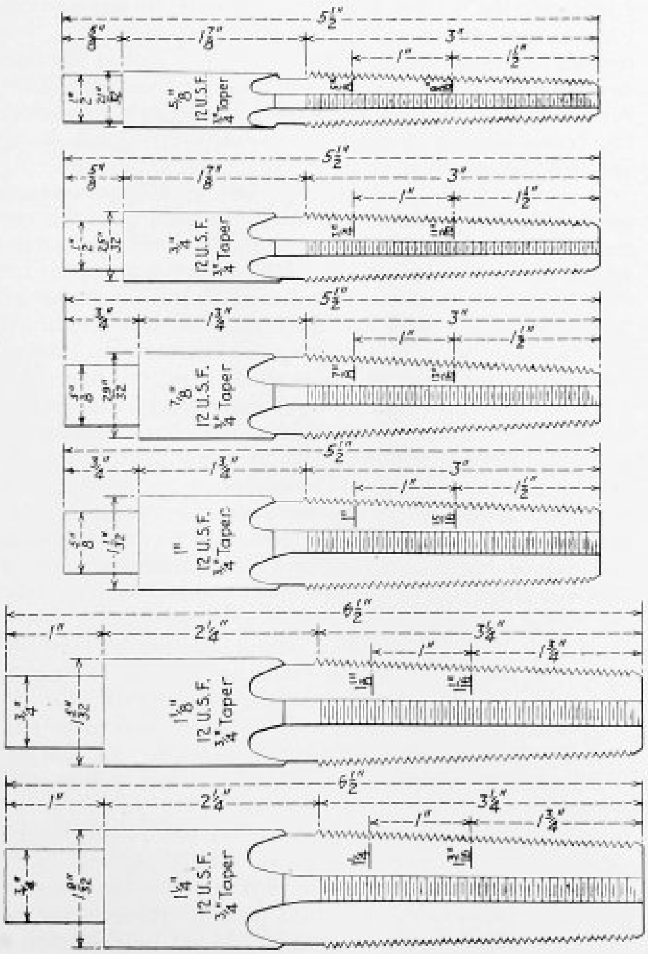


Fig. 8.—Taper boiler taps (4 flutes)

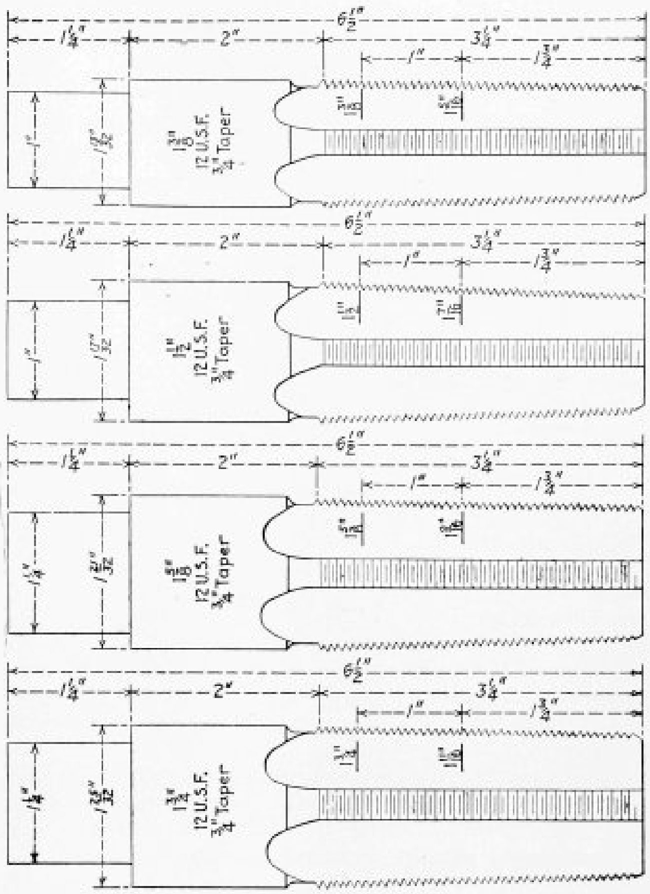


Fig. 8. (Cont.)—Taper boiler taps (4 flutes)

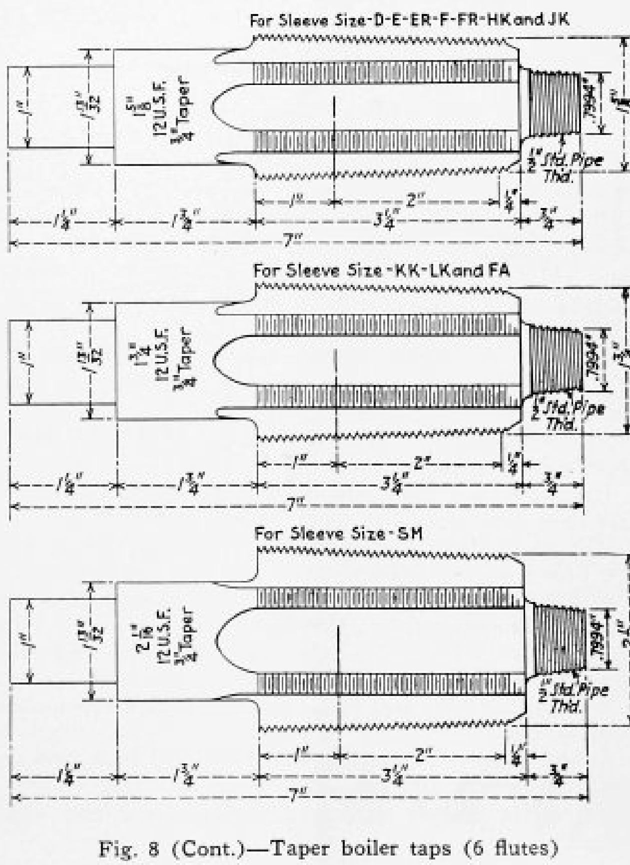
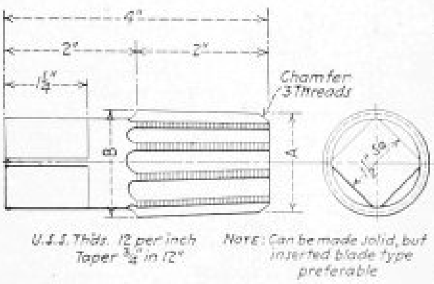


Fig. 8 (Cont.)—Taper boiler taps (6 flutes)

Reamers.—All reamers for boiler work above 9/16 inch should be high speed and spiral fluted. The taper for the entering point should be ¾ inch in 12. This taper should extend back ⅓ of length, except in the case of reamers for mud rings of extra thickness, when



B	A	Line No.	B	A	Line No.
			2"	1⅞"	0
2 11/16"	2 9/16"	11	2 1/16"	1 15/16"	1
2¾"	2⅝"	12	2⅛"	2"	2
2 13/16"	2 11/16"	13	2 3/16"	2 1/16"	3
2⅞"	2¾"	14	2¼"	2⅛"	4
2 15/16"	2 13/16"	15	2 5/16"	2 3/16"	5
3"	2⅞"	16	2⅜"	2¼"	6
3 1/16"	2 15/16"	17	2 7/16"	2 5/16"	7
3⅛"	3"	18	2½"	2⅜"	8
4"	3⅞"	19	2 9/16"	2 7/16"	9
4¼"	4⅛"	20	2⅝"	2½"	10

Fig. 9.—Washout plug taps

the straight end reamer should be of a length to suit. Driving end should be Morse taper and "use-em-up" shank. Sizes under 9/16 inch should be straight shank for adjustable chuck of No. 1 Morse; 9/16 inch to ¾ inch, No. 2; 13/16 inch to 1 1/16 inches, No. 3; 1⅛ inches to 1⅝ inches, No. 4; 1 11/16 inches to limit No. 5. This size is to be used on all unusually heavy work. All reamers should have "use-em-up" flat to insure full measure of wear on tool.

Pneumatic Hammers.—Pneumatic hammers should be classified after being tested out and assigned a shop and department working number, and service entry date, stamped plainly on hammer with 3/16-inch or ¼-

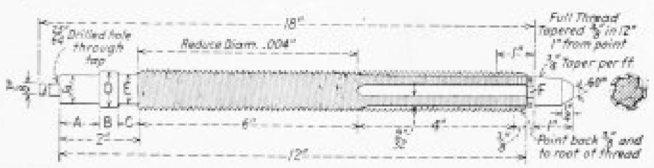


Fig. 10.—Spindle staybolt taps

TABLE OF SPINDLE STAYBOLT TAP SIZES

Size	Square	A	B	C	D	E	F	No. flutes
15/16"	¾"	1"	½"	½"	15/16"	13/16"	13/16"	5
1"	¾"	1"	½"	½"	1"	⅞"	⅞"	5
1 1/16"	¾"	1"	½"	½"	1 1/16"	15/16"	15/16"	5
1⅛"	¾"	1"	½"	½"	1⅛"	1"	1"	5
1 3/16"	⅞"	1⅛"	½"	⅜"	1 3/16"	1 1/16"	1 1/16"	5
1¼"	⅞"	1⅛"	½"	⅜"	1¼"	1⅛"	1⅛"	5

inch numbers. Shop number should be 5/16-inch or ⅜-inch high for easy checking, as follows:

Chippers and Calkers.—For hot work in roundhouse, scaling boilers and general cleaning up work use 1 1/16-inch by 1-inch and 1½-inch chippers.

For light chipping, medium calking on general work, use a tool, 1 1/16 inches by 2 inches and 2½ inches.

For medium heavy chipping, calking of flues and general shop work use a tool 1 1/16 inches by 3 inches.

For extra heavy chipping and calking use a tool 1 1/16 inches by 3½ inches.

For special for expanding flues in roundhouse on washouts and monthly inspections, ash pan work, cutting off ⅜-inch and ½-inch rivets on tanks and cabs and driving ½-inch hot rivets on ash pan and ⅜-inch cold rivets on cabs and steel cars use a tool 1 1/16 inches by 4 inches.

Long Stroke Hammers.—No. 50 or 5-inch stroke, tanks, steel cars, and cab work up to ⅝ inch.

No. 60 or 6-inch stroke, staybolt driving and light riveting.

No. 80 or 8-inch stroke for flue expanding, driving crown radials and ¾-inch and ⅞-inch rivets.

No. 90 or 9-inch stroke, for all classes of general heavy boiler work, double gunning, rivets ⅞ inch and larger, backing out of all rivets ¾ inch and larger, laying up patches and flanges and expanding superheater flues. Heavy duty No. 90 with 1⅛-inch plungers are capable of cutting off and backing out heavy rivets and bolts and stripping work. The self-supporting No. 90 hammer is also a very valuable tool for holding on and setting up rivets on barrels, casing sheets and mud rings.

Motors.—Motors to be classified and numbered same as air hammers, as follows:

Piston grip small turbine or toggle motor with adjustable chuck to be used for tell-tale hole work only, 3/16-inch drill. Breast motors with No. 1 Morse socket or adjustable chuck to be used for cab and sheet-iron work and light drilling and countersinking of telltale holes in staybolts, size drill from ¼ inch to ½ inch.

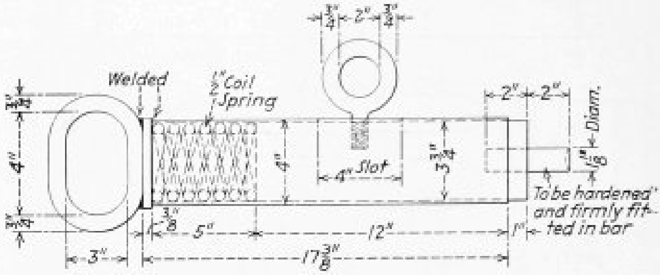


Fig. 11.—Spring bar with teet for holding-on rigid and flexible staybolts

Light motors with No. 2 Morse socket to be used for general tank sheet and tank patch application, and light drilling from 17/32 inch to 23/32 inch. Medium motors with No. 3 Morse socket, speed from 160 to 200 revolutions per minute to be used for general shop drilling from ¾ inch to 1 1/16 inch reaming up to 1 1/16 inches for staybolt tapping.

We recommend speed from 180 to 200 revolutions per minute for carbon tap. For flue rolling we recommend a higher speed motor with No. 3 Morse socket, speed from 250 to 300 revolutions per minute of reversible type. A heavy motor with No. 4 Morse socket to be used for drilling, reaming and tapping above 1 1/16 inches to 1⅝ inches, tightening up crown radials, flexible staybolt caps, rolling superheater flues with power rigging and other work above capacity of the motor with No. 3 socket. No. 5 socket motors to be used for flexible staybolt sleeve reaming and tapping above 1⅝ inches to limit. These motors are also adapted to removing of flexible caps and cutting off superheater flues with power rig in front end, reaming and tapping for special heavy work such as application of special washout plug bushings which many roads are now applying to their boilers. The corner or close quarter motor, reversible with No. 3 and No. 4 Morse "use-em-up" socket is indispensable on boiler work for rolling of arch tubes, reaming and tapping in close quarters.

Spring Bars.—We understand this has reference particularly to bars for holding on staybolts. In the majority of shops most of the staybolt driving is done with the boiler or firebox in upright position.

Where bars are to be suspended we recommend a spring bar as shown in Fig. 11. This plunger is reversible and can be used either for rigid or flexible staybolts by removing eye bolt and turning plunger around. The teet which extends from machined hole in end of bar is inserted inside of spring, eye bolt is replaced and bar is ready for rigid staybolts. For the flexible staybolt the 1⅛-inch teet is machined to fit the bolt head. An ordinary old flexible D-cap is cut out and welded in a piece of 1¼-inch diameter pipe to guide the teet squarely onto the head of the bolt while driving. The holder-on has three of these old D-caps, which are charged while the bolt is being driven. The weight of the plunger is about 40 pounds, and it is made from a 3½-inch to 3¾-inch old piston. A ½-inch coil spring is used to back up the plunger. The body of the bar is made from an old 4-inch flue with ⅜-inch plate and handle welded on. Where boilers are turned, hook and sledge, air jack, or self supporting hammers may be used to drive both ends of hollow staybolts at the same time.

Fig. 12 shows carrier complete for holding up bars, motors, and any other appliances which need to be suspended. This is made up in the shop and takes the place of chain falls, balancers and other expensive tools.

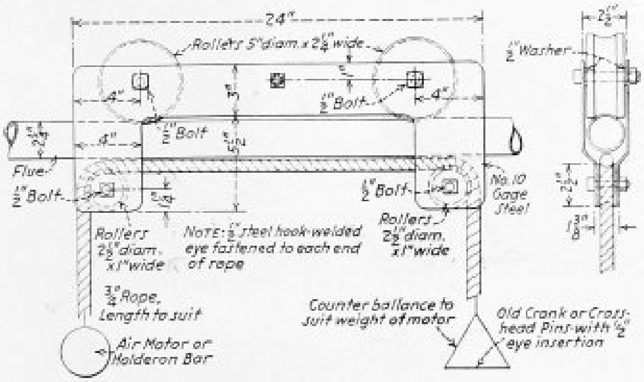


Fig. 12.—Carrier for bars and motors

This has been tried out in one of the largest shops for a period of six years and has proved itself a very valuable tool. Such a carrier can be made up and put on a 2-inch or 2¼-inch flue of desired length, belled out with the ends of the flue so the carrier will not come off. Counterweights to suit motors of various sizes and bars may be used. These carriers together with flue, rope, hooks and counterweights can be kept in a convenient place on rack in shop. Counterweights may be made up from small scrap, crank or crosshead pins with ⅜-inch or ½-inch ring inserted to hook on for safety.

In submitting the foregoing report we are taking into consideration the fact, that the subject is not complete with our recommendations and will in our opinion require more research in the future. Many different methods are used for doing boiler work in shops throughout the country. Where special requirements must be met, special tools necessarily must be utilized.

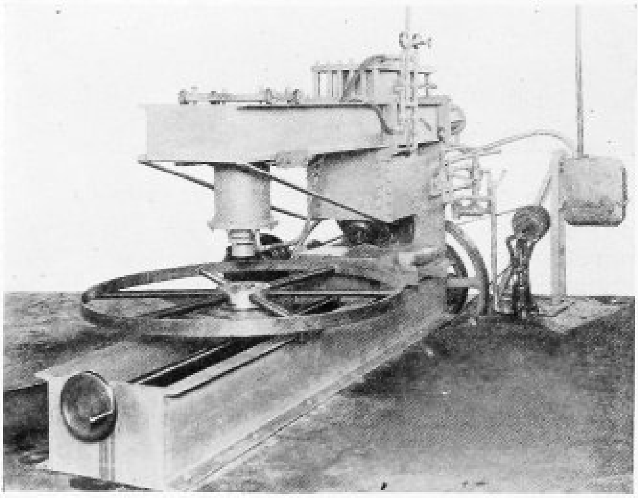
Your committee has been supported in this topic by a committee from the American Railway Tool Foremen's Association, with A. A. Ferguson, chairman, tool supervisor of the Missouri Pacific Railroad; E. J. McKernan of the Santa Fe and Messrs. Shaffer, Dolensky and Burke.

Quite a bit of investigation has been done by the Tool Foremen's Association in conjunction with the tap manufacturers and the Boiler Makers' Association, and recently the American Society of Mechanical Engineers has agreed to take up this work in conjunction with their Technical Committee No. 12 of the Sub-Committee No. 3 on Small Tools and Machine Tool Elements.

This report was prepared by a committee composed of W. N. Moore, chairman, J. A. Graulty and I. J. Poole.

Flanging Machine Equipped with Roller Bearings

THE Blue Valley Machine and Die Works, Kansas City, Mo., has recently announced a new type of Timken bearing equipped flanging machine, which incorporates several interesting features. The machine has been developed for flanging boiler and tank heads either flat, bulged, concave, round, or square, but it can easily be adapted for work on special

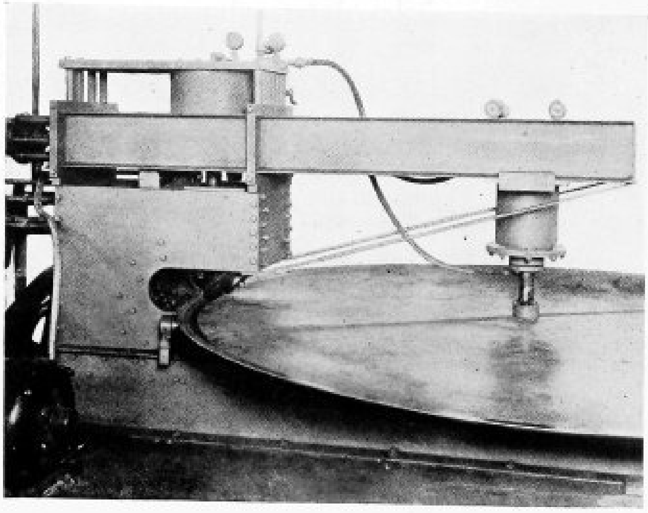


General view of high-speed flanging machine

shapes. The entire line includes four standard machines for use on material 24 gage to ¼-inch, 24 gage to ⅜-inch, 24 gage to ½-inch, and 16 gage to ¾-inch plate, respectively. All the machines will take heads 18 inches to any diameter, and can be supplied with special attachments to take those of smaller diameter. One of the interesting features of the machine is the speed with which it operates. As an example, the machine rolled a flange 2½ inches deep on a flat head of ¼-inch plate, 12 feet in diameter, in one minute from the time it was set up and started.

The body is built of steel plate, cut to shape and firmly bolted together. The two extension members, one of which carries the center hold-down and its air cylinder, and the other the supporting spider, are made of heavy channel sections, the ends being formed of steel plates butt welded to the sections. The upper member is braced by two heavy straps running from the end to the main frame, and welded in place. The supporting spider is also of welded construction, the run consisting of a heavy strip rolled to shape, and butt welded. The spokes are of seamless tubing, set in holes drilled in the hub, and welded to the rim.

The flanging mechanism is mounted in the main frame and is quite simple in its construction. The high-speed spinning process is used, the flange being bent up instead of down. The mechanism proper consists of two working rolls and a spinning roll, the latter being the only driven roll. The two working rolls consist of an upper, 45-degree roll, and a segment or flanging roll. The former is mounted on a stub shaft on the extension of the plunger of a compressed air cylinder, which serves to raise and lower it. The segment roll is mounted on a carriage which fits in curved guides on the sides of the body, which permit it to be moved so



Close-up showing the flange spinning operation

as to bring the roll face to any angle up to 90 degrees with the working face of the 45-degree roll. This movement is controlled by a two-way hydraulic cylinder. Both of these rolls are mounted in Timken bearings.

The spinning roll is driven by back gears from a counter-shaft, which in turn is driven through a silent chain by a 10-horsepower and up squirrel-cage induction motor. Both the roll spindle and the counter shaft are mounted in Timken bearings. The motor also drives the pump which supplies hydraulic pressure for moving the segment roll.

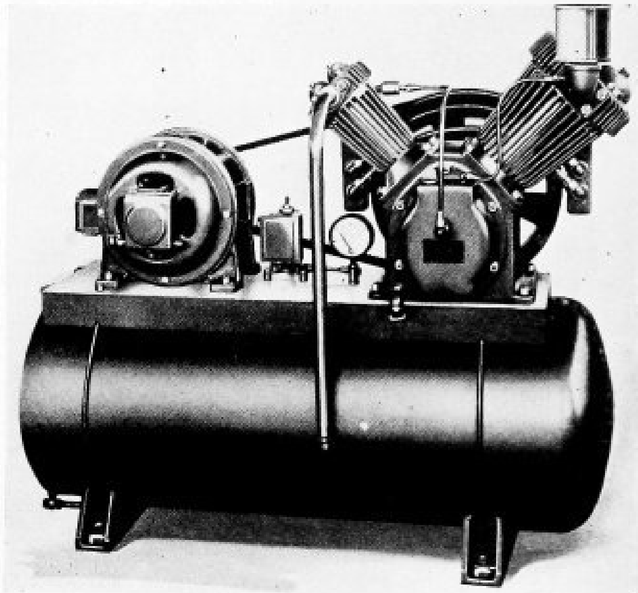
In operation the plate to be flanged is placed on the supporting spider, the position of the latter being adjusted manually by an endless screw which moves the carriage along the guides. The center hold-down is brought into position over the plate, and the plunger forced down by compressed air. The pressure is sufficient to hold the plate in position with no possibility of slippage. Starting the motor causes the plate to revolve at which time the 45-degree roll is lowered to the working position, and the segment, or flanging roll brought up to the required angle by hydraulic pressure. All of these operations are performed through a centralized group of controls, whose position is such that the operator has a clear view of the work at all times. When the flange is completed the working rolls and center hold-down are backed off, releasing the plate, and the motor is stopped, the finished plate being removed from the machine. It is claimed, that, as a result of the roll arrangement and control, flanges are made with no sign of distortion or wrinkling in the finished head, despite the speed with which the operation is performed.

TYPE-T METAL.—The Fusion Welding Corporation, Chicago, Ill., has announced the introduction of Type-T metal in a four page bulletin. Type-T metal is a new alloy furnished in the form of welding rod for applying a highly wear resistant surface by either the oxy-acetylene or metallic arc welding processes. It generally outwears the next hardest surfacing material by two to one or better. Its development is the direct result of investigation into the theory of abrasion by the company's research department. Heretofore hardness has been the only factor considered. Type-T metal is not only as hard or harder than other alloys, but in addition possesses ductility which gives to it very unusual properties. Industrial losses through wear are enormous and Type-T metal welding rods effect substantial savings.

Air-Cooled Compressors

THE Ingersoll-Rand Company has announced a new line of air-cooled, two-stage air compressors, known as the Type 30. V-type belt drive is employed. Both motor and compressor have ball bearing.

The units are self-contained, the motor and compressor being mounted on a steel base, which is attached to the top of the air receiver. The latter, which is made of heavy pressed steel, is built to withstand a working pressure of 200 pounds. With this arrangement, no special foundation is required for correct alinement of the compressor and motor. The intercooler is located



Automatic start and stop compressor

behind the fan-type flywheel, and a constant current of circulating air is driven directly across the cooling coils. This reduces the temperature of the discharge air.

Automatic start and stop control, furnished as standard equipment, operates independently, but in conjunction with the unloader. When the pressure in the air receiver reaches a point at which the regulator is set to unload, the motor is automatically shut off. A centrifugal governor allows the air in the high-pressure cylinder and intercooler to exhaust through the crankcase. This prevents the compressor from starting against a load.

It is claimed that this improved two-stage design reduces power from 10 to 30 percent. At the same time, less floor space is required. It is built in four sizes: 3/4, 1 1/2, 3, and 5 horsepower. All sizes are built for a working pressure up to 200 pounds continuous duty. These compressors are fully described in Bulletin 3060 now being distributed by the Ingersoll-Rand Company, 11 Broadway, New York, N. Y.

SAND-BLAST MACHINES.—The Macleod Company, engineers and machinists, Cincinnati, O., has issued a bulletin covering a number of hose sand-blast machines for cleaning boiler flues. These machines come in a number of sizes for both stationary and portable use. By using a nozzle of special construction, water is ejected at the same time as the sand thereby preventing dust arising.

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.

Below are given records of the interpretations of the committee in Cases Nos. 637-641, inclusive, as formulated at the meeting on October 25, 1929, all having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 637. *Inquiry:* Can the manufacturer of safety valves stamp thereon a size greater than the inlet and stamp the valve A. S. M. E. Standard?

Reply: It is not permissible to mark a safety valve a size greater than the nominal initial base inlet diameter required under Par. P-273*b*. This diameter must be at least equal to the inside diameter of the nominal-size pipe required for the particular pressure.

CASE No. 638. *Inquiry:* Is it necessary, under the requirements of Par. P-317 of the code, that check valves and stop valves be inserted between an economizer and the boiler to which it is connected, where the economizer is so arranged that there is a free flow of water or of steam and water from economizer to the boiler?

Reply: Where an economizer is connected directly to the boiler without intervening valves, it shall be considered as part of the boiler and the construction thereof should conform with Power Boiler Rules. The feed valves and check valves shall in such an arrangement be placed on the inlet of the economizer.

CASE No. 640. *Inquiry:* Is it permissible to weld the flanged-in edges of the firedoor opening of a vertical tubular boiler where no staybolts are used between the furnace and outside sheet around the door opening because the furnace is of the corrugated self-supporting type?

Reply: Par. P-186 of the code is mandatory in its requirement for staybolting or other form of support around the door-hole opening in case the flanged-in edges of the plates are welded. The use of this form of construction without staybolting or other equivalent method of support for the sheets adjacent to the opening will therefore not meet the requirements of this paragraph.

CASE No. 641. *Inquiry:* Is it permissible, under the requirements of Pars. P-197 and U-38 of the code, for manufacturers to furnish dished heads with the radius of dish 6 inches less than the nominal outside diameter of head, considering that present standard diameters starting at 30 inches and increasing in increments of 6 inches have their dishing radius the same as nominal diameter of the head?

Reply: Pars. P-195 and U-36 of the code do not require that the dishing radius must be the same as the nominal diameter of the head, and it may be made less than this if desired.

Marine Boiler Designed for Dual Firing

By G. P. Blackall

FOR some time past the firm of Cochran & Company (Annan), Ltd., has been engaged in designing a special watertube vertical boiler which can be simultaneously employed for oilfiring and the recovery of waste heat from the exhaust gases of marine oil engines. The first boiler of this type was recently installed on the motor vessel *Sheaf Holme*.

The propelling machinery of this vessel comprises a three-cylinder opposed-piston oil engine, with a designed output of 1500 shaft horsepower.

This boiler is furnished with two upper nests of tubes for waste-heat recovery and a lower nest of tubes for oil firing, the latter being in direct communication with the furnace. All the tubes are secured between two common tube plates. The two upper nests are furnished with 1½-inch external diameter tubes, there being 311 tubes and 41 stay tubes in the top nest and 297 tubes and 55 stay tubes in the second nest, making a total of 704 tubes with about 1390 square feet of heating surface for the waste-heat recovery. The oil-firing portion of the boiler is fitted with 102 tubes and 29 stay tubes, each of 2½ inches external diameter, with a total heating surface of about 500 square feet. The grate area is 41 square feet and the designed working pressure is 120 pounds per square inch. The oil burner is of the Wallsend low-pressure air type.

As installed in the *Sheaf Holme*, the boiler is furnished with two separate funnels, so that the waste gases from the heat-recovery part of the generator and the oil-fired portion are kept entirely separate. The arrangement is such that it is claimed that the possibility of an explosion being caused through the ignition of an oil vapor and air mixture within the furnace or flues by the heat of the exhaust gases is avoided.

Lancashire Boilers Designed for Higher Pressures

(Continued from page 4)

furnace tube, ample in fact to take up a total longitudinal expansion of ½ inch without any appreciable movement at the root of the flanges. This enables the flue tubes to breathe in unison with the boiler shell, which prevents leakage at the front end and at the flue seams and is claimed to entirely eliminate grooving in the end plates and flue rings. In addition there is less strain on the riveted joints, greater accessibility to the bottom of the boiler owing to the additional space between the tubes and increased efficiency of heating surface owing to the flames being forced to impinge on the flue rings.

As regards the end construction, Fig. 4 shows a good system involving an external ring riveted to the shell and to the end plates, while Fig 5 shows the back end plate construction of these same boilers.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Rolling One-Piece Locomotive Boiler Crown and Sides Sheet

Q.—Please find attached a sketch of a firebox with crown and sides and combustion chamber in one piece. Would you be kind enough to furnish me with information regarding this type of firebox. Can it be rolled in a pinch roll? If so, I would like to know the method used. A.H.M.

A.—The following method is used in rolling the crown and sides on fireboxes having combustion chambers.

Figs. *1* and *2* illustrate the crown and sides and combustion chamber as submitted in the question. The first operation is to roll the bottom of the combustion chamber as designated by *A-A* in Fig. 2. This is done with

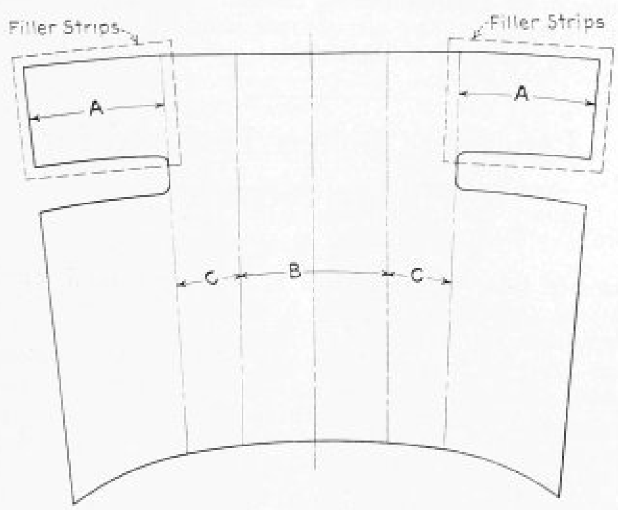


Fig. 1

the use of filler strips as illustrated in Figs. 1 and 3. The filler strips are generally ⅜-inch thick and a sufficient number are used, so that the crown and sides will pass freely through the rollers, the filler strips and combustion chamber being rolled to the desired diameter.

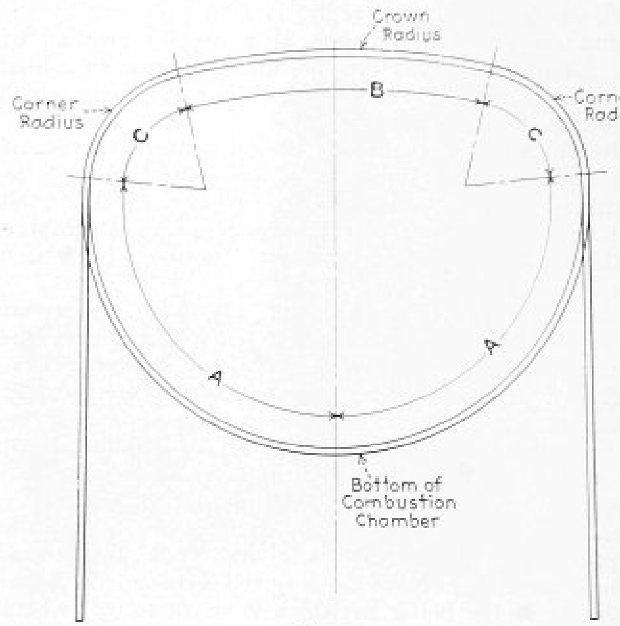


Fig. 2

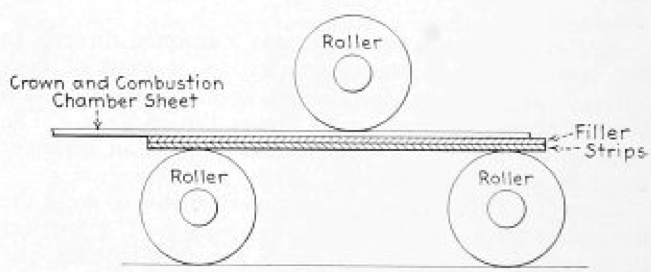


Fig. 3

The second operation is to roll the corner radii on each side as designated in Fig. 2 by *C*, these radii being rolled the entire length of the sheet.

The third operation is to roll the crown radius *B*, this radius being rolled for the entire length of the sheet.

Designing Boiler Patches

Q.—Please show a method for determining the size and design of boiler patches. G.M.

A.—For longitudinal cracks from one to twelve inches, the following method of determining the size of patch can be used.

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

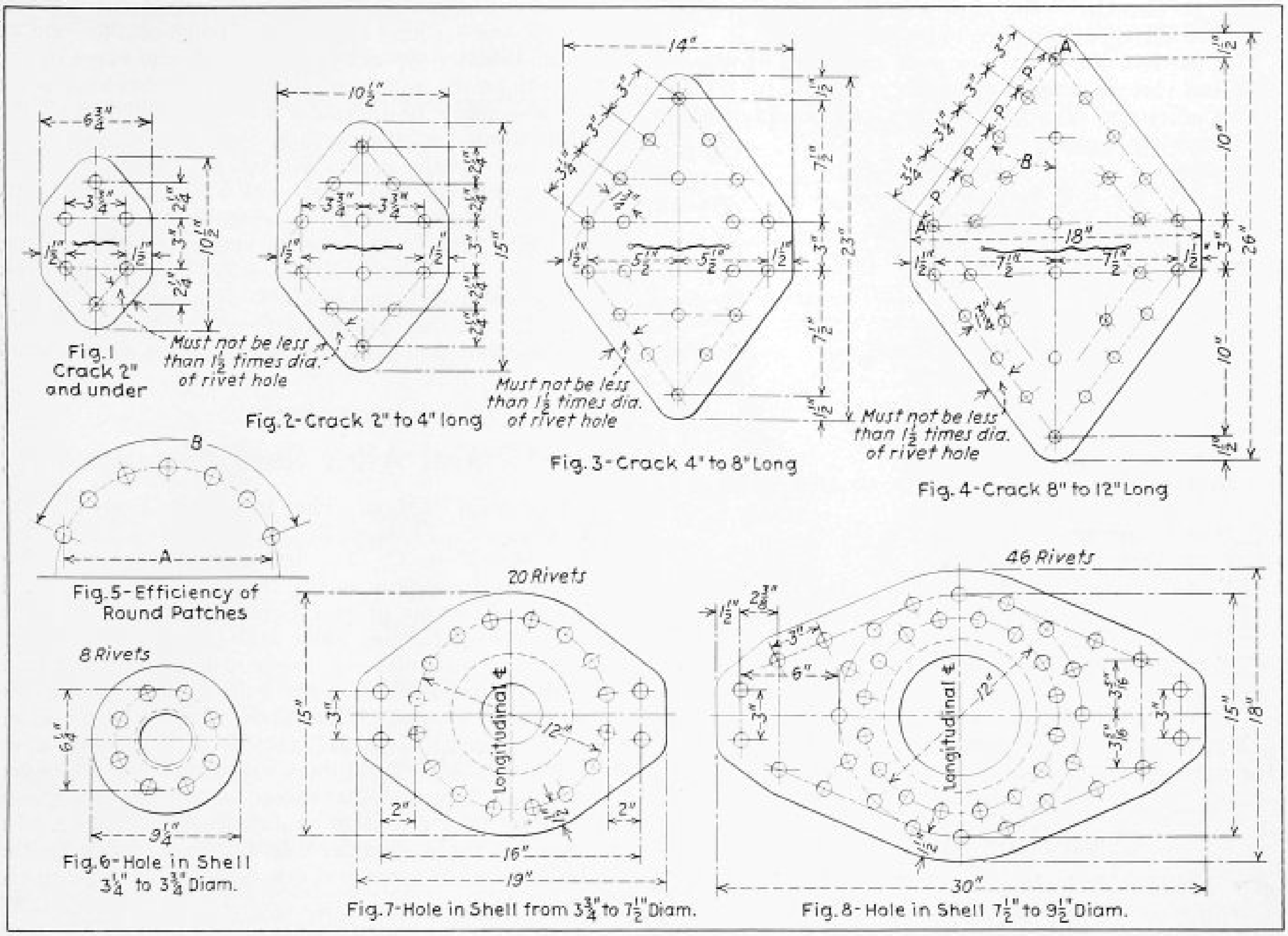


Fig. 1 Crack 2" and under

Fig. 2-Crack 2" to 4" long

Fig. 3-Crack 4" to 8" Long

Fig. 4-Crack 8" to 12" Long

Fig. 5-Efficiency of Round Patches

Fig. 6-Hole in Shell $3\frac{1}{4}$" to $3\frac{3}{4}$" Diam.

Fig. 7-Hole in Shell from $3\frac{3}{4}$" to $7\frac{1}{2}$" Diam.

Fig. 8-Hole in Shell $7\frac{1}{2}$" to $9\frac{1}{2}$" Diam.

Patches for cracks and holes in boilers

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. 4, 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. 4, without considering the angularity. The next step is to determine the angle *B*, Fig 4, 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. 4. In summing up, the entire formula can be expressed as follows:

$$\text{Angular Efficiency} = \frac{2\,(P - d)}{P\,3 \times \text{sine B}^2 + 1}$$

Not more than three holes in a row may be drilled in a boiler shell without determining the 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. This does not apply to stayed portions of firebox sheets. Roof sheet of crown-bar type of boilers should be considered the same as the barrel of a boiler and no welding is therefore to be permitted.

The patches illustrated are good examples of patches used for various length of cracks. (Figs. 1 to 4.)

The efficiency of round patches can be obtained by the following formula:

$$E = \frac{B \times TS \times t}{A \times TS \times t}$$

$$BP = \frac{TS \times t \times E}{R}$$

$$FS = \frac{BP}{P}$$

where:

A = Projected area in inches.
B = Length of arc in inches—6 rivet holes (D) Fig. 5.
D = Diameter of rivet holes in inches.
E = Efficiency in percent.
FS = Factor of safety.
BP = Bursting pressure in pounds per square inch.
P = Working pressure in pounds per square inch.
TS = Tensile strength in pounds per square inch.
t = thickness of plate in inches.
R = Radius of boiler (inside) in inches.

Fig. 6 to Fig 8 are good examples of patches used for various size holes.

Centering Metal Disks

CENTERING sheet-metal disks may be done in several ways and the two given below may be found handy. For small disks, up to 24 inches in diameter, place an ordinary steel square or a piece of sheet metal known to be square, upon the disk and bring a corner of the square on the plate, even with the edge of the disk. With a scratch, or a well sharpened soapstone marker, draw a fine line along the square, both against blade and against the tongue, carrying the lines to the edge of the disk; or, mark the disk only at its edges, as that portion of the two lines is all that is necessary.

As soon as the two marks have been made, draw a line across the disk from one edge mark to the other; or, if you do not care to mark up the work so badly, make a short mark in the middle of the disk. Then, move the square around about 90 degrees, more or less, and repeat the above described operations, placing the resulting mark in the center of the disk across the first line made there. If the work has been carefully done, the center of the disk will be at the intersection of the two short central lines. Care must be taken to have the corner of the square between the blade and tongue, always accurately flush with the circumference of the disk before drawing the two central lines. When a considerable number of disks must be centered, lay out the center on a very thin disk as small or a little smaller than the smallest disk to be centered; make a hole in the middle of this pattern; place the pattern upon a disk; and center the pattern with the eye, which can be done with considerable accuracy even when a disk is an inch or more larger than the centered pattern. When accurately centered, mark the disk with a center punch through the small hole for that purpose in the middle of the pattern.

In case a square or a squared piece of sheet metal is not at hand, open the dividers any convenient distance and with one leg held exactly at a point on the edge of the disk, describe two short arcs, across the edges of the disk, both to the right and to left of the starting point which also, must be carefully marked. Then, with the dividers opened a little further, place one leg in succession at each of the points marked on the edges of the disk and describe two short arcs which shall intersect near the edge of the disk opposite the point of beginning. The first point must be connected with a line, to the new intersection. Then select another point on the edge of the disk and about 90 degrees from the first point. Repeat the operations from the new point and where the two disk lines intersect, will be the required center of the disk.

Central Alloy Steel Expands

ACQUISITION of The Interstate Iron & Steel Company, Chicago, Ill., by the Central Alloy Steel Corp., Massillon, O., has become effective with the transfer of Interstate assets, it is announced by F. J. Griffiths, chairman of the Central Alloy Steel Corp. Work of co-ordinating sales and production activities of the two companies will begin at once, Griffiths said.

With the acquisition of the Interstate properties, assets of the Central Alloy Steel Corporation are increased approximately $17,000,000 to a total of more than $92,000,000. Total ingot capacity of the Massillon company will be 1,938,000 tons, including an addition of 396,000 tons representing Interstate's capacity. Interstate has three plants in East Chicago. Its properties include over 300 acres and one mile of frontage on the Calumet River.

Prominent Engineer Becomes University Professor

ERWIN E. DREESE, chief engineer of The Lincoln Electric Company, Cleveland, O., has been appointed professor of electrical engineering at Ohio State University, as part of a program of adding more men of national reputation to the faculty of that institution. The appointment became effective January 1.

Mr. Dreese is a graduate of the University of Michigan, where he received his electrical engineering degree in 1920, and although he is only in his middle thirties has won an outstanding place in the field of electrical engineering.

Boiler Book Revision

DUE to changes in the requirements of the Boiler Code of the American Society of Mechanical Engineers in reference to the allowable working pressures on spherical heads, the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., has revised its second edition of *The Boiler Book*. Since all details of construction covered by the book were intended to conform to the requirements of the Boiler Code, pages 33 to 37 (inclusive) of *The Boiler Book* have therefore been revised and reprinted. These additional pages are obtainable by all holders of *The Boiler Book* from the Hartford Steam Boiler Inspection and Insurance Company.

Associations

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

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

Steamboat Inspection Service of the Department of Commerce

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Boiler Code Committee of the American Society of Mechanical Engineers

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

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

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	

Cities

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

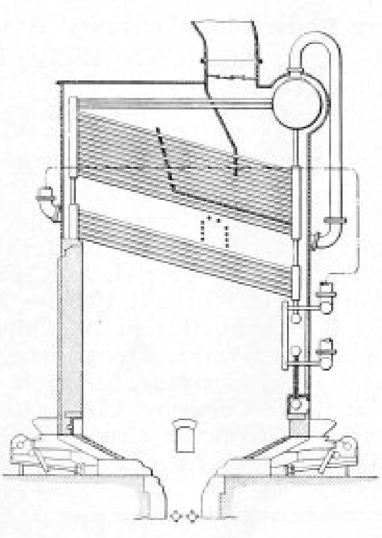
Selected Boiler Patents

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,718,344. BOILER CONSTRUCTION. JAY A. FREIDAY, OF EAST ORANGE, N. J., ASSIGNOR TO THOMAS E. MURRAY, OF BROOKLYN, N. Y.

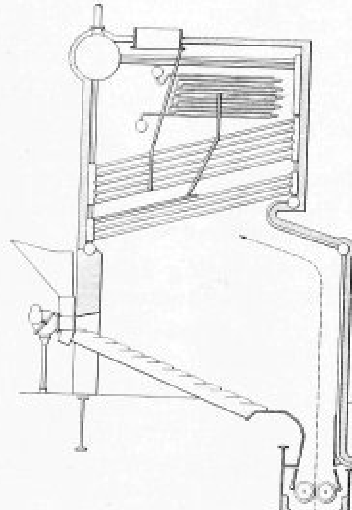
Claim.—The combination with a boiler having a mud drum of a furnace having a tubular water wall with a top header and a shield on the inner



side of said mud drum and top header comprising tubes extending over the inner sides thereof. Two claims.

1,718,345. BOILER. JAY A. FREIDAY, OF EAST ORANGE, N. J., ASSIGNOR TO THOMAS E. MURRAY, OF BROOKLYN, N. Y.

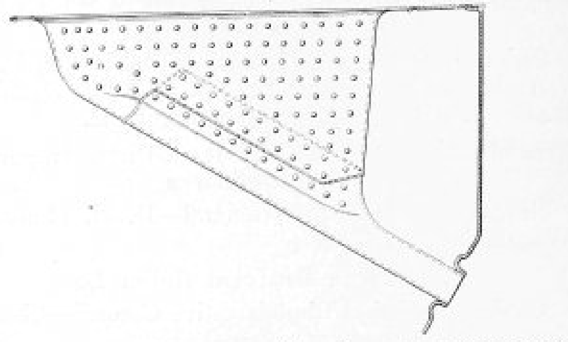
Claim.—A boiler having approximately horizontal overhead tubing and a furnace with a high rear wall which is offset beyond the rear ends of the overhead tubes, with an arch at the upper end of said rear wall spanning the distance between it and the rear ends of said overhead tubes, said



offset rear wall extending upward vertically practically to the rear ends of the overhead tubes and extending downward well below the level of the front wall and forming a comparatively high combustion chamber of the full width of the overhead bank of tubes, of greater length than said tubes throughout substantially the full height of the chamber and of greater depth at the back than at the front. Seven claims.

1,717,033. THERMIC SIPHON AND METHOD OF MAKING SAME. WALTER H. HINSCH AND GUST J. CHRISTENSON, OF CHICAGO, ASSIGNORS TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, A CORPORATION OF DELAWARE.

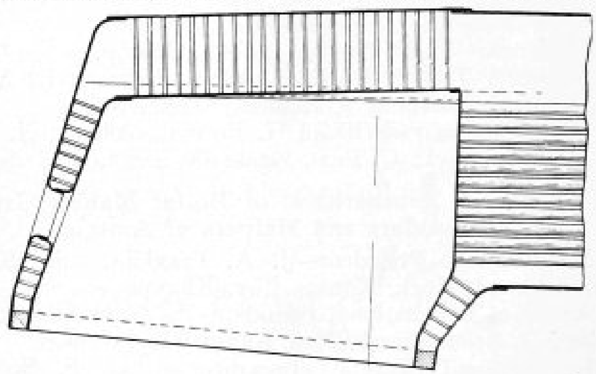
Claim.—The method of making thermic siphons of the kind described which consists in providing a flat hollow siphon body having an open bottom, in longitudinally slitting a seamless metallic, tube throughout a



portion of its length beginning at one end thereof, opening portions of said tube on opposite sides of the slit to provide upstanding walls thereon, Fitting said walls to the open bottom of the siphon body and then welding the same thereto, the unslitted end of said tube providing a neck extension for the siphon. Thirty claims.

1,712,614. LOCOMOTIVE BOILER. CHARLES GILBERT HAWLEY, OF CLEVELAND, OHIO, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

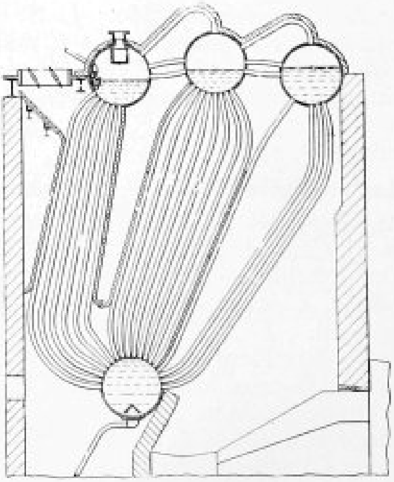
Claim.—A locomotive boiler embodying therein, a firebox including a crown sheet and a flue sheet, said crown sheet being formed to provide



channels therein which are deeper at the front ends where they open through the top portion of the flue sheet. Four claims.

1,717,015. BOILER. DEXTER EDGE, OF PITTSBURGH, PA.

Claim.—In a watertube boiler, the combination of a plurality of elevated steam and water drums, at least one mud drum positioned at a materially lower level than said steam and water drums, banks of tubes connecting each of said steam and water drums with said mud drum, water circulation tubes connecting each of said water and steam drums, means for delivering feed water to one of said steam and water drums at



a point below the surface of the hot water in said drum, and means cooperating with said feed water delivering means and acting as an inspirator to cause a flow of the hot water in said drum from front to rear so as to maintain a layer of hot water at the surface of the water in said drum, thus preventing absorption by and heating of the incoming boiler feed water by the steam in said drum. Four claims.

The Boiler Maker

Name registered U. S. Patent Office

Volume XXX **February, 1930** **Number 2**

Published Monthly by the
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

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The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

Request for change of address should reach us on or before the first day 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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Supply Men

JUST a reminder that the twenty-first annual convention of the Master Boiler Makers' Association and the Boiler Makers' Supply Men's Association is to be held at the William Penn Hotel, Pittsburgh, Pa., May 20 to 23. Companies planning to hold exhibits at the convention should reserve space through the secretary of the Supply association if they have not already done so.

Boiler Manufacturers' Meeting

DUE to the confidential nature of the mid-winter meeting of the American Boiler Manufacturers' Association, held at the Hotel Cleveland, Cleveland, O., February 4, it is not possible to publish the report of the proceedings. This meeting was devoted almost entirely to separate sessions of the watertube boiler division, the firetube division and the heating boiler division. A short session in the afternoon for the discussion of standing committee reports pertaining to the industry in general concluded the work of the association at this time.

Boiler Inspection and Politics

FROM the action of the governor and legislature of the State of Ohio in appointing the present chief boiler inspector of that state, it would appear that a lifetime connection with the plumbing industry is an essential qualification for this important position. The new incumbent has exactly that background of experience. However good a politician, diplomat or organizer he may be, his appointment can hardly be justified on the ground that his constructive knowledge of boiler work will be an aid to the industry.

Ohio has been in the front rank of the states supporting a progressive policy of boiler legislation. Under the leadership of C. O. Myers, chief inspector of the division of boiler inspection for the past twelve years, regulations beneficial to the builders and users of boilers alike were introduced and enforced in such a way that safety was assured without hardship to any individual connected with the industry. Largely through his efforts, the National Board of Boiler and Pressure Vessel Inspectors was organized and has reached its present outstanding position in the administration of uniform boiler and pressure vessel regulations throughout the United States.

For the first time since the division of boiler inspection was created in 1912 in the State of Ohio the position of chief inspector has now been withdrawn from civil service jurisdiction and made purely political in its requirements. In the eighteen years of its existence the post has always been filled by a qualified engineer. From now on each succeeding administration has within its power the juggling of this important post in the lap of some political favorite, regardless of the individual qualifications he may have for the office of chief inspector.

The action of Ohio in withdrawing this position from civil service in June, 1929, was taken in the face of opposition from boiler manufacturers, power plant operators, officials of the Uniform Boiler Law Society and of the American Society of Mechanical Engineers as well as others interested in seeing the integrity of the boiler laws maintained. Concerted efforts should be made by these same groups to have the post of chief inspector reinstated under civil service requirements, which would automatically insure the appointment of the most competent individual. Further, this action should serve as a warning of the possibility of other states, well established in their boiler laws, following the example of the politicians of Ohio in acquiring another office to be filled by patronage. Such action does not constitute progress in legislation, especially since the community safety is at stake but is a horrible example of political inefficiency.

The Boiler Code and Welding

THE possibility of utilizing the fusion welding processes in the fabrication of power boilers seems nearer of realization than ever before. In the January issue through the courtesy of the American Society of Mechnical Engineers Boiler Code Committee, the "Recommended Procedure for Fusion Welding of Pressure Vessels" was published in order that any of our readers interested in the matter might make such criticism or comment on the rules as would aid constructively in their final adoption.

A recent communication from members of the Boiler Code Committee calls attention to the fact that "this is the first of a number of important steps in the direction of broadening the provisions for welded construction and it can be truly stated that this recommended procedure (which was prepared by the American Welding Society for the Boiler Code Committee) is the first attempt on record to introduce such a control of fusion welding as will not only insure sound and safe welded construction but also enable such results to be duplicated at any place and at any time. It is an exceedingly important step and the committee desires that the proposed methods be given the widest possible discussion. Anything that The Boiler Maker may be able to do to bring the proposed new method of control to the attention of those who are vitally interested will be greatly appreciated."

Too great emphasis cannot be placed on the importance of the industry co-operating with the American Welding Society and the American Society of Mechanical Engineers, Boiler Code Committee, in making this proposed code entirely practical. Now is the time to smooth out any differences of opinion on the specific provision of the rules and not after the code has been approved. It is designed to help the boiler and pressure vessel industry and not to work a hardship on any individual. If any of our readers can help the progress of this recommended welding practice along by constructive criticism or suggestion communicate at once with the secretary of the Boiler Code Committee.

Communications

Applying Staybolts

To the Editor:

I have noticed various comments on the application of flexible staybolts in The Boiler Maker. My experience perhaps, is more limited than that of the others who are writing on this subject, but it is my opinion that there is more trouble derived from the improper fitting of bolts than any other one thing in the process of application.

It is a known fact that a flexible that is loose on the thread will draw considerably more than one that is tight while driving, therefore, if we will see that the bolts fit so that they can be handled with a 14-inch wrench, then we can give them equal breathing space, and feel assured that each bolt is carrying its proportion of the load. By so doing we will greatly increase the service that is to be had from a flexible staybolt.

Shreveport, La. W. M. Mattingly.

Alloy Steel Boiler Materials

To the Editor:

Being a subscriber and very interested reader of your most valuable paper for the past fifteen years I wish to call on you for some information.

Being boiler foreman on a railroad using oil as fuel in a very bad water district with some wells showing an anlysis above 40 grains encrusting, and 80 grains non-encrusting solids, am experiencing considerable trouble with leaking staybolts, cracked flue and side sheets.

We are now using the ordinary mild acid steel firebox material and iron staybolts. Would like to see more on the results being obtained from tests of steel staybolts; also nickel and chrome firebox steels, which I understand are being tested on a number of roads under similar conditions with which I am troubled. No doubt some of your readers can give some very valuable information on these tests, as well as the theoretical advantages of these materials.

It would also be interesting to see a chart showing the physical characteristics of these materials, such as: Tensile strength; yield point; elongation in 8 inches; reduction of area; expansion per inch due to one degree rise in temperature.

It is my understanding that chrome firebox steel has much less thermal expansion than mild steel, consequently less expansion strain is exerted on staybolts, firebox, and boiler. Also that this material remains tough and pliable up to about 900 degrees F., while the ordinary mild steel becomes brittle at about 500 degrees F. This would indicate a very decided advantage in favor of the chrome steel, for if these claims are correct it will reduce the very heart or foundation source of our worst troubles.

El Paso, Texas A. M. Harryman.

Editor's Note.—Our readers are requested to supply any information available on the above subject, that has come within their experience. All accepted replies will be paid for at regular rates.

Methods used by readers for

Carrying out Boiler Repairs

FROM the numerous suggestions received on methods of carrying out boiler repairs, as a result of the editorial "Think this over" in the last issue, it is quite evident that our readers are keenly interested in a department of this character. Several of the letters received are published on the following pages, and more will appear in later issues.

Although we could hardly expect to receive letters from all our readers on any one subject, there are many who have not yet written to us who are well qualified to discuss this question of repairing boiler cracks. Every article submitted will be given careful attention and if found to be accurate will be published in as early an issue as possible. Since this whole matter is open for discussion, comments and suggestions as to the merits of the methods suggested by our readers will be equally acceptable.

Cracked Flanges

By Wm. E. Alexander

New boilers coming out with ogee flanges at the fire door have given considerable trouble with fire cracks and leakage at this point. For a time, the rivets were cut out, the plates properly V'd out and welded, after which the rivets were redriven. It was found that this cracking was not only due to unequal expansion and contraction on account of opening the fire door, but also to the fact that the plates were not laid up metal to metal before the rivets were driven.

To overcome this objection, several of the manufacturers have resorted to welding of the fire door and shell plates with considerable success. The plates are flanged in, and the edges properly V'd out before welding. It is also necessary to support the area around the fire door by staybolts to take the stress, and to comply with the requirements of the boiler codes.

We also have had considerable trouble with cracked bridges or ligaments in the upper tube sheets of vertical tubular boilers, one of the main causes of which was excessive rolling of leaky tubes. Now that tubes are welded at the upper tube sheet we have reduced the number of cracks at this point, besides preventing corrosion and wasting away of the tube sheet.

In the older horizontal tubular boilers, we find many diagonal braces in the lower part of the boiler, and at this point where the palm of the braces meets the shell plates, we find cracks. As welding is not permitted in the shell plates of boilers, except certain cases at the girth seam, it is necessary to cut out the plate in the area of the crack, and apply a properly riveted patch.

The only place that cracks may be welded in the shell of boilers is at the girth seam. These cracks may be as follows; extending from the rivet hole to the edge of the plate, between rivet holes but not extending from rivet hole to rivet hole, also cracks that extend beyond the edge of the lap of the inner plate not more than 6 inches. Before welding these cracks, it is necessary to remove rivets for a distance of at least 6 inches each side of the affected area, properly V out the cracks to permit proper fusion, weld cracks, ream rivet holes and redrive rivets, then calk or weld the calking edge. For preventing the running of cracks, drill a ⅜-inch hole at the end of the cracks before the weld is made.

I do not advocate welding of cracks in the flanges of the throat sheet, backhead, or in tube sheet flanges. I believe that until such time as welding is performed by competent and experienced welders, that properly applied patches by riveting, if possible, shall be resorted to, otherwise applied by patch bolts. The applying of patches at these points, or in any other part of a boiler should only be permitted by experienced boiler makers, who in turn, should be under the supervision of efficiently trained inspectors, who prior to their inspector's position rose from the rank and file of boiler makers.

The welding of cracks in drum heads of watertube boilers is positively and strictly prohibited, regardless of the length or direction of such cracks, and immediately upon evidence of such a crack or defect, the boiler should be taken out of service, and proper recommendations made by the inspector.

It is also strictly prohibited to make repairs to the longitudinal seam lap crack, and the boiler must be discontinued from service. Cracks between the ligaments of tube holes in watertube boilers shall not be welded, (that is, in the drums) nor shall cracks in the crown sheet of locomotive boilers be welded.

Repairing Belpaire Fireboxes

By Joseph Smith

The page in the January issue of THE BOILER MAKER, entitled "Think This Over," comes just at a time when a few of us are discussing the proper method of repairing the wagon top of a Belpaire-type locomotive boiler. These tops, as you are well aware, are flat with a short radius at the sides, where the sheet continues down to the seam line of the wrapper sheet. A full installation of flexible radial stays are used. These sheets develop cracks at the front row of radials, extending in some cases 10 to 12 inches each side of the center line. The usual procedure of repairs has been to remove sufficient radials, also rivets in the seam where the wagon top is riveted to the first course in the barrel, then apply a patch without removing the section of the wagon top that is cracked. This is done, we suppose, for the sake of economy, which I believe is a short-sighted policy, as in a short time the patch cracks in the same way.

It is my contention that, as this sheet is flat and, where riveted to shell course (which seam is in close proximity to the steam dome flange), we have a section of boiler that is intensely rigid and thus the drilling of the large holes for the flexible sleeves would undoubtedly weaken the plate. This, combined with the possibility that, in the assembling of these plates, recourse was had to the drifting of holes to pull the plates into the proper alinement, would necessitate the dealing with constructional stresses and working stresses.

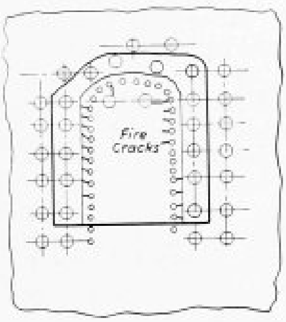
Would it not be best, then, to cut away some of the old material before applying the patch? By removing enough material and a sufficient number of rivets in the barrel seam, the constructional stresses that may have been there in the first place would be eliminated and thus pave the way for a more uniform section, leaving only working stresses with which to contend.

Applying Various Types of Locomotive Boiler Patches

By M. M. Smith

The ears of the riveted inside throat sheet develop fire cracks quicker than any other part of the firebox. When this trouble occurs, a patch that is found suitable and satisfactory can be put in by cutting out the damaged area, including one row of staybolts. Butt weld the patch and apply the staybolts before the patch is welded to hold it in place. Such a patch is shown in Fig. 1. The presence of flues makes it difficult to use clamps to hold the patch in place.

In applying a new firebox, the throat sheet should



The ears of the inside throat sheet give trouble from fire cracks, and a welded patch made to suit taking in one row of staybolts gives longer life to firebox. When making application of new firebox make the throat sheet to include one row of staybolts in chamber and one in side sheet, butt welding together; this does away with riveted seams.

Fig. 1.—Inside throat sheet patch

include a row of staybolts in the chamber and a row of staybolts in the side sheet. A butt weld between the first and second row of bolts should be used. This practice does away with rivets in the inside throat sheet and takes care of a lot of the trouble that is experienced with riveted throat sheets.

Considerable trouble has been experienced with cracked flue sheets and many suggestions have been made to remedy the situation. A welded patch, shown in Fig. 2, is a quick remedy and gives complete satisfaction. The patch should be made to suit the style of sheet and the length of the crack, leaving a row of flue holes at the bottom blank. These should be burned out and reamed after the patch is welded and riveted in place. The weld should be reinforced on the water side and ground smooth on the fire side.

Fire cracks from rivet holes to the lap and from arch-pipe holes to the staybolt holes in the inside throat sheet of combustion-chamber type locomotives may be remedied by applying a patch as shown in Fig. 3. The old plate should be cut out and the new piece welded in, replacing rivets in the chamber with plugs, and welding around the calking edge. If no flange block, suitable to flange the patch on, is available use the damaged part

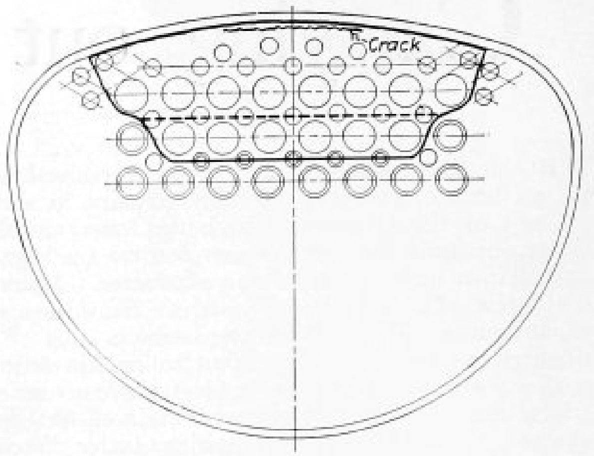
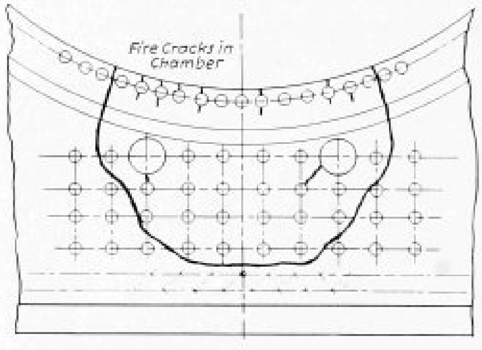


Fig. 2.—Welded patch, any sheet

A good deal of trouble has been had with cracked flue sheets and lots said to relieve situation. A welded patch proves to be the quickest remedy and gives entire satisfaction. Make patch to suit style of sheet and to length of crack. Leave row of flue holes at bottom blank and burn and ream out after patch is welded and riveted in. Reinforce weld on water side and grind smooth on fire side.

that has been cut out as the form to make the patch.

To remedy cracks and oversize staybolt holes in the side sheets, throat sheets and door sheets, cut out the



Patch applied to take care of fire cracks and cracks from arch pipe holes. Cut out old plate and weld in new piece, replacing rivets in chamber with plugs.

Fig. 3.—Inside throat sheet patch

bad part of the sheet with an acetylene torch and chip the plate edge to a 45-degree bevel. Make a patch, as shown in Fig. 4, to suit, offsetting the edge about 3/8

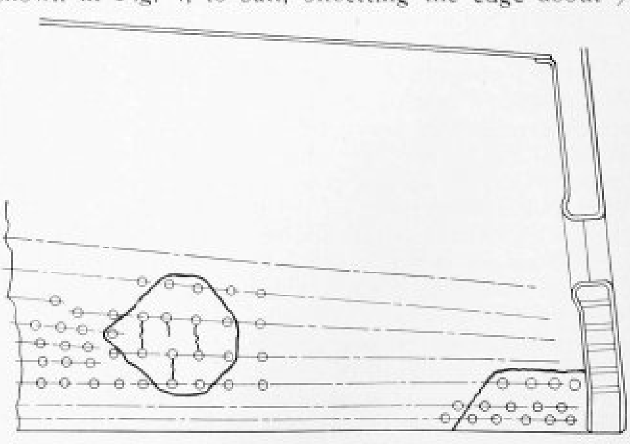
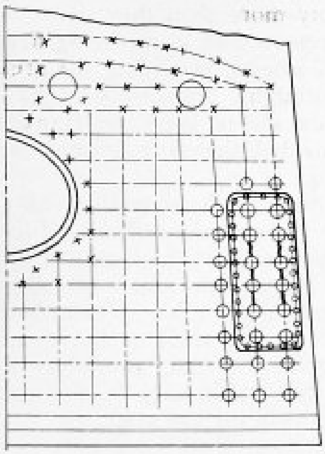
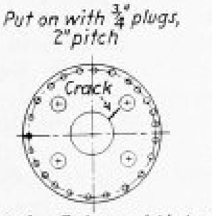


Fig. 4.—Side sheet patches

Patches for cracked side sheet and sheets with oversize staybolt holes should be offset at edge a little to take care of expansion of welding. Weld before applying bolts. Corner patches put in straight and welded before rivets or bolts are put in.

inch and allowing a $\frac{3}{16}$-inch opening for the weld. This offset takes care of expansion during welding. Weld in the patch before applying staybolts. Corner patches





Patch for Enlarged Holes, Washout or Arch Pipe

Fig. 5.—Backhead patch

For backhead or throat sheet patches when firebox is not out apply patch with ¾-inch plugs, 2-inch pitch, using ½-inch B. S.

should be put in straight and welded before rivets or bolts are inserted. In the case of backhead or throat sheet patches when the firebox has not been removed, the patch should be applied with ¾-inch plugs having

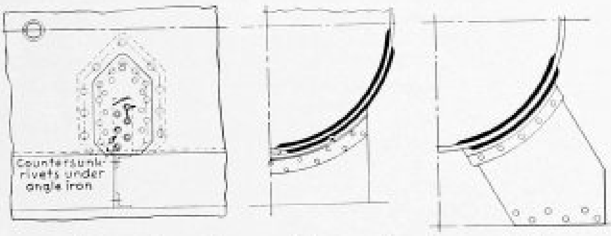


Fig. 6.—Patch for crack at waist sheet angle iron

Where one angle iron is used put a filler under angle and rivet on with countersunk rivets, using holes that held angle. Weld up holes in angle or make new and let angle ride loose on patch and filler. If both sides are cracked extend patches under boiler to take in both ends of angle iron. All rivets under angle to be countersunk

a 2-inch pitch. A ½-inch butt strap should be used as shown in Fig. 5.

The strain of the engine at the connection of the waist sheet and the boiler often causes cracks at the angle iron. In remedying this trouble, apply a patch to specifications using the original holes of the angle iron and making these rivets countersunk. In replacing angle iron, rivet to the waist sheet and let this ride loose on boiler. Some engines use two angle irons and some one. If the crack makes it necessary to extend the patch the full length of the angle iron, shorten the waist sheet plate so the angle iron will ride on the patch. If the patch does not take in the full length of angle-iron use a filler the thickness of patch, fastening this to the boiler with either countersunk rivets or plugs chipped off smooth and using the rest of the original angle iron holes in the boiler that are not included in the patch. This type of patch is shown in Fig. 6.

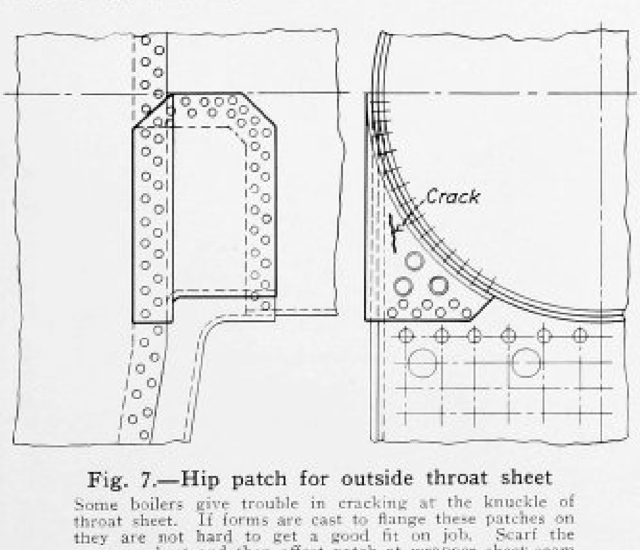


Fig. 7.—Hip patch for outside throat sheet

Some boilers give trouble in cracking at the knuckle of throat sheet. If forms are cast to flange these patches on they are not hard to get a good fit on job. Scarf the wrapper sheet and then offset patch at wrapper sheet seam and put patch on outside instead of wedging wrapper sheet out.

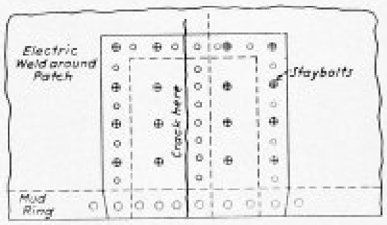
Some boilers give trouble by cracking at the throat sheet. A southeastern railroad had a number of engines giving this trouble and they had a form cast to serve as a right and left flange block. By flanging patches on this form a very good fit could be obtained which required little laying up on the job. In preparing the throat sheet, take out the rivets and chip off that part of the wrapper sheet which will come under the patch and weld the edge of the wrapper sheet to throat sheet. This makes a tight seam under the patch. Put several holes in the patch and bolt up; use an oil heater or acetylene torch to heat the patch and offset it at the wrapper sheet as indicated in Fig. 7. The patch is now ready for marking off the rivet holes and sleeve holes. Take the patch off and drill holes; cut off lap and chip. Countersunk rivets make a tight job.

Hand-Hole Opening Repair

By Thomas B. Sweeney

Since the advent of oxy-acetylene and electric welding, I have repaired a large number of boilers at the rear hand-hole. It is getting quite common now to receive a call to build up or patch a hand-hold opening where corrosion has so damaged the plate that it is impossible to keep the plate tight.

Occasionally this can be done by cutting away damaged metal and using a larger hand-hold plate. However, in a good many cases, corrosion is so extensive this cannot be done, so a patch is the only remedy.



Fire crack repair

I take a small piece of ½-inch boiler plate, somewhat larger than the hand-hole, and punch out the required size hole, usually about 4 inches by 6 inches. This is then trimmed down to leave 1 inch around the hole, making the finished plate 6 inches by 10 inches. After cleaning and chipping away all corroded metal, this plate is inserted through the hand-hole and laid up tight against the inside of the head and welded either by oxy-acetylene or electrically.

I first cut out all the rivets in holes that showed any sign of a crack. Then all the cracks were chipped out V shape and built up to original thickness with electric welding. The rivet holes were then reamed out to size and new rivets driven. After chipping back the girth seam a little and calking, you have a first-class job.

Patches on Power Boilers

By C. W. Carter, Jr.

Autogenous welding has been a boon to the application of patches on boilers, and in making repairs to boilers due to cracking, yet it must be thoroughly understood that welding has not yet come to that point of perfection whereby it can be safely applied to surfaces that are not thoroughly supported by other construction, and where the strength of the vessel is dependent upon the weld. It is plain suicide to attempt repairs to the shells or barrels of boilers by means of welding at any place, except certain cases at the girth seam as outlined below.

Our greatest trouble in the stationary boiler field is in girth-seam cracks, although we occasionally get a longitudinal-seam crack in lap and butt-joint boilers. In case of a longitudinal lap-seam crack, we absolutely forbid any repairs to be made, but require that the same shall be permanently discontinued from service as a steam-pressure vessel. The same would apply to the boilers which have developed cracks in the longitudinal seams as a result of inter-crystalline cracking.

Cracks at the girth seams are allowed to be welded, provided that the following conditions are met with, namely, fire cracks at the girth seam that extend from the edge of the plate across the seam, if located between rivet holes, but not extending from rivet hole to rivet hole may be welded, cracks that do not extend beyond the edge of the lap of the inner plate more than six inches may be welded. Proper procedure requires that the rivets at least 6 inches each side of the place to be welded shall be removed, the cracks shall be properly V'd out by cutting away the metal to permit of proper fusion of the metals to the bottom of the cracks. After being welded, the rivet holes shall be reamed out, and new rivets driven. For a weld that extends beyond the plate as explained above, it is necessary to drill a ⅜-inch hole to prevent the running of the crack.

One of our greatest troubles at the present time, is to find a competent welder to perform the repair work right. The country is flooded with men who are doing welding of an inferior quality; they merely skim the surface of the metal and are not welding at all. This is one of the main reasons that the states are refusing to accept fusion welding any more than they do.

Fusion welding may be resorted to in replacing firedoor patches of the furnace sheets, providing the area around the fire door is thoroughly supported by staybolts. Patches in the firebox sheets, tube and furnace sheets may be welded, provided the area around the same are properly supported.

Cracks of the bridges of tube sheets may be welded, providing the tubes have been removed around the cracked bridges, the cracks properly V'd out and welded, then the tube holes reamed out and the tubes replaced.

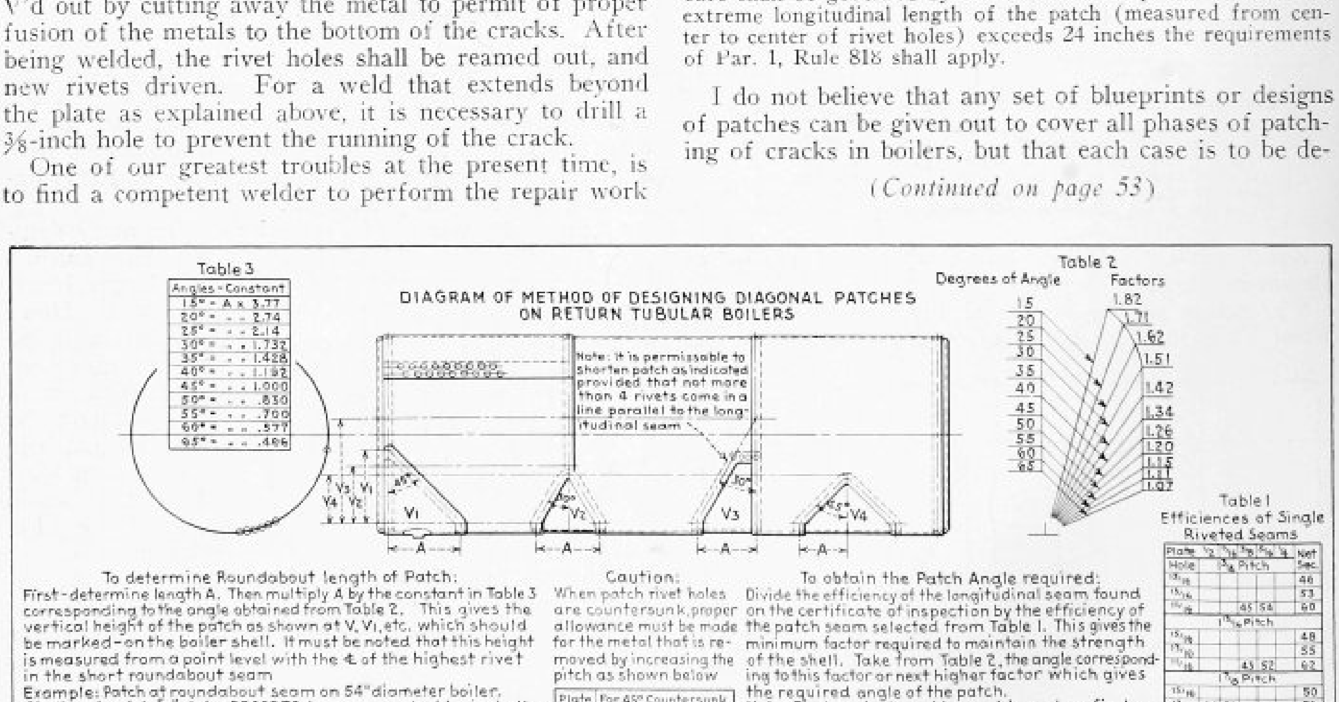
Rule 818 of the New York State Code is explained hereafter regarding patches to the shell or barrel of horizontal tubular boilers, gives the exact procedure to be followed, and I believe that credit is to be given to the Chief Inspector of California for the same.

Rule 818. All patches to a shell of a boiler shall be applied with rivets and the patch shall be thoroughly calked. Patches may be applied with tap bolts or machine bolts where strength of structure is not dependent upon the patch and where staybolts will be inserted through patch to support same. All patches on a boiler shell or drum, which exceed 24 inches in length, measured on a line parallel to the longitudinal seam, and between the center lines of the extreme rivet holes, shall be calculated for the safe working pressure from said patch seam, the efficiency of which shall be determined in the usual manner. The efficiency of the patch seam may then be increased by multiplying said efficiency by a factor which is determined by the angularity of the inclined patch seam to the girth seam, according to the table below:

A patch on a shell or drum may be used and the operating pressure maintained provided the size and design is such that in the opinion of the commissioner the original construction is not weakened. If the patch weakens the boiler, the pressure shall be governed by the value of the patch. In case the extreme longitudinal length of the patch (measured from center to center of rivet holes) exceeds 24 inches the requirements of Par. 1, Rule 818 shall apply.

I do not believe that any set of blueprints or designs of patches can be given out to cover all phases of patching of cracks in boilers, but that each case is to be de-

(*Continued on page 53*)



Instructions for designing horizontal return tubular boiler patches

Florida East Coast makes

High Flue Mileage Record

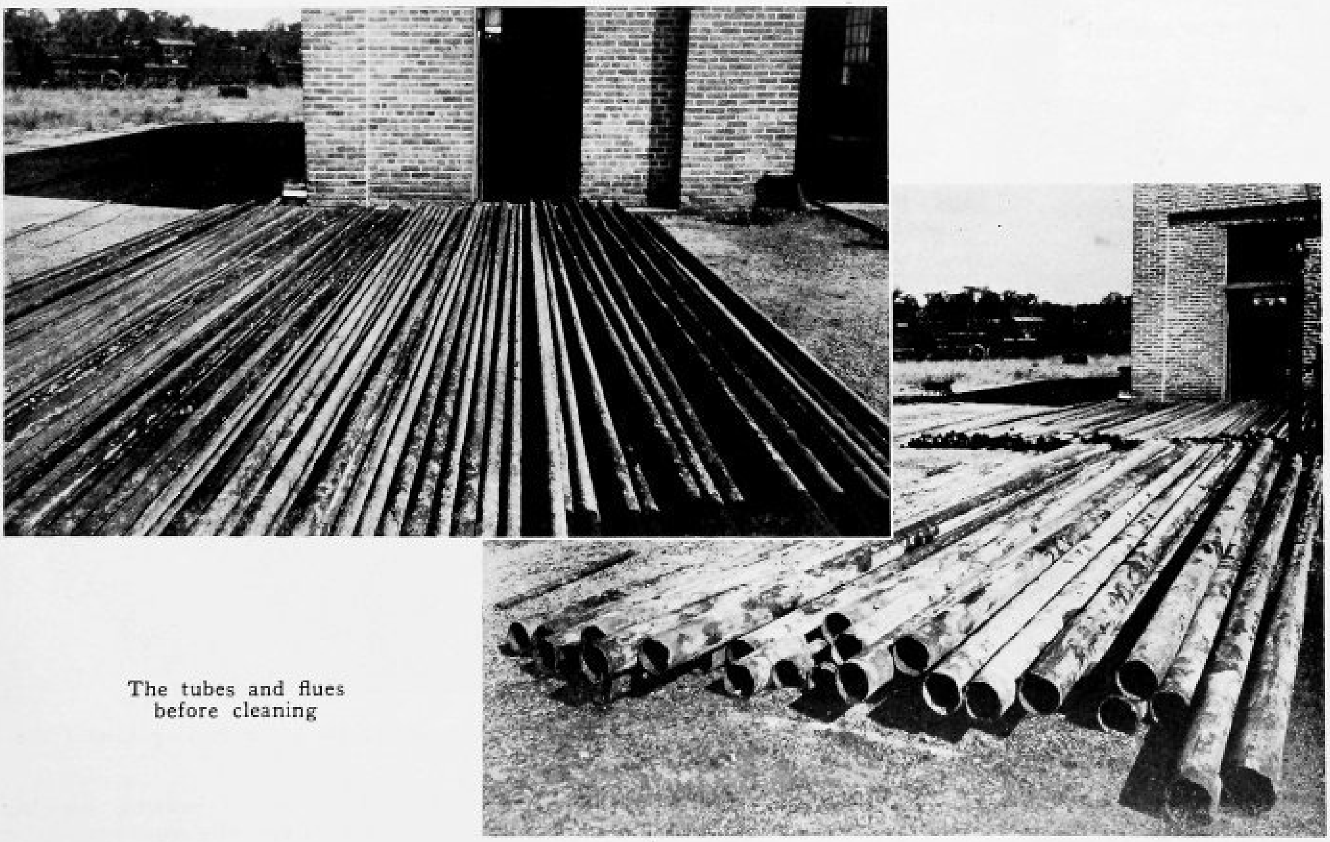
Total of 305,058 locomotive-miles made between settings on oil-burning 4-8-2 type in heavy passenger service

*By F. S. Robbins**

EARLY in 1925 the Florida East Coast purchased a number of Mountain 4-8-2 type locomotives from the American Locomotive Company, for passenger service, having a tractive force of 44,000 lb. and designed to burn oil. These locomotives are equipped with two Nicholson thermic syphons and Worthington feedwater heaters and are designed with 54-in. combustion chambers. They have a complete installation of Flannery hollow flexible staybolts. All of the radial stays are of the rigid type except four transverse rows on the front of the combustion chambers which are of the Flannery flexible type. In addition, each of these locomotives is equipped with a Type A superheater and has 181 2¼-in. tubes and 36 5½-in. flues, 22 ft. in length.

Locomotive No. 432, one of the 4-8-2 types referred to, was placed in service in May, 1925. At the end of ten months service it had accumulated a flue mileage of 59,579 miles when it was necessary to renew the flues on account of a heavy scale formation and fire-cracked flue beads. This locomotive was again placed in general passenger service in April, 1926, and with the exception of two months, has continued in that service until the present date.

In November, 1927, this locomotive was placed in service on the "Havana Special," trains 75 and 76, a heavy passenger train usually consisting of from 15 to 19 cars and with a 400-mile locomotive run. Locomo-



The tubes and flues before cleaning

* Superintendent Motive Power and Machinery, Florida East Coast, St. Augustine, Fla.

tive No. 432 hauled this train until October 9, 1929, when it was removed from service for class repairs. At that time it had an accumulated flue mileage of 305,058 miles.

The flues on the firebox end of the boiler were found to be in first-class condition with no fire cracks on the beads or welding. No work of any nature had been performed on the flues since they had been reset in March, 1926, until they were removed last October. The firebox sheets, stays and braces were practically free from scale. The illustrations showing the interior of the boiler after the flues were removed indicates a light scale formation, and also on the flues, tubes and front flue sheet. The total weight of all scale removed from the flues and boiler was approximately 2,500 lb. There was no indication of pitting. There was, however, after the flues were cleaned, a depreciation in weight due to internal wear from the use of sand in cleaning flues.

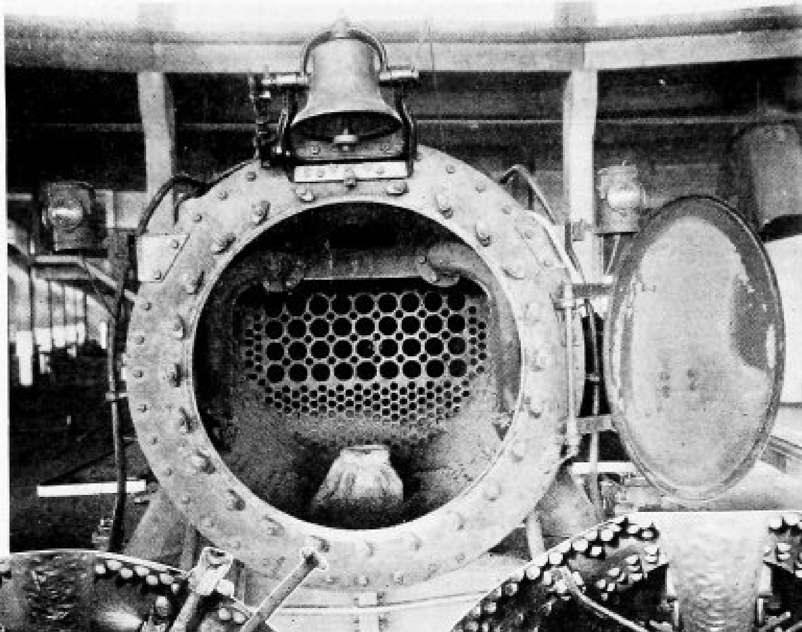
On the original setting of the flues, there was an accumulated mileage of 59,579 miles and on the last setting, 305,058 miles, making a total of 364,637 miles. The weights were as shown in Table I. Both the tubes and flues are of charcoal iron.

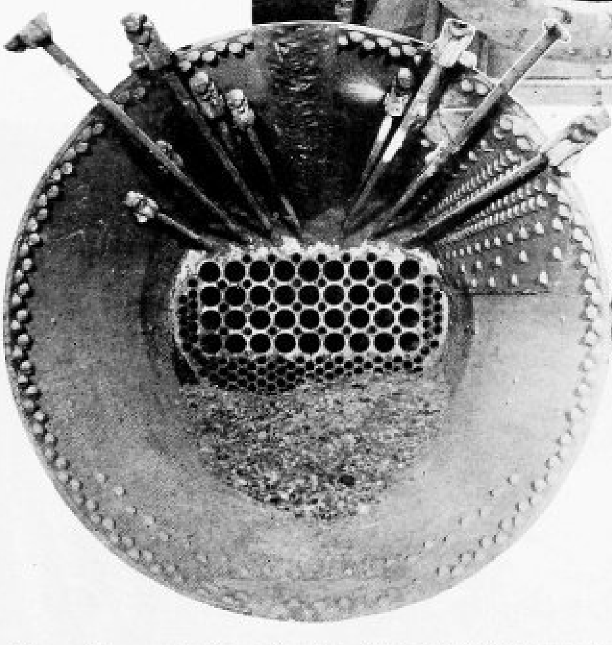
From the results shown in Table I, it is reasonable to assume that the tubes reset in the same locomotive will be good for approximately 350,000 miles additional service before reaching the condemning limit.

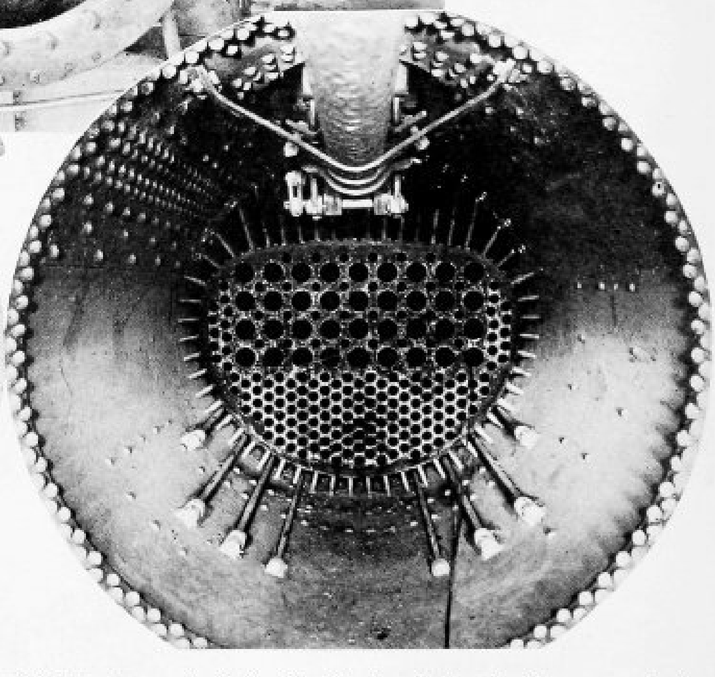
The feed water hardness analysis at New Smyrna, Fla., and Homestead, two of the principal stations where the locomotive was supplied with water since being assigned to the "Havana Special" in November, 1927, are shown in Table II. The fuel-oil consumption in gallons per car mile, between November, 1927, and October, 1929, is also shown in the same table.

The statement in Table II showing the water treatment for hardness at New Smyrna and Homestead is selected only to indicate what is accomplished by water treatment. Other treating plants where water was received en route by this locomotive were not considered in collecting the data in connection with the preparation of this article, two plants only being reported in detail.

A real improvement has been accomplished since 1925, through a construction program in which new and up-to-date plants have been provided for the treatment of water and with closer supervision over the process at these plants. These improved facilities, together with locomotives of modern design in service which are equipped with combustion chambers, syphons and feedwater heaters, together with the installation of hot-water boiler wash systems at







Top: The smoke box after the tubes and superheater had been removed—Left: Inside the boiler looking toward the front flue sheet—Right: The rear flue sheet

TABLE I—WEIGHT PER FOOT OF THE TUBES AND FLUES INSTALLED ON FLORIDA EAST COAST LOCOMOTIVE NO. 432

	Weight per ft., lb.
2¼-in. tubes, new	2.9
2¼-in tubes, when cleaned	2.5
2¼-in. tubes, loss in weight	.4
5½-in. flues, new	9.5
5½-in. flues, when cleaned	8.0
5½-in. flues, loss in weight	1.5
Estimated condemning limit of weight, per ft. 2¼-in. tubes	2
Estimated condemning limit of weight, per ft. 5½-in. tubes	7

our enginehouses have produced results on this road.

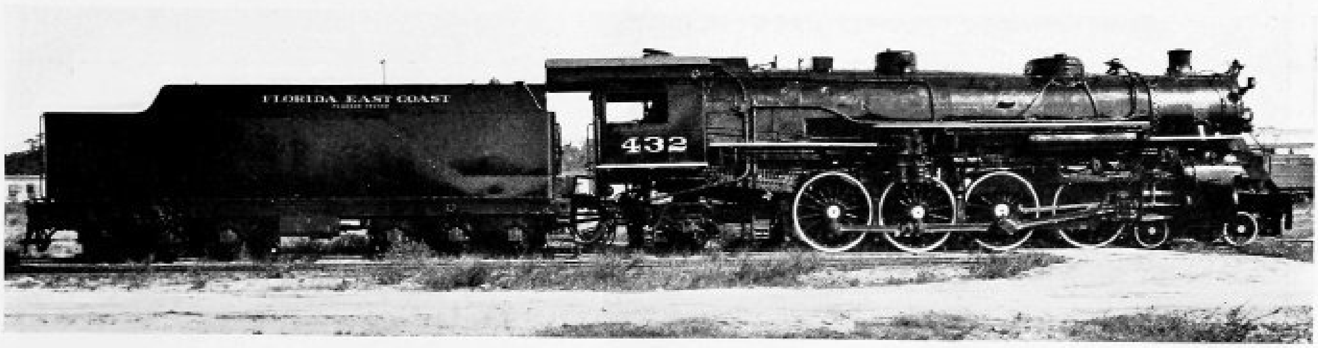
Locomotives assigned to this long passenger run have a schedule for boiler wash after 2,400 miles. Only a few years ago, 60,000 miles was the maximum flue mileage and often it was necessary to renew the flues after 30,000 flue miles. Flues were removed on account of scale accumulation which, in turn, affected the fuel consumption. The front flue sheet of the boilers would become solid with scale and it was formerly considered economical to renew the flues and scale the boiler.

Boilers are Washed on a Mileage Basis

All locomotives are washed on a mileage basis, ranging from 2,000 to 2,400 locomotive miles. All washing and filling of boilers is done with hot water, the washing water at a temperature of 130 deg. F. and the filling water from 180 to 200 deg. F. After the boiler is drained and all plugs are removed at regular monthly inspection periods, the front part of the boiler is sprayed with Dearborn Chemical Company's formula No. 134. This compound is sprayed with an air jet in a fine mist against the flues, front flue sheet, braces and boiler shell. This is followed by washing the boiler and refilling as soon as possible after washing. This solution dissolves the carbonate scale which has formed from the use of treated water, and all other scale which has adhered to the carbonate scale is thrown off.

All locomotive boilers have two blowoff cocks, one located at the center of the throat sheet and the other on the boiler shell immediately back of the front flue sheet. At terminals, when the locomotive is taken from the enginehouse and before being coupled to the train, the locomotive is moved to some established place and the boiler is filled with water. When the water gage is full, the fire is cut out and the feed-water pumps or injectors are shut off. Two gages of water are then blown out, using the front and back blow-off cocks intermittently for a duration of not over ten seconds each. Injectors and feed-water pumps are not operated unless there is a bright fire in the firebox.

Enginemen are instructed to take advantage of blowing at station stops and water stations, where possible to do so, using the front and back blow-off cocks intermittently for a duration of not over ten seconds each. When boilers are blown at station stops or water stops, the injectors or water pumps must not be operated. It is desirable to blow the boilers when the locomotive is standing and this must be practiced where possible. Blow-off cocks should not be opened when starting or accelerating a train, or while the boiler is being worked at its maximum capacity.



Locomotive on which the flue-mileage tests were made

TABLE II—CONSUMPTION OF FUEL OIL FOR 21 MONTHS AND HARDNESS ANALYSIS OF THE BOILER FEED WATER USED IN LOCOMOTIVE NO. 432

Fuel oil		Hardness analysis of feed water			
		New Smyrna		Homestead	
Month	Gal. of fuel per car mile	Raw	Treated	Raw	Treated
November, 1927	.89	H 20.4	H 3.6	H 11.6	H 2.1
December	.68	20.0	4.6	11.4	2.2
January, 1928	.57	18.8	4.7	11.4	3.4
February	.54	19.8	3.0	11.8	1.9
March	.56	19.3	2.7	11.5	1.8
April	.55	19.8	1.9	11.5	1.8
May	.55	18.9	1.7	11.2	1.7
August	.56	20.8	1.7	12.3	3.1
September	.59	16.9	2.4	9.0	2.5
October	.57	20.8	1.9	11.6	2.1
November	.62	20.2	2.1	9.5	2.0
December	.55	20.1	1.8	10.3	2.0
January, 1929	.62	20.4	1.6	10.7	2.1
February	.70	20.2	1.5	11.4	1.9
March	.55	20.7	1.8	11.5	2.1
April	.57	20.7	1.5	11.5	2.1
May	.57	20.2	1.9	11.6	2.0
June	.58	19.9	2.7	11.2	2.1
July	.58	20.4	1.9	11.3	2.0
August	.57	20.0	1.9	11.6	1.9
September	.59	20.5	1.7	11.4	1.7

The boiler washing method using the Dearborn chemical compound No. 134 has been in effect since June 1, 1927. This treatment of water and boiler blowing has reduced boiler foaming and delays from this source are now rare.

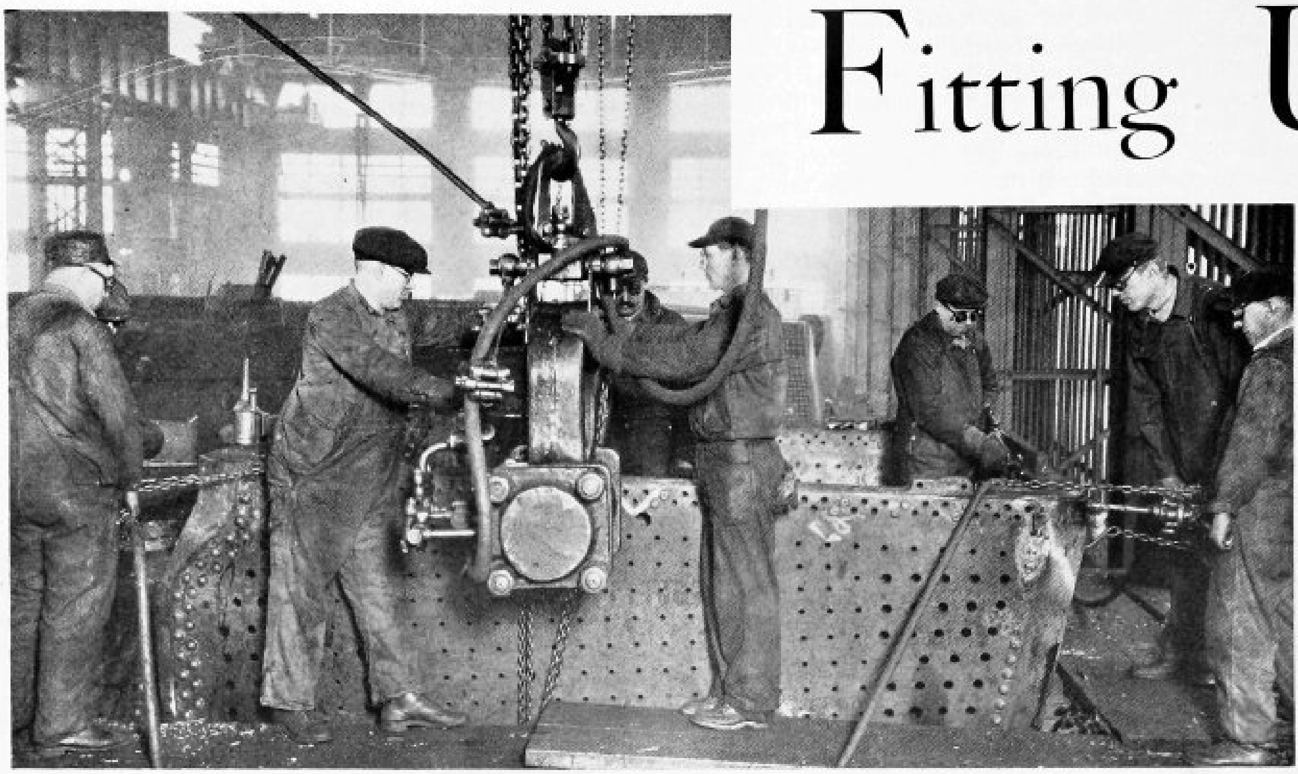
Attention is also called to the fuel performance data in Table II, which shows there was comparatively little increase in fuel consumption after the locomotive had reached this high mileage.

Laying Out Sheet Metal

TRIANGULATION APPLIED TO SHEET METAL PATTERN CUTTING. By F. S. Kidder. Size 6 by 9 inches. Pages, 312. Profusely illustrated. New York, 1930: The Sheet Metal Publication Company. Price, $4.

This volume, the seventh edition of Mr. Kidder's work, presents a reprint of two books of the author,—the main treatise from which the title is derived and the author's "Elbow Patterns for All Forms of Pipe Made from Sheet Metal" which appears with the foregoing as an appendix to the same. The book is a comprehensive treatise for cutters, draftsmen, foremen and students, progressing from the simplest phases of the subject to the most complex problems employed in the development of sheet metal patterns. The subject of triangulation has been interpreted in a manner which affords the average worker an opportunity of grasping the underlying principles without merely copying a number of worked-out examples.

Fitting Up

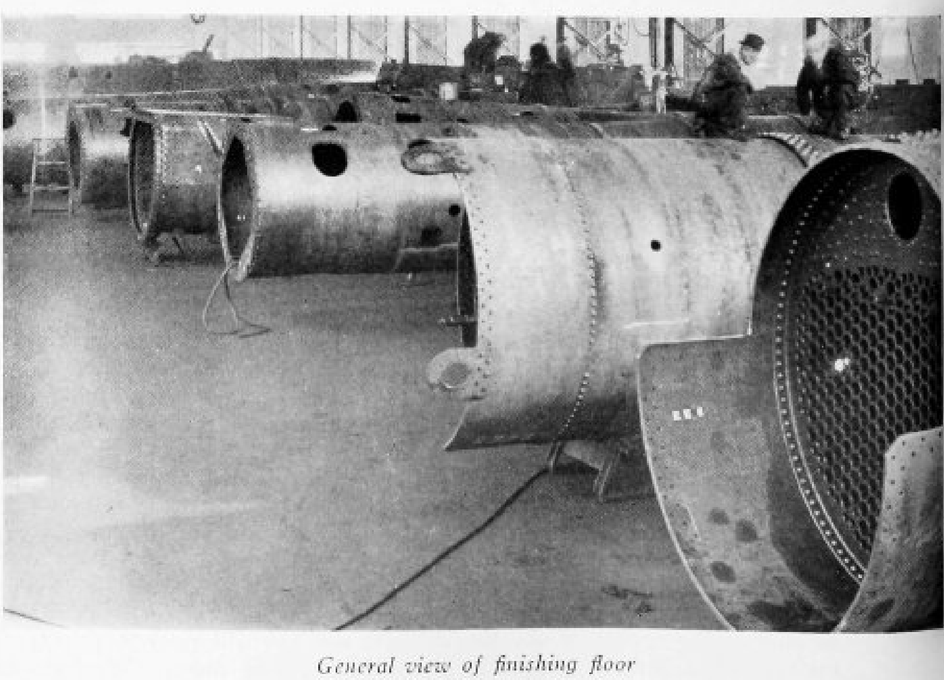


THE greatest economy in locomotive boiler construction is derived through systematic handling of materials and through the subdivision of labor into groups of skilled mechanics, each group specializing in one branch of the work. Each process in the manufacture of boilers should be handled by that group of workmen whose training and skill best suits the case. Throughout the entire boiler shop of The Baldwin Locomotive Works, Eddystone, Pa., this method of subdividing the work and fixing the responsibility of each department is in practice.

The finishing floor, as described in the January issue of THE BOILER MAKER, occupies bays Nos. 2, 3 and 4 and the personnel employed on completing the locomotive boiler prior to its delivery to the erection shop, is made up generally of eight gangs, each with its leader, and under the direct supervision of a foreman. These gangs or departments are responsible for the manufacture of staybolts, fitting of braces, pneumatic riveting, chipping and calking, air drilling and reaming, applying staybolts, hammering staybolts and the final assembling of the boiler. The manufacture of staybolts and the fitting of braces have been described in foregoing articles so that at the present time we find the partially completed boiler on the finishing floor. The boiler is complete with the exception of the firebox and the smokebox; the backhead is applied; the braces are fitted and the boiler is placed on its back in position for the application of the firebox.

Prior to applying the firebox to the boiler, the odd rivets in the boiler are pneumatically riveted. Only such rivets which cannot be driven on the hydraulic riveters are applied with hand-operated pneumatic hammers. The seams of the firebox on the water side are calked before the firebox is applied to the boiler. The inside or fire-side seams are flattered only before the application of the firebox to the boiler. When the staybolts have been applied and hammered, the fire-side seams are then calked with a round-nose tool.

When the firebox is received from the firebox gang, the waterspace-frame rivet holes are not completely drilled. Only such tack holes as are necessary for the preliminary bolting and assembly of the mudring have



General view of finishing floor

Fireboxes

Assembling, lining up and riveting back ends of locomotive boilers at the Baldwin Works

Calking boiler seams

been previously inserted in place in the sides sheet.

The firebox is placed on its back, the mudring fitted in position to the firebox and held in place by means of bolts, and the whole assembly is lifted by crane to a position directly above the back end of the boiler. It is then lowered in place. Cranes with two hooks are generally employed, one hook being fastened to the back of the firebox, and the other to the front. This permits raising and lowering one end or the other in order to fit the box. This is of primary importance in the case of fitting fireboxes with combustion chambers where considerable maneuvering is required to lower the firebox in place. By means of pinch bars and hammers the firebox is fitted in place. Bolts are fitted in the tack holes of the firebox through the mudring and back end.

Before the remaining mudring rivet holes in the firebox are drilled, the staybolt holes in the crown and sides sheets are checked for alinement with the staybolt holes in the firebox. After this process, the boiler has its final line up. This line up is similar to the preliminary line up, discussed in the December, 1929, issue of The Boiler Maker. A notable difference between the two line-ups is that in the case of the preliminary line-up the boiler is upright, while the final line-up is taken with the boiler on its back.

Following the line up, the firebox, mudring and back end are bolted together through the tack holes, previously located.

The plates at the corners of the mudring are set up so that metal to metal condition exists. With the mudring as a template, the rivet holes in the firebox are drilled and reamed. The sheets are then bolted with bolts located every third hole in both rows of rivet holes. The mudring corner holes are drilled and reamed at this time. In the layout of corner holes, a template prepared by the layout department, located in bay No. 12, is employed for duplicate orders. In single or small orders, however, each boiler has its mudring corners laid out separately, the data or location of rivet holes being taken from the boiler drawing.

Drilling of all the rivet holes is accomplished by the use of pneumatic drilling machines operated by two men. The drills are equipped with a long handle, held by the two men and a chain-type old-man is used to maintain a sufficient pressure on the work to assure speed in drilling. This chain-type old-man is merely a length of link chain with a hook at each end, the hooks being fastened to the work through rivet holes and the chain passing over the adjusting screw which feeds the drill into the work. Following the drilling process, all holes are reamed full size; the burrs are removed from all holes and the plates are ready for riveting.

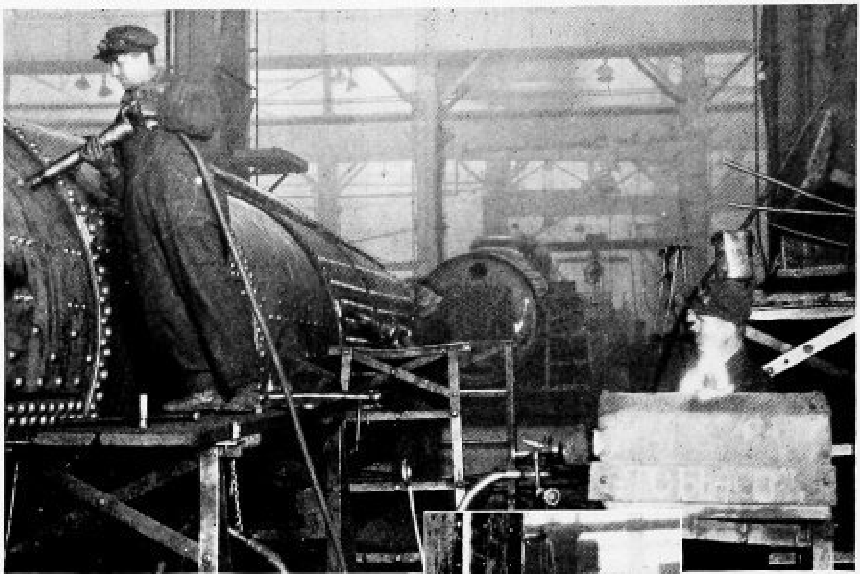
Prior to riveting, and with the plates firmly bolted to the waterspace frame, excess material on either the firebox or the back end, extending beyond the waterspace frame is removed by chipping. For this purpose, one man is employed using a pneumatic chipping hammer. For this work and other operations of a like character, safety at The Baldwin Locomotive Works, strictly requires the wearing of goggles. This precaution has been instrumental in saving the sight of many eyes, endangered by flying chips and other particles.

The mudring line of rivets are now ready to be applied and for this purpose a hydraulic portable riveter, shown in the illustration, is employed. This riveter is suspended from a hand jib crane with the jaws in position to take the plate vertically. These riveters, of which there are seven, were developed in most cases by The Baldwin Locomotive Works and are capable of exerting a pressure sufficient to drive one-inch diameter rivets. Three of the riveters are of Sellers make. Rivets are heated in a portable oil heater previously described and passed to the gang in the usual manner.

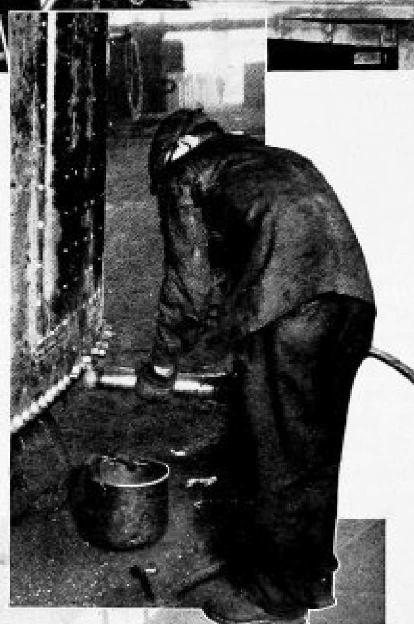
The rivet gang consists of three men (a rivet-passer and two bull riveters).

Following the completion of the waterspace-frame rivets, the waterspace-frame plate laps are calked, pneumatic tools being employed. In some cases, specifications call for welding of the seams at the corners of the waterspace frame. This practice assures tightness at points where leakage is likely to occur. Electric arc welding machines, of the single operator type are employed for this purpose.

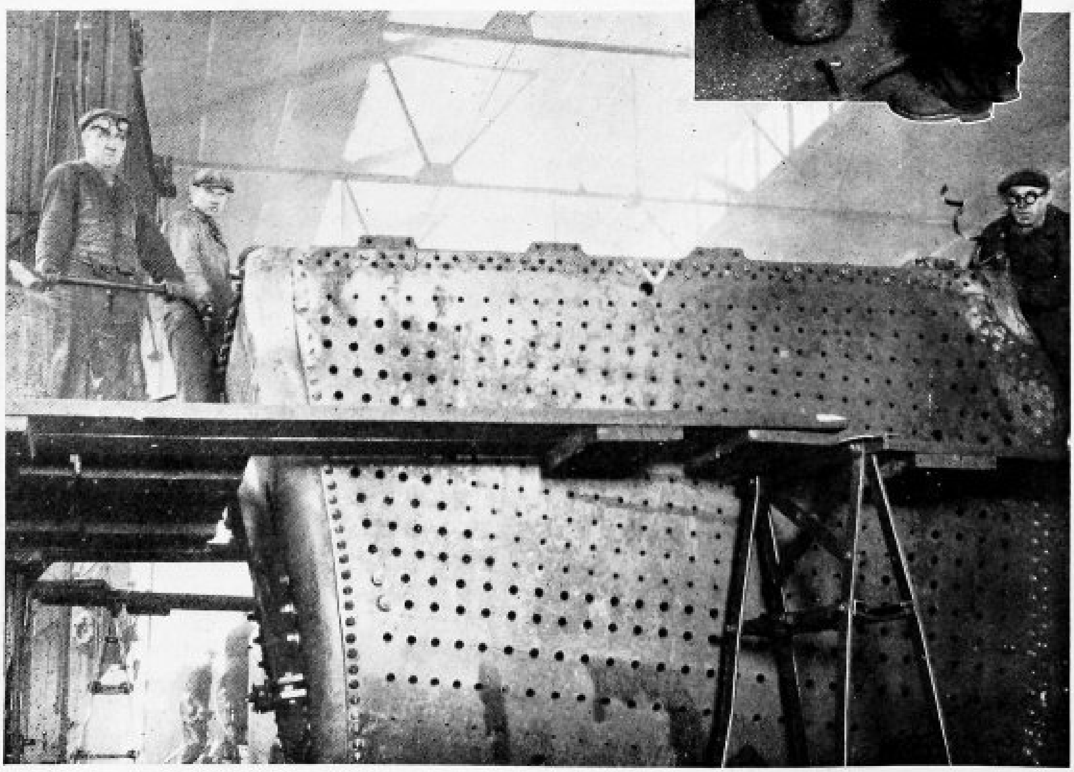
The locomotive boiler is now ready for the application of staybolts, a description of which will appear in a later issue.



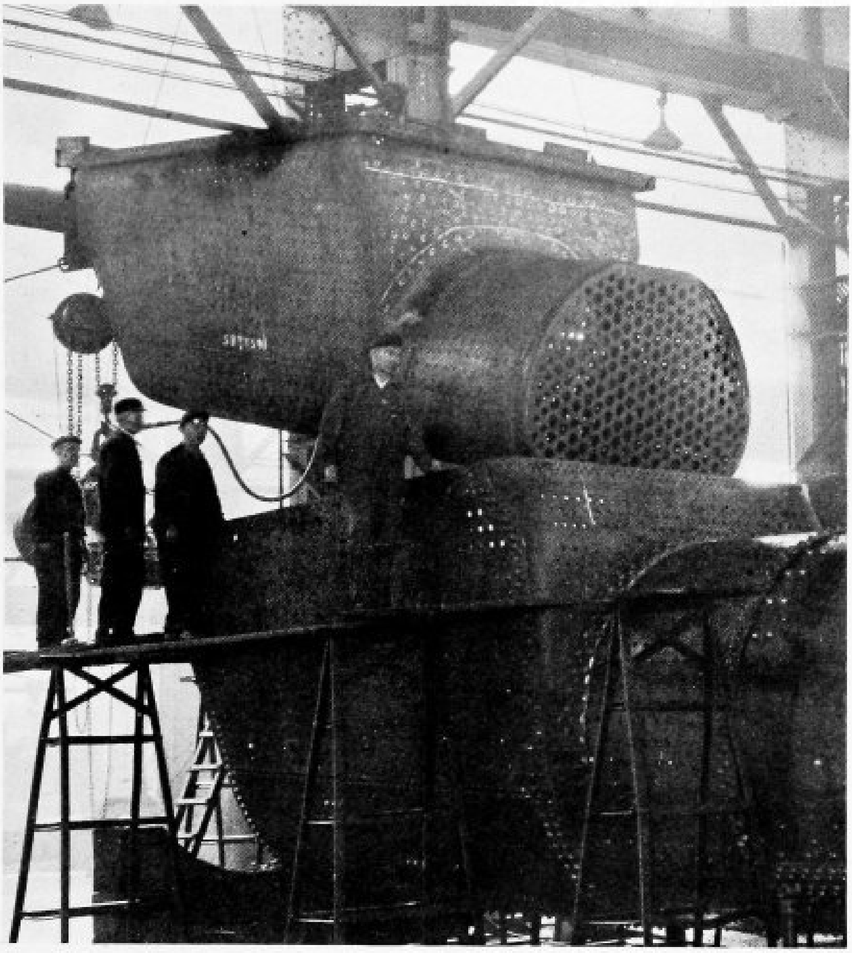
Inserting odd rivets in the barrel



Hand fitting odd firebox rivets

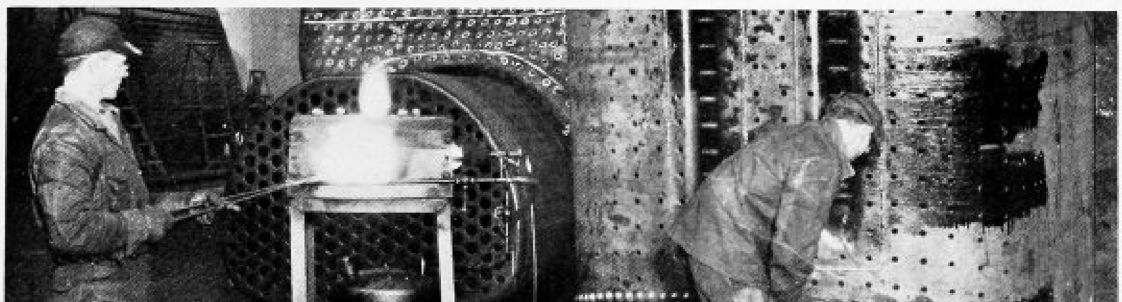


Setting-up plate at the mudring corners



Lowering the firebox with mud-ring attached into the backend

In the case of locomotive boilers having riveted fire doors, the riveting is done before the staybolts are applied. This practice is the exception rather than the rule today, welding being specified by most railroads at the present time. Riveted fire doors are generally of two types, having the lap either in the waterspace or in the form of a flange outside the hole. In the latter case, riveting may simply be accomplished by pneumatic riveters, but where the joint lies in the waterspace, considerable awkwardness results. In this case, the door is riveted before the mudring is fitted, a long curved bar being used as a dolly and the boiler shifted



Fitting odd rivets

in position to facilitate the work. The riveter is generally of the pneumatic type and is operated from the fire door side, the dolly being applied on the water-space side. The door holes of the welded type are finished after the application of the backhead staybolts.

Constant inspection throughout the departments of The Baldwin Locomotive Works boiler shop serve to maintain a high standard of workmanship. Each operation is inspected, the contractor in charge being responsible for his own work. He insists on good work in his own department and does not accept work from a previous contractor until that work is correct. By this system, such mistakes that do occur are found in the preliminary stages of construction where such discovery prevents excessive loss of time, material and labor.

Plate Inspection at the Steel Mill

By E. N. Treat

THE inspection of plates is a matter in which all who are in any manner connected with such material should consider himself associated. The best place of course to inspect plates is at the steel mill where they are manufactured, and although the inspection of such material at the mills is considered very thorough, additional inspection by the boiler maker and shop inspector can be only to the benefit of all concerned.

Defective material is not often discovered until it is about to be used several months after it leaves the mill. This defect may be at the mill's fault or possibly the fault may be that of the transportation company due to the method of handling, but the general cry is for a replacement plate which is needed at once. This state of affairs leads us to believe that the material was not inspected when it reached the boiler shop. It was probably unloaded and stored until it was to be used.

In addition to a replacement plate being furnished, the manufacturer usually must stand the loss of the defective plate at a loss in profit. Thus it may be seen that it is the manufacturer's desire to furnish material of good quality.

To safeguard the interest of the manufacturer and his customer, the manufacturer has built up an inspection service of his own. This mill inspection staff comes under the physical testing department and their duty is to inspect material before the inspector representing the purchaser is called to examine that material.

It would be very costly to assemble an entire order of plates, and then have the inspector representing the purchaser reject those that are defective. Thus it may be seen that by the mill inspection force first examining the material, only such plates as in their opinion might be accepted are presented to the customer's inspector. This practice saves handling, checking, weighing and stamping.

Inspections at the mills are namely for metallurgical and mechanical defects. Of course, the inspection covers such errors as incorrect stamping, incorrect dimensions and accidents in handling through the various stages before arrival at the loading bank.

Metallurgical defects are those which originate in the metal while it is in the fluid state. The pipe and seam are metallurgical defects and their cause may be traced to the mould condition.

Mechanical defects are those produced during the working of the ingot. The most common of these defects are cracks, shear strain, lamination, roll marks, cinder spots and scabby surface.

Mechanical defects are often found on the surfaces while metallurgical defects are located internally. Surface defects are more common than internal defects, and especially so if the plate be of light gage. Heavier material, unless ferro-silicon or aluminum has been added to the steel, is more liable to contain gas occlusions than light gage material.

The inspector usually views the pipe and seam with much concern, for though it may to all appearances extend into the plate only a fraction of an inch; it may continue several inches. These defects cause the discard of many ingots.

The pipe originates in the ingot when gasses are hemmed in. The ingot is rolled into a plate and the gas cell is elongated. The plate is next laid out for the correct size and then sheared. At this time the pipe is discovered and if the plate cannot be cut down to a smaller size sufficiently to eliminate the pipe, the plate must be rejected.

The lamination is similar to the pipe though it is smaller and may be found at other than the centre top of the finished plate. It is caused by careless working when a part of the plate is folded over on itself. Worn rolls may cause this defect and no matter what the cause, the condition is serious.

Inspectors at the mills give much of their attention to surface defects. The scab and cinder spot are sometimes difficult to find. They may be only as deep as the thickness of tissue paper or they may be half an inch or more thick and tightly embedded in the plate.

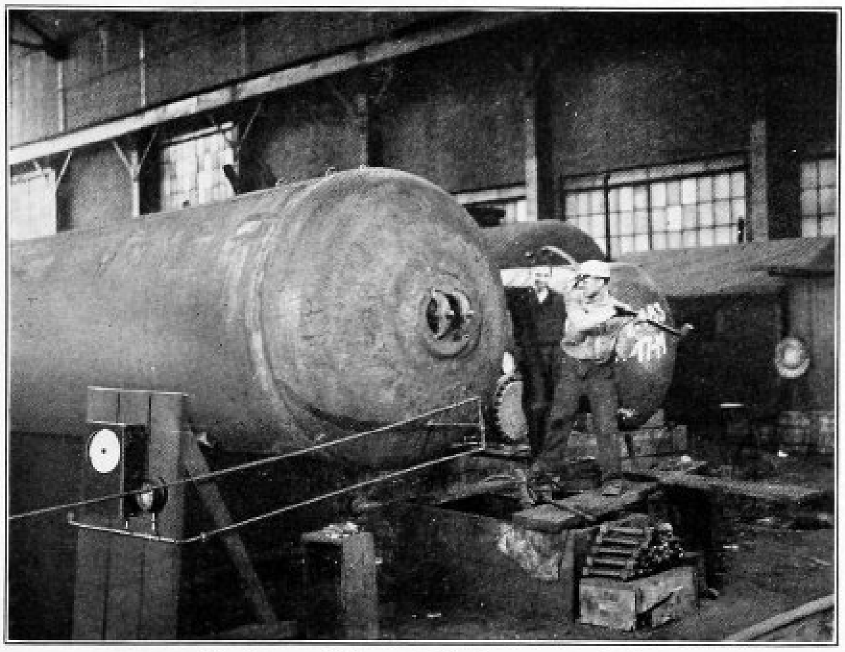
The inspector representing the purchaser is notified when the material is ready for inspection, and upon his arrival at the loading bank he first checks the heat and ingot number on the plate with those of his records. He next examines the top surface of the plate and when he has completed the examination of this part, the plate is raised so that he may examine the sides and ends. The plate is then kept suspended until he has examined the bottom surface. This examination is usually made with the aid of a flash light.

A special hammer test inspection is made of much material at the steel mills. This test is usually made by a man employed by the mill who does nothing but apply this test. The testing of plates in this manner requires considerable skill as the inspector strikes every inch of the plate's surface in order to detect an internal defect. This test requires considerable time and cannot be done hurriedly. There are few men qualified to make this test and say with any degree of certainty that there is an internal defect at a certain spot.

The conclusion is that the mill inspections are thought to be sufficient, but even though the mill has given all three inspections and the plate is accepted by all those inspectors, it is not always true that the plate will be found free from defects on arrival at the boiler works. Rough handling or a defect that has escaped the eyes of all the mill inspectors may be found by the boiler maker to seriously impair that plate for use.

Inspectors at the mills are human and as such are liable to make mistakes. For the benefit of the purchaser in securing a replacement plate as early as possible and for the benefit of the manufacturer and the inspectors at the mills, it is always desired that the boiler maker and the shop inspector give the final thorough inspection to that material both before it is used and during the process of fabrication.

Fabricating Welded Boilers*



Testing welded vessel by hammer method

Application of fusion welding to pressure work and testing methods

By E. R. Fish†

THE idea of fabricating high-pressure steam boilers by welding processes is not new. It has, however, been practiced to a considerably greater extent abroad than in the United States. There have been some serious failures of welded boilers that have to a very great degree discouraged its use here. So far as the writer is aware, there are no high-pressure boilers constructed by the fusion welding process in this country, but there are some forge-welded ones. Therefore, so far as the adaptation of welding processes to actual boilers is concerned, there is but little to discuss. You will note that reference is made to high-pressure boilers, for the above statements refer only to boilers which are designed to carry pressures in excess of 15 pounds per square inch.

Low-pressure boilers used practically exclusively for heating purposes are manufacturered on a production scale in tremendous volume without the use of any riveting whatever. This, of course, involves only relatively light plate, rarely over 7/16-inch thick. The A. S. M. E. Boiler Code for Low-Pressure Heating Boilers specifically recognizes the progress of the art by permitting this method of joining low-carbon steel plates in fabricating boilers of this class. There are literally thousands of welded heating boilers in use with a very gratifyingly low record of failures. But it is with power boilers that we are now particularly concerned. First let us examine the hazards involved. As the pressure increases the boiling point of water rises. If the pressure be reduced, the stored heat immediately evaporates a portion of the water and if the reduction of pressure is sudden there is created an explosive action similar to that of gunpowder. Professor R. H. Thurston some years ago calculated the stored energy in boilers which very clearly illustrates why boiler failures are so disastrous.

This energy is divided between the steam and water. For each pound in weight, that in the steam is very much greater, at the usual operating pressures than in the water, but as the number of pounds of steam in a boiler is much less than the weight of water, the total energy in the latte is far greater than that in the steam and hence ha .he greatest destructive potentialities. To give an idea of these quantities, the following table has been prepared. These figures are approximate only and are not given as being exact.

Pressure	When Reduced to Atmospheric Pressure and 212 degrees F. Available Energy in Foot-pound-inches			
by Gage	One Lb. Water	One Lb. Steam	30,000 Lb.* Water	90 Cu. Ft.* Steam
5	146	16,800	4,380,000	57,500
25	1,600	54,000	48,000,000	463,000
50	3,875	78,800	116,250,000	1,064,000
75	6,050	94,800	181,500,000	1,740,000
100	8,100	106,000	243,000,000	2,460,000
200	15,000	130,000	450,000,000	5,475,000
500	30,100	166,000	903,000,000	16,400,000
1,000	49,000	180,000	1,470,000,000	35,650,000

* Typical 500-horsepower watertube boiler.

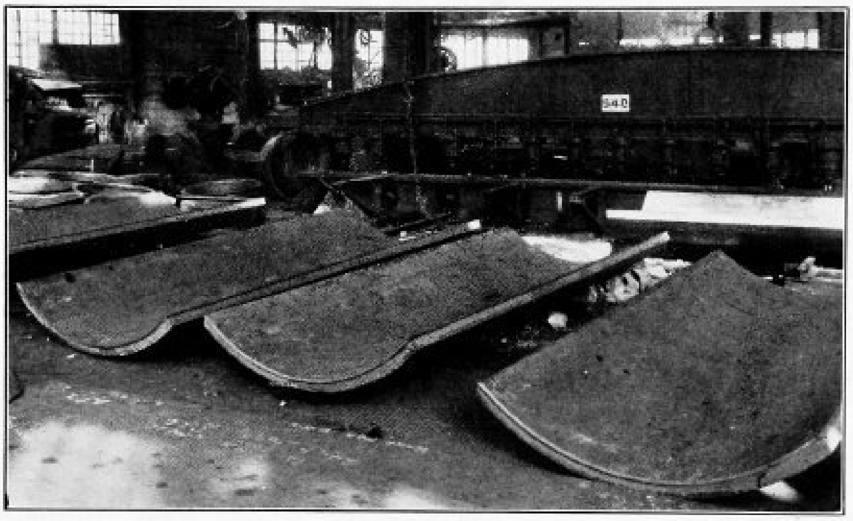
One of Dr. Thurston's concrete examples is of a watertube boiler of 3000 square feet of heating surface, ordinarily referred to as a 300 horsepower size, and at 100 pounds working pressure, a very low one today,

* Paper presented at October 21, 1929, meeting of Philadelphia Section, American Welding Society.
† Combustion Engineering Corporation, New York.

in which there would be available stored energy in the water and steam of nearly 110,000,000 foot pounds. If suddenly released and all applied to moving the boiler structure, this energy could project the boiler to a height of over 2000 feet.

It will be evident therefore that the destructive potentialities of high pressures are very much greater than at the lower pressures. It is because of this consideration of disastrous possibilities alone, that has deterred those in authority from heretofore accepting any except forge welding in the construction of high pressure boilers. Records are replete with failures of autogenously welded pressure containers, the reasons for which may be attributed to the relative inexpensiveness and ease with which anyone can set up a welding shop, and through the rapid expansion of the use of welding in fabricating containers and pressure vessels of many kinds. This has resulted in the establishment of many shops to fabricate vessels of this sort, frequently without proper precautions as to the competency of the welders and methods and often without an appreciation of the responsibilities involved. In addition, there has been the necessity of learning by experience, by even the most conscientious and painstaking fabricators how to solve the problems that developed. It is now recognized that sufficient progress has been made to justify serious consideration of the application of this kind of welding as it relates to boilers. But it may be asked, why the necessity for departing from the long accepted and practiced method of joining plates by tried and true riveting? There are two reasons.

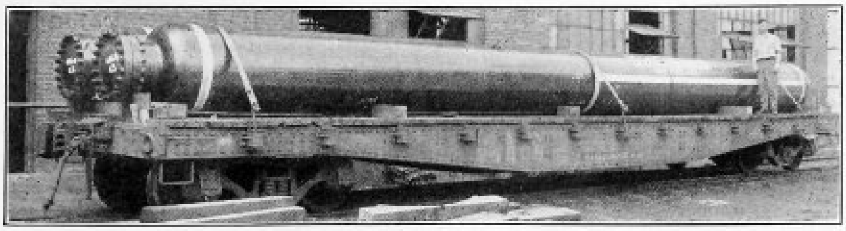
(1) The rapid development of power plant practice, particularly the adoption of the steam turbine, made unforeseen demands on the boiler makers. Unheard of volumes of steam per hour were insistently demanded. When reciprocating slow-speed engines were the prime movers, the engine room was the dominating part of a power plant as regards space. Pressures and steam temperatures were also limited. But the turbine entirely upset the situation. Requiring only possibly one-tenth the space needed by the old engines of the same capacity, the boiler room became dominant as to space, and efforts were directed to getting more and more steam from single units both by increasing the steaming capacity and the size of boilers. Had that been the limit of the demand it would not have been so hard on the boiler manufacturer, but the economy of and consequent demand for higher and higher pressures very greatly complicated the manufacturing problems which had to be faced. It is the cylindrical drums that constitute the greatest difficulty. Practical considerations limit the thickness of plate which can be satisfactorily riveted to about 2½ inches, and there are but few shops that can go that high. Couple this with shell lengths up to 40 feet or more and it becomes evident such structures are not easily made. For riveted construction, the usual diameters of drums therefore limit possible pressures to the order of 600 pounds per square inch, which, however, is now not regarded as very high. There are a dozen or more large units running today at 1200 pounds to 1400 pounds and three in process of installation to carry 1840 pounds. The thickness of shells for such pressures is over 5 inches quite beyond any possibility of riveting. Up to the present all such are seamless, forged from a single ingot with the heads integral. However, high-pressure chambers for oil refineries with wall thicknesses up to 5 or 6 inches have been fabricated by fusion welding. All such are made of several plates formed to shape hot and rigidly held in place while being worked on. There are a great number of pressure stills of this type in use and the reported failures are very few. This is excellent evidence of the sufficiency of good welding.



Preparation of plate for welding pressure still

(2) The mysterious cracking of plates of boiler drums, at first in some isolated and fairly well-defined localities and later much more widely distributed, led to investigations that indicated quite positively that certain water characteristics are the principal causes of this cracking which always occurs where plates, rivets or tubes are in close contact. This theory has become generally known as caustic embrittlement and will be referred to hereafter as plate embrittlement.

It has been the thought of some engineers that the elimination of riveted construction would avoid trouble of this kind. However, it can be greatly minimized, if indeed not entirely avoided, by inside calking as is now quite generally practiced. The need for welding instead of riveting in order to prevent possible embrittlement, in the plate thicknesses that admit of either method of construction, is therefore not necessarily de-



Forge and hammer welded boiler drums

manded although some prefer not to take any chances whatever. The possibility of this phenomenon appearing in all types of fabrication is always present at the tube holes, since the method of inserting and rolling tubes is identical for all.

The applications of welding to boiler fabrication may be divided into two principal classes with a possible third and fourth minor ones—forge or hammer welding, autogenous or fusion welding, electric resistance welding and thermit. The former is hoary with age, having been used since the beginning of the art of the working of iron and steel. However, the problems involved in welding the edges of long plates is quite a different matter from that of limited areas. But the reasonable certainty with which the edges of plates may be joined by this process caused it to be permitted although with restrictions. The quality of the steel best suited to this purpose is such as to give physical characteristics less than the regular flange or firebox qualities. To be readily weldable the carbon content must not exceed 0.15 percent and in consequence the tensile strength runs from 45,000 pounds to 55,000 pounds as against a range of 55,000 pounds to 65,000 pounds for firebox quality. The maximum thickness of plate that can be forge welded is about 2 inches and present facilities limit the length to 30 feet. It will be seen therefore that this method, as applied to drums is limited to pressures of about 500 pounds. It is also used to a considerable extent in the manufacture of headers for watertube boilers but that is quite a specialized branch. Recognizing that there is some uncertainty as to the integrity of the weld the unit stress to be used in making calculations is limited to 7000 pounds as against 11,000 pounds for riveted joints and flange or firebox quality of plate.

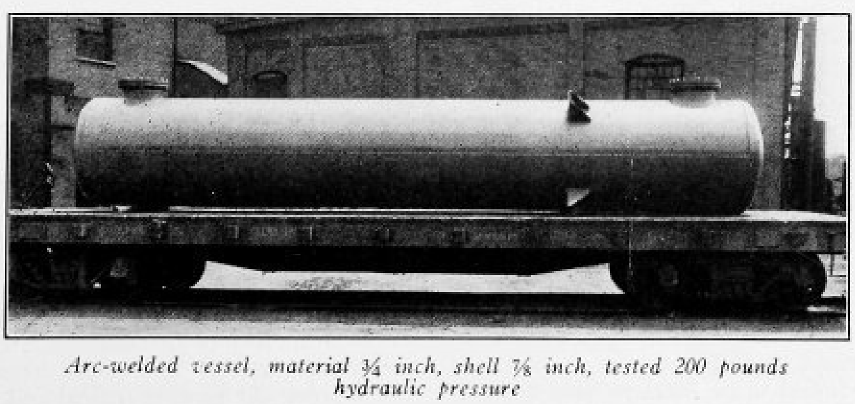
The second welding process is the autogenous, either electric or oxy-acetylene, wherein extraneous metal is introduced to effect the bond between the edges. It will be appreciated that the thicknesses concerned are such that the weld metal must be deposited by a series of operations and that its mass is considerable. In the course of its operation a boiler is subjected to many unmeasurable stresses and distortions of shape due to pressure and temperature changes. It is because of these that ductile material is so essential. It is imperative that the weld metal shall partake to a reasonable degree of the physical characteristics of the base metal. Only in this way can freedom from the effect of the localization of the unknown stresses be assured. Until very recently the character of the deposited metal has been uncertain and variable. Improvements in both methods and material now make it possible to meet the requirements. In order to insure uniformity in such large welds, automatic welding machines are highly desirable although not absolutely necessary. Fortunately it is not likely that there will be defects at the same place in each of the layers, so the risk of a poor weld is minimized.

The third method which is of very limited scope is electric resistance welding, which has been recognized as the equivalent of forge welding. It is as yet applicable only to the joining of very small surfaces and hence is not included as one of the methods for fabricating large drums or other parts.

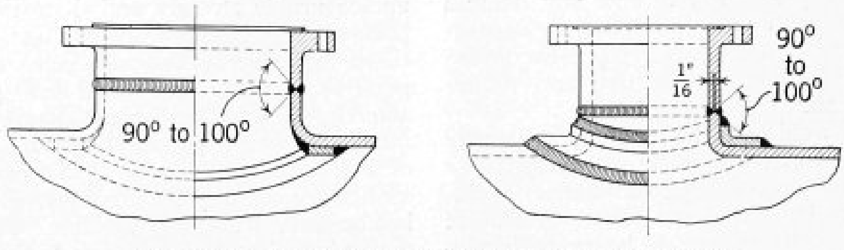
The fourth method of welding the edges of plates is by the use of thermit. This has been talked of but experiments of only the most primary character have as yet been made so the idea is in the preliminary stage. To it will doubtless apply the same restrictions as affect the fusion method. It has the advantage that the nature of the deposited metal is more readily controlled than is the case with the others. The cost, however, would probably be against it and outweight the advantages. It is mentioned here as a possibility.

The local heating of large plates inevitably sets up stresses in the colder parts contiguous to the welds and which must be relieved before being put to use. It is therefore necessary to "stress relieve" the structure when the welding is completed. From the dimensions heretofore given it is evident that a very large heating furnace will be a necessary part of the equipment for any shop which may undertake to make welded drums by whatever method.

How can the soundness of a welded vessel be as-



Arc-welded vessel, material ¾ inch, shell ⅞ inch, tested 200 pounds hydraulic pressure sured is an inevitable question. It has been asked innumerable times and a satisfactory answer must be given, but about this there are wide differences of opinion. It is, of course, manifestly impossible to investigate every weld by cutting at frequent intervals or by testing to destruction. A non-destructive test that will prove the integrity of the weld with reasonable certainly is required. It has been proposed and practised to some extent to vigorously hammer the weld or the immediate vicinity while under a test pressure of twice or more the designed working pressure. Exception has been taken to this practice. There have recently appeared two suggestions for other methods. One is a modification of the Sperry scheme for detecting defective rails. There follows extracts from a paper by Mr. Sperry.



Methods of welding-on nozzles and reinforcing openings

"With the successful application of the electric method of inspection to the examination of rails in track, it was but natural that the inspection of welds should be one of the first problems to be considered. The inspection of welding includes not only the location of pockets, cracks, inclusions, overlaps, etc., but also the detection of unwelded surfaces which frequently are held in intimate contact under heavy pressure produced by shrinkage in cooling the weld. The following research item had as its object the investigation of this phase of the problem.

"The faces of two 1-inch steel cubes were so accurately ground, lapped and polished that they fit perfectly over the entire surface, it being possible to lift one cube by its well-known adhesion to the other. The polished surfaces were then carefully washed with ether to remove any trace of grease or dirt. The cubes were now pressed together between two copper outer terminal pads with a pressure of 5000 pounds. A current of 100 amperes was passed through the blocks and the average voltage drop noted over unit lengths of the sound metal at different points, then over the same unit length containing the junction of the two blocks. Here were two surfaces as nearly perfect as could be made, pressed together with 5000 pounds, yet the electrical resistance of the unit length containing the gap was one hundred seventy-five times the resistance of an equal length of sound metal. This demonstrates that the electrical method is applicable to the detection of any interruption of the molecular continuity of a metal. Many fissures are practically sub-microscopic.

"The initial work on the testing of welds by the electric method was performed on welds joining ½-inch cold-rolled plates. Both gas and electric welds were tried, each sample containing a hidden defective spot. An adaptation of the standard test method was quickly developed, which made possible the accurate location of the defective spots. This method is not only applicable to welded plates but may be applied to the inspection of welded drums, pipes, etc.

"A plant has been constructed for testing welded joints of plates up to between 3 and 4 inches in thickness and forming drums of different diameters. The inspection to date is found to be accurate and dependable. It goes forward at a rapid pace and gives an ink record which is in the nature of a certificate of complete soundness of the weld. This apparatus is capable of adjustment so as to record very minute defects or it will record only those exceeding a certain predetermined area or percentage of a unit length of weld equal to the plate thickness. This widens out the adaptability and usefulness of the method. The circumferential seams are serviced without difficulty, sometimes more easily even than those running longitudinally as they require less length of primary conductor and less flexibility, but this is a minor detail.

"It would thus seem that the time is close at hand, if it has not already arrived, when by a simple combination of a well-known group of scientific facts and elements we are able to ascertain the internal structure throughout any weld or any critical part thereof, thereby finally establishing its complete integrity and freedom from hidden flaws of any type, establishing it as a 100 percent union throughout its entire extent longitudinally.

"It is believed that electrical inspection should follow closely the welding process, especially on structures, so that if a hidden defect is discovered it can at once be dug out and corrected on the spot, reinspected and the process repeated until a 100 percent weld is secured. It is hoped that the great ease with which the complete soundness of welds may quickly be tested and a permanent record secured by so simple and straightforward a method will give welding a new impetus, and by removing uncertainties will broaden its scope of application and usefulness."

The other method is based on sound transmission by the metal, using an ordinary physician's stethoscope and the X-ray, developed by Kinzel, Burgess and Lytle of the Union Carbon & Carbide Research Laboratory.

"In searching for a non-destructive test of welds the use of sound transmission or sound characteristics of the joint as affected by discontinuities and irregularities was investigated. It is known that the presence of a serious defect in a vessel can often be determined by its ring. The village blacksmith used this principle when he hammered metal cold on the anvil to test it by ring. In sounding a tank, however, there are a great many difficulties to be encountered, due to the forced and natural vibrations of the tank and the tendency for the natural vibration to drown out all other sounds. The authors have used the stethoscope to overcome these difficulties. The instrument consists of the ordinary physician's apparatus, with a gum rubber tip to exclude extraneous sounds and give contact on the irregular surface of the plate, as well as to minimize dampening of the oscillations at the contact of stethoscope and metal. The drum, pipe or plate in question is struck with a small hammer at the spot to be tested. The weight of the hammer and force of the blow depend upon the thickness of the plate, and the stethoscope is applied to the tank in the general vicinity of the striking zone. The sound heard at the instant of first tapping the joint is critical and is a function of the character of the material at the spot struck. Shortly after the tapping the waves are reflected and the sound picked up by the stethoscope becomes a composite of the natural vibration of the tank as a whole and of the forced vibration of the material immediately under the striking hammer. When the defect is very serious, however, it has a dampening effect on the total sound, so that its presence is also clearly evident in the after ring. The problem is analogous to that encountered in the well established method of testing staybolts by noting the character of the sound on striking. Testing staybolts in this way has proved to be very satisfactory.

"Each welded structure has a characteristic sound. After this is determined by brief preliminary tests the striking hammer and stethoscope are moved along the weld so that any irregularities are discernible."

The nature of the defects located by the stethoscope is of decided interest. Lack of fusion, particularly at the bottom of a vee or along the scarf gives a characteristic reedy, high pitch, initial note. In many instances the points at which welding was started and stopped and where tacks have been made are also discernible with the stethoscope, but the characteristic tone is such that these points are readily different from lack of fusion. To date the authors have been able to check each other in most satisfactory manner in the testing of welded plates, pipes, pressure vessels and welded structural joints.

An X-ray examination may be used either in conjunction with the stethoscope or as an independent sampling method. In the past most of the X-ray work on welds consisted in taking radiographic pictures through the weld, the X-rays passing in a line normal to the plane of the plate. As a result some idea of the porosity is noted, but the lack of fusion on the scarf in vee welds is not clearly registered on the film. By taking two photographs, one with the X-rays passing parallel to one scarf and one with the X-rays parallel to the other scarf, in addition to the photograph normal to the weld, this difficulty is eliminated. Thus, if there is lack of fusion with or without thorough penetration at the bottom of the vee or along the face of the scarf, X-rays pass along this place unabsorbed and leave their characteristic dark mark on the developed film. From the appearance of the films and a knowledge of the plate metal and welding rod used the ultimate strength of the weld may be estimated with considerable accuracy after a little experience.

A number of welded single vee and double vee coupons were X-rayed in the manner described, and the ultimate strength estimated from the films. In order to have some poor welds in the series a number were taken from the work of welders who had failed to pass the test required to qualify them for important work under procedure control. The authors had no knowledge of the condition of any particular weld prior to the X-raying. The coupons were then pulled in the tensile testing machine and the actual strength and the estimated strength compared.

The concordance of estimated and actual strength of the coupons tested is remarkable, and a maximum deviation of 3000 pounds per square inch resulted. In a 50,000-pound per square inch weld, this is within 6 percent of the actual value.

The general plan for a complete method of nondestructive testing of pressure vessels consists in going over the welded joints with the stethoscope and then making X-ray examinations of any points in question.

The following conclusions may be derived from the above methods of testing welds:

1. Defects in line welds, girth seams or structural joints may be detected by the use of the stethoscope.

2. A quantitative estimate, good within 3000 pounds per square inch of the strength of the weld, can be obtained from X-ray photographs made in accordance with the above-described methods.

3. A combination of the use of the stethoscope and X-ray constitutes a satisfactory quantitative non-destructive method of testing welds.

The complete papers describing these methods were presented at the recent fall meeting of the American Welding Society and appear in the September, 1929, number of its journal. These developments are cited to show that some of the uncertainties as to the soundness of welds can be definitely removed and that the problem is well along toward solution. Assurance that a weld is perfect will go far in furthering the willingness of insurance companies and boiler users to accept this method of construction. Both of the methods referred to, as well as the hammer test, are practicable shop operations.

If fusion-welded drums are permitted as is quite likely in the not distant future, it will inevitably be under drastic restrictions that will prevent any but adequately equipped shops, as regards men, methods and machines, from attempting to manufacture by this process. The tentative draft of the regulations now under consideration by the A. S. M. E. Code Committee is of interest. The following are the principal points:

Test plates from which specimens may be cut will have to be welded at the same time and under the same conditions as the shell.

Tension tests must be made which should fail in the plate, but if failure occurs in the weld the stress must not be less than the mean of the range for the plate.

Bend test specimens transverse of the weld must bend cold under free bending conditions until the stretch on the surface is 30 percent with width of surface cracks deducted, none of which shall be longer than 10 percent of the width of the specimen.

Impact test specimens from the bottom, middle and top shall have minimum Sharpy value of 20 foot-pounds.

Chemical analysis of weld metal with maximum requirements for manganese, phosphorus, sulphur and iron nitride.

The complete welded structure shall be heated uniformly to certain specified temperatures for different thicknesses, but averaging about 1100 degrees F. and held for one hour per inch of thickness for the purpose of relieving stresses due to welding.

The welded joints shall be explored by means of some form of non-destructive apparatus as will determine quantitatively the size of a defect.

After being stress-relieved the vessel shall be subjected to 10,000 applications of hydrostatic pressure varying in a cycle from zero pounds to one and one-half times the working pressure, after which the welds shall again be explored by the non-destructive test apparatus.

Make macro and micro-photographs to show freedom from excessive porosity, incomplete fusion, laps, etc.

No holes shall be located in a weld nor shall a hole be nearer to the edge of the weld than the thickness of the plate with a minimum of 1 inch for plates less than 1-inch thick and 2 inches for plates of that thickness.

When constructed in accordance with the proposed specification the maximum unit working stress may be taken as 16 percent of the minimum of the specified range for the plate.

It must be understood that these provisions have not been adopted and many of them may be changed or omitted and still others may be added before a final conclusion is reached. It is even possible that there may be enough objection raised so that a code acceptable to all the varied interests concerned cannot at this time be agreed to and that the matter will therefore be more or less indefinitely delayed.

It will be evident from the foregoing that at present, with the exception of forge welding, high-pressure boilers may not be made otherwise than riveted or seamless, but that progress is being made and that probably fusion welding will soon received recognition in the boiler field.

While the A. S. M. E. code does not now sanction the use of fusion welding subject to major stresses, revisions have been made that permit its use in many minor ways, particularly in small firebox types of boilers. In these the bottoms of waterlegs, fire-door openings, furnace sheets, etc., may be welded provided the surfaces are adequately supported otherwise. Also attachments of various kinds can be affixed by welding, thus avoiding riveting that not infrequently causes annoyance by leaking besides being cheaper and really better. It will then be seen that the code committee has been relenting in its attitude toward welding and is apparently on the verge of a major leap.

At about the point where it is no longer possible to use riveted construction it becomes practicable to use seamless forged drums, the most ideal structure for the purpose that can be imagined but very expensive.

Where conditions are such as not to make welded construction either forged or fusion of paramount importance and first cost is a prime consideration riveted work will continue to be used. Roughly the former costs from two to three and one-half times that of the latter. That this disparity may in time be lessened is probable, but just now it is a real factor in making a decision.

The progress of the welding art is so rapid that any developments of the past can be of value only historically. The attempt has been made herein to deal only with the immediate present and imminent future without rehearsing the steps either at home or abroad of the ladder of experiences on which present knowledge and practice has mounted to its present status. It is hoped that what has been said will be of some interest and service to all.

Device for Bending Plate

A CONTRACT welding shop recently had a problem submitted to it which involved the question of whether it would be cheaper to have some heads for tanks pressed out of steel plate or to make them in the shop themselves.

The tanks were of irregular shape and the amount which the head was to be dished was not very great. It was to be bent in a radius of 2 inches and afterward welded on the seams. It was finally decided that it would be easy enough to make these heads in the shop, and that it would not be necessary to send the plate out to a machine shop fitted with a brake which would turn out the heads. The following was the method used:

A 2-foot length of 2-inch shafting was used as a form over which to bend the sides of the plate. A vee extending from one side of the shafting to within ¼-inch of the other side was cut out by means of the oxy-acetylene cutting blowpipe. The piece was then heated and bent at an angle of 45 degrees. This gave a rounded corner which was tack-welded to the stand. For bending, the plates were then laid across the top of this home-made form and heated on the corners by means of a large oxy-acetylene blowpipe. With a little hammering, the heads could be bent into the desired position. This is a very speedy method of doing this work, and the fact that it was inexpensive saved considerable money, which would have been necessary if these heads were machine made.—*Oxy-Acetylene Tips.*

Hidden Defects

WHILE examining a Scotch marine boiler recently, an inspector noticed slight leaks at a girth seam and around the manhole reinforcement ring. On questioning attendants, he found that they were aware of the leaks and had made an unsuccessful attempt to stop them by calking. The condition was such as might indicate cracks in the plate, so the inspector had the engineer remove enough of the lagging to permit examination of the longitudinal seam. There he found four broken rivets and two others that appeared to be cracked.

The engineer did not share the inspector's apprehension, and instead of granting a request to have the butt strap removed, he urged that the rivets be redriven and

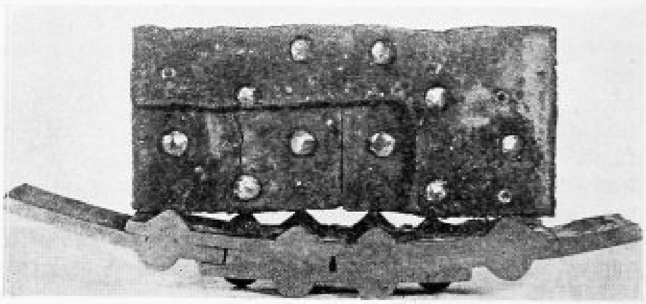


Fig. 1

the boiler put back onto the line. However, after considerable urging, he agreed to allow a hydrostatic test. A hammer test of rivet heads with the boiler under 150 pounds water pressure brought to light several more defective rivets. The inspector had just finished marking them for removal when the seam gave way in the middle course. Needless to say, that brought the test to a halt.

From the appearance of the rivet at the extreme left in Fig. 1 it is evident that slippage of the plate had subjected the outer row of rivets to a heavy shearing stress. Had the rupture taken place while the boiler was in service there is little question but that there would have been complete separation at the joint, and a violent explosion.—*The Locomotive.*

BOILER NOZZLES.—Taylor seamless forged steel boiler nozzles made from a solid billet of steel are described in a folder issued by the Taylor Forge & Pipe Works, Chicago, Ill. These nozzles are said to be economical, safe, standardized, approved and uniform.

Effect of Heat Treating Firebox Plate and Flues *in the Process of Manufacture*

THERE are three individual subdivisions of the subject of the relative merits of heat-treating materials, as discussed at the last annual meeting of the Master Boiler Makers' Association convention, which are as follows:

Cold-drawn tubes compared with hot-finished tubes.

Cold-flanged firebox plates compared with hot-flanged firebox plates.

Annealing or heat-treating firebox sheets before application.

The question on flues is self-explanatory. The question concerning flanged firebox plates is interpreted to include the back tube sheet, inside throat sheet and door sheet. The last question concerns firebox sheets and may be taken to include the wrapper sheet comprising the crown and side sheets and combustion chamber. None of these latter sheets are flanged but merely rolled to the same general shape or contour of the firebox.

We are agreed the last question covering the annealing or heat-treating firebox sheets is intended to apply to the flanged plates referred to, since for obvious reasons it would not be practical or economical to attempt to anneal a firebox wrapper sheet.

In answering the first question we have the following to report:

"Have cold-drawn flues an advantage in service as compared to hot-finished tubes?"

Surface.—Cold-drawn tubes require soft annealing which is annealing at rather high temperatures, and such tubes have a surface scale which is not always as tightly adhering as might be desired. Hot-finished tubes, because of being mechanically worked by reelers and sizing rolls, practically down to the critical temperature, have a more uniform, thinner, and more closely adhering scale.

Crystalline Structure.—Cold-drawn tubes, because of more severe mechanical working in a longitudinal direction, develop a tendency for crystals to show an elongation which is sufficiently pronounced to be visible under the microscope, even though the tubes are thoroughly annealed and which indicates greater strength longitudinally than transversely. Hot-finished tubes show a more uniform crystalline size and a structure which is uniform in any direction.

Physical Properties.—When a cold-drawn tube is annealed to such an extent that its elongation is practically the same as hot-finished tubes, the yield point and ultimate strength of the cold-drawn tube is from 5000 to 8000 pounds under the yield point and ultimate strength of the hot-finished tube. These figures are given from a tabulation of average results and indicate that the hot-finished tube is stronger than cold drawn with practically the same ductility.

Strength Under Pressure.—Hot-finished tubes, on account of being finished above the critical point of the steel, as previously pointed out, are practically as strong transversely as longitudinally. They show higher bursting pressure figures than cold-drawn tubes, which fact is only partly accounted for by the higher physical properties. Cold-drawn tubes, on account of the method of manufacture, tend to develop lines of weakness to transverse stresses, which slightly lowers their resistance to bursting stresses.

Malleability.—Cold-drawn tubes, because of their longitudinal crystalline structure will not stand beading or other severe manipulating tests as well as hot-finished tubes, which show slightly less tendency to split open under test than cold-drawn tubes.

Uniformity.—In commercial annealing it is difficult to absolutely hold all tubes to the same degree of final anneal and, therefore, cold-drawn tubes are not always entirely uniform as to physical structure. In the method of manufacture of hot-finished tubes there is more assurance of uniform structure.

Resistance to Corrosion.—As far as practical experience is concerned, we have found no appreciable difference in the resistance to corrosion of hot-finished or cold-drawn tubes. What difference there is seems to favor the hot-finished tubes. The department of metallurgy and research of a large manufacturer of boiler tubes has checked up several investigations and references on the matter of the relative corrosion of hot-finished and cold-drawn tubing, and has found that while there may be some evidence that the hot-finished tubing corrodes less than the cold-drawn, the difference between the two is not very great although it is sufficient for them to be inclined to favor the hot-finished tubing in this connection.

Dimension Tolerances.—This is one point where cold-drawn tubes show an advantage over hot-finished. From the nature of the cold-drawn process, it is quite evident that tubes can be furnished with a smaller tolerance than obtained on hot-finished tubes. In this connection, would refer to standard specifications for boiler tubes, wherein cold-drawn tubes are furnished within a thickness tolerance of two gages while hot-finished tubes call for three gages variation.

Practical Service Comparison.—From what information we can gather, the service of hot-finished tubes indicates that more mileage is obtained per flue setting than for cold-drawn tubes but at the same time, all this cannot be credited to the hot-finished tubes as the change to long runs and water treating conditions have helped this. Of course, the most efficient manner in which to definitely determine this is to conduct a test in actual service, one side of boiler being fitted with hot-

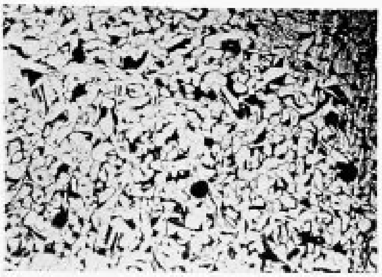


Fig. 1

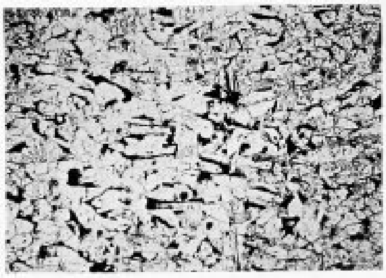


Fig. 2

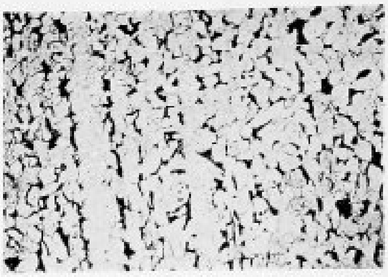


Fig. 3

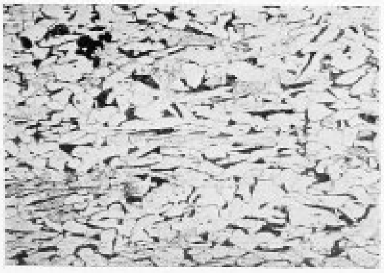


Fig. 4

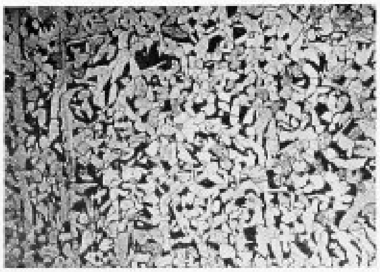


Fig. 5

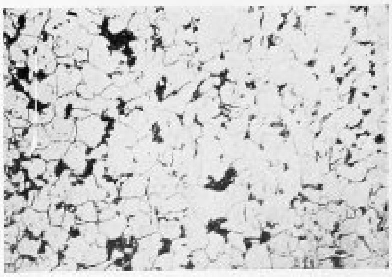


Fig. 6

finished tubes and the other side with cold-drawn tubes. This test would run over a period of several years and, therefore, this committee is unable to state at this time what the actual results would be.

The Navy Department, about twenty years ago, conducted laboratory corrosion tests on lap weld Bessemer steel, lap weld iron, cold-drawn seamless steel and hot-finished steel boiler tubes. This test was conducted by the Bureau of Steam Engineering of the Navy Department. Care was taken to secure representative samples of each material and according to the reports the whole test was conducted very carefully. The test lasted through a period of 64 weeks, and the samples of the different kinds of material were removed, thoroughly cleaned and weighed. Of these four classes of steel, the hot-finished open-hearth material showed the least amount of loss. The Bessemer steel was second, the charcoal iron third and the cold-drawn open-hearth steel fourth. Using the corrosion figure of the charcoal iron tubes as 100, the losses in weight were as follows:

Hot finished	93.7
Bessemer steel	94.5
Charcoal iron	100.0
Cold drawn	101.3

It appears from information which we have that probably 60 percent of the seamless steel boiler tubes used by the railroads is hot-finished material. In other lines of business where seamless tubing is used under pressure conditions in stills, etc., the hot-tubing tonnage runs nearer 80 percent or 90 percent. The preponderant use of hot-finished tubing is likely due in considerable measure, to the fact that it is cheaper in price than the cold drawn, yet when two railroads operating through practically the same territory use the one exclusively, viz., hot-finished, and the other cold-drawn exclusively, it is difficult to draw any positive conclusion regarding the reason thereof in the absence of any tangible supporting data.

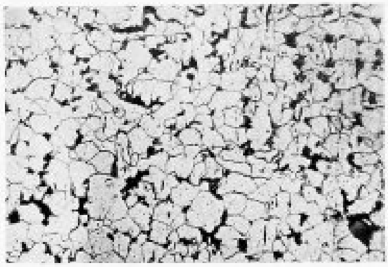


Fig. 7

Conclusions.—We feel that we have given here an impartial opinion on the relative merits of cold-drawn and hot-finished tubes and we believe that all things considered, hot-finished tubes are the more satisfactory product for boiler service.

On the questions, "Have cold-flanged firebox plates an advantage in service as compared to hot-flanged plates? What benefit, if any, is derived from annealing or heat treating flanged firebox plates prior to application?" we beg to state that a direct answer to the first question cannot be frankly stated, since the field in which we conducted our investigation did not bring out any data indicating that cold-flanged plates are being applied without first annealing them. It is, therefore, impossible to present any evidence as to what comparison there is between the service obtained or advantages of cold-flanged plates compared to hot-flanged plates. However, from careful analysis made to determine the relative merit of each method, it is concluded that cold-flanged plates unannealed, would not appear to be as satisfactory as hot-flanged plates. In view of this, the following report is in answer to the combination of the two questions and, briefly, consists of showing the change in the characteristics of the metal due to flanging the plate either hot or cold and the restorative effect that takes place when the plate is annealed after the flanging process has been completed.

Test sections for pulling were made by flanging sheets ½-inch and ⅝-inch thick, 2 feet long and 6 inches wide, with proper knuckle radius the full length of the sheet. One of each thickness was flanged hot and one of each flanged cold. The center section was then cut out to a width of 2 inches and a length of 9 inches in each case and the wide ends flattened to afford a grip for the testing machine. This procedure gives the comparative strength and elongation of the hot and cold-flanged knuckles.

The following table shows these physical characteristics:

	½ in. Cold	½ in. Hot	⅝ in. Cold	⅝ in. Hot
Ultimate tensile strength, pounds per square inch	59,000	53,700	66,900	63,000
Yield point, pounds per square inch	42,500	33,400	47,300	39,300
Yield point, percent ultimate tensile strength	.72	.62	.71	.62
Elongation in 8 inches, (percent)	6.25	14.07	9.40	18.75

The above table plainly shows that the cold-working of the plate has raised the tensile strength of the metal while there has been a reduction in the ductility of the material as shown by the low percentage of elongation. On the other hand the results on the hot-worked plate show lower tensile strength, but increased ductility.

While this shows the hot-flanged plate to have the advantage over the cold-flanged, the following table is presented to show the results of testing a specimen and the advantages of heat-treating or annealing a cold-flanged sheet.

	Cold Flanged Untreated	Cold Flanged Heat Treated
Ultimate tensile strength, pounds per square inch	66,000	61,700
Yield point, pounds per square inch	41,000	40,250
Yield Point, percent, ultimate tensile strength	.62	.65
Elongation in 8 inches, (percent)	6.25	28.12
Reduction of area, percent	24.52	49.26

Treatment: Bar heated to 1650 degrees F., held for one hour, allowed to cool in furnace to 1200 degrees F., time 25 minutes, and cooled by air.

From the above, it will be noted that by annealing, the ductility of the metal has increased considerably over that shown by the table covering either the ½-inch or ⅝-inch hot-flanged plates.

The Reading Company has made similar tests of cold-flanged plates and while they differed only in that the plate was also annealed before and after flanging, the elongation ran 27.0 percent, 30.0 percent and 31.0 percent on three specimens, the average being 29.3 percent or slightly higher than shown by the above table. They have met with very successful results in doing this as they claim it makes the plate soft and more pliable. However, from replies received from other roads, very few anneal their work before flanging. From the tables herewith shown, it would appear that annealing before flanging is not necessary due to the small improvement noted.

In connection with the foregoing, we also submit the following micrographs to illustrate the change that takes place in the grain structure of the metal due to cold flanging, and the annealing of each.

Plate No. 1 shows microstructure of boiler plate as taken from stock. This will represent either ½-inch or ⅝-inch stock as both samples had the same structure under the microscope. The dark spots show the pearlite and the white grains are ferrite. This structure shows grains more or less equal along both axes.

Plate No. 2 shows ½-inch plate cold-flanged. Note the grains are greater in length along one axis than the other, this is the distortion due to cold working.

Plate No. 3 shows ½-inch plate hot-flanged. The grains here are practically equi-axial as the heat during flanging does not allow the retention of the long distorted grains. This structure is superior to that shown by plate No. 2. The light stripe bordered by the thin black streaks is merely a slight carbon segregation which has been rolled into the plate from a condition existing in the billet or ingot from which the plate was rolled.

Plate No. 4 shows effect of cold flanging on a ⅝-inch sheet. The distortion of the grains is plainly seen.

Plate No. 5 shows effect of hot flanging on a ⅝-inch sheet and shows more equal axial grains, the structure being much superior to that obtained by the cold flange.

Comparison of plates 2 and 4 with plates 3 and 5, and at the same time, bearing in mind the physical characteristics of the material as given in the first table mentioned, it would appear evident that it would not be good practice to apply cold-flanged plates in preference to hot-flanged plates. However, to illustrate the effect of annealing or heat-treating these flanges, the following is shown:

Plate No. 6 covers ½-inch plate cold-flanged, and plate No. 7 a ½-inch plate hot-flanged, after annealing treatment of 1600 degrees F., for one hour cooling to 1200 degrees F., in the furnace and to room temperature in air. This treatment has made the material of normal equi-axial structure for both hot and cold-flanged material. The larger crystals are due to growth during annealing. All micrographs are magnified 100 times and etched 2 percent nitral.

Comparing plates 6 and 7 with the others and noting the physical characteristics as given in the second or last table mentioned, it is evident that by annealing plates after flanging, the strains set up in the metal due to flanging, as will be noted by the distorted grains, have been removed and the metal restored to normal.

While the ultimate result as pictured in the foregoing does not appear to show that there is any advantage, whether the plates are flanged hot or flanged cold, since plates worked by both methods should be annealed after flanging, it is our opinion that the cold-flanging method would be preferred in shops not equipped with presses for handling hot-flanged work. Plates can be cold-flanged to closer dimensions than by hot-flanging, as by the hammer method over blocks, and we believe it does not abuse the sheets nearly as much.

A general view seems to prevail among boiler makers "that there is no noticeable difference" in the service obtained by either hot or cold-flanged plates. However, from information we have been able to obtain, the annealing of knuckles which were cold-flanged after laying up and fitting, has increased the length of service to a marked degree.

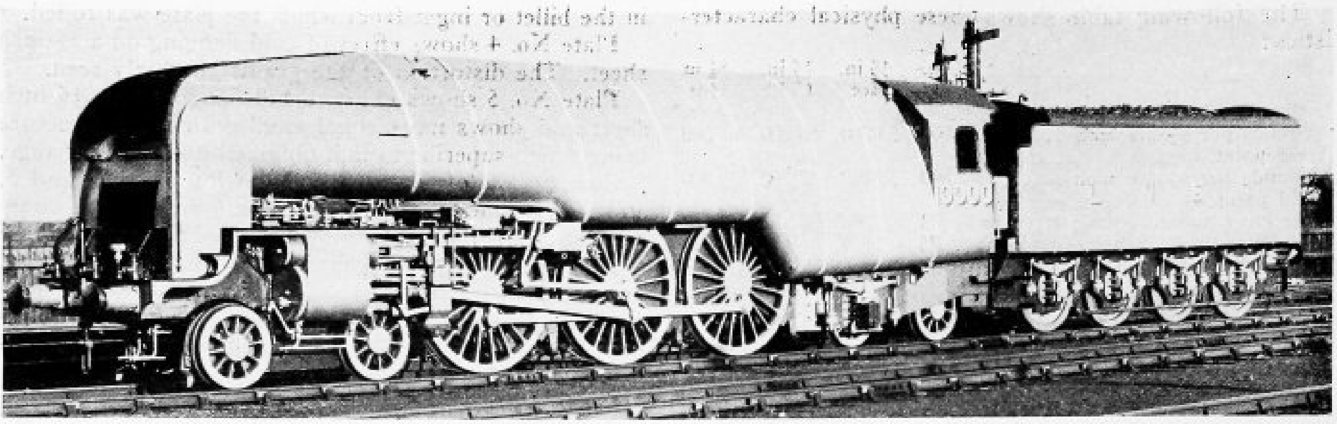
This report was prepared by a committee composed of O. H. Kurlfinke, chairman, G. L. Young, and H. V. Stevens.

Patches on Power Boilers

(Continued from page 36)

termined by the boiler maker doing the work, as conditions vary so much.

For the benefit of the boiler maker doing repair work or applying patches, I might suggest, that it is not feasible for him to go ahead and do the work on his own initiative, but it would be much better to request, or even demand that the state or insurance inspector issue written orders as to how the work should be done; the design of the patch, pitch and size of rivets, plate thickness of patch, and all other necessary details. In taking these precautions, the repairman will not get in wrong, and there can be no come back by the inspector after the work has been done, providing it has been done according to the written instructions.



Britain's largest locomotive equipped with boiler operating at 450 pounds pressure

New Locomotive Employs Highest Boiler Pressure in Britain

By G. P. Blackall

THE London & North Eastern Railway has just completed a new locomotive of unique design for use on its East coast route express passenger service. In outward appearance this new locomotive is a radical departure from previous practice in locomotive design in the United Kingdom and many of the constructional details are very novel.

The boiler has been constructed to the extreme limits of the railroad gage and there is no room for a stack to project above the boiler. The stack has, therefore, been sunk within casing plates which are so arranged as to throw the smoke upwards and clear of the driver's view from his position on the footplate. Considerable experimenting was undertaken and the new outstanding design was arrived at by tests conducted with a model of the locomotive in a wind tunnel with air currents of speeds up to 50 miles per hour.

The locomotive operates under the high boiler pressure of 450 pounds per square inch, which constitutes the highest pressure which has ever been used for a British railroad locomotive. The pressures hitherto used have been between 200 and 250 pounds. This high pressure has necessitated the use of a watertube boiler, a type never previously applied to a locomotive in Britain.

In conjunction with Harold Yarrow, H. N. Gresley, chief mechanical engineer of the London & North Eastern Railway, designed a type of watertube boiler suitable for use in locomotives, and this has been patented in their two names, the boiler being manufactured by Yarrow & Company. It is built up with one steam drum, 3 feet inside diameter by 27 feet 11⅝ inches long, and two steam drums on either side of the firebox, each 18 inches in diameter and 11 feet ⅝ inch long, and also two other drums under the forward part of the boiler, each 19 inches in diameter and 13 feet 5¾ inches long. The forward drums are connected to the steam drums by 444 2-inch tubes and 74 2½-inch tubes. The drums at the side of the fire grate are connected to the steam drum by 238 2½-inch tubes, and there is a back screen of 12 2½-inch tubes. All the drums are solid forged and machined. Special types of safety valves, relief valves, reducing valves, and regulators have been installed. The main regulator admits high-pressure steam to the high-pressure steam chests, but, to facilitate starting, an additional supply of steam can be admitted through a small regulator, 1-inch in diameter, to the low-pressure steam chest. In order to prevent too high a pressure in the low-pressure steam chests, a pop safety valve which blows off at 200 pounds pressure is fitted. For the auxiliary services there is a manifold above the firehole door from which the connections to the auxiliary services are taken. A reducing valve maintains the steam pressure in this manifold at 200 pounds per square inch.

A Gresham & Craven high-pressure injector and a Davies & Metcalfe low-pressure injector are fitted, while a special form of superheater is contained in the main flue on the boiler side of the regulator. There is an air space between the flues and the outer casing, and the air supply to the ashpan for combustion purposes is taken through this air space, the object being to preheat the air. The intake is at the front of the smokebox, and, if necessary, cold air can be admitted to the ashpan through the front damper.

In order to overcome the formation of scale, the feed water is introduced into the forward portion of the steam drum, a weir being placed across the bottom half of the drum. The feed water is delivered into the forward space by means of heater injectors.

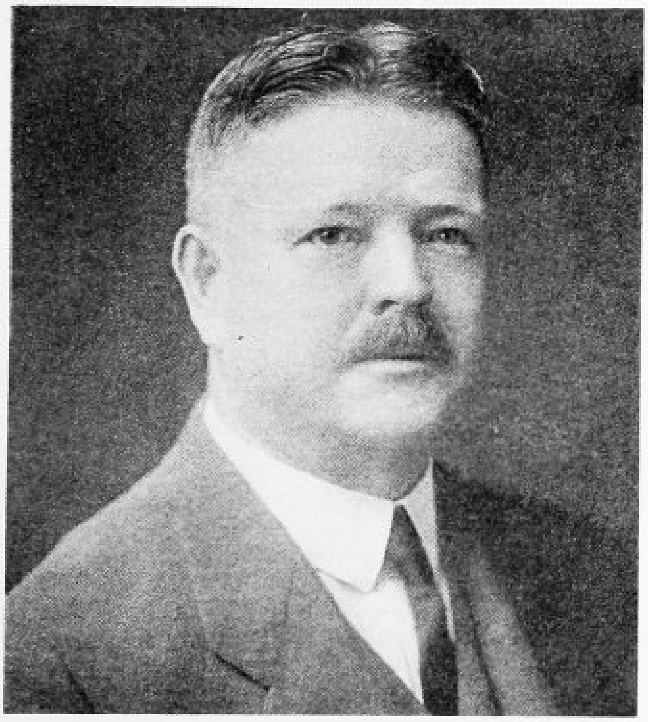
A. F. Huston Dies

ABRAM FRANCIS HUSTON, chairman of the board of the Lukens Steel Company, Coatesville, Pa., died on January 12 at his home in Coatesville. Mr. Huston was born on July 7, 1852, and was educated at Taylor Academy and at Haverford College, from which he was graduated in 1872 with the degree of Bachelor of Arts. On leaving college he at once entered the employ of the Lukens Iron Works and served in the mill. He held positions in various departments after which he served as bookkeeper, purchasing agent and sales agent. In 1882 when his father retired from the management, he was put in control of the business. In 1890 the company was incorporated under the name of the Lukens Iron & Steel Company. In 1897 Mr. Huston was elected president of the company which has been known since 1917 as the Lukens Steel Company; in 1925 he became chairman of the board which position he held at the time of his death. In 1902, Mr. Huston was elected president of the Association of Steel Manufacturers and to the chairmanship of its executive committee. At the time of his death, he was a director of many industrial organizations.

A Tribute to S. F. Jeter

SHERWOOD F. Jeter, vice-president of The Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn., and recognized as a leading and influential authority on the engineering aspects of power plant insurance, died on December 31, 1929 at Hartford, Conn.

Born in Columbus, Ga., in 1872, Mr. Jeter was a graduate of the Georgia School of Technology. In 1893 he began his career as an engineer for the Mexican Telephone Company at Mexico City, and five years later he established his first connection with The Hartford Steam Boiler Inspection & Insurance Company as a boiler inspector at the company's New Orleans office. He remained with the company at New Orleans, Pittsburgh and Hartford until 1906 when he left to accept a position as master mechanic for the Pittsburgh, McKeesport and Connellsville Railway at Connellsville, Pa. In the latter part of the same year he was retained as chief engineer by the Bigelow Company at New Haven, Conn., and while there he redesigned the Hornsby watertube boiler to conform to manufacturing and operating conditions in the United States.



Sherwood F. Jeter

Returning to The Hartford Company in 1910 as supervising inspector, Mr. Jeter was given charge of the company's inspection work throughout the country. In 1915 he was promoted to the post of chief engineer and, in 1927, he was made vice-president with full responsibility for the engineering side of the company's business.

Mr. Jeter was long a member of the American Society of Mechanical Engineers of which he was for three years a manager and for two years a vice-president. He has served on the society's Boiler Code Committee since 1913 and had had an important influence in helping to establish standards of safe boiler construction now recognized throughout the country. He was one of the founders of The Hartford Engineers Club and was one of its past presidents.

William R. C. Corson, president of The Hartford Steam Boiler Inspection & Insurance Company, in speaking of the death of Mr. Jeter, stated that: "vice-president Jeter's broad acquaintance with all the features of power engineering and his intimate knowledge of steam boiler construction and operation especially fitted him for the direction of the engineering side of our business. Under him it has progressed with the development of modern power plant equipment and maintained the high reputation which our company has enjoyed in its peculiar field of insurance protection. Mr. Jeter himself has been widely recognized throughout the country as an expert in the safeguarding of power production and his advice has been constantly sought and freely given in developing new apparatus.

"Personally, Mr. Jeter thought and talked with a directness and straightforward honesty of the trained engineer. His judgments were clear and formed on a close analysis of the facts to be considered. His sincerity impressed itself on all who had contact with him."

Personal

Joseph V. Santry has been appointed head of the Combustion Engineering Corporation, New York, by Wilfred R. Wood and the Irving Trust Company, receivers of that company. He succeeds Colonel H. D. Savage. Mr. Santry, who became identified with the Combustion Engineering Corporation shortly after its organization in 1914, served successively as director and vice-president in charge of sales for five years and as president for four years, resigning about two years ago.

Benjamin O'Shea, formerly president of the Union Carbide Company and the Electro Metallurgical Company, both units of the Union Carbide and Carbon Corporation, 205 East 42nd street, New York, has been elected chairman of the board of directors of each company. Fred H. Haggerson, formerly vice-president of the two companies was elected president and F. P. Gormely was elected vice-president and general manager of both companies.

Arthur J. Herschmann, 50 Church street, New York, has discontinued his connections with the Limited Company, formerly the Skodawarks. He now represents the steelworks of Witkowitz of Czechoslovakia, established in 1829, manufacturers of steel, forgings and castings. Mr. Herschmann was formerly in charge of the mechanical department of George A. Fuller Company, New York, and the U. S. Realty Corporation, New York.

Verl E. McCoy, combustion engineer of The Chicago, Milwaukee, St. Paul & Pacific Railroad, has entered the service of the Bird-Archer Company, Chicago, Ill., as assistant to the president, with office at 122 S. Michigan avenue, Chicago. Mr. McCoy was born December 17, 1900, at Lincoln, Nebraska. He graduated from the Montana State College in mechanical engineering in the class of 1925 and immediately entered the service of the Chicago, Milwaukee & St. Paul Railway as a special apprentice, becoming combustion engineer of that railroad in 1928.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Layout of 90-Degree Elbow

Q.—I would like to see the easiest and quickest way to layout a tapered 90-degree elbow—a good practical layout, for example: An elbow connecting two pipes of 54-inch and 48-inch diameter respectively. H. H.

A.—In the April issue of The Boiler Maker, was described the layout of a 90-degree tapered elbow, developed by triangulation. This method requires less room for laying out than is required by the method of conic sections as; for instance, if the large end were 36 inches in diameter and the small end 30 inches, and each half section 10 inches long from the center line, making the whole length 80 inches. The radius would be a little over 40 feet, and if the taper was less than six inches, the radius would be proportionally larger and in either case not very easy to handle; whereas, in the case of triangulation, all the preliminary work can be done on the drawing board, making the drawings to scale, and when taking off the different lengths to lay down the pattern, multiplying their lengths by the scale.

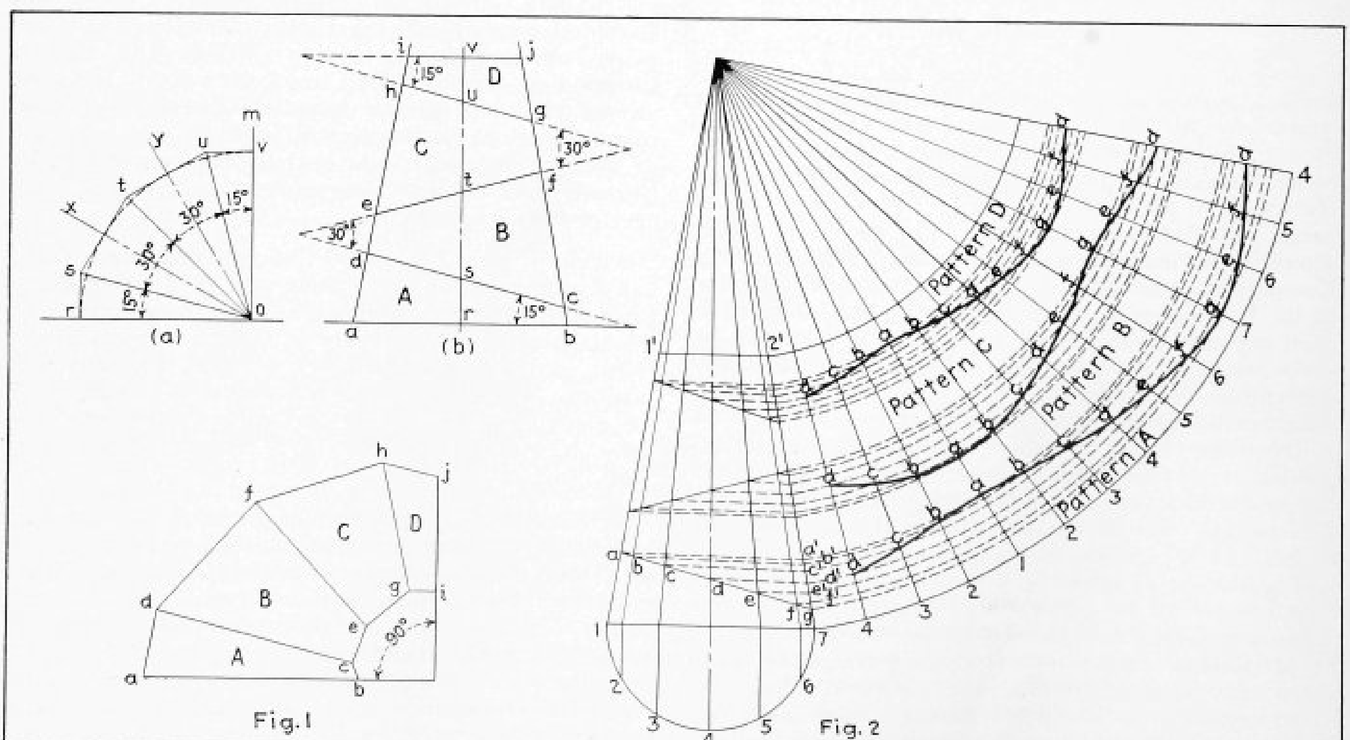
For your information, the following is the method for developing a 90-degree tapered elbow by conic sections, and which you may find to be an easier way to lay out this elbow for your particular line of work.

In the layout, Fig. 1 represents the method of laying off an elevation for a tapering elbow having four sections, *A*, *B*, *C* and *D*. The preliminary work involved is shown at (*a*) and (*b*).

In (*a*) the center arc *r-v* is drawn first to the required radius of the elbow. Lines *r-s*, *s-t*, *t-u* and *u-v* are the axes or center lines for the elbow sections. They are determined in the following way: Divide the arc *r-v* into one less the number of sections in the elbow, in this case three, as at *r-x*, *x-y* and *y-v*. Then draw the radial lines *o-x* and *o-y*. At right angles to these lines draw the center lines tangent to the arc *r-v* as shown.

In view (*b*), a base line *a-b* for the frustum is drawn. A perpendicular line *r-v* to *a-b* is then laid off. Spaces *r-s*, *s-t*, *t-u* and *u-v* on this line are equal to the corresponding ones in view (*a*).

Lay off the frustum *a-b-j-i* equal to the dimensions of



Development of 90-degree tapering elbow

the elbow, so that *a-b* equals the large opening and *i-j* the small opening. Through the points *s*, *t* and *u*, draw respectively the lines *c-d*, *e-f* and *h-g*, making 15- and 30-degree angles as shown.

The sections *A*, *B*, *C* and *D* are now assembled in a frustum of a cone. By reversing the positions of these sections in view (*b*), so that the shortest side or throat connections come as shown in view (*c*), and elevation of the elbow is completed with the sections shown assembled.

The radial method, Fig. 2, is a practical and quick way of handling this work. The sides of the frustum, view (*b*), Fig. 1, are extended, meeting in point *x*, Fig. 2. The object *x-1-7* is a right cone, and therefore any part of its surface may be developed by the use of its elements.

These are determined by drawing first the semi-circle and dividing it into equal parts. Projections are drawn from the points *2*, *3*, *4*, etc., to intersect the base *1-7*. Radial lines are then drawn from the points on the base to point *x*.

Before the pattern can be drawn, the true length of the construction lines must be found. This is done, for example, by projecting points *b*, *c*, *d*, *e*, etc., to the outer element *x-7* of the cone, thus locating points *b'*, *c'*, *d'*, etc. With *x-7* as a radius, draw the arc *4-4*. Make it equal in length to the circumference around the base of the cone. This is equal to its diameter multiplied by the constant 3.1416.

The distance may be laid off by the measuring wheel or by transferring the spaces from the semicircle, Fig. 2. Draw the lines *x-4*, *x-4* in the pattern layout and also the radial lines *x-1*, *x-2*, and *x-3*. With *x* as a center, draw arcs from *a'*, *b'*, *c'*, etc. intersecting the radial lines in the pattern.

The layouts in this case do not show any allowances made for laps; this must be taken care of in the work. The idea brought out in Fig. 2 is just to show the use of the radial method. If the taper between the bases of the frustum is small, then the sides will not intersect within a distance suitable for the use of the trammel points, in such cases short approximate solutions are used or the triangular method is applied.

Draft and Nozzle Size of Oil-Burning Locomotive

Q.—Here are a couple of questions which I would like to see published in The Boiler Maker magazine of which I am a subscriber.

(1) What is the proper method of calculating the proper amount of draft that an oil-burning locomotive takes and what percent of the total area should be given at the fire door?

(2) What is the proper method of calculating the correct size of nozzle in the front end of an oil-burning locomotive? J. H.

A.—(1) The proper location and the correct size of air openings in the fire pan and fire door are of utmost importance on oil-burning locomotives. A safe rule is for air openings to be seven times the diameter of the cylinder. Sufficient air should be admitted around the burner to prevent it from becoming overheated. Too much air admitted around or under the burner, unless proper damper control is provided, may result in chilling the lower flues, as the air takes the line of least resistance and goes up the front brick wall and into these flues on its way to the stack. Leaky flues are often the result.

Admitting the major portion of air to the firebox through a flash hole varying in size from 8 by 10 inches to 13 by 20 inches and located from 9 to 18 inches in front of the flash wall and through a 2 by 35-inch opening in the hooded fire door is one practice of the Southern Pacific Lines. The air openings are approximately as follows: Flash hole, 25 percent; burner openings, 5 percent; and door damper, 5 percent of the minimum area of tubes allowing for units. This is what is known as the vertical draft having the hooded door, as against a solid door with a 5-inch circular hole used in sanding flues.

The horizontal draft differs slightly in that it admits the air through small openings in front of the fire pan around the burner and through the hooded door. Each of these methods are in general use on the Southern Pacific.

(2) The following table can be used for determining the diameter of the exhaust-pipe nozzles on oil-burning locomotives:

Cylinders	Exhaust Nozzles		
Simple or Compound	Single or Double	Ratio of Nozzle Diameter to Diameter of one Cylinder (High Pressure when compound) Saturated	Superheated
Simple	Single	0.25	0.225
	Double	0.177	0.159
Two Cylinder Compound	Single	0.238	0.214
	.....	....	....
Four Cylinder Mallet Compound	Single	0.325	0.293
	Double	0.230	0.207

To determine exhaust nozzle diameter, multiply the cylinder diameter by the factor in the table corresponding to the given type of engine and add 1/8 to 1/4 inch to the diameter of stroke, and steam pressure need not be considered.

Layout of Screw Conveyor

Q.—Please show me how to lay out a screw conveyor. Thanking you for past favors. J. F. D.

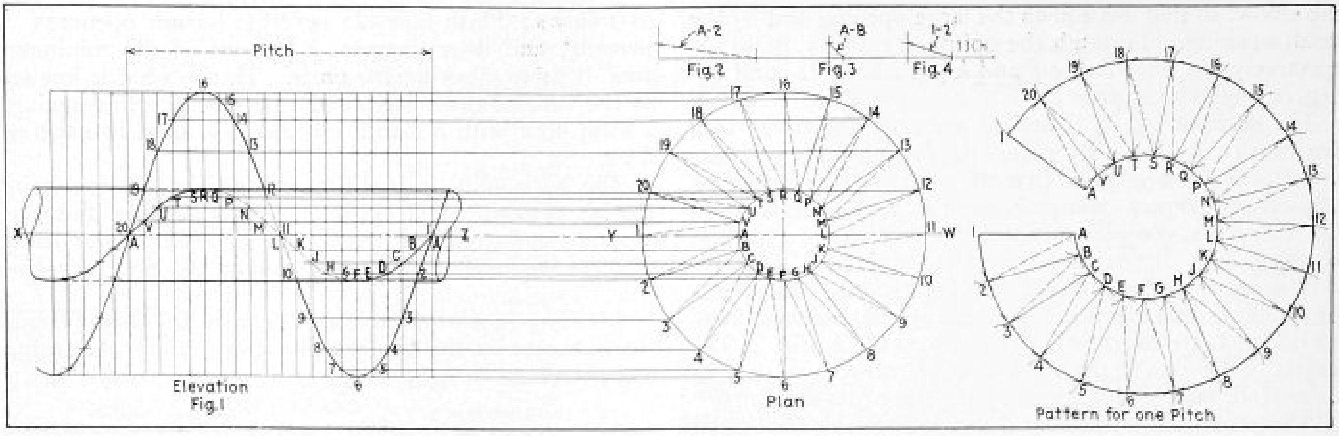
A.—The layout of the screw conveyor shown in Fig. 1 may appear to be a very difficult problem, but if the method described is followed closely it will be found to be comparatively simple, as it merely involves a few principles that are not usually found in the average types of problems found in laying out sheet metal.

First, lay out the plan of the conveyor. Divide the large and small circles in the plan into the same number of equal parts, and mark the points with letters and figures as shown.

Then on the line *WX* space off a distance equal to the pitch as shown in Fig. 1. Divide the distance representing the pitch, in the elevation, into the same number of equal parts as the large and small circles of the plan were divided, and at these points erect perpendiculars to and cutting the line *WX*. Parallel to the line *WX* and through the points *1* to *20* of the plan view, draw lines cutting the lines just made in the elevation, locating the points *1* to *20* in the elevation, as shown. Connect these points with a curve, thus forming the outside contour of one pitch of the screw conveyor. Repeat this process with the points *A*, *B*, *C* to *V* of the plan view, locating these points in the elevation as shown. Connect these points with a curve, thus forming the inside contour of one pitch of the screw conveyor.

The construction triangles must now be formed as shown in Figs. 2, 3 and 4. As all the triangles are found in the same manner it is only necessary to show the three cases where the true length of the surface lines are found by right-angle triangles. The true lengths found by these triangles are used for laying out the entire pattern.

With a pair of dividers take the length of the line *A-2* of the plan, and place it on the horizontal line in Fig. 2. The height of the triangle will be equal to one division of the pitch in the elevation. Place this on the perpendicular line in Fig. 2. Scribe a line through the two points



Elevation and patterns for one turn of screw conveyor

just found, forming the first construction triangle or the true length of the line *A-2*. Next, take the distance between the points *1* and *2* in the plan and place it on the horizontal line in Fig. *4*. Then take the distance equal to one division of the pitch in the elevation and place this on the perpendicular line. A line across the two points will be the true length of the metal between the points *1-2*. Next, take the distance between points *A-B* in the plan and place it on the base line in Fig. 3, then take the distance equal to one division of the pitch in the elevation and place it on the perpendicular line in Fig. 3. A line across the two points will be the true length of the metal between the points *A* and *B*.

The last operation will be the formation of the pattern. Scribe a straight line at any convenient place on the sheet and lay off the distance between points *1* and *A* in the plan. This will be the true length of the line, as it does not rise, as will be seen in the side elevation, this also holds true for the lines *2-B*, *3-C*, *4-D*, *5-E*, etc. With the point *1* as a center and the distance *1-2* in Fig. 4 as a radius, scribe an arc. Then with point *A* as a center and the distance equal to *A-2* in Fig. *2* as a radius scribe an arc cutting the arc just made, locating the point *2*. Then with *2* as a center, and the distance *2-B* in the plan as a radius, scribe an arc, and then with A as a center and the distance *A-B* in Fig. 3 as a radius, scribe an arc cutting the arc just made. Continue in this manner, completing the pattern. The distances *3-C*, *4-D*, *5-E* to *20-V* are taken equal to their corresponding lengths in the plan view. The distances *B-3*, *C-4*, *D-5*, *E-6*, *to 20-A* are taken equal to the distance *A-2* in Fig. 2. The distance *B-C*, *C-D*, *D-E*, to *V-A* are taken equal to the distance *A-B* in Fig. 3. The distances *2-3*, *3-4*, *4-5*, *5-6*, to *20-1* are taken equal to the distance *1-2* in Fig. 4.

The pattern thus completed is for one pitch of the screw conveyor, and additional patterns may be cut from the same layout for the number of turns required.

Ryerson Company Expands Facilities at Detroit

JOSEPH T. RYERSON & Son, Inc., has recently completed a new heated building with increased facilities for storing and dispatching all kinds of steel sheets, Allegheny metal, Ascaloy and other high grade steels at 1600 East Euclid Avenue, Detroit, Mich. This addition marks the fourth large expansion program of the Ryerson Company during its twelve years of steady growth in the Detroit area.

The new unit is 120 by 300 feet, including five bays and a large transfer bay at one end with facilities for the inside loading of freight cars. Five cranes will move material from all parts of the building to the transfer bay where another crane loads it onto the cars.

With the view towards future expansion, the Ryerson Company has ground space reserved to give an ultimate of 110,000 square feet of added space. Of this amount, 67,500 square feet is partially developed and may be acquired as heated warehouse area by adding another floor to the present structure and enclosing the open space.

C. C. Osterhout in New Position

FORMERLY chemical engineer with the Rome Iron Mills, Rome, N. Y., C. C. Osterhout has recently been appointed manager of sales of the Rome division of the Wrought Iron Company of America with headquarters at Lebanon, Pa. Mr. Osterhout graduated from Cornell University in 1904 and became associated with the Rome Iron Mills in 1911 as chemist and engineer of tests; in 1925 he was appointed assistant manager of sales and from 1929 to January, 1930, was manager of sales. As manager of sales of the Rome division of the Wrought Iron Company of America Mr. Osterhout will have exclusive charge of sales of Rome staybolt and engine bolt irons to the trade.

C. C. Osterhout

OXWELDING.—"Oxwelded Construction for Modern Piping Services" is the title of a 77-page book published by the Linde Air Products Company, 30 East 42nd street, New York. This booklet has been compiled with the idea of presenting under one cover salient facts concerning the welding of steel and wrought iron piping for modern services. It is not intended as a text, but rather to set forth the advantages of the process and the reasons for its employment.

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

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Assistant International President—William Atkinson, suite 522, 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.	St. Joseph, Mo.	Memphis, Tenn.
Detroit, Mich	St. Louis, Mo.	Nashville, Tenn.
Erie, Pa.	Scranton, Pa.	Omaha, Neb.
Kansas City, Mo.	Seattle, Wash.	Parkersburg, W.Va
Los Angeles, Cal.	Tampa, Fla.	Philadelphia, Pa.
	Evanston, Ill.	

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	

Cities

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

Selected Boiler Patents

Compiled by
DWIGHT B. GALT, Patent Attorney,

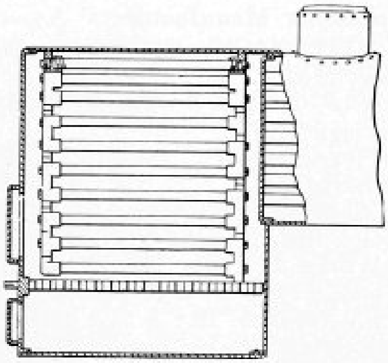
Washington Loan and Trust Building,

Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,715,919. BOILER WATER PREHEATER. JOHN HATCH, OF GOLD PINES, ONTARIO, CANADA.

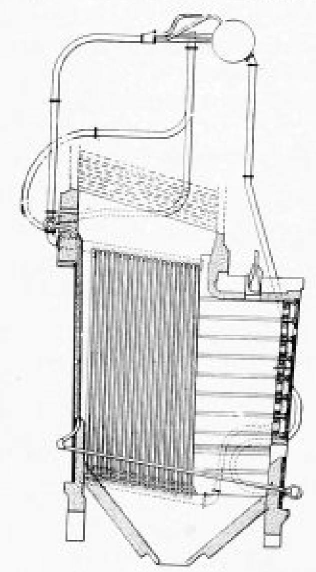
Claim.—An apparatus of the class described comprising a plurality of tubes arranged in spaced parallelism and a plurality of castings for communicating the tubes together for providing a sinuous circulating conduit,



each casting comprising a hollow body having laterally extending sleeves to receive the tube, and provided at its ends with lugs one of which is tapered and the other of which is recessed for holding the castings in end to end spaced relation, said castings being provided with lateral spacing lugs to engage the interior wall of a firebox. Two claims.

1,714,673. BOILER FURNACE. GEORGE P. JACKSON, OF FLUSHING, N. Y., ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, A CORPORATION OF DELAWARE.

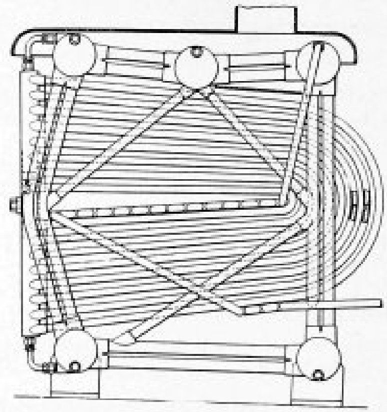
Claim.—In combination in a pulverized fuel burning furnace, a water screen in the lower part thereof composed of relatively widely spaced tubes which project through a wall of the furnace, a water wall composed of relatively closely spaced exposed tubes along an upright wall of the furnace, the ends of said latter tubes being bent and extending at an angle through a wall of the furnace and terminating adjacent the ends of the



water-screen tubes, there being substantially twice as many tubes in the water wall as in the water screen, a junction box, V-shaped in side elevation and inverted triangular shaped in front elevation, said junction box having two tube holes in the upper part thereof in angles of the triangle into which pairs of the said water wall tubes are connected and a single tube hole in the lower angle of said triangle into which a single tube of the said water screen is connected, said tube holes facing in the same general direction, and means connecting the screen and water wall into the circulation of the boiler.

1,712,806. STEAM GENERATOR. WILLIAM E. BAKER, OF ERIE, PENNSYLVANIA.

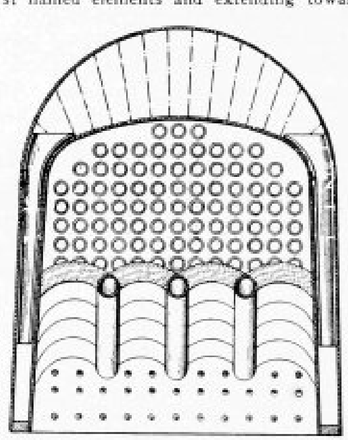
Claim.—A steam generating system comprising a pair of upper headers and a pair of lower headers, pipes interconnecting the upper headers with the lower headers, pipes interconnecting the lower headers, generating



elements connected between one of the lower headers and one of the upper headers, a third upper header intermediate of and connected with said pair of upper headers, water return pipes connecting said intermediate upper header with said lower headers, and return pipes from another of the upper headers to the lower headers. Five claims.

1,712,615. LOCOMOTIVE BOILER. CHARLES GILBERT HAWLEY, OF CHICAGO, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, A CORPORATION OF DELAWARE.

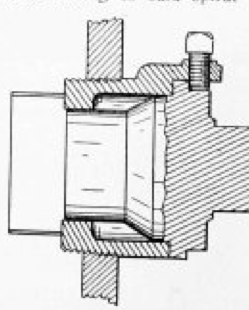
Claim.—In combination with a locomotive boiler shell and its self contained firebox separated by the usual water-leg spaces, baffle plates carried by one of the first named elements and extending toward but being free



from engagement with the other of the first mentioned elements for substantially closing off communication between the top portion of said side water legs and the forward boiler space. Four claims.

1,713,345. BOILER PLUG. PETER E. McINTOSH, OF KALAMAZOO, MICH., ASSIGNOR OF ONE-EIGHTH TO CHARLES R. ALLEN, OF KALAMAZOO, MICH.

Claim.—In a boiler plug the combination with a one-piece externally threaded bushing having its outer end faced to provide a bearing seat and its inner end conformed to provide oppositely disposed symmetrical spiral surfaces and having stop lugs at the ends of said spiral surfaces, said bushings having opposed internal longitudinal grooves extending from end to end thereof and leading to said spiral surfaces, and a lateral lug



with projecting ear, a radially disposed set screw through said ear, and a one-piece plug having a collar-like peripheral flange at its outer end faced on its inner side to coact with said bearing seat of said bushing and having an elliptical seat outside of said flange for engagement by said set screw, said plug having opposed lugs at its inner end adapted to be introduced through the said longitudinal grooves of said bushing into engagement with the said spiral surfaces thereof, whereby the bearing faces of said bushing and plug are clamped together by a rotative movement of the plug, said plug being adapted to receive a wrench. Two claims.

The Boiler Maker

Name registered U. S. Patent Office

Volume XXX **March, 1930** **Number 3**

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

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THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

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Master Boiler Maker Reports

THIS notice is intended as a reminder to members of the Master Boiler Makers' Association serving on special topic committees that the dead line for completing their reports is rapidly approaching. Unless these reports are submitted to the secretary, Albert F. Stiglmeier, at Albany, New York, within a very short time it will be impossible to include them in the proceedings of the twenty-first annual convention of the association, to be held in Pittsburgh May 20 to 23.

A better presentation of the topics for discussion is possible if the papers are in the secretary's hands in complete form early, so that he may be able to arrange for the production work necessary to include them in the program distributed at the convention. This routine work includes correcting and editing copy, setting it in type and getting the approval of the various committee members after the material is in printed form. This all must be done before the program can be published. In addition, cuts must be made from the photographs used for illustrating the various papers and sketches or drawings have to be put in shape for making additional cuts. The whole job takes time, so help the secretary make this most important feature of the convention a success. All of the officers have worked hard in the interests of the association and are entitled to the support of the committees and members in general.

Come Across!

HOW many readers of THE BOILER MAKER are following the discussion on repairing boiler cracks which has been appearing in the last two or three issues? It is our belief that even the comparatively few articles which have so far been published on this subject have made a great majority of them realize the fact that our pages are open at all times to any one who has a worthwhile bit of information to pass on to others in the trade.

Now it is hardly possible that everybody agrees with the efficiency or economy, or the readiness with which the repairs described can be carried out. If the methods indicated suggest easier or better ways of doing the same job, or, if they recall other repair experiences of interest, be sure to send the details to us, because the subject will be closed in the April issue.

So long as the interest is maintained in the "Think This Over" department, as evidenced by the answers submitted for publication covering the questions asked, this idea of presenting practical boiler shop methods will be continued. The response to the first question on boiler patches was excellent. We hope as many or more of our readers will contribute to the discussion of the next question which will appear in April.

The subject of what steps enter into operations—either repair or production—is of great importance in the running of any boiler shop, and from time to time requests have come from our readers asking for information of this character on all kinds of work. For example, how do different shops carry out safe-ending operations? What methods do they use for renewing side sheets, crown sheets, throat sheets, complete fireboxes? Specific details of questions along this line will be asked in April. In the meantime, send in more discussions on boiler patches and think over how you might answer such questions as those given above, if your boss asked you how the work was done. Tell us about it in the same way you would tell him.

Steel Specifications

THE practice of ordering boiler steel by specifying physical properties has been in vogue as long as the steel mill has been in existence. Tensile strength, yield point and ductility tests have taken precedent over chemical qualities, but with the advent of welding, high pressures and high temperatures, something often omitted from specifications is necessary to produce a first grade steel. This quality is understanding of the service in which the steel is to be used and often leads to success or failure of the metal. Plate ordered for riveting purposes will often fail if welded. Then again, a plate may serve well if arc-welded and fail if acetylene welding is employed, or vice-versa. In this case the carbon content is of particular importance in view of the carbonizing or oxidizing effect of welding, whichever method is used. With this knowledge of service, the steel mill will be able to produce a metal which will not only meet the specifications but will suit the service as well.

Steel Boiler Orders

ORDERS for steel boilers placed during the year 1929, as reported to the Department of Commerce by 81 manufacturers comprising most of the leading firms in the industry, indicated a growing tendency towards increased size of boilers and greater heating surface. Total orders for 1929 amounted to 18,518 boilers having 19,453,258 square feet of heating surface, as compared with 19,672 boilers in 1928 having 17,684,811 square feet of heating surface. From these figures, it develops that the average heating surface of boilers ordered in 1928 was 899 square feet as compared with 1051 square feet in 1929. This indicates an average increase of 16 per cent in the heating surface of new boilers.

Outstanding in volume of manufacture is the production of boilers for heating service of which 62 per cent of the total number of boilers constructed were used. Of the power field, however, watertube boilers for stationary and marine service comprise 70 percent of the total heating surface of the boilers ordered.

A marked increase in production is shown in that section of the report dealing with oil country boilers. This report shows 1,142 boilers with a total of 1,168,817 square feet of heating surface in 1929 as compared with 956 boilers with a total of 900,317 square feet of heating surface in 1928. These are in general larger and with greater heating surface than previously ordered.

In the marine field, the tendency is toward the adoption of watertube boilers. Of the Scotch boilers ordered, however, the trend toward greater heating surface is shown increasing 60 per cent over that of the previous year.

Communications

Emergency Boiler Tube Repairs

TO THE EDITOR:

Forty years ago when Northeastern Michigan was the scene of logging operations, railroads were put in to haul the logs to the grounds of the various rivers. These locomotives, like others of that day, were a source of trouble and it is interesting nowadays to look back on the emergency repairs and difficulties with primitive tools that we experienced in keeping these locomotives in service. One particular experience is recalled to mind.

A message came to a shop in Saginaw that the boiler was in need of a set of new tubes—at least that was the way the order was interpreted. Also the message stated that the tubes were on the ground at the lumber camp 150 miles away from the shop.

"Please send man and tools to put them in the boiler," so we were instructed to go and do the job—a simple one so we thought. So taking the midnight train at Bay City, we arrived at the nearest station to the camp at daylight one winter morning many years ago.

After several hours driving with the tote team and sleigh, we arrived at the logging camp, but what a surprise it was when we found out that instead of a new set of tubes to be put in, there were just enough new ones to be cut up for safe ends for the old tubes which had been removed from the boiler by the engineer. What were we to do? We had never welded a tube in all our experience. Of course, we had seen hundreds of them welded and knew the procedure. We also knew what tools were needed for the job.

As this camp was the headquarters of the logging operations, there was the usual blacksmith shop, with the old-fashioned bellows and the standard anvil, and some iron and steel of different sizes for use in making repairs to the camp equipment.

The usual practice in doing a job of this kind was to remove the old tubes and send them to the shop for cleaning and welding, but we were informed by the superintendent of the logging camp that they understood that a boiler maker could do the job in the field. After the conversation with the superintendent, we decided that with the local help we would make the tools necessary and do the job.

We first made the mandrel on which to weld the tubes. We made this out of a 2-inch bar, about 4 feet long, swedging down the end so that it would go into the 2-inch tubes. On this mandrel we shrunk a collar some distance from the end suitable for the length of the safe end, then a top and bottom swedge was made, the bottom swedge to be placed in the end of the anvil.

The new tubes were cut into suitable safe-end lengths with a buck saw. The old tubes had to be cleaned by hand and the ends cut off with the saw.

The next operation was to prepare the tubes and safe ends for piercing. The tube end was scarfed to an edge and turned in. The safe end was scarfed to an edge and turned out. They were pieced in the following way: The safe end was heated and it was slipped over the tapered end of the mandrel against the collar. Then the tube was driven lightly into the flared end of the safe end. Then the flared end was hammered down on the tube.

After the tubes were all pieced, the fire was prepared for the welding in the following way: Taking three fire bricks, we placed one on each side of the forge fire. The third brick was laid across the top and the fire was banked around some distance away.

When all was ready, with the blacksmith as a helper, we made the welds, placing the tube in the fire and constantly turning it until it became hot enough. It was tapped lightly with a long-handled light hammer, the top brick being removed for this operation. After this, it was allowed to heat again, then it was removed from the fire, quickly slipped over the mandrel, the helper striking the swedge lightly and quickly, the tube being turned on the mandrel until the weld was made. Then the tube was placed in the bottom swedge and rounded up.

After the welding and when the tubes had cooled off, they were tested for leaks by driving a wooden plug in the new end and then pouring water into the tube. If a leak developed, the tube was rewelded. A very small percent showed any signs of leakage.

The boiler now was measured for length of tubes, the tubes heated and cut to length with the buck saw.

Bay City, Mich. JOHN A. ANDERSON.

Concerning Staybolts

TO THE EDITOR:

A few short paragraphs about flexible staybolts in the February issue of THE BOILER MAKER, certainly starts a man to thinking! What are "flexible" staybolts, anyway? Are there any staybolts which are not flexible to a greater or less extent? Quite likely, if there are any non-flexible staybolts, they are the ones which break. Possibly, the staybolts which leak, are not flexible enough to meet the go and come of breathing movements of the sheets to which the staybolts are attached.

It does not require much study to enable a man to make up his mind that the staybolt has a deuce of a hard time—all the time—and that the wonder is, not why staybolts break, but how can any staybolts stand up under the stresses to which they are subjected.

Even with staybolts in their most favorable positions, say in plain inner and outer cylinders, it is doubted if there be one staybolt in the entire boiler, which is subjected merely to a straight tensile pull, due to the pressure upon the inner and outer cylinders.

Due to the irregular movements of portions of the inner and outer cylinders while pressure is being applied, it is evident to the thinking man that there will be developed sidewise pulls or stresses which tend to push one or both ends of a staybolt out of alinement. This sidewise movement of one end of a staybolt can only result in bending the staybolt unless it is sufficiently flexible to spring back to its original position after the side stresses have been removed.

Let's see what can and does happen when the inner and outer sheets of a boiler are not symmetrical, or are tied together in an irregular manner by gusset sheets, flanges, mud rings, fire doors or other parts securely riveted to the two cylinders to which the staybolts are securely attached.

How would you like to make a few simple tests which will show exactly in which way a staybolt in a boiler is being bent, or at least pushed by the stresses developed by the comparative movement of one stayed surface or the other? The following paragraphs show how to make individual tests of each staybolt, in a manner which allows its deviation, if any, to be observed and comparatively measured.

If possible, select for the tests a boiler fitted with hollow staybolts. If it be found necessary to use a vessel with undrilled staybolts, it will be necessary to drill the end of each staybolt to be tested. The holes need be drilled only about ½-inch deeper than the inner side of the shell plate and preferably, a drill should be used which will make a hole the same diameter as the holes in drilled staybolts. Next, procure two small reamers, one just large enough in diameter to clean out the holes in staybolts to be tested. This reamer should be run into each staybolt hole to a distance of at least ½ inch below the inner surface of the boiler sheet. The other reamer should be about 1/100 inch larger than the first mentioned reamer and this should be run into each staybolt to be tested, but only deep enough to barely reach flush with the inner side of the stayed sheet.

Next, procure some pieces of cold-rolled steel rod, just large enough to make a driving fit into the staybolt holes which have been reamed ½ inch below the inner surface of the boiler sheet. These pieces of cold-rolled steel should be about 30 inches long, provided there is room for them to project that distance when driven into the holes in staybolts. If necessary, shorter rods may be used, but, bear in mind that the longer these rods, the more apparent becomes the bending effect in any staybolt. The number of rods required, will be the number of staybolts which it is desired to test at the same time—a separate rod for each staybolt, will be required; but any number of staybolts can be tested with a single rod by making the tests one after the other. However, it is better to test several bolts at the same time, as the tests reveal also, the direction in which a staybolt is bent or flexed.

Procure also a similar number of pieces of cold-rolled steel of slightly larger diameter. In fact, this second batch of rods should be just large enough to be driven tightly into the larger holes, reamed plate-thickness deep, in the ends of the staybolts. These larger rods should be about 8 inches longer than the 30-inch rods.

To make a staybolt test, drive one of the smaller rods tightly into the staybolt to be tested, making sure that the rod does not touch the staybolt until below the inside of the shell plate. Into an adjoining staybolt drive one of the larger rods, taking care that the rod goes no deeper than flush with the inside of the shell plate. Now, bend the end of the longer rod until its tip lies directly over and in line with the 30-inch rod in the staybolt under test. The rods should not touch, but their ends should be fairly in line with each other. Fit up as many other staybolt test rods as you desire—the more the better—and then you can see how some staybolts are deflected in one direction and some in another.

With the test rods solidly in place, put the boiler under pressure, either by getting up steam or hydrostatically, and then watch the test rods. They will tell you how the staybolts are being affected by distortion stresses caused by shell movements.

Indianapolis, Ind. JAMES F. HOBART.

MULTIPLE RETORT STOKERS.—A new catalogue describing the CE multiple retort stoker has been published by the Combustion Engineering Corporation, 200 Madison Avenue, New York. This super-station type of stoker is a comparatively new design and is the result of three years' extensive research and development.

Repairing Boiler Cracks—

as suggested by readers

A GRATIFYING number of replies were received from our readers to the "Think This Over" editorial in the January issue. The question asked was "How do you repair boiler cracks?" and the first letters discussing this subject appeared on page 33 of the February issue. Several more replies are published on the following pages, while the final answers will appear next month. If there are any comments to make on the letters already published, or if any more of our readers wish to submit a contribution to the discussion now under way on repairing boilers, send it in at once, for the subject will be closed after the April issue and a new question will be asked, as indicated on the editorial page of this issue.

Locomotive Boiler Patches

By Joseph Smith

The response to your "Think This Over" campaign as evidenced by the February issue of THE BOILER MAKER shows just the right kind of spirit among our fellow craftsmen, and, as you solicit comments, this can be done without fear of harsh or unfriendly criticsm. The method of patching side sheets as outlined by M. M. Smith in Fig. 4 of his "Applying Various Types of Locomotive Boiler Patches," in the February issue, specifies the offsetting of the edges of the patch to take care of expansion in welding. This was the practice several years ago, but as far as my own knowledge goes, the practice has been discontinued. Patches now are applied without offset, the edge of the patch beveled to about 45 degrees, the edge of sheet also beveled, and a clearance of not more than ⅛ inch allowed all around between the patch and the sheet. Results have been all that could be desired.

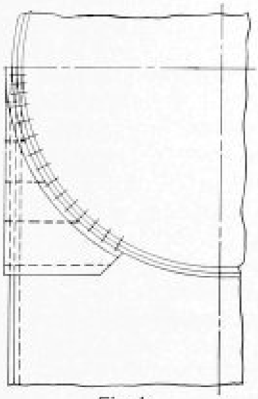


Fig. 1

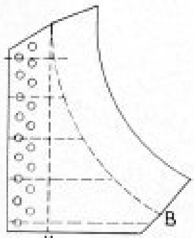


Fig. 2

Patch for throat sheet of locomotive boiler

In Fig. 7 of M. M. Smith's article we have an interesting patch, and as the writer has made and applied these patches the method used may be of interest to some of our working friends. Removing sufficient rivets in the wrapper sheet and barrel seam to take in the patch, we remove two or more rivets both at the top and bottom on wrapper seam. This is for the purpose of wedging the wrapper sheet open so that the patch can be slipped in between the wrapper and the throat sheet connection of flange. Scarfing down the wrapper sheet is not advisable. For this reason, in all probability, a new throat sheet will have to be applied before a new wrapper sheet, and in such a case if the edge of the wrapper sheet has been scarfed down for a patch, you have a rather unsightly wrapper sheet exposed.

Not being equipped with proper flange forms, we find it necessary to lay off the patch with the minimum amount of material. This is done by dividing the section to be patched into several spaces, as shown in Fig. 1. Lay off the height of the patch on the plate and transfer all holes in the wrapper seam to the patch, as shown in Fig. 2. Now take a narrow strip of very light tin or paper and set it on these lines and get distance from the wrapper holes to where the turn in the barrel flange commences; transfer the distances to the patch along the horizontal lines as shown, then allow sufficient material for barrel flange, allowing a little extra material at the bottom of the patch as there will be some take-up in fitting the bottom corner. All wrapper sheet holes in the patch are drilled after this section has been scarfed down, preferably a size smaller, so that a little reaming is necessary after fitting. The patch is heated all over to a cherry heat in furnace, and put into a clamp at the proper distance with the drilled section in the clamp. Then, at a distance midway between the two bends the patch is broken down, using a blacksmith's heavy fuller and commencing at the bottom and gradually working up to the top where it is tapered off to the flat section. Having worked down the section between x and B, Fig. 2, we turn the radius flange down over an old disused tire with edges rounded off. If care has been taken, the final fitting up will not be difficult.

Repairing Steam Drums

By Chris S. Handler

In 1921, while the writer was foreman in an old-established boiler shop and shipyard, we received a telephone call one morning from a steamship company which operated several river steamers. They wanted a new steam chimney built for a boiler on one of their steamers.

These so-called steam chimneys, were frequently used in connection with low-pressure boilers on the older steamers, some of which were made up of an outside cylinder of suitable size and another inside cylinder, approximately 24 inches smaller in diameter, giving the

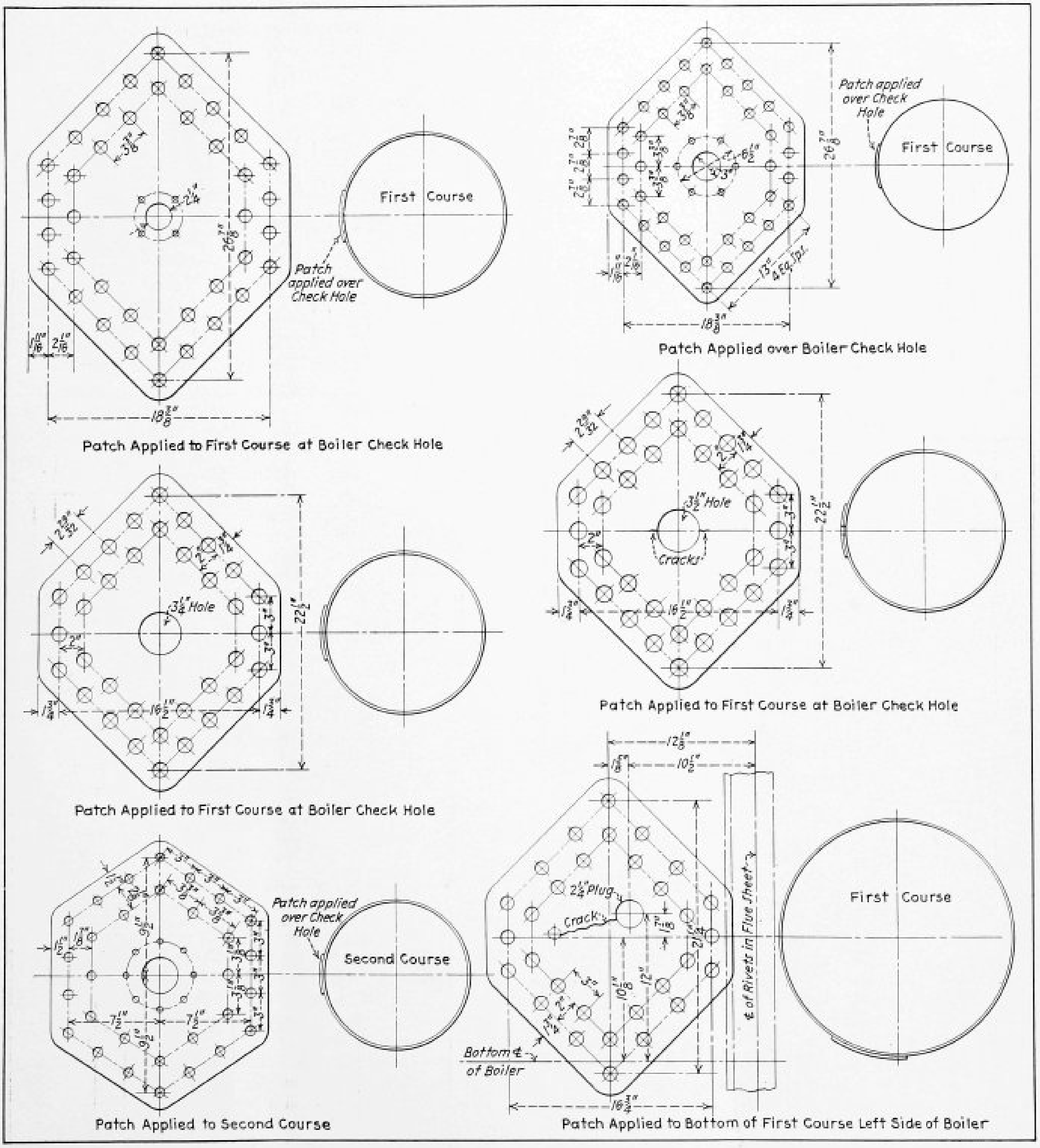
(*Continued on page 68*)

Central of Georgia Boiler Patches

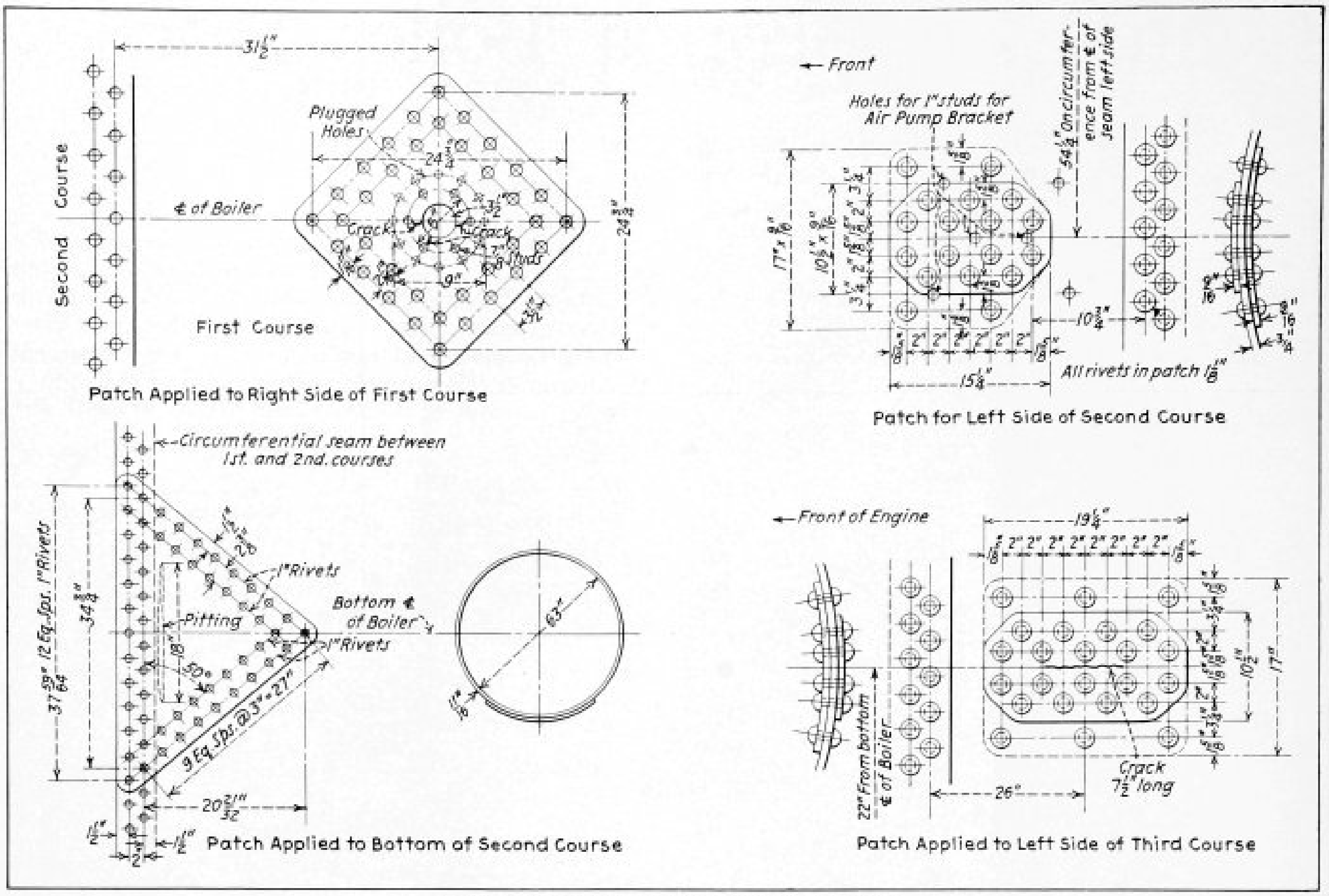
By Charles F. Petzinger *

I HAVE noted and carefully read the editorial, "Think This Over." In repairing cracks to boilers, the following refers to unstayed surface only. When cracks develop the boiler is immediately taken out of service and the crack is repaired with a patch. This patch is riveted on. To do this a sufficient number of flues have to be removed in order to allow men to get inside of the boiler to hold on rivets. Patches are applied to meet government inspection, and an alteration report is filed with the Chief Inspector, Bureau of Locomotive Inspection, Interstate Commerce

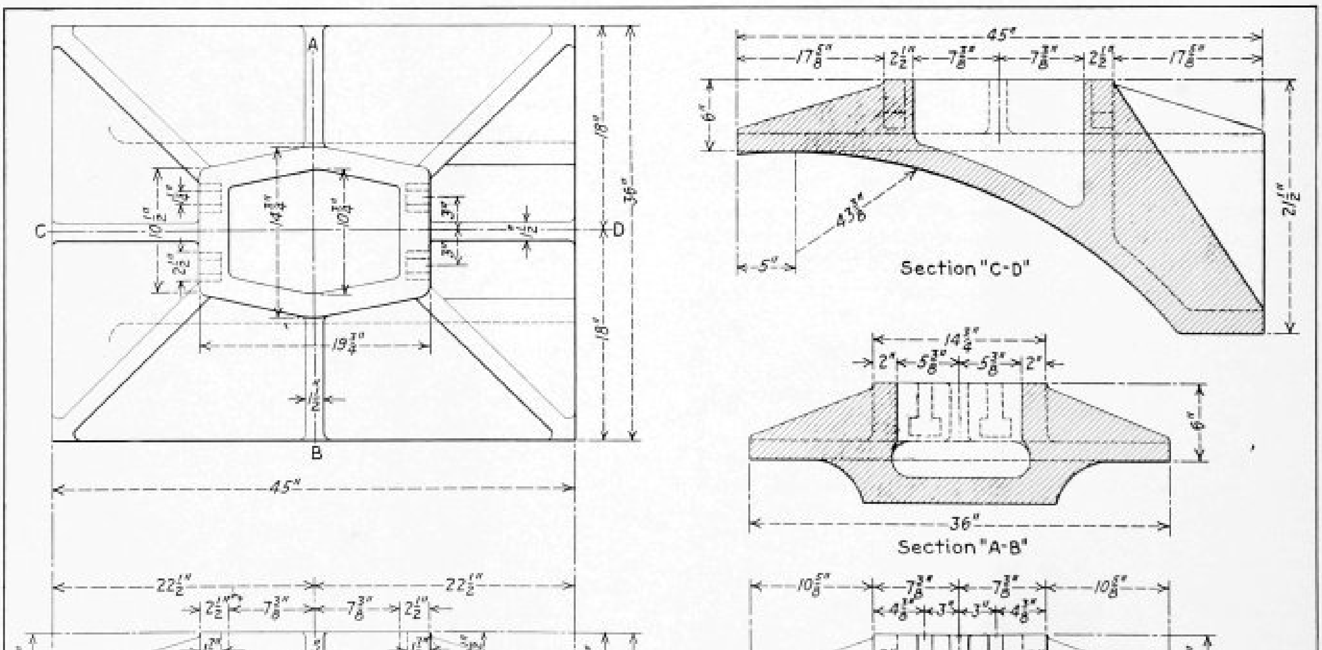
* General foreman boiler maker, Central of Georgia Railway Shops.



Methods of patching boiler check holes



Patches for first, second and third courses



Top die for throat sheet patch

Commission, Washington, D. C. It is a good practice when these cracks develop in boilers to drill a small hole ½ inch or ⅝ inch in each end of the crack, this to prevent the crack from extending any further after the patch is applied. It is a recommended practice on the Central of Georgia Railroad that, when boilers that have patches applied are placed in the shop for classified repairs, the section of the boiler that is patched is removed and part or an entirely new section applied and another alteration report filed with the Chief Inspector of Locomotive Inspection.

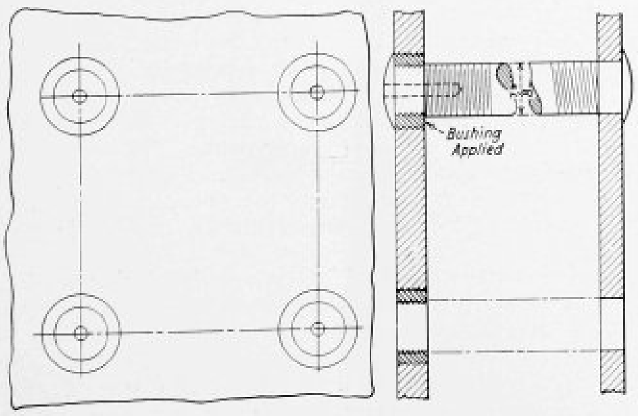
I am enclosing several prints of patches as they are applied on our road, also sending you a blue print of a former to make throat sheet patches. You will note that with this former I make two patches at one time, one right hand patch and one left hand patch. When this is formed the hole is cut in two with an acetylene torch. On this former I can make a patch from 8 inches long to 54 inches long. This is a great saving over the old way of making throat sheet patches one at a time, as it takes just two minutes to form these two patches after they are placed under the press. This work is done under a 200-ton R. D. Wood flanging press. If the throat sheet is cracked, it is a good practice to cut out the crack and weld it before the patch is applied. Also a good practice is to apply these patches before cracks develop, this referring to boilers that you know give trouble from throat sheets cracking after they are in service for a certain length of time.

I have the poster you sent tacked up on my bulletin board and I think it has been read by all the employees of my department.

Enlarged Staybolt Holes

By E. J. Lloyd

In answer to your inquiry of November, 1929, in reference to enlarged staybolt holes, a method which is in general use at St. Paul is the application of a bushing 1¼ inches in diameter. The outside sheet is tapped and



Bushings used in staybolt holes

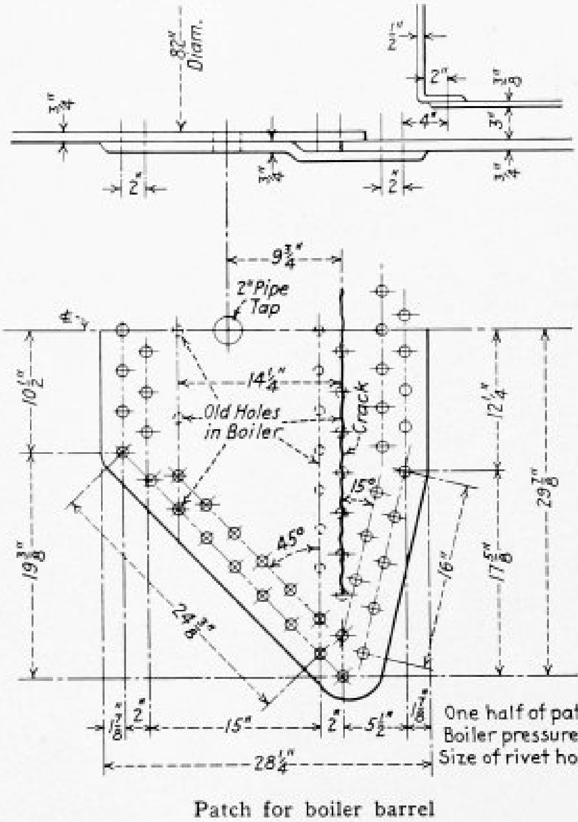
the bushing is expanded in the sheet by driving in a pin. Then, the outside and firebox sheets are tapped for ⅞-inch straight staybolts. This method is used when we have a large number of enlarged holes in the outside sheet when applying new firebox sides. This does away with combination staybolts and welding. The accompanying sketch will perhaps be useful.

Patch for Circumferential Seam of Barrel Course

By J. B. Becker

The accompanying sketch illustrates a patch we had occasion to apply on the bottom of the barrel course over the circumferential seam of a rebuilt Vanderbilt boiler which had a crack 42 inches long, 21 inches each side of the centerline through the rivet holes.

The arrangement of this patch had to be somewhat different in design to similar patches applied in ordinary practice. Because of the cylindrical firebox in this boiler



Patch for boiler barrel

extending close to the crack, there was a limited space on one side to put the rivets through the holes of the patch. The other side had to take in an existing washout-plug hole and also clear some old plugged-up staybolt holes so they would not interfere with the proper location of rivet holes in the patch.

The fabrication and application of this job proceeded in the following manner: A plate of the required thickness, of sufficient size to allow for trimming was heated in the flange fire. The depression in the plate was made in the flanging clamp to a depth equal to the thickness of the material by means of a fuller. This depression extended throughout the length of the plate, tapering out to nothing at the ends to retain a flat surface where the so-called laps would come.

The next operation was to bend the plate to the proper circumference of the boiler. To retain the depression, strips of plates equal to the thickness of the patch with the ends tapered were laid on opposite sides while the patch traveled through the bending rolls. After this process, all holes were laid out to sketch, drilled and excess material trimmed off.

The old rivets in the circumferential seam in boiler were cut off with an acetylene torch; but with the exception of four on each end composing the lap rivets and one on each side of the center line on the bottom to facilitate bolting patch in place, the old rivets were not backed out. The old plate was not cut out.

The sharp edge of the circumferential seam was rounded off slightly to conform to the contour of the depression on the patch, at the four end or lap holes. The plate was scarfed down sufficient to provide an even graded flat surface to facilitate fitting the ends of the patch at these points. Sufficient tubes were removed to permit entering the boiler for holding on the rivets.

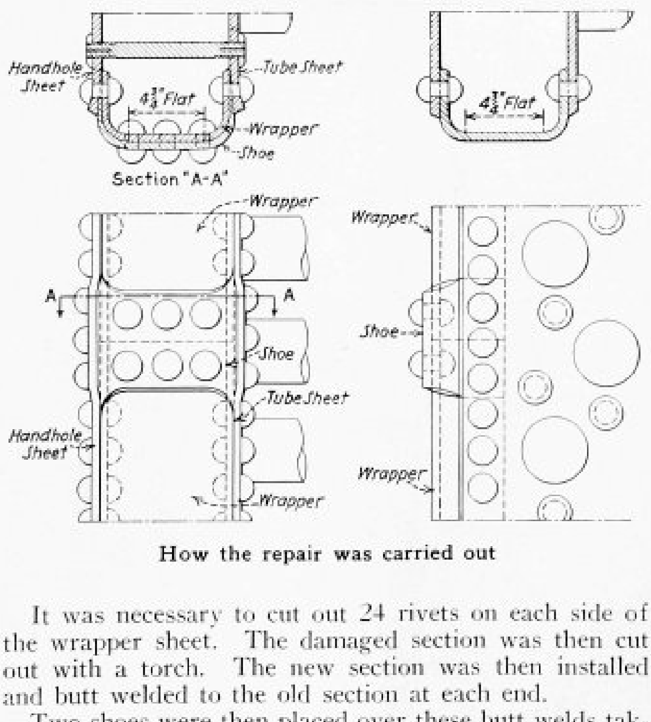
The patch was bolted up by drilling tack holes at suitable places to insure a tight fit, then all remaining rivet holes were drilled through the boiler plate.

Repairs to Wrapper Sheet of Watertube Boiler

By J. Curran

We were recently called upon to repair an unusual fracture in the front wrapper sheet of a watertube boiler which had bagged and cracked at about the center of the waterleg due to an accumulation of scale and dirt in the front waterleg and subsequent overheating at this point. The front waterleg of this type boiler is protected by a brick arch, and due to the carelessness of the operator, the boiler was operated after this arch had fallen. If the boiler had been withdrawn from service until the arch had been repaired, this failure would not have occurred.

It was first suggested that we install a new bottom wrapper sheet, but the owner of the boiler objected to this on account of the expense. A new section about 52 inches long, was then put in the wrapper sheet.



How the repair was carried out

It was necessary to cut out 24 rivets on each side of the wrapper sheet. The damaged section was then cut out with a torch. The new section was then installed and butt welded to the old section at each end.

Two shoes were then placed over these butt welds taking one rivet on the ends of the old sections, one rivet on each end of the new section and one rivet directly in the center of each weld on the sides of the wrapper sheet. Also, three rivets were fitted on each side of the shoes at the bottom of the wrapper sheet.

The rivets on the tube-sheet side and the bottom of the wrapper sheet were bucked up by placing a bent bar through the handholes in the handhole sheet. The rivets on the handhole side were bucked up by using an S bar through the handholes. By the use of the S bar it was not necessary to remove any of the tubes. The most difficult part of the job was the bucking up of the rivets on the handhole-sheet side. The handhole sheet, tube-sheet and shoes were then chipped and calked.

The welding of the new section to the old sections was not necessary. This was done merely as an additional safeguard against leakage.

It would have been advisable to have placed a blow-off connection in the new section to prevent future accumulation of scale and dirt.

Repairing Steam Drums

(Continued from page 64)

necessary steam space and connection with a bend at each end. Through the inner cylinder the waste gases pass from the boiler before entering the stack.

In this particular one, the outer shell was approximately 60 inches in diameter, the inner shell, 36 inches diameter made up of ⅜-inch plate. The inner shell was further strengthened by being reinforced with tee-iron rings. Both longitudinal seams were double riveted and carried 100 pounds pressure. I should judge this boiler was about twenty years old.

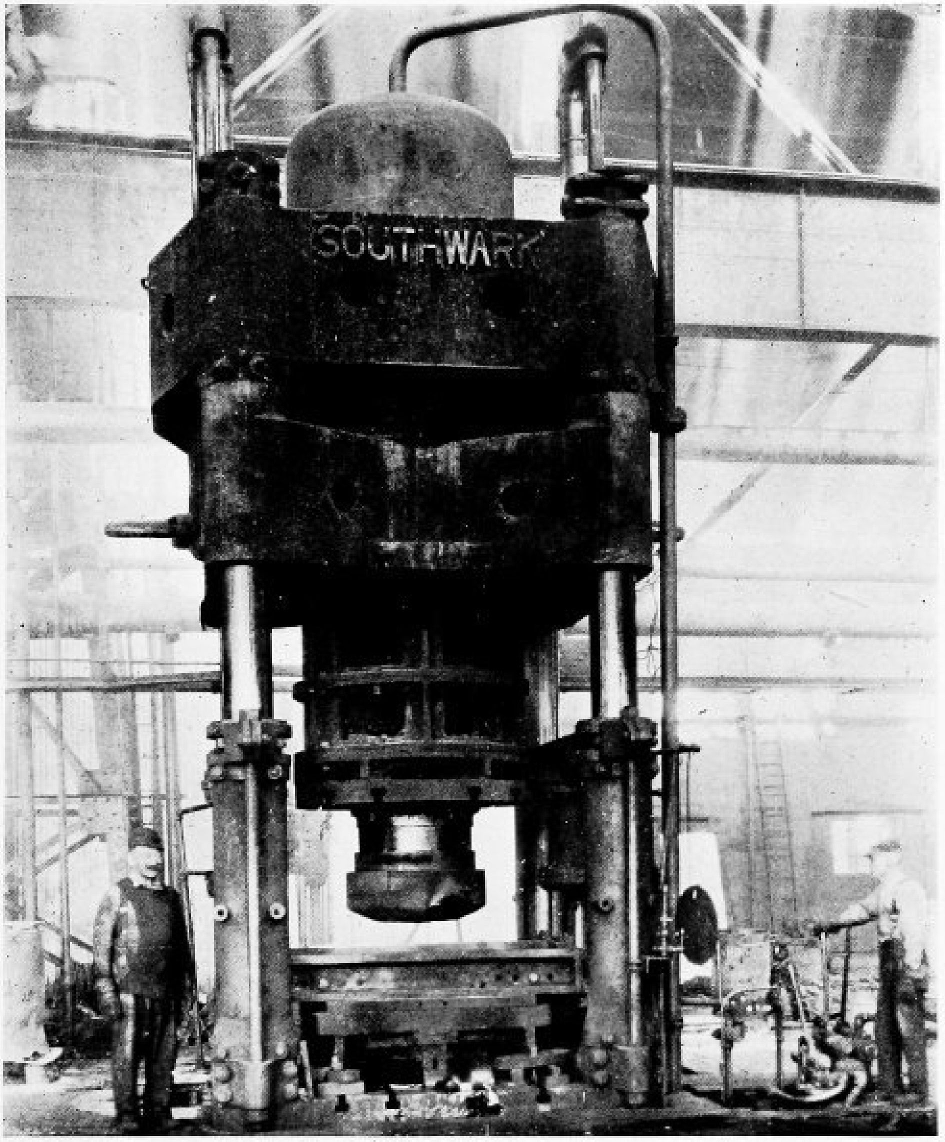
I found by internal inspection that the plates, especially the inner shell plates, were badly pitted. Also, in a number of places the webbs of the tee-iron rings were badly deteriorated and rivet heads nearly gone. After making a pencil sketch of the drum and pipe connections, I was asked if the drum could be repaired and I promptly advised, "no, too far gone" and returned to the shop. My firm submitted a price for a new drum.

However, after waiting several days we did not hear from the steamship company so we began to inquire and were advised that the defective plates were built up with fusion welding and the steamer was again in service.

In 1924, while reading a local newspaper, I noted the report of a boiler explosion on that particular steamer, resulting in the death of a fireman. The cargo and steamer were damaged considerably. I began to quietly look around, and found it was the so-called steam drum which exploded having torn loose on the inside shell plate.

It is not the writer's object to criticize fusion welding but to set forth a lesson to boiler makers to make proper and safe repairs, especially when plates are in tension or compression. The writer is enthusiastic about welding, as it has improved boiler work, in fact all plate and structural work from every standpoint; but welding on repair work, such as in the case herein described, should only be done under the supervision of a carefully trained boiler maker or engineer.

Lockwood Hill, for the last 10 years a member of the Blackman Hill Company of St. Louis, Missouri, has organized a new company known as the Hill Equipment Engineering Company with offices at 4620 Delmar Boulevard, St. Louis, Mo.



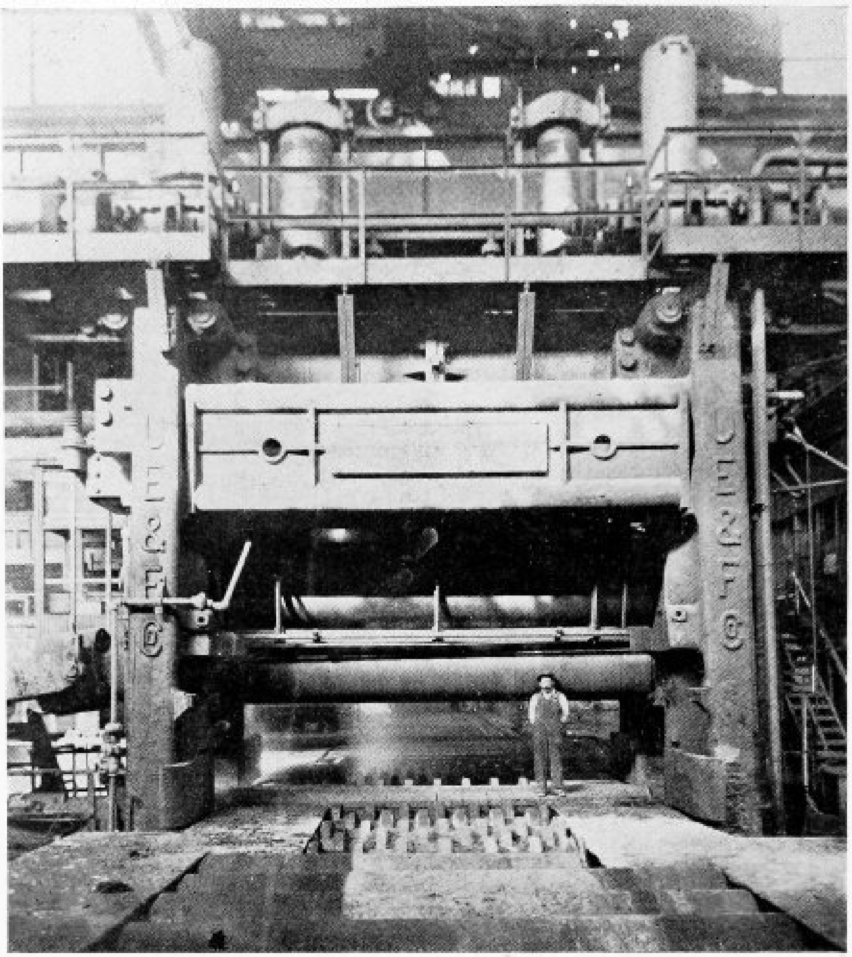
Flanging

OF the industries allied to boiler making and upon which the manufacture of boilers and pressure vessels depends, the most indispensable is the steel industry. The finished boiler, while a product of the boiler shop, may be said to have its origin in the steel mill. Not only does the steel mill manufacture plates and shapes necessary for boiler making but it also performs many functions which if analyzed are strictly adapted to the boiler or pressure vessel.

While most steel mills do not make a general practice of fabricating boiler parts, they are, nevertheless, in a position to do so, much to the advantage of boiler shops whose equipment or handling facilities are limited. Plates may be ordered cut to size, trimmed, planed, drilled and in some cases shaped for the desired use.

It is not the intention of the steel mill to function in competition with the boiler shop; their main interest is the supply of steel, but in some cases, particularly in intricate flanging, the steel mill performs a real service due to the skill and facilities available.

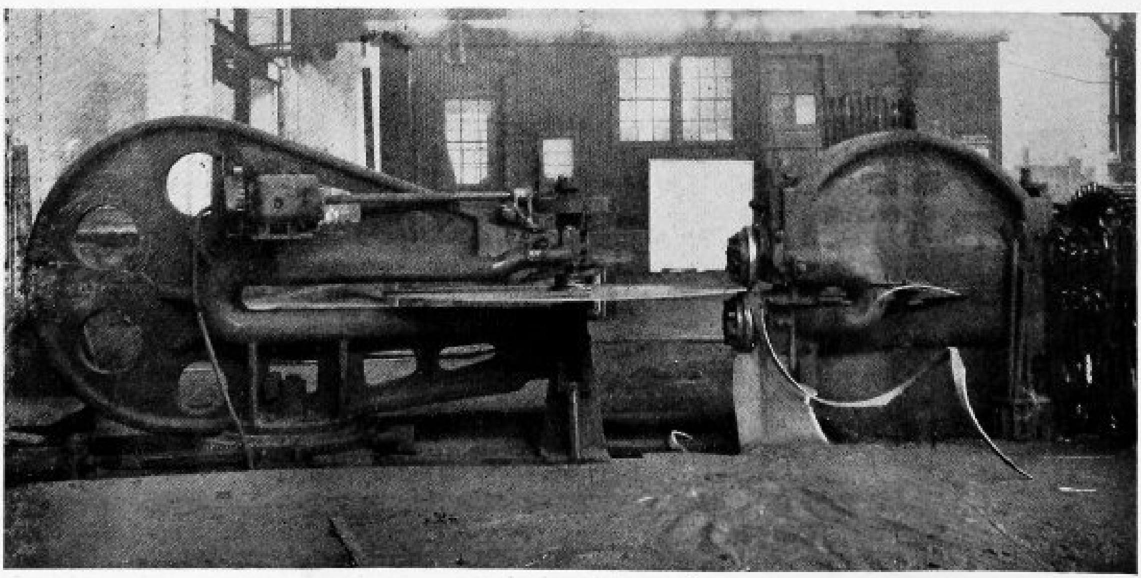
Such is the case of the Lukens Steel Company, Coatesville, Pa., whose primary interest is the manufacture of steel plate, but which, in addition, has specialized in the flanging of steel, particularly in the manufacture of pressed and spun heads for various services. This firm has produced the world's largest flanged and spun heads and also has furnished the largest one-piece crown and sides and combustion chamber sheet yet produced. This sheet was cut from a plate 250 inches by 195½ inches by ⅜ inch, and was employed by The Baldwin Locomotive Works for the construction of locomotives for the Atchison, Topeka and Santa Fe Railroad Company. Such a plate was rolled in the 206-inch plate mill, the world's largest, located in the Lukens



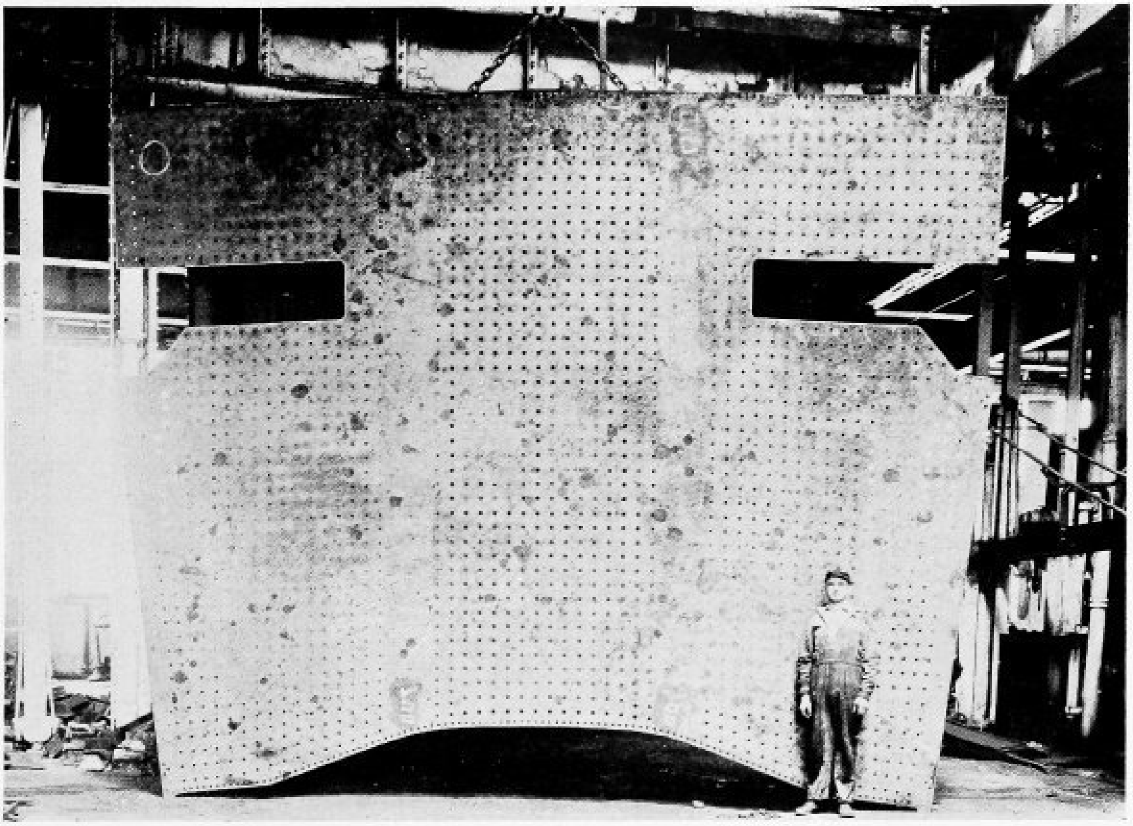
206-inch plate rolls at Lukens Steel Company

Steel Company plant. It is of the 4-high reversing type, and 206 inches in size. There are two 34-inch diameter by 206-inch working face operating rolls of chilled iron, and two 50-inch diameter backing rolls of cast steel. The 34-inch diameter operating rolls weigh about 40 tons each while the backing rolls weigh about 60 tons each.

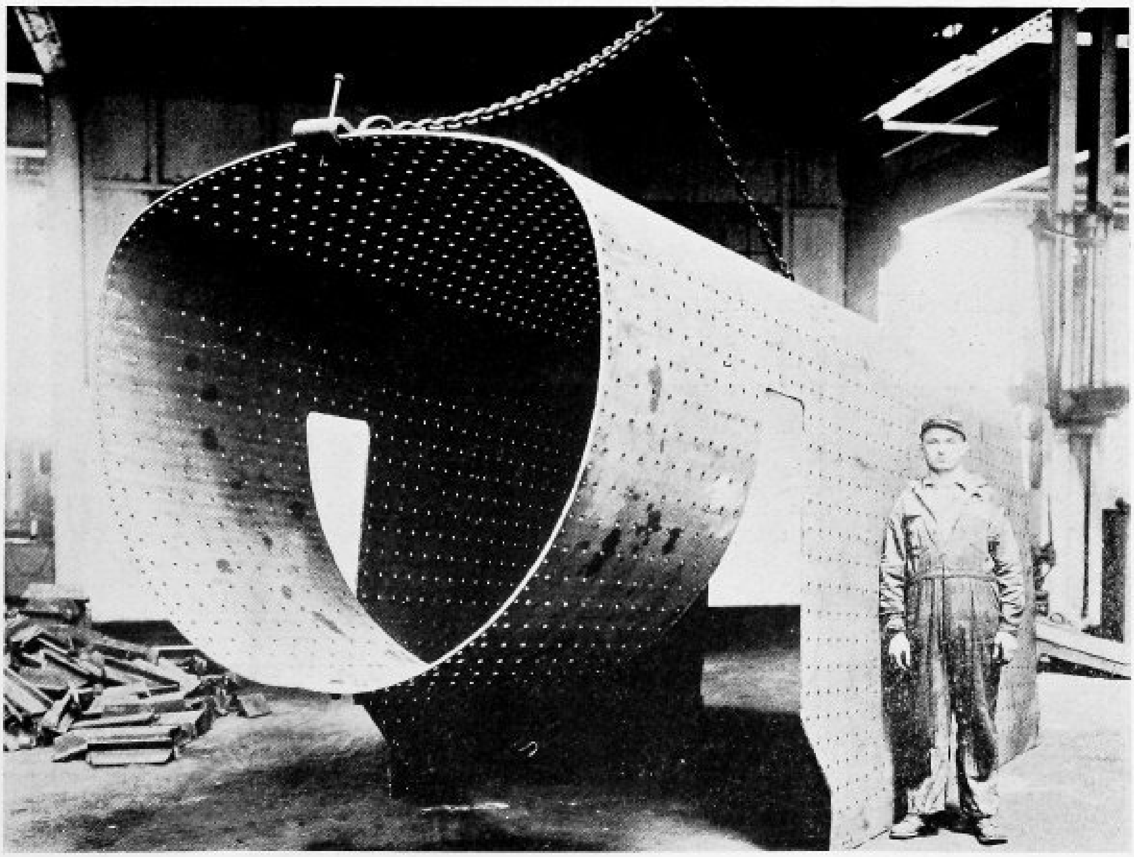
The origin and development of the Lukens Steel company is of interest, having been established in 1810. The actual and original establishment, however, dates back to 1790 when Isaac Pennock built a mill at Rokeby, Pa. In 1810 he bought a saw-mill at Coatesville and converted it into an iron mill. Dr. Charles Lukens, son-in-law, took over the management in 1816 and carried the work on until his death in 1825, his wife taking the reins until 1855, when Dr. Charles Huston became



Circular cutting machine



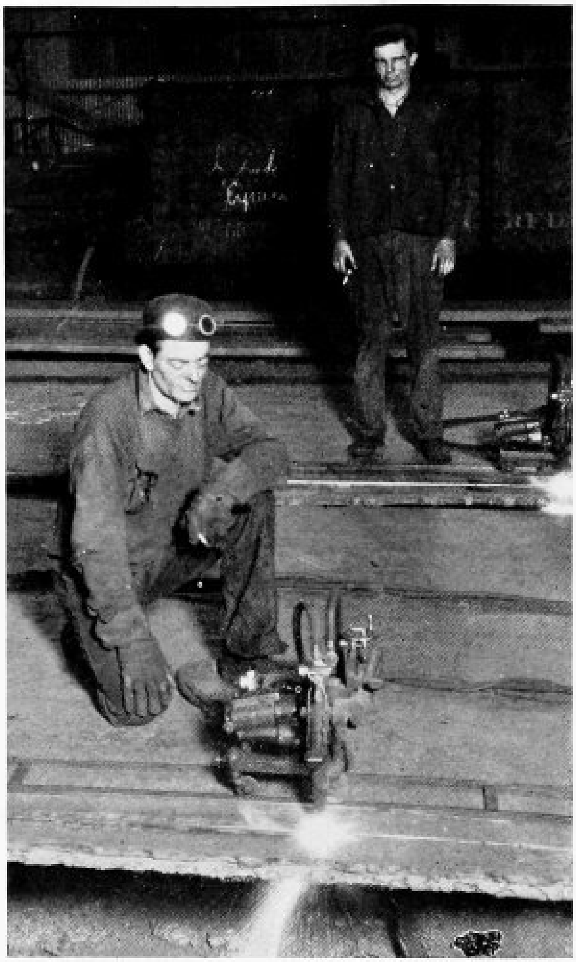
World's largest crown, sides and combustion chamber sheet before rolling



Largest one-piece crown, sides and combustion chamber sheet rolled to shape president. Dr. Huston remained head of the concern until his death in 1897 at which time A. F. Huston became the prime mover. Mr. Huston served as head of the Lukens Company until his recent death in January of this year.

The present property of this company covers an area of about 350 acres upon which stand the following buildings: A spacious main office, several department mill offices, a 206-inch plate mill, a 140-inch plate mill, a 48-inch universal mill, three open-hearth steel plants, (one containing six furnaces, one eight 60-ton furnaces, and still another containing ten 100-ton furnaces), a large boiler house, an 84-inch plate mill, a 112-inch plate mill, a machine flanging shop, a machine shop, a punch shop, a roll-turning shop, physical and chemical laboratories, an electrical repair shop, a locomotive repair shop and welding shop. Such is the extent of this plant.

It is not the intention of this article to discuss the manufacture of steel plates as applied to industry at large, but in considering the boiler making methods employed by the Lukens Company, particularly flanging, it might be well to follow an order for flanged material through the various departments.

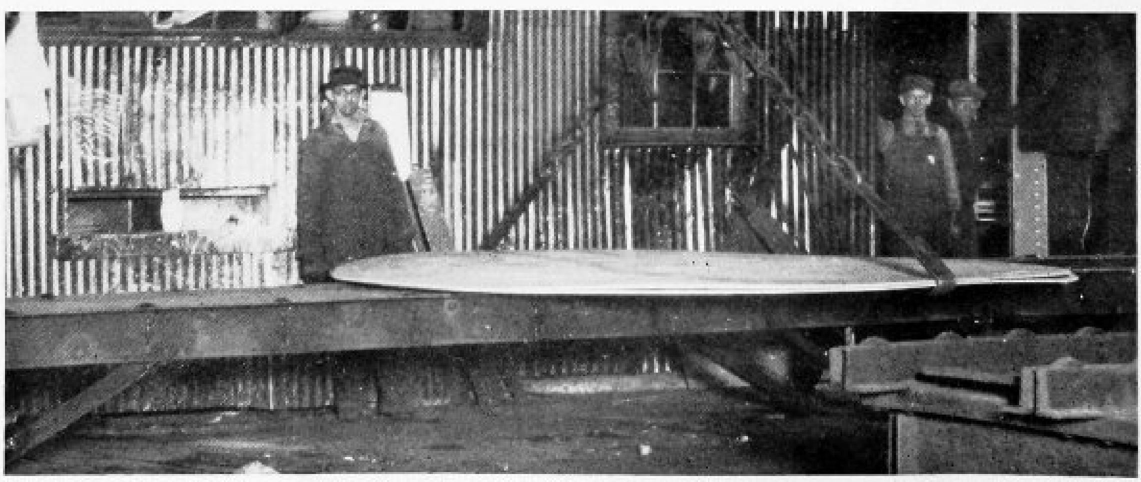


Automatic oxy-acetylene cutters in action

The primary interest of the boiler maker in the production of boilers, is to know that the material supplied conforms to the specifications, and that the steel will be delivered in such condition that his manufacturing schedule will not be upset by the discovery of defective material from a physical or metallurgical standpoint. The industry on which he must rely for this service is the steel industry, which is equipped with an organization of steel makers and rollers, backed up by metallurgists, testing engineers, inspectors and shippers, who make the production and delivery of high-quality plates possible.

To appreciate the great amount of detail involved and the infinite care and supervision necessary to successfully manufacture first quality steel plates to given specifications, it seems advisable to cite the more important steps of manufacture and inspection, so far as the open-hearth and rolling mills are concerned. In the open-hearth process the steel is produced from the raw materials, pig iron, steel scrap and the fluxes to control the melt. Steel is made by the acid process or the basic process, and either process is in demand for the production of boilers. In the acid process the sulphur and phosphorus are controlled by the addition of pig iron and steel scrap low in these elements to the heat. In the basic process the impurities are controlled by limestone additions, which are not attacked by the basic lining of the furnace. As soon as the heat is in melt, sample tests are taken from time to time to control the analysis at the time of tapping. The steel, when poured into ingots, is under complete control and the specification is correct for the purpose for which the material is ultimately to be used.

The pouring of the steel into ingots is effected by top pouring and bottom pouring methods, the latter method being universally used, as it tends to improve the product. By this method the pouring time is increased in



Weighing finished plate before shipment proportion to the number of molds connected to the same runner which provides a slower rising of the metal in the mold and permits the escape of the gases which require time to be eliminated. This method also produces clean ingots and eliminates the splashes which cause scabs, when the ingot reaches the mill, and in addition eliminates the slag from the mold.

On receipt of an order from a customer the purpose for which the material is to be used is investigated by the metallurgical engineer who incorporates into the order the qualities of a metal for that particular service. This process is important inasmuch as a metal ordered to specifications or to pass certain tests, may live up to the requirements and still fail in the service for which it is intended. An example of this is found in the case of steel to be welded where the carbon content is particularly important.

Based on the instructions given by the customer and the metallurgical department as to quality and discard of ingot necessary, the steel is then estimated and ordered from the open-hearth department. The steel is then sent to the soaking pits or furnaces of the mill on which the plates are to be rolled. The period of heating ranges from four to sixteen hours depending on the size of ingot, the greater time being necessary for an 88,000-pound ingot, the largest now available. Each heat of each furnace is recorded in detail as to chemical and physical characteristics. This data is filed in the records of the company and is obtainable at any time for reference. Thus each ingot of each heat is marked with the heat number for identification.

Following the approval of the metallurgical engineer, the customer's order is sent to the order department where separate mill orders are made out. This original order may be broken up into many mill orders covering each mill which manufactures plate to fill the order. These orders are entered to the mill on special number and each sub-order covers the various items to be rolled in a particular mill. Specifications, sizes, purpose of the material, test specifications and chemical characteristics are included on each sub-order for one customer. Each order is made in several copies, which are sent to the departments interested. In the case of an order for flanged or dished heads, the flat size of a plate necessary to fill the requirements of the final head is determined. Experience in flanging has taught the allowances and tolerances necessary for each type of work. Thus, with the diameters of the flat plate included in each order, waste is reduced to a minimum.

During the rolling process the inspections are constant, starting with heating of the ingot, which can be too great or too little unless close attention is given. As the ingot is broken down, the scale is removed by directing steam over the surface, and as the reduction is continued the remaining scale is blown clear by the addition of salt and gunny bags soaked in brine. The pressure built up by the heat and the rolls effectually cleans the plate surface of all foreign matter. The cleaning method as used is virtually as effective on nickel steel as on carbon steel. During the rolling, plates are checked for gage, surface and laminations following which the laboratory conducts tests for the physical properties of tensile strength, ductility and solidity. In addition to the routine mill inspections of the heavier gages, a special inspector makes a minute inspection of top and bottom surfaces before the plates are passed.

After cooling, the plate is carefully inspected, then stamped with the mill number, qualities, etc., and passed to the layerout who marks the plate to the size of pattern for cutting.

The plate is then sheared to size in a hydraulically-operated cut-off shear having a 215-inch gap. As a general practice, plates under two inches in thickness are sheared; over that thickness they are cut with automatic oxy-acetylene torches.

In the cutting of circles for flanged heads, it is the practice to cut an octagon first with sufficient allowance for cutting. This reduces the scrap from the circular cutter.

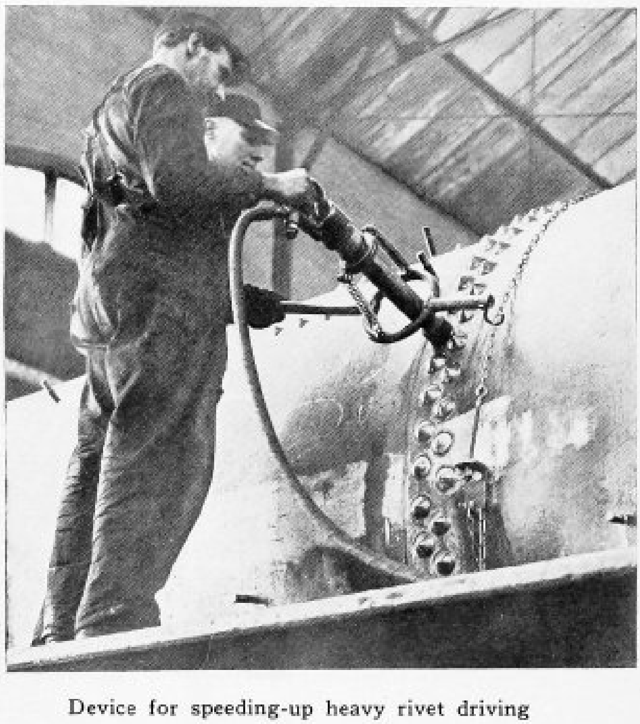
The circular cutter used at the Lukens steel plant consists mainly of a jaw-shaped casting in which are mounted two rolling cutters upon which sufficient pressure may be exerted. The plate is held at the center by means of a pivot press which is hydraulically operated and holds the plate tightly in its grasp. This pivot press which rotates may be adjusted any distance from the cutters to give the required radius of plate.

After shearing, the plates are again inspected then measured and weighed, the records being kept with the mill order as the plate passes through the shop. Rectangular plates are sent to the loading bank, and circular plates are transported to the flanging department where the sheet is further fabricated into heads and other flanged parts.

Following the mill handling, the plates are passed on to the shipping department where a rigid floor inspection is given. This is continued during the weighing and finally all details of the order are checked on the loading bank.

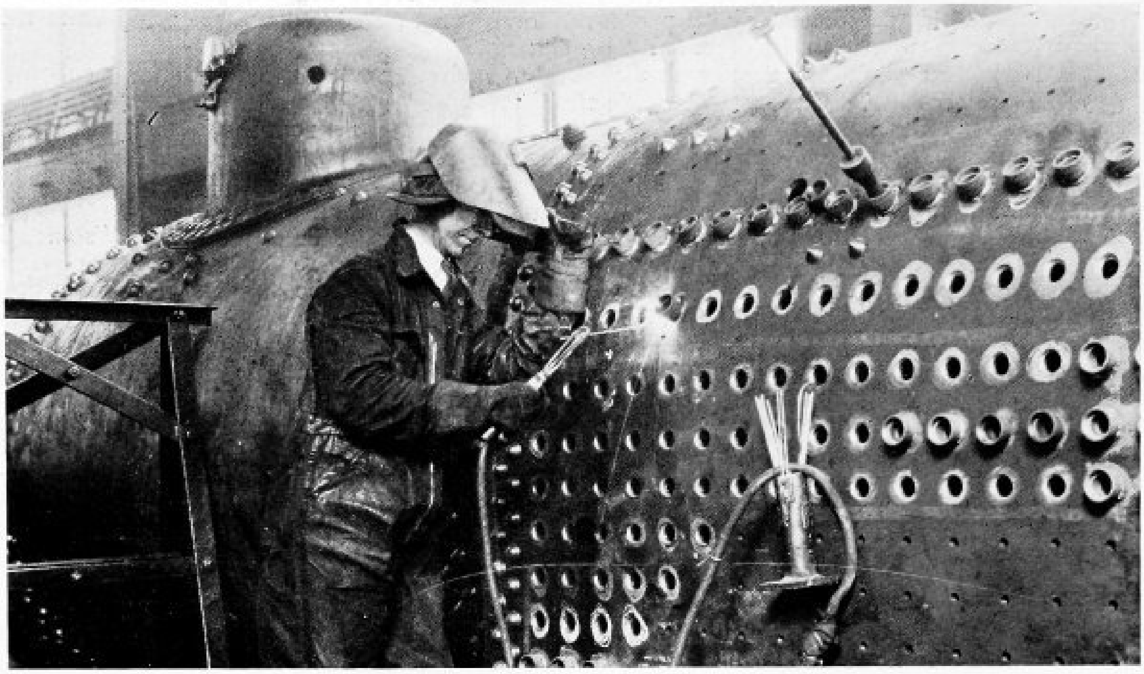
In addition to the multiplicity of inspections covered in the manufacturing, a most important detail from the consumers point of view is the fact that the details and progress of each order from day to day are known. A special staff composing a schedule and service department devote their entire time to maintaining the schedule of production.

A subsequent article to appear in The Boiler Maker will follow the plate through the flanging department, where methods and equipment for pressing and spinning heads will be discussed.



Device for speeding-up heavy rivet driving

Installing Locomotive Boil



Welding flexible staybolt sleeves

STAYBOLTS are of primary importance in the construction of locomotive boilers in an effort to support all surfaces that are not truly cylindrical, as well as firebox surfaces generally. Extreme care is necessary in the preparation and installation of staybolts in order that each staybolt will carry efficiently its portion of the load according to the design. In view of the precautions required in installing staybolts, it is interesting to review the procedure in staybolt application as carried out at The Baldwin Locomotive Works, Eddystone, Pa.

On page 316 of the November, 1929, issue of THE BOILER MAKER, the methods and equipment employed in fabricating staybolts at the Baldwin Works were outlined. From this article is seen the care taken in preparing staybolts for installation and also the methods used to accomplish high production in such fabrication may be noted.

The work of manufacturing staybolts consists mainly of performing the machining operations on blanks received either from the outside manufacturer or from the forge shop of the Baldwin plant. These bolts are ordered for each particular job, the length of bolt being specified for each type of work. Installation is performed in bay Nos. 3 and 4.

The installation of staybolts follows the completion of the riveted back end of the boiler; the methods employed in installing the mudring or waterspace frame having been outlined in the February issue. With the boiler in the condition as left by our previous article, staybolts are next applied.

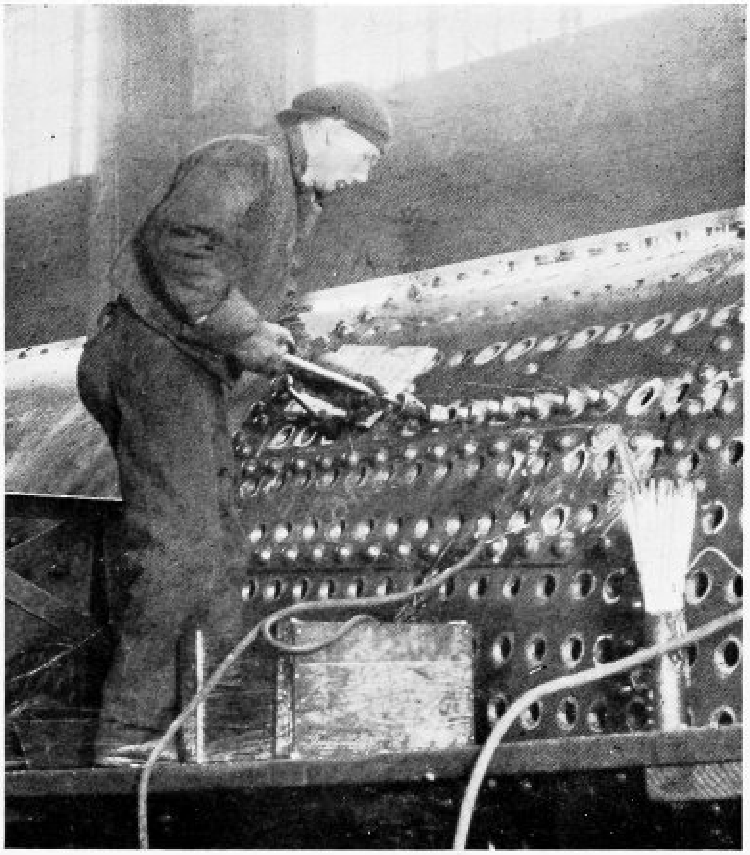
Procedure in applying staybolts depends largely on the type of staybolts called for by the design, but in general, the sleeve bushings used for flexible staybolts are first applied. These may be either of the screw or welded type: the method of application differing in each case.

Where welded sleeves are to be employed, it is particularly important to fit them before any rigid bolts are applied, because of the oil used in reaming or tapping, which would be detrimental to the welding operation. The holes in the wrapper sheet, into which the sleeves are to be fitted, are reamed and countersunk by pneumatic tools provided with pilots or leads running into the corresponding staybolt holes in the firebox sheet.

The lead thereby lines up the tool with the two holes in the waterspace so that on installation of the staybolt, perfect alinement will be attained. With the holes in the wrapper sheet reamed and countersunk, the surface of the plate in the vicinity of the holes is ground with a pneumatic hand-operated grinder. This procedure frees the surface of the plate from scale and dirt. With the holes thus prepared the sleeve, which is tapered at the base, is applied by means of a special applicator. This consists of a rod approximately 3 feet in length having a taper screw at one end to fit into the firebox sheet and a handle at the other end. A sliding cone so formed as to fit on the inside of the sleeve is fitted on the

Staybolts

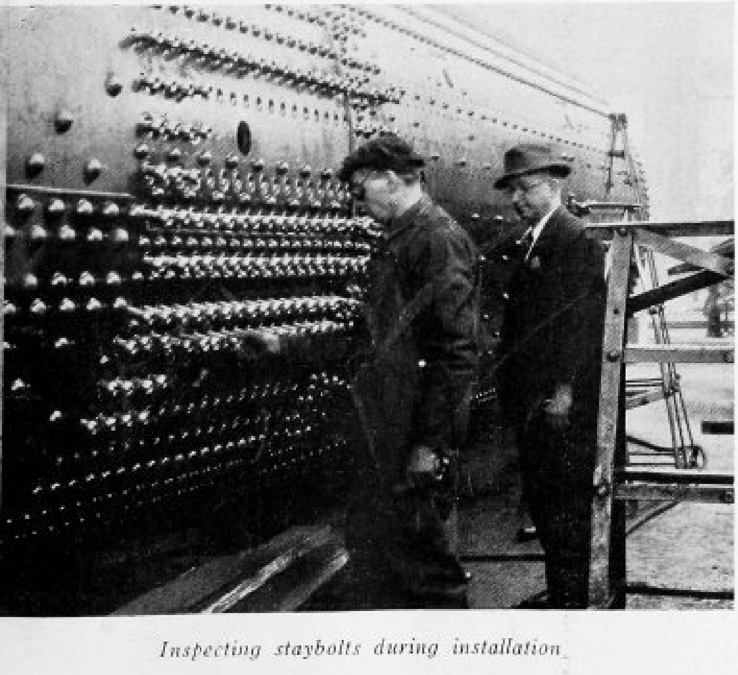
Preparing stayed surfaces and finishing boilers at the Baldwin Works



Fitting flexible staybolt sleeves prior to welding

rod. In application, the sleeve is placed on the cone, the rod applied through the hole in the wrapper sheet and fitted to the hole in the firebox sheet. Then the sleeve is pushed into the countersunk hole in the wrapper sheet, being held by the cone on the rod in perfect alinement for welding. In this position the sleeve is tack-welded to the plate. In like manner, all of the sleeves to be welded on the boiler are so fitted. Following the tack-welding of all the sleeves, the final welding is done, a continuous weld being employed in each case.

In the case of flexible staybolts in which the head seats directly into the wrapper sheet (so that no sleeve, but a welded covering cap is employed), the flexible staybolt holes in the entire back end are drilled, reamed, countersunk and faced before the bolt is applied. The facing of the plate consists of machining an area around the hole slightly larger in size than the diameter of the cap to be applied. The plate is thus slightly grooved and the cap fits into this groove assuring a tighter and more satisfactory joint. The firebox sheet is also reamed and tapped for the flexible staybolt, a lead tool being employed. The staybolt, which is generally of the round slotted-head type, is then applied and tightened from the outside of the boiler. The fireside end of the staybolt is allowed to project beyond the firebox sheet, which projection is removed at a later time and the staybolt hammered.



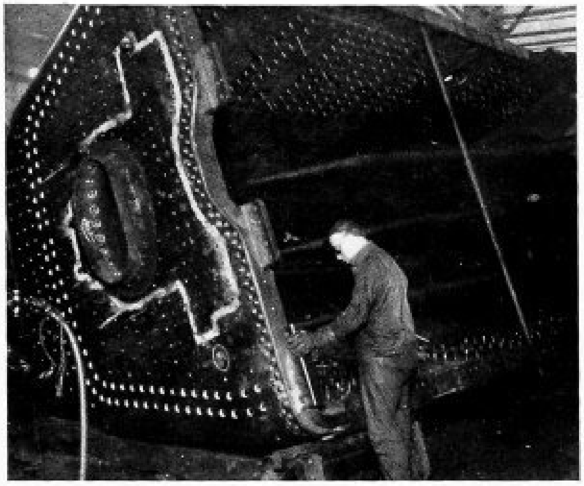
Inspecting staybolts during installation

We are ready to apply the caps, except that all oil is cleaned off the area with a soda solution. The caps are tacked and welded in place in the same manner as the welded sleeves except that no applicator is required.

In boilers employing screw sleeves, these are also applied in the boiler before any of the rigid bolts are fitted. The holes are first reamed and then taper tapped. For this work a reamer and tap having a lead mandrel suitable to engage in the firebox staybolt hole is employed as previously mentioned. Thus the holes in the outside throat sheet, wrapper sheet and back head are finished before the firebox holes are machined. The sleeve is applied to the back end side of the staybolt hole by a pneumatic machine which quickly tightens the sleeve in position. A lever is then employed to bring the sleeve up to maximum tightness.

When the sleeves are in place the firebox sheet is reamed and tapped. For this purpose a guide is fitted in the sleeve for holding the tap centered in tapping the firebox sheet. Following this process, the flexible staybolts are then applied. The firebox end of the staybolt is allowed, as before, to project on the fire side of the plate.

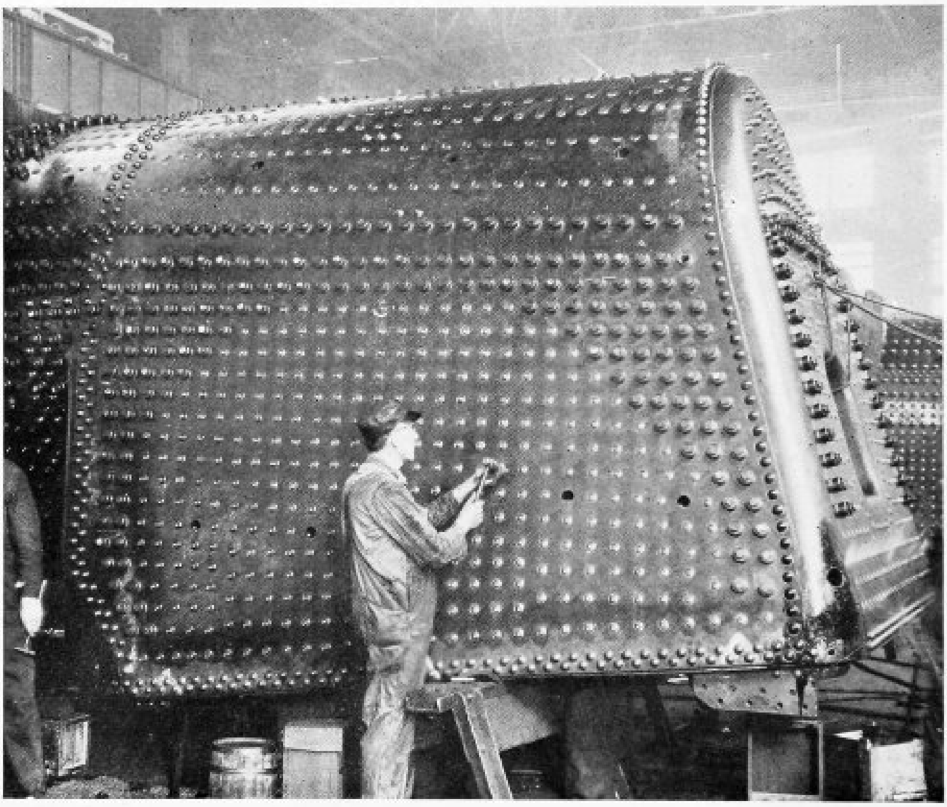
When all flexible staybolts are in place, the rigid bolts are applied. In this case the holes are reamed and tapped, as before mentioned, a straight reamer and a tap preparing the holes in the back, sides, throat sheet, and holes for drop bolts. Taper bolts, however, are fitted



cut by means of an oxy-acetylene torch provided with a gage on the tip of the torch to regulate the distance from the plate that the torch is held. This distance assures the maintenance of the required length of bolts projecting from the plate to allow for hammering. This projection is then hammered by means of a pneumatic hammer to form a slight head both inside and outside in the case of rigid bolts and on the inside in the case of flexible bolts. For flexible bolts a dolly bar is fitted over the head of the bolt, a cap with a hole being fitted over the sleeve to center the dolly on the staybolt head. The inner end of the bolt is hammered as are other bolts.

When all the staybolts have been hammered, it will be found that the telltale holes will have been partially filled with metal due to this process. It is then necessary to drill, by means of compressed air tools, the telltale holes, opening them to the required depth. The

Inspecting a five syphon locomotive boiler back end



Hammer testing rigid staybolts

in the center of the crown sheet. The taper bolt hole is prepared—first with a straight tap, the tool being inserted into the hole from the outside and machined through both inside and outside plates at once. Following this process, the hole is tapered from the inside, a taper reamer with a lead being used followed by a taper tap cutting through the firebox crown sheet only.

On completing the preparation of the holes, the rigid staybolts and tapered bolts are applied from the inside of the firebox. This procedure in applying staybolts from the inside in the case of straight bolts is necessary in order to assure a uniform depth of telltale hole in the bolt. The depth of the telltale hole is measured from the outside of the back end and by inserting the bolt from the inside and thereby providing a uniform projection of the bolt from the outside, the depth of the telltale hole can easily be judged and kept uniform.

When all stays, both flexible and rigid are fitted, the projecting ends of the bolts on inside and outside are ends of the staybolts, which were hammered, are then dressed to suit by removing the burr.

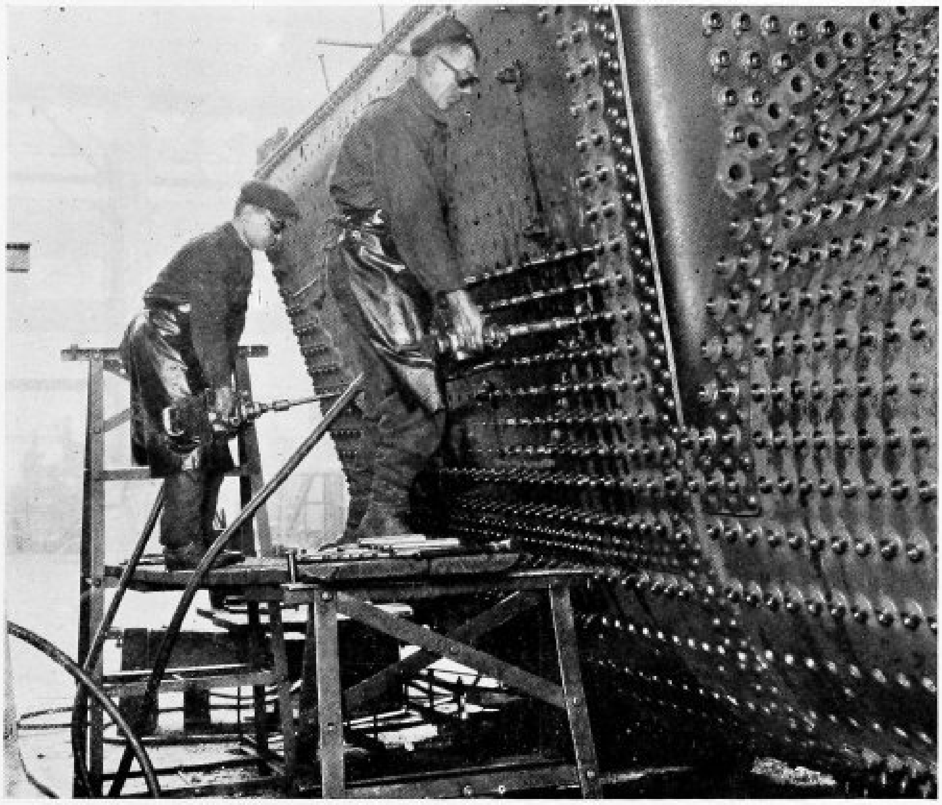
It is essential throughout the process of applying staybolts to see that all machined surfaces are free from cuttings or dirt before the application of any of the staybolts. The presence of foreign material between the surfaces of the staybolt and the sheet is apt to cause leakage and unsatisfactory results are sure to be obtained. To prevent such occurrence, all cuttings and dirt are blown with compressed air from the vicinity of the staybolt holes before such bolts are applied. The back end of the boiler is then completed with staybolts installed.

Most boilers come to the finishing floor with the smokebox applied, but where the smokebox is fitted with Coffin feedwater heaters it is not usually applied until the rest of the boiler is fitted. The smokebox is heated and shrunk on to the boiler in a manner similar to the practice employed in fitting rings in the waist department. The smokebox is fitted by means of bolts, after which the holes are reamed and riveted by hand-operated pneumatic tools. The holes for the multiple-throttle valves are burned out of the smokebox on the finishing floor by means of oxy-acetylene torches, and if a liner is required for this purpose as in the case where large holes are necessary, such liners are prepared, trimmed and fitted to the boiler. These liners are generally welded in place.

The boiler is then ready for the general finish which consists of a complete inspection of the boiler, and cleaning. Throughout the course of construction each operation is inspected, each contractor in charge of the various operations being responsible for his own work. In addition to inspecting his own work, he reviews that of the previous contractor and does not accept the boiler for his particular operation until the previous work is correct. Following the inspection, in which among other things, the flue sheets are carefully checked for straightness, the boiler is transferred to bay No. 2 where the measurements between the flue sheets are taken in order to obtain the proper dimensions for the tubes. The boiler is then shipped to the erection shop where the boiler is finished, including the installation of flues and superheaters.

At the Baldwin Locomotive Works, this completes the manufacture of the locomotive boiler so far as the boiler shop is concerned. In addition to the processes outlined in the last few months, which are performed in the boiler shop, the Baldwin management has recently installed in the boiler shop two new departments; namely, the flue shop and the superheater shop. These departments are manufacturing departments only and prepare the flues and superheaters which are applied to the boiler after it arrives in the erection shop. Descriptions of these departments will appear in The Boiler Maker at a later date.

In reviewing the methods of manufacturing locomotive boilers at Eddystone, it is interesting to note what can be done with modern equipment and with ample space in which it may be used. Electric equipment is employed as far as possible, individual motors being employed for the majority of machines. The plant, the largest of its kind in the world, is laid out to best advantage, being arranged to obtain a constant direction of material flow in order to reduce handling to a minimum and save time and energy. Manufacturing departments have been placed adjacent or as near to the installing departments as possible to reduce the distance of travel of manufactured parts and to bring about coordination between manufacturing and installing departments. These factors—modern production control, modern equipment and modern material handling, as well as effective layout, aid The Baldwin Works in the efficient production of locomotive boilers.



Applying flexible staybolts by machine

Clipping excess material from smokebox liners

Reliability of Fusible Tin Boiler Plugs in Service

IN CO-OPERATION with the Steamboat Inspection Service a study has been made at the U. S. Bureau of Standards of the reliability of fusible boiler plugs of the type installed in ship boilers under the jurisdiction of the inspection service. It has been found that under certain conditions fusible plugs would not operate due to the formation in service of a refractory oxide replacing the tin in the fire end of the plug. This obviously constitutes a very dangerous state of false security.

The Steamboat Inspection Service requires that plugs shall be renewed at each annual inspection except in cases where plugs were installed or renewed not more than six months prior to annual inspection, in which case they may be allowed to remain until the next following annual inspection, or for a period not to exceed 18 months.

A total of 184 plugs were received from the Steamboat Inspection Service and examined. The data indicate that approximately 10 percent of the plugs examined would not have functioned in service. The average time in service of all of the plugs examined was ten months.

The cause of the failure to function was evident in every case. It was always due to the presence of a hard, "infusible crust" packed tightly in the fire end of the plug and replacing some of the tin filling. In general, this deposit was apparent upon inspection, but in many cases, especially when the tin in the fire end had been melted out for an appreciable distance back in the plug, it was difficult to determine its presence, and in some instances a plug which was apparently in good condition failed to function in test because of it.

It is evident that the tin melted during test and that the plug would have functioned except for the obstruction which had formed in the fire end during service. This is typical of all plugs that failed to blow out in test.

The cause of the formation of the deposit of "infusible crust" was not at first apparent. Chemical analyses of these deposits are given in the original article, together with the composition of the tin filling after test in the "blow-out" apparatus.

Chemical analyses were also made of the tin blown out of many of the plugs that functioned properly. It is evident that, in general, the tin after test conforms to the specification requirements except for the copper content, which undoubtedly increased during the test, as discussed later in the report.

Further tests have shown that the type of firing, i.e., coal or oil, has no apparent relation to the formation of the infusible crust. Neither does there seem to be any relation between the crust formation and the pressure in the boilers in which the plugs were used. Data are not available regarding the positions from which the plugs tested were taken.

It is of interest to note that of the total of 18 plugs that failed to function in the tests, 15 were outside plugs and only three inside plugs, a ratio of five to one. These data are rather too few to allow drawing any general conclusions, but they indicate the desirability of having in all plugs the least possible length of projection of the fire end beyond the boiler shell into the fire chamber.

Chemical analyses of the infusible crusts indicated that they were chiefly stannic oxide (melting point, 1127 degrees C.) with oxides of other metals present, and in some instances a surprisingly large percentage of calcium sulphate (melting point, 1360 degrees C.).

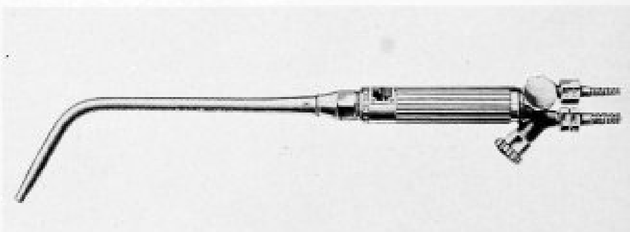
The general rules and regulations of the Steamboat Inspection Service require that "fusible plugs shall be so fitted that the smaller end of the filling is exposed to the fire, and shall be at least 1 inch higher on the water side than the plate or flue in which they are fitted." Under these conditions it would be expected that any molten tin in the fire end of the plug would run out. This occurs in the majority of cases. In fact, it is probable that the tin filling is melted out of the fire end after very few days or hours of service.

The formation of the "infusible crust" in some cases was believed to be due to the melting of the tin in the fire end and its being prevented from dropping out due to the presence of ash or other obstructions. The tin then apparently oxidized, together with some of the copper from the casing, eventually replacing the tin in the fire end with a hard mass of very high melting point. In other instances the formation of the crust was found to be due to a small leak in the plug, permitting boiler water which may have contained appreciable amounts of calcium and magnesium sulphates and carbonates reaching the fire end. Here it would be evaporated but would leave a small deposit of the dissolved salts. Over a long period of time these deposits apparently become appreciable, and eventually form a hard, compact mass in the fire end.

Certain recommendations in this regard are made at the end of the paper.—John R. Freeman, Jr., J. A. Scherrer, and S. J. Rosenberg, in *Bureau of Standards Journal of Research*, vol. 4, no. 1, Jan., 1930, pp. 1-22, 5 tables, 8 figs. Abstract by *Mechanical Engineering*.

Welding Blowpipe

OXWELD Acetylene Company, 30 East 42nd street, New York, has recently announced another new blowpipe. The type W-17, as it is called, employs the same low-pressure injector principles used in other Oxweld blowpipes.



Oxweld type W-17 blowpipe with one-piece tip

New principles of design have been incorporated in this blowpipe. The tip and welding head are of one-piece construction, being combined in a long and slender stem of the goose-neck type. Careful study has been devoted to the design of the injector and mixing chamber for each of the ten welding heads. The injector is located at the base or handle end of the stem. Each welding head has its own nut for attaching it to the handle of the blowpipe. The nut has been constructed so that it extends beyond the injector when the welding head is detached from the blowpipe and serves to protect the injector from damage due to careless handling. A fine pitch thread makes it possible to tighten or loosen the nut easily without the use of a wrench. The handle of this new blowpipe is made of a special brass tubing having longitudinal ribs. This offers a sure grip to the operator and also reinforces the handle. The valve wheels are of a new design and located to be readily accessible yet out of the way during the welding operations.

A. S. M. E. Proposes

Rules for Welding Boilers

Boiler Code Committee specifications for drums and shells of power boilers

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 on in the proper place in the code.

The Boiler Code Committee has received and considered suggestions for Proposed Specifications for Fusion Welding of Drums or Shells of Power Boilers. This movement is a result of the inadequacy of both riveted and forge-welded construction for such drums or shells for boilers to operate at from 900 pounds to 1500 pounds, unless the diameters are kept down to impracticable limits. On the other hand, recently, refinements in the application of fusion welding have made practical the welding of drums and shells of plate thicknesses up to 3 inches or more, and vessels constructed in this manner have been successfully used in large numbers in connection with petroleum-refinery equipment. The proposed specifications which are now under the joint consideration of the American Welding Society and the Boiler Code Committee are submitted below for criticism and comment thereon from any one interested. Discussions of the proposed specifications should be mailed to the secretary of the Boiler Code Committee, 29 West 39th street, New York, N. Y., in order that they may be presented to the committee for consideration.

Proposed Specifications

1. Drums or shells of power boilers may be welded by the fusion welding process when materials suitable for welding are used in accordance with Pars. S-5 to S-17, or S-264 to S-279, of Section II of the Code, and provided the following requirements are fulfilled.

2. *Test Plates for Longitudinal Joints.* Two (2) sets of test plates from steel of the same heat as the drum plates, prepared for welding, shall be attached to the shell being welded as in Fig. 1, one set on each end of one longitudinal seam, so that the edges to be welded in the test plates are a continuation of and duplication of the corresponding edges of the longitudinal seam in the shell. Weld metal shall be deposited in the test plates continuously with the weld metal deposited in the longitudinal joint of the shell.

NOTE: Recommendations have been made that as an alternative, the test specimen be allowed to be cut out of the welded longitudinal joint at any point, and the hole thus made welded up afterward if the tests of the specimen show the vessel to be acceptable.

3. *Test Plates for Circumferential Joints.* When test plates are welded for the longitudinal joints, none need be furnished for circumferential joints in the same vessel. Where a drum has circumferential joints and no longitudinal joint, a set of test plates of the same material as the shell shall be welded in the same way as the circumferential joint.

See also note under Par. 2.

4. *Stress Relieving.* The complete welded structure or such welded parts separately as may be later assembled by means other than welding, shall be heated uniformly to at least 1100 degrees F. The structure shall be brought slowly up to the specified temperature and held at that temperature for a period of at least one hour per inch of thickness, and shall be allowed to cool slowly in a still atmosphere. The test plates shall be subjected to the above stress-relieving operation either attached to or placed within the parent vessel.

5. *Test Specimens.* The inspector shall select one of the two welded test plates, from which the coupons for tension, impact, and bend tests and for macro and micro examinations shall be removed as shown in Fig 2.

6. *Tension Tests.* The tension specimen shall be transverse to the welded joint, and shall be the full thickness of the welded plate after the outer and inner surfaces of the weld have been machined to a plane surface flush with the plate. When the capacity of the available testing machine does not permit of testing a specimen of the full thickness of the welded-plate, the specimen may be cut with a thin saw into as many portions of the thickness as necessary, each of which shall meet the requirements.

Each tension specimen should fail in the boiler plate, but if failure occurs in the weld metal or along the line of fusion between weld metal and the plate, then the tensile strength shall not be less than the minimum of the specified tensile range of the plate used.

7. *Bend Tests.* The bend-test specimen shall be transverse to the welded joint of the full thickness of the plate and shall be of rectangular cross section with width 1½ times the thickness of the plate. When the capacity of the available testing machine does not permit of testing a specimen of the full thickness of the welded plate, the specimen may be cut with a thin saw into as many portions of the thickness as necessary, each of which shall meet the requirements. The inside and outside surfaces of the weld shall be machined to a plane surface flush with the plate. The edges of this surface shall be rounded to a radius equal to 10 percent of the thickness of the plate. The specimen shall then be bent cold under free bending conditions until the least elongation between any two points within and across the weld on the outside fibers of the bend-test specimen is 30 percent, with the width of any surface cracks deducted. No surface crack shall be longer than 10 percent of the specimen's width, when the elongation of the outside fibers has reached 10 percent.

8. *Impact Tests.* Three coupons for impact tests shall be taken transverse to the welded joint and prepared so that the cross section of the specimen through

which fracture will occur shall contain: (1) the bottom surface, (2) the middle section, and (3) the top surface of the weld. The notch in the bottom specimen shall be opposite the bottom surface, and in the top

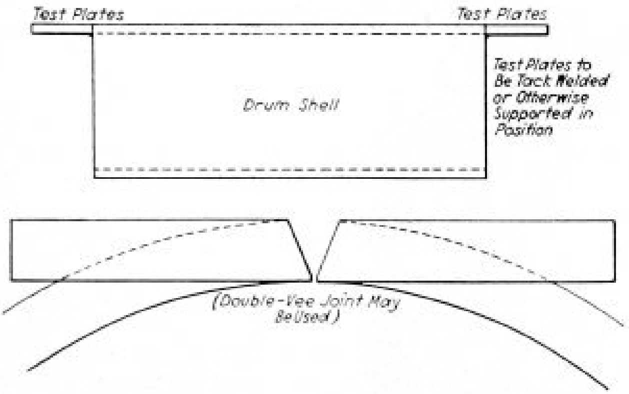


Fig. 1.—Sketch showing test plates attached to shell

specimen, opposite the top surface. The minimum value of the impact test shall be 20 foot-pounds, standard A.S.S.T. Charpy impact specimen.

9. *Chemical Analyses.* Drillings from the weld metal representing an average sample shall conform to the following requirements:

Manganese	0.30-0.60 percent
Phosphorus	not over 0.04 percent
Sulphur	not over 0.045 percent
Nitrogen as iron nitride	not over 0.020 percent

The nitride content shall be determined by the modified Allen method of the Bureau of Standards

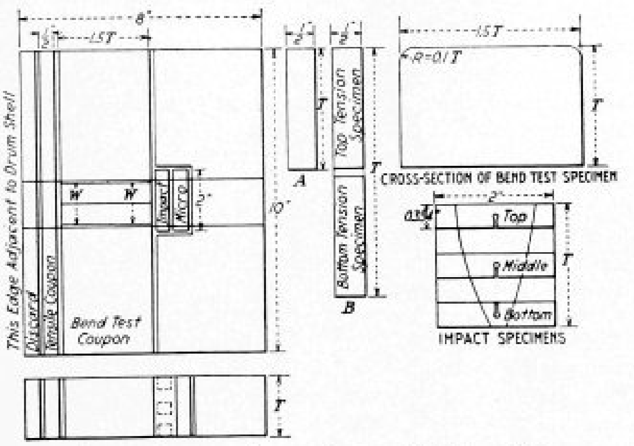


Fig. 2.—Test specimens from welded test plate

A = cross section through tension specimen.
B = cross section through tension specimen parted in two.
T = thickness of plate.
W = gage length on bend-test specimen.

(Scientific Paper No. 457, U. S. Bureau of Standards).

Note: A majority of those who have been consulted consider this test unnecessary.

10. *Macro and Micro Examinations.* Macrographs prepared from coupons taken across the welded joints and etched with suitable reagents shall show no laps, excessive porosity, nor incomplete fusion. Micrographs of polished specimens taken in the same manner shall show no evidence of coarse-grained material.

Note: A majority of those who have been consulted consider this test unnecessary.

11. *Retests.* Should the bend or impact tests fail to meet the requirements by more than 25 percent, retests shall be allowed on specimens cut from the second welded test plate. These retests shall comply with the requirements. Should any of the original tests fail to meet the requirements by 25 percent or more, no retests shall be allowed. If the tension test fails to meet the requirements, additional tension tests shall be allowed on two specimens cut from the second test plate and both of these shall meet the requirement.

12. *Non-Destructive Tests of Vessel.* The welded joints of the annealed structure shall be explored by an approved recording non-destructive test, such as an electrical or magnetic fissure detector or X-ray apparatus, which will determine quantitatively the size of a defect.

Note: A majority of those who have been consulted consider this test unnecessary.

13. *Fatigue Tests.* The annealed vessel shall be subjected to 10,000 cycles of pressure, each cycle varying from zero to 1½ times the working pressure. These cycles of pressure should preferably be applied at the rate of 10 to 12 per minute.

The welded joints shall then be again explored by the approved non-destructive test apparatus. The second set of readings shall show that no change in the welded joints has occurred during the fatigue test.

Note: Objections have been raised against this test by those who consider it unnecessary or capable of dangerously affecting the structure.

14. *Holes.* No holes shall be located in a welded joint.

When holes in the plate are located near a welded joint, the minimum distance between the edge of a hole and the edge of a joint shall be equal to the thickness of the plate, when the plate thickness is from 1 inch to 2 inches. With plates less than 1 inch thick, this minimum distance shall be 1 inch. With plates over 2 inches in thickness, the minimum distance shall be 2 inches.

15. *Allowable Working Stress.* When constructed under the above provisions, the maximum unit working stress of a welded joint may be taken as one-fifth of 80 percent (16 percent) of the minimum of the specified tensile range of the plate used.

Note: Criticisms have been received which claim that the maximum unit working stress allowed should be from 90 to 100 percent of the minimum of the specified tensile range.

Underground Piping

NEVER bury compressed air pipes in the ground. Such pipes surely will have to be dug up, perhaps more than once, in a hurry to stop leakage or to repair a break; and loss of time is the penalty for burying air-pipes in the ground. The same applies to service pipes around the air-compressor.

In most shops it is necessary to use underground distributing pipes for compressed air, but such pipes should be put in neat conduits flush with the shop floor or ground line. Cover the conduits so that they are instantly accessible, then you will avoid all trouble from buried compressed air piping.

Wilson 100-Ampere Welders

TO meet the need for a small, light weight arc-welder, suitable for operation in limited space, Wilson has brought out a Type-100 ampere machine which should prove particularly adaptable for repair work in general. This new welder (one hour rating on fixed resistance 50 degrees C. rise) combines all the major operating features of the large capacity machines with unusually light and compact construction. It has a welding range of 30 to 125 amperes.

Fusion Welding Applied to
Boilers and Pressure Vessels*

By C. W. Obert †

Attitude of authorities on the acceptance of welding as a fabricating process

UNDOUBTEDLY one of the controlling factors relating to welding in boiler construction and repairs in this country has been the A.S.M.E. Boiler Code which is operative in nineteen states and fifteen cities of the United States. This code, which is the result of the great uniformity movement that took form in 1911, permeates all of the stationary code jurisdictions in the United States with the single exception of Massachusetts, the pioneer state in enforcing boiler regulations; the Massachusetts law was introduced in 1906, five years before the uniformity movement that centered around the A.S.M.E. actually began. The authorities in that state have never seen fit to join hands with neighboring states to the extent of accepting A.S.M.E. Code constructions. Aside from the nineteen above-mentioned states and Massachusetts, the remaining states of the Union have no regulations or restrictions on boiler construction or operation.

During the past four or five years, there has been a marked change in the position held by fusion welding in the boiler, pressure vessel, and piping fields. Part of this is due to change in public opinion, and part to improvements in welding processes and practices; probably the latter is the underlying cause. Some of the recent developments and their effect upon the welding industry, are reviewed in the present paper.

As the situation in the boiler field now stands, there are no established provisions for welded construction in a broad sense, other than for low-pressure heating boilers for pressures not exceeding 15 pounds per square inch for steam, and 160 pounds per square inch for water heating, which may of course be wholly welded under the Heating Boiler Code. However, the Boiler Code Committee has taken some advance steps in the pressure vessel field, which are reacting favorably upon the boiler field, and it is more than probable that something will be heard about some large-scale developments in boiler welding before long. It can be said, however, that welding is now admissible in power boiler construction to a considerable extent. In a number of details, opportunities have been found for applying welding, and some of these will be outlined here.

The applications of fusion welding that are most generally used in boiler construction embrace a number of important elements, among which may be named the joints in boiler furnaces of both the staybolted type and the self-supporting type. These joints are now quite generally welded, for they are subject to compressive stresses only. Also, the seal welding of tube ends has been quite extensively practised in fire-tube boilers, particularly in railway locomotive practice. In addition, fusion welding has for some time been used for the attachment of inserted nozzles, threaded outlets, brackets, supports and other mechanical fastenings to boiler shells for the connection and support of piping, auxiliary apparatus, and structural details. With the recent rather extensive revision of Par. P-186 of the A.S.M.E. Code, the welding of turned-in flanges of firedoor and similar openings, and of flanged-in edges of waterlegs has been made practical: supplementary to this, is an official interpretation that permits the welding in of rings formed of steel plate for furnace firedoor openings. As experience in the practical application of fusion welding develops, new mechanical applications of welding to boiler construction are continually being found.

One of the most interesting features of this development in welding, which is now actively before the boiler experts, is the promise of preventing the so-called caustic embrittlement, which welded joints offer. There is a growing opinion that if boiler drums could be welded throughout so as to eliminate the microscopic cracks and seams that exist in riveted joints, the tendency toward concentration of caustic salts therein and consequent embrittlement of the plate would be eliminated.

In the State of Massachusetts very little credit has been given to welded construction for any but low-pressure heating boilers, and even for that class of boilers, cylindrical shells must have riveted longitudinal joints in any case, indicating very limited faith in welded seams. As far as the writer is informed, no boilers have been admitted to that state for power purposes with any but some of the most minor and unimportant details welded.

In the Canadian Provinces, the situation is quite similar in a general way to that in Massachusetts, although the Conference of Canadian Chief Inspectors is co-operating actively with the Boiler Code Committee, and they seem to be inclined to advance in all matters of this kind with the practice that develops on this side of the border line. In all of the provinces,

* Abstract of paper read before the 30th annual convention of the International Acetylene Association, Chicago, Ill., November 13 to 15, 1929.

† Union Carbide & Carbon Research Laboratories, Inc., Long Island City, N. Y.

I think, welded low-pressure heating boilers are admissible. Also a number of the provinces have accepted certain of the details enumerated in preceding paragraphs for power boiler construction, as a result of co-operation with the Boiler Code Committee. Ontario has taken an advance step in signifying its willingness to accept welded boiler drums for high-pressure operation, provided the process and construction methods meet the approval of their inspection department.

The A.S.M.E. Unfired Pressure Vessel Code exemplifies the first tangible results of the intensive studies of fusion welding made over a period of many years by the Boiler Code Committee. When it was issued in 1923, it was considered an important advance, but the limits imposed therein on the application of welding were such as to narrow the use of welded construction principally to air pressure tanks of comparatively small sizes. This was naturally disappointing to those interested in the advancement of the welding art, but in the absence of the much-looked-for means of measuring the strength of a welded joint, the limits, namely, 20 inches in diameter, length not to exceed three times the diameter, working pressure of 100 pounds per square inch, plate thickness of 5/8 inch, and unit working stress of 5600 pounds per square inch, represented the best that could be agreed upon by the Boiler Code Committee, which would at the same time prove acceptable to the inspectors' organization.

While very few states and cities have accepted the A.S.M.E. Unfired Pressure Vessel Code, the State of California took action in 1926 toward adopting the essentials thereof, except that it broadened the limits on welded construction considerably over those in the A.S.M.E. Code. For instance the diameter limit was increased to 60 inches, the pressure limit to 200 pounds per square inch, and the unit working stress in double-V longitudinal joints to 8000 pounds per square inch. The Boiler Code Committee gave its sanction to the changes from its Pressure Vessel Code, provided only that the state could enforce such regulations and restrictions as would insure sound and safe welding. This the California Department was able to establish by a form of registration for manufacturers, and their code went into effect on January 1, 1928. So far as the writer has been able to learn, the results there have been generally satisfactory.

Since the original edition of the Unfired Pressure Vessel Code was issued, the American Welding Society has been working to liberalize the established rules for welded construction, and a step of great importance was taken when it formulated a recommended procedure for sound and safe welding, which was formally presented to the Boiler Code Committee last February. This recommended procedure established for the first time in code work, a set of rules for welded construction, which if followed out, could be expected to insure safe welded vessels. The Boiler Code Committee after making a study of this procedure, decided that it promises to furnish that connecting link between fusion welding and sound safe construction which is so greatly needed, and using it as a foundation, took steps to so revise the Unfired Pressure Vessel Code as to render it uniform with the California code. These proposed revisions were published in the January issue.

As a result of this activity in welding rules, the State of Ohio has recently taken action to adopt the A.S.M.E. Unfired Pressure Vessel Code with the above-mentioned modifications included. Oregon, which was one of the first states to enforce the rules of the Unfired Pressure Vessel Code, is now taking steps to modify the rules in accordance with the revisions under consideration, and thus keep its code up to date. Similar moves are being talked of in the cities of Seattle, Wash., and Detroit, Mich., although the author has not as yet learned of definite results. The states of New York and Pennsylvania have given some study to the question of pressure vessel rules, and may perhaps take action thereon within another year or so, if these revisions to liberalize the welding rules meet public approval and work out satisfactorily. The chief boiler inspector of New Jersey also favors the revisions in question, and is preparing to act along similar lines.

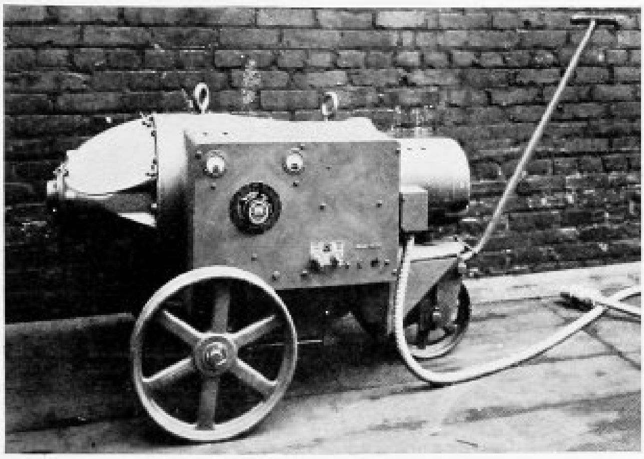
Massachusetts has air tank regulations which, like its code for boilers, make no provisions for fusion welded construction of any character. Its air tank code appears to be an abridgment of its code for boilers, as the detailed rules for riveted joints and other items therein are an exact duplication of those in the boiler code. It is, therefore, evident that the scope of neither of its codes has been extended to embrace the developments in fusion welding.

The Canadian Provinces, while slow in this respect, have shown better progress than Massachusetts. Most of the provinces have formulated rules for pressure vessels, but not all of them have given adequate consideration to fusion welding, the absence of rules for welding being usually construed as prohibition thereof. British Columbia has adopted the A.S.M.E. Unfired Pressure Vessel Code, and therefore accepts welded construction to a limited extent. Ontario has been the most progressive in this respect, as it accepts welded construction for all sizes and pressures, provided only that the process and construction methods meet the approval of its inspection department.

Flex-Arc Welders

THE Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., announces a new and original development in arc-welding machines which is now applied to its line of single-operator welders. An entirely new principle has been incorporated in all these welding machines which makes it much easier for the operator to strike and maintain the arc under all operating conditions, and eliminates explosive arc characteristics. The welding machines employing this new principle are known as Flex-Arc welders.

This improvement in welding-machine characteristics is obtained by the use of a special piece of apparatus, known as a flexactor, replacing the reactor formerly used and differing in principle of operation from all other types of reactors now in use. The volt-ampere curve of a welding generator indicates a certain current for a given voltage. However, it is well known to designers that such a current is not obtained at all times. In striking the arc, the current exceeds the steady value shown on the curve, causing the troublesome sticking of the electrode. The chief function of the flexactor is to prevent this overshooting of current and resultant tendency of the electrode to stick. Furthermore, any lengthening of the arc causes the current to momentarily drop below the normal steady value tending to interrupt the arc, all of which is corrected by the flexactor. In the arc-welding process, momentary short circuits are caused by globules of metal passing across the arc. Such short circuits re-



New Flex-Arc welder with the flexactor mounted directly under the unit frame

sult in current surges and arc explosions just as in striking the arc. This explosive action is also eliminated.

Other features of this machine are drip-proof, rugged and compact construction; mobility; wing nut terminals for welding cable connections; single rheostat adjustment with calibrated dials for accurately adjusting the welding current over the entire range; and high overall efficiency.

Boiler Plug Seat-Facing Tool

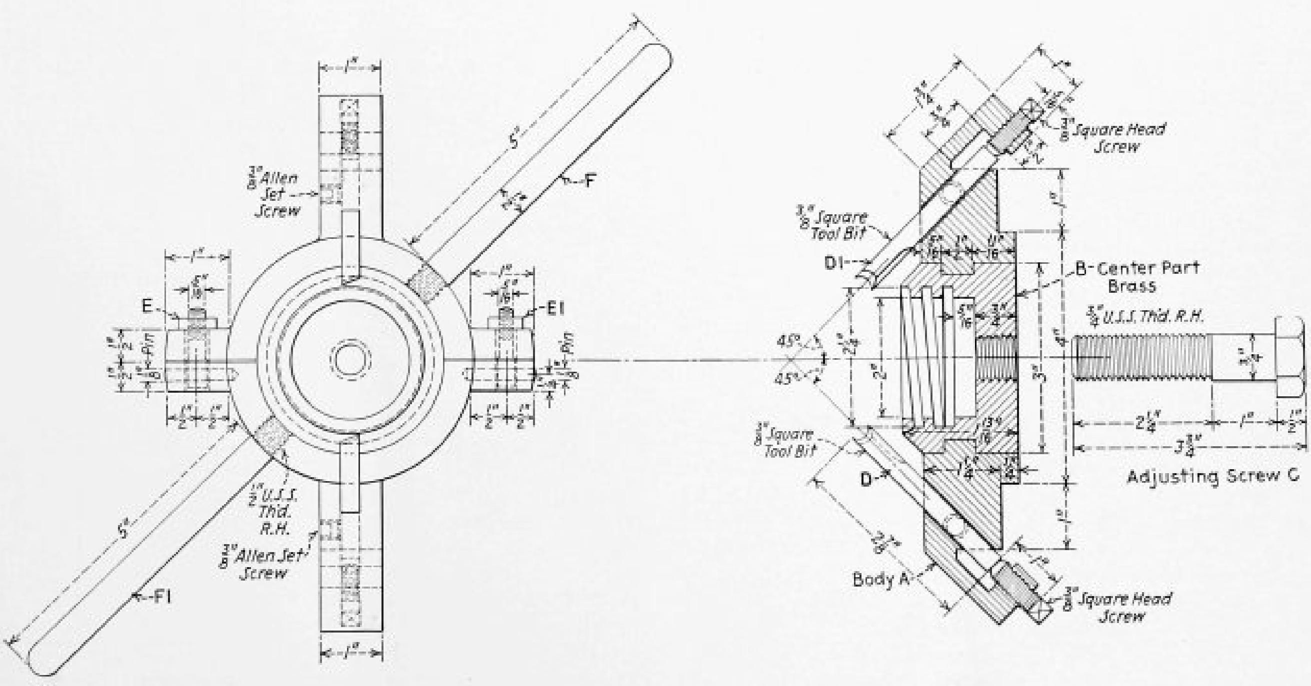
By J. H. Hahn

HURON washout and arch-tube plugs are designed for long service, and have a copper joint that seats against the bushings that are applied permanently to the boilers. At times these copper seats become damaged in various ways which cause the plugs to leak under pressure. The seats can be faced by chucking the plugs in a lathe which will produce a fairly good joint, but there is a possibility of facing the seat in such a way that the joint will not be true with the threads on the plug. This will result in the seat not bearing properly on the bushing when the plug is screwed in and might also create a condition that will cause the plug to leak.

The tool shown in the accompanying drawing will face the seats on these plugs in such a way that the seats will be true with the threads on the plugs and at the same time produce a smooth seat with the correct radius to insure a good steam-tight joint when the plugs are tightened in the bushings. The tool consists of a body *A*, which is made of steel, and a center part made of bronze, designated as *B* on the drawing, into which the plug is screwed. The adjusting bolt *C* is used to determine the amount to be faced off of the seat to restore it to the proper condition to insure a tight joint. The two tools *D* and *D*' are held in the tool holders made integral with the body *A* and held in position with set screws. The body is made in two parts hinged on the center line and held together with the clamp bolts *E* and *E*'. The handles *F* and *F*' are used to turn the facing tool during operation.

The method of operation is as follows: The plug to be faced is clamped in the vise by the square on the end of the plug. The center *B* is screwed on to the plug; the body *A* is then placed on the center; the clamping bolts *E* and *E*' are tightened and the tools set for the amount to be faced off of the seat of the plug; the adjusting bolt *C* is then tightened down against the plug to prevent the tools from facing too much off of the seats, and to insure a uniform cut being taken, the tools are ground to a gage with the correct radius, clearance, etc., for cutting copper. A cutting compound of lard oil or kerosene oil should be used to produce a smooth seat on the plug. The tools are rotated around the seat by the handles *F* and *F*' and a very smooth and uniform seat can be produced on the plugs.

The facing tool can be used in the shop or roundhouse. If used in the roundhouse, considerable time can be saved, as it is not necessary to carry the plugs to the machine shop to have the seats faced. The life of the plugs can be materially increased, and any possibility of a leak may be prevented by the use of the facing tool shown.



This tool insures a tight seat for washout plugs

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Computing Radial Stays

Q.—I am enclosing a sketch of the radial stay arrangement on the wrapper sheet of a locomotive type boiler. Will you kindly publish at your earliest opportunity your criticisms of same? You will notice that, in figuring the efficiency of the wrapper sheet between the stayholes, the full diameter of the stay was used. With the larger size staybolts the difference between the diameter outside and at the root of the thread shows a right receptacle difference which is reflected in the resulting efficiency. Would it not be permissible to carry out the instructions in Par. P-208 of the A. S. M. E. Boiler Code and use diameter at the root of the thread for obtaining the efficiency between the staybolt holes?

Furthermore, will you kindly state your opinion as to the application of Par. 204 wherein it is stated that the pitch may not exceed 8½ inches. Does this, in your opinion, apply to the transverse pitch on the wrapper sheet?

Again, in the second part of Par. 212-a, are we correct in using the transverse pitch of each stay on the outside wrapper multiplied by the longitudinal pitch on the outside wrapper as the surface supported by the stay? Attention is called to an article in the June, 1928, issue of The Boiler Maker, under the Questions and Answers Department and also in the July, 1928, issue by Mr. R. J. Furr, page 200. Each of these articles used different methods. The June article used the exterior area and the July article used the area on the crown sheet. Your comment on the above is solicited. T. C. E.

A.—In checking the wrapper sheet calculations submitted in the question, I find that they are fundamentally correct, there being a few minor corrections and suggestions as follows:—

The first part should be corrected as follows: Working pressure,

$$\frac{TS \times t \times E}{R \times FS} = \frac{55{,}000 \times 0.625 \times 0.75}{29.5 \times 5} = \frac{25{,}781.25}{147.5} =$$

174.78 pounds.

also where,

$$W.P. = C \times \frac{T^2}{P^2} = 70 \times \frac{T^2}{P^2}$$

The formula is correct for stationary boilers; C can be increased to 80 for locomotive boilers in accordance with Par. L-43a, Section 111, Part 1 of the A. S. M. E. Boiler Construction Code.

The working pressure for this boiler using 80 for the value of C, provided the boiler is used on a locomotive could be increased as follows:

Par. 212-a Page 29 1927 A.S.M.E. Boiler Code

1st.

Horiz. Pitch of Stays = 4.5"

Diameter of Stay = 1⅛"

Eff. of Wrapper between Stay Holes $= \frac{4.5" - 1.125"}{4.5"} = 75\%$

$$W.P. = \frac{TS \times t \times E}{R \times FS} = \frac{55{,}000 \times .625 \times .75}{29.5 \times 5} = \frac{25{,}771.25}{147.5} = 174.72 \text{ lb.}$$

To this add

$$W.P. = 70 \times \frac{T^2}{P^2} = 70 \times \frac{10^2}{4.5^2} = 70 \times 4.9 = 343 \text{ lb.}$$

Then

W.P. = 174.72 + 343. = 517.72 lb.

2nd.

Maximum Transverse Pitch = 10½"

Maximum Horizontal Pitch = 4.5"

Allowable Load on 1⅛" Stay @ 7,500 lb. per sq. in. U.S.F. Th'ds.

No Tell-Tale Holes = 6,089 lb.

Diam. of 1⅛" U.S.F. Stay = 1.0168

Gross Area = 10.5" x 4.5" = 47.25□"

Net Area = 47.25 − 1.0168 = 46.233□"

$$W.P. = \frac{\text{Allowable Load}}{\text{Net Area}} = \frac{6{,}089}{46.233} = 131.6 \text{ lb.}$$

Add this to result found in 1st. part of 1st. par.

W.P. = 174.72 + 131.6 = 306.32 lb.

2nd. b

$$W.P. = \frac{11{,}000 \times t \times E}{R - S \times \Sigma \sin a}$$

In which

t = .625, E = .75, R = 29.5, S = 4.74, Σ sin a = 2.6092

$$W.P. = \frac{11{,}000 \times .625 \times .75}{29.5 - (4.74 \times 2.6092)} = \frac{5{,}156.25}{29.5 - 12.3676} = \frac{5{,}156.25}{17.1324} = 300.9 \text{ lb.}$$

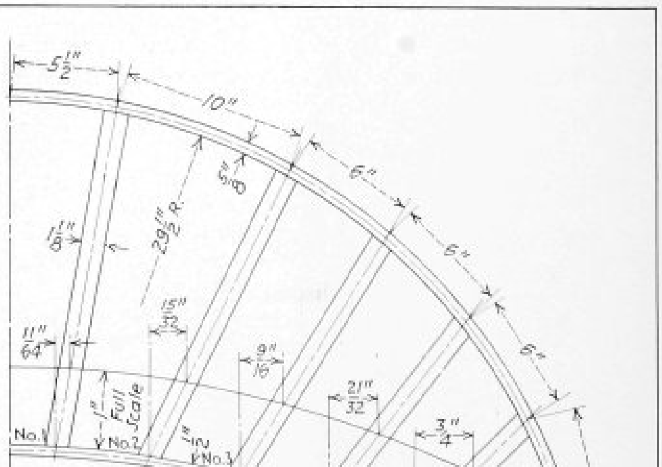


Fig. 1.—Computation of radial stays from A. S. M. E. Boiler Code

$$W.P. = 80 \times \frac{T^2}{P^2} = 80 \times \frac{10^2}{4.5^2} = 80 \times 4.9 =$$
392 pounds.

$$392 + 174.78 = 566.78 \text{ pounds.}$$

The second part should be corrected as follows:

The net area supported by the staybolt should be

$$47.25 - 0.81193 = 46.438 \text{ square inches.}$$

The area at the root of the thread should be deducted from the gross area and not the diameter at root of thread.

The allowable pressure corresponding to the strength of the stay would then be

$$\frac{6089}{46.438} = 131.12 \text{ pounds,}$$

and the allowable working pressure would be

$$174.78 + 131.12 = 305.9 \text{ pounds}$$

The sketch submitted shows the dimensions of the transverse pitch of the stays on the wrapper sheet, taken as the chord of the distance between the stays at the neutral axis of the sheet, these dimensions should be taken radially along the neutral axis of the sheet.

I would bring to your attention that the working pressure of the boiler would fall below 300 pounds based on the strength of the staybolts supporting the crown.

Area supported by one stay:

$$4.74 \times 4.5 = 21.33 \text{ square inches}$$

$$21.33 - .81193 = 20.518 \text{ square inches, net area.}$$

Allowable load 1⅛-inch diameter staybolt U. S. F. threads at 7500 pounds per square inch maximum allowable stress = 6089 pounds.

$$\frac{6089}{20.518} = 296.7 \text{ pounds allowable working pressure}$$

with no allowance for tell-tale hole.

The efficiency of the wrapper sheet is the ratio which the strength of the ligament between the centers of the staybolt holes has to the strength of the solid plate between these centers. The area of the ligament theoretically would be neither the distance between the centers of the staybolts minus the diameter of the staybolt at the root of the thread multiplied by the thickness of the plate, nor the distance between the centers of the staybolt minus the diameter of the staybolt multiplied by the thickness of the plate, but would be the actual area that the threaded hole would cut in the plate as shown in Fig. 2 deducted from the total area of the plate between the centers of the staybolts.

The efficiency would theoretically be the ratio that the strength of this area has to the strength of the solid plate.

However, for all practical calculations I believe that it is preferable to take the diameter of the staybolt in computing the efficiency of the wrapper sheet. This method might reduce the efficiency to some extent, but it is always best to calculate any doubtful condition, by the method that gives the safest construction.

P-208, A.S.M.E. Code, 1927, is as follows:

"The diameter of a screw stay shall be taken at the bottom of the thread or wherever it is of the least diameter."

I do not believe that this paragraph is applicable to the 1st section of Par. 212 (a) of the 1927 A. S. M. E. Code, which is as follows:

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

Fig. 2.—Reduction of plate area due to staybolts

braced and stayed surfaces given in Par. P.199, using 70 for the value of C."

For reasons I have already outlined, also for the reason that it would seem more practical to assume that this paragraph was intended for use when the strength of the staybolt itself was involved as in the second section of Par. 212 (a) which is as follows:

"The maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure shall be added the pressure corresponding to the strength of the stays or braces for the stresses given in Table P-7, each stay or brace being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay or brace."

Par. 204, A. S. M. E. Code 1927, is as follows:

"The formula in Par. P-199 was used in computing Table P-6 where values for screwed stays with end riveted over are required for conditions not given in Table P-6, they may be computed from the formulae and used, provided the pitch does not exceed 8½ inches. Where the staybolting of the shells of boilers is unsymmetrical by reason of interference with butt straps or other construction, 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 one side of the bolt to the center of the spacing on the other side."

In my opinion this paragraph does not apply to the transverse pitch on the wrapper sheet as illustrated in this question, for the reason that the wrapper sheet is not a flat plate nor does it require staying as a flat surface, as required in Par. P-199.

In the second part of Par. 212 (a), it is my opinion that using the transverse pitch of each stay, multiplied by the longitudinal pitch on the outside wrapper as the surface supported by each stay, as illustrated in the June, 1928, issue of THE BOILER MAKER is correct, as we are computing the allowable pressure corresponding to the strength of the stay supporting a load carried by this area of the wrapper sheet.

Methods of Welding Safe Ends on Superheater Flues

Q.—Kindly advise if it is permissible to safe-end locomotive superheater flues by fusion welding. If so, which is the better process, electric or gas welding? And what is the best method of procedure? E. A. R.

A.—Welding safe ends on locomotive superheater flues by fusion welding is permissible and is common practice on practically all the railroads.

The two most common methods of safe ending flues are the oil and electric welds. Of the two, the electric welding is considered the best and most efficient method. It is safe, clean, and more reliable in service.

With this method the tubes are first cleaned in a rattler to remove all scale and dirt; either a dry or wet rattler can be used, the best argument in favor of the submerged wet rattler is that it is dustless and almost noiseless. The tubes and safe ends are then cut off either square or beveled as desired. When cut off square the tubes are butt-welded together giving the greatest amount of solid surface in contact. When beveled the tube is scarfed and the safe end beveled, both to the same degree, thus forming a lap to guard against the tube falling into the boiler if the weld should be defective or overheated. All burrs should be removed after cutting the tubes.

The next step is to clean the tubes and safe ends where the welding electrodes are to be clamped on. This is done to obtain a good contact with the tube and with the safe end, so as to prevent the tubes from heating at these points instead of at the junction of the tube and the safe end when being welded in the welding machine.

The general principle of the welding machine is that the heat is induced by passing a large volume of electrical current of low voltage through the butting tube and safe end to be welded, the heating effect being caused by the resistance of the metal to the flow of the current. The greatest resistance to the flow of current is between the butting ends which therefore become hot first and when they reach the proper welding temperature the current is turned off and pressure applied mechanically to force the molten ends together thereby producing a weld. This operation takes about 45 seconds.

The most important part in welding safe ends on flues is the careful observation of the heat. Steel will fuse at about 2450 degrees F., and will make a very sound weld at about 2500 to 2600 degrees F., at which point the metal is much softer. At about 3000 degrees F., the danger point of overheating will be reached.

The tubes are then removed quickly from the machine and placed on the rolls, which roll the weld down on a mandrel, which finishes the weld by compressing and shaping it. The tubes should then be given a hydrostatic test.

In the case of the oil weld, the process is the same with the exception that an oil furnace is used to make the weld.

The welding of tubes with an oxy-acetylene torch can be done, but the method is more expensive and slower.

Novel Boiler of Experimental Swiss Locomotive

By G. P. Blackall

DURING the past few years the Swiss Locomotive and Machine Works at Winterthur, Switzerland, has been carefully considering the adoption of high-pressure steam, it being found that an increase of the working pressure from 220 to 880 will result in a remarkable saving of both coal and water. After first submitting a boiler and steam engine to exhaustive tests on a stationary testing floor over a year or so, the concern went ahead with the construction of an actual locomotive.

In this new locomotive the tube boiler is arranged over the driving wheels and has in front of it the smokebox, the stack and the exhaust pipe. In the front of the locomotive is installed a high-speed steam engine. The compact design of the boiler enables the steam engine to be arranged in front of the former without any undue increase of the wheelbase, thus allowing a ready access from all sides. The locomotive has been designed for hauling passenger trains and is comparable in power to the two-cylinder superheated steam locomotives of the Swiss Federal Railways.

The tube boiler is made up of a large upper drum, serving as a steam accumulator, and two smaller lower drums. Three water walls and a number of tube elements serve to connect these drums with one another. The upper drum includes a manhole for inspection purposes, while the lower drums have accessible flanges. The water walls and tube elements have been fitted with inspection valves, which also serve for scavenging. The superheater is a vertical tube system, while the tubes of the exhaust gas preheater are horizontal. After removing the superheater and exhaust gas preheater, these can be mounted into separate tube elements for thorough overhauling. Tests with absolutely uncleansed water have proved that no solid limestone will settle in the boiler itself, there being merely separated a small quantity of fine mud in the lower drums, which can readily be washed out. In fact, inasmuch as the feed water has been preheated to boiling, the precipitation of solid boiler scale occurs in the preheaters, which are readily cleansed by mechanical means.

The weight of the locomotive ready for operation is approximately 63 tons. The steam engine has been designed for single-stage expansion and comprises three identical cylinders arranged in parallel. A comprehensive series of trials have been made with this new high-pressure locomotive and a superheated steam twin locomotive of the Swiss Federal Railways in order to ascertain the saving of coal and water on the high pressure as compared with the low-pressure engine. Both engines have about equal coal and water capacity. The following is a summary of the test results:

	High Pressure	Low Pressure
Mean speed per hours in kilometers	61.8	60.7
Coal consumption in kilograms	776	1176
Water consumption in liters	5250	9700

These figures correspond to a saving of coal of 35 to 40 percent and to a saving of water of 47 to 55 percent.

H. H. Knowles, the Pacific Coast representative of the Reading Chain and Block Corporation of Reading, Pa., has announced the appointment of the Murry Jacobs Company, 554 South Pedro street, Los Angeles, Cal., to represent the Reading Chain and Block Corporation in Southern California. The latter company is well qualified by experience in representing kindred lines as well as by personal knowledge of the field, to represent the Reading Company in that district. Harry T. Lynam will be in charge of the Los Angeles office and a good stock of chain blocks will be carried there for quick service needs. The Reading Chain and Block Corporation manufactures a complete line of overhead conveying equipment, including the Reading-T-Rail system, hand and electric hoists in all sizes and ratings, and a line of enclosed gear chain hoists in various sizes and ratings. They manufacture all the equipment in their plant at Reading, Pa.

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

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	

Cities

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

Selected Boiler Patents

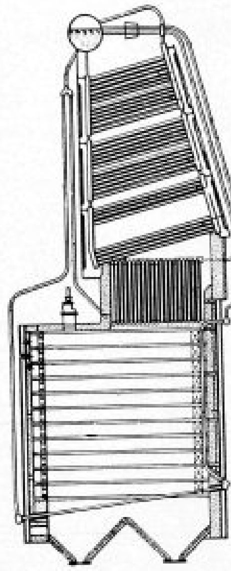
Compiled by
DWIGHT B. GALT, Patent Attorney,

Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,714,600. FURNACE AND BOILER. GEORGE P. JACKSON, OF FLUSHING, N. Y., ASSIGNOR TO COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

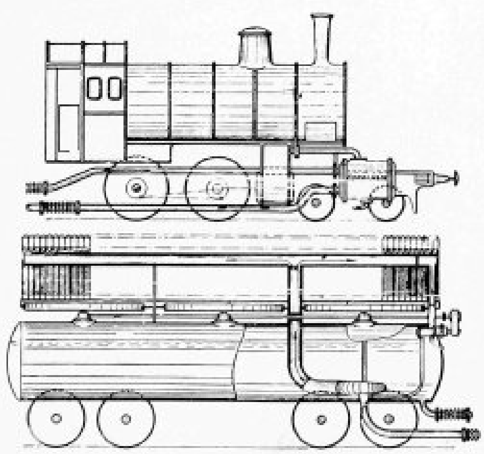
Claim.—In combination, a boiler furnace having an outlet throat in an upper part, means for admitting finely divided fuel into the furnace in an upper part in a downward direction to one side of said outlet so that the



fuel and flame stream describes a U-shaped course through the furnace, a boiler consisting of three groups of boiler elements, a bottom and side wall screen forming one group, a throat screen forming the second group, and a series of banks of short tubes constituting in effect an economizer section forming the third group, a steam and water drum, and separate connections between each group of boiler elements and the steam and water drum. Three claims.

1,717,457. CONDENSER PLANT FOR LOCOMOTIVES. FREDRIK LJUNGSTROM, OF LIDINGO-BREVIK, AND ALF LYSHOLM, OF STOCKHOLM, SWEDEN, ASSIGNORS TO AKTIEBOLAGET LJUNGSTROMS ANGTURBIN, OF STOCKHOLM, SWEDEN, A CORPORATION.

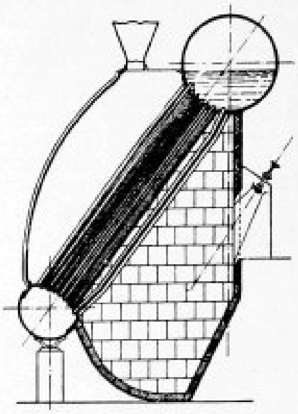
Claim.—In a condenser plant for locomotives and the like, a condenser, means for conducting exhaust steam to the condenser, a fluid container, means for passing fluid from said container directly through said con-



denser, to condense the exhaust steam therein, and for returning the heated fluid to said container, cooling apparatus and means for conducting fluid from said container directly to said cooling apparatus to be cooled and returning the cooled fluid directly to said container. Four claims.

1,713,176. WATERTUBE BOILER. ODOARDO GIANNELLI, OF EMPOLI, ITALY.

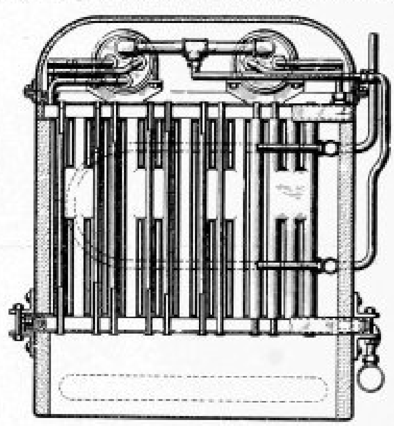
Claim.—A watertube boiler including a combustion chamber, headers arranged on opposite sides of the combustion chamber, one of which is arranged higher than the other, a single nest of tubes connecting said headers and arranged diagonally across the combustion chamber, means



for injecting liquid fuel at an angle from the top of said chamber and parallel to the lower sides of said tubes, means for feeding water to the upper header, and a screen arranged for deflecting a stream towards the outer row of tubes where the heat is at the lowest temperature, and the bottom of the combustion chamber being arranged so that hot gases are deflected thereby to pass obliquely across the said tubes, substantially as and for the purposes set forth.

1,714,829. STEAM BOILER. ERNEST H. VINCENT, OF OAKLAND, CAL.

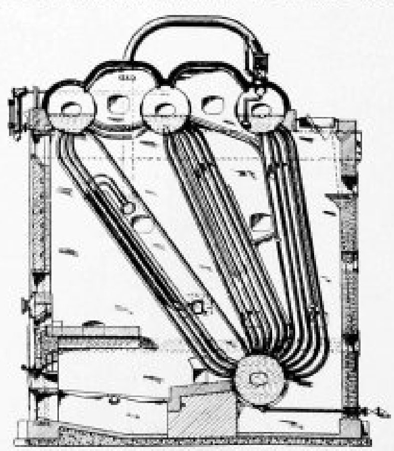
Claim.—A steam boiler comprising a plurality of boiler units, each unit having horizontally extending upper and lower headers, sets of watertubes extending between the headers, the tubes of each set being connected by



water circulating connections intermediate the headers, other tubes extending between the headers intermediate the sets whereby water columns of unequal weight will be formed in each unit, and flue tubes extending upwardly through certain of the water-tubes. Two claims.

1,713,091. SUPERHEATER. ARTHUR D. PRATT, OF SHORT HILLS, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim.—In combination with a watertube boiler, having a plurality of watertubes exposed to the radiant heat of the furnace, a baffle behind said



tubes, a superheater comprising headers located back of said baffle and tubes connecting said headers and extending in front of said baffle and entirely exposed on one side to the radiant heat of the furnace, said superheater tubes being spaced among said boiler tubes. Two claims.

The Boiler Maker

Name registered U. S. Patent Office

Volume XXX **April, 1930** **Number 4**

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

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THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

Request for change of address should reach us on or before the first day 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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How Do You Repair Fireboxes?

On page 91 a new "Think This Over" question is published. This time the subject of firebox repairs is brought forward for discussion. Every construction and maintenance operation in the firebox is of tremendous importance in relation to the performance and life of a boiler, and much time and thought are devoted by the entire mechanical staff, from the engineers down to the men in the shop, to ensure that firebox work is done properly. For this reason there is probably no boiler shop operation more familiar to the staff than firebox repairs. Strange as it may seem, however, no two shops perform the work in the same way in all its details. Now, from the variety of details and methods employed, certain shops must have developed systems of handling this work that are more efficient than others.

Details of methods and equipment that have thus saved time, labor and money are worth talking about, so we are asking our readers to again come forward with their suggestions of how best to handle firebox operations. As noted in a subsequent editorial, the Norfolk & Western Railroad has so standardized its repairs that great savings in shopping time are made. Other roads have developed methods equally efficient. Every reader of THE BOILER MAKER is interested in knowing about them. Jot down the details of the way you handle this work in your shop, covering any or all sheets in the firebox, either repair or replacement, or new construction, and send these notes to us.

Many valuable suggestions resulted from the first question asked in January on repairing boiler cracks, and there is every reason to believe that more of our readers will get into this spirit of exchanging ideas and write to us on this subject of fireboxes. We sincerely trust that a great many of our readers will contribute some of their experience to this discussion.

Standardizing Boilers

Standardizing locomotive boiler parts so that each sheet of each class of boiler is interchangeable presents certain advantages which railroads cannot afford to overlook. The success of the Norfolk & Western Railroad in carrying out this standardization experiment indicates savings not only in labor but, due to the interchangeability of parts, lessens the time lost by locomotives during repairs and actually reduces the motive power requirements of the railroad.

In the case of new boiler construction, each plate casting or forging is designed complete in every detail, even to the last rivet hole. The location of each hole is fixed, the tolerances in various dimensions are reduced to a minimum so that savings of appreciable magnitude are realized not only in the cost of raw materials but in the cost of machining operations. Because of the complete layout of each part, every hole in a plate that requires rolling may be drilled or cut at the time when that process can be performed most easily.

What is more important, however, is the assurance that each part, when assembled, will fit exactly with those adjacent to it and will serve equally well on any boiler of its class. Not only is this true in the case of new construction, but in the case of replacement parts required after years of service, as well. Such sheets or parts may be fabricated miles from the locomotive and when assembled in position will fit exactly.

This is the secret of reduced shopping time for repairs. The required part may be ordered far in advance of the schedule period of layup and, without the necessity of taking measurements from the locomotive in order to fabricate the part that is being replaced. In this way the new back end, firebox, tube sheet, or other replacement is ready for assembling at the time of the scheduled layup.

Such savings in boiler repairs may be realized only by foresight in the preliminary design of the boiler, when plans for interchangeability may be prepared with the least effort. Proper design, adherence to dimensions, standard plate developments, and ready access to development plans form a basis of savings in locomotive maintenance which may be realized through the entire life of every locomotive.

To Superintendents of Motive Power

Another convention of the Master Boiler Makers' Association is about to take place. This time it will be held at the Hotel William Penn, Pittsburgh, Pa., from May 20 to 23. Each year there are members who cannot arrange with their railroads to attend the meetings, either because of press of work or failure to obtain the authorization from their superiors.

Under certain conditions shop schedules cannot be altered to provide for the absence of foremen. If for this reason, or some other unavoidable condition, a member is unable to be present at the convention, his absence is understandable. On the other hand, if permission is withheld by his superiors, then either in times past he has not shown proper appreciation of the privilege, or the value of the meetings has not been sufficiently well explained to the officials.

To clear up any doubt on this point, it may be stated emphatically that as a group the Master Boiler Makers' Association is probably the most businesslike and hard working of any organization in the railroad field. This will be testified to by railroad officials from presidents down, who each year in ever-increasing numbers sit in at sessions of the convention. Committee reports prepared on subjects pertaining to shop problems of the trade form a symposium of best practice in the industry. Education, not only in how best to meet these problems, but in the more intangible phases of railroad work that go to make good foremen, inspectors and supervisors in the boiler department, form the basis on which the program is built.

This year an opportunity is being presented for members to inspect several of the steel mills where boiler materials are made. If no other benefit could be derived from the convention, this alone would be worth while; for it will be the first time that the vast majority of the men will have seen the source of raw materials from which they produce finished boiler parts. In addition, the Boiler Makers' Supply Men's Association will present for inspection the only comprehensive display of the latest in tools and equipment used exclusively by the boiler shop.

As a matter of duty, all members of the association should be at the convention this year, and superintendents of motive power are urged not only to grant permission to their men if requested but, further, to make it more or less a matter of compulsion that certain of their staff attend.

Communications

Do You Dare to Weld Boiler Cracks?

TO THE EDITOR:

Although the use of welding for repairing boiler cracks is frowned upon by the authorities, there are many cases where it is applied for minor or temporary repairs, particularly in sections where boiler laws are not properly formulated or enforced.

When you weld a crack in a steam boiler, what has happened? Have you made a permanent repair with the weld as strong as the uncracked sheet, or have you only temporarily mended the crack which may reappear again either in the same place or adjacent to the weld in a supposedly sound bit of steel? Does this mean that the weld is liable to break loose through internal strains or is the mended steel in condition to withstand the strains to which it will be subjected?

Let us assume that a soft non-oxidized weld has been made, either by the oxy-acetylene or the electric arc process, and that the weld is as tough and as strong as sound shell steel or firebox plate. How will you answer the query—can a welded crack withstand the strains set up by the welding operation, in which a narrow portion of the sheet is heated to the melting point and allowed to be placed under steam pressure and stress with no attempt whatever to relieve the local welding stresses? The outlook isn't very good, is it? Looks as though the welded crack and the adjacent sheet for some distance around in every direction should be heated to a red heat and annealed in order to relieve the strains of welding and to give the metal in and around the weld even a halfway chance to remain safe, sound and solid.

A few simple experiments, easily made in any shop, may go far to determine whether or not a sheet, once cracked, be capable of holding a weld, or whether or not the sheet will or will not soon crack again adjacent to the first crack? The experiments are described in the following paragraphs, but as a lead-up to them, the writer wishes to tell of some experiments made several years ago which show that bending a piece of steel stiffens it so that it requires more force to bend the piece of steel again in the same place, but that many repeated bendings will harden the steel and eventually cause it to break.

The tests in question were made to demonstrate whether or not a piece of steel was weakened after it had been bent and straightened again. Having

How Do You Renew Fireboxes?

What methods do you use in removing, repairing and installing complete fireboxes; side sheets; crown sheets; throat sheets; tube sheets; door sheets?

Select as a subject any sheet or the complete firebox and explain the various steps followed in your shop in making the repairs, from the cutting out of the sheet, through the details of laying out, fabricating and fitting the new sheet and finally installing it. Give details of the tools used, the number of men needed, the time for various operations and sketches or photographs of important points described.

If your railroad follows the practice of building fireboxes for stock and then, when a renewal is necessary, the old firebox is removed and a new one from stock installed, tell how successful the system is in saving time and money, and just how you build to the required standard.

If your boss asked you how firebox repairs were handled you could immediately prepare a complete and accurate report of the work. In answering this same question for publication write the details down in the same way, just as the work is carried out step by step.

All letters that accurately describe firebox work of almost any kind will be published in this department and will be paid for at our regular rates.

access to a testing machine, the writer placed a piece of soft steel—about 30 point carbon, in the testing machine and applied pressure laterally until the steel had been bent about 30 degrees. Then the steel was turned, with the bend uppermost, and pressure applied until the steel had been straightened and then bent about 30 degrees in the opposite direction.

A record of the pressure exerted during each bending was kept and it was observed that the pressure necessary to bend the piece increased slowly but surely until the fourteenth bend, after which the bending pressure fell off until the piece of steel broke at the sixteenth bend. This test proved to the writer's satisfaction, that repeated bendings stiffened the steel and caused it to become crystallized and less ductile.

In order to determine whether or not repeated slight bendings, or very many applications of heat and pressure stresses have crystallized the sheet, proceed to cut out a cracked sheet from some steam vessel, weld the crack in the most approved manner, then shear off a strip of the cracked sheet at right angles to the welded crack. We are all quite familiar with the boiler code of ductility requirements, so proceed to apply them to the strip of welded steel by bending it cold upon itself right in the weld. Should the strip of steel pass the requirements by bending double upon itself, and being straightened again without cracking, then you may feel sure that the weld is a good one and therefore quite permissible in any steam vessel. However, should the weld break and the steel seem to peel from the weld, it may be possible that the metal to which the weld has been attached, is so badly crystallized as to be unable to survive the bending test.

In case the strip of shell steel proves brittle and easily broken, what is the use of welding cracks in similar sheets? It will also be very interesting to learn if the entire sheet has become crystallized.

It should be kept in mind that, while sixteen bendings back and forth through an angle of about 30 degrees are required to break the piece of steel in a testing machine where the angle of bending is only one or two degrees or less, as in portions of a steam boiler, it may require many hundreds or even thousands of slight bendings in order to cause a sheet to crack. Therefore, do you dare to weld cracked sheets?

Indianapolis, Ind. James F. Hobart.

Repairing Locomotive Boilers

To the Editors:

In trying to answer the above question I am giving the readers of this journal a little of my experience extending over many years.

To many readers this question looks like a simple one to answer, and to those of us who work in shops equipped with modern appliances it is. Take, for instance, the locomotive firebox, where usually the most cracks occur; if it is really necessary to repair cracks on account of urgent need of the engine, the usual way is as follows:

Having determined the full extent of the crack, then with a diamond-point tool cut out the crack its full length to the depth of the sheet, perferably leaving about ⅛-inch opening on the waterspace side. This insures that the weld is through and has taken hold on the inside. By welding in this way, cracks in almost any part of the firebox can be repaired. This method can be applied also to corrugated furnaces of marine boilers, when the work is done in dock, where the electric method is close at hand, otherwise the old-time way comes in handy.

The old-time way of repairing cracks in marine furnaces and locomotive fireboxes, when it was inconvenient to patch was as follows.

Having, as in the other case, located the full extent of the crack, start at one end of the crack by drilling, usually a hole that will tap out to ½-inch, then using a ½-inch 12-thread taper, tap out the hole, leaving a little taper in it. Then having prepared some ½-inch copper plugs, apply to the first hole and when in tight cut off about $\frac{3}{16}$-inch from the sheet. Then drill another hole letting your drill cut into the copper plug about $\frac{1}{16}$-inch so that when the hole is tapped out there will be a full thread in the copper plug. Now do the same the full length of the crack and you will have, when properly finished, instead of a crack one plug filling the whole space. In working the copper down to the sheet use an ordinary hand flatter roughed on the face. A tool of this kind worked all over the plugs roughs them into one whole mass. Then use a smooth flatter (hand) and smooth the whole down to a fine edge, and the job is completed.

Some years ago this writer was called upon to repair a crack in the crown sheet of a dinky locomotive. After removing the mud from the crown sheet (the cause of the crack), we proceeded just exactly as above described and with good results. Many times we have repaired cracks this way on engines during the washout period when time was limited. When all is said and done, however, plugging cracks is really an emergency job and should never be used when there is time to apply a patch.

When cracks occur in the shell or barrel of any kind of boiler, patching is necessary to make a safe and sure job. In shops where a layerout is employed, the laying cut and preparation of patches generally falls to his lot but in the case of a shop that does not always have a layerout the boiler maker gets the job, and in that case there are many such men who, although good all-round workers, do not know the formula for obtaining the proper pitch of rivet holes. Therefore, after determining the size and shape of the patch, you want to get very close to the proper pitch required for the patch by using that of the rivets in the seams of the boiler you are working upon either for single or double riveting. Make your patch large enough to get away from the crack. Also, when you have determined the length of the crack, be sure to drill a small hole at each end to prevent the crack extending any further.

Pittsburgh, Pa. Flex-Ible.

Device for Bending Plate

To the Editor:

During my perusal of the February issue of The Boiler Maker, I was very interested in reading the paragraph headed "Device for Bending Plate" and credited *Oxy-Acetylene Tips*. I could not quite grasp the kink as explained, and I really think that a small sketch would have been helpful. But the real point at issue was that by the use of the oxy-acetylene process considerable money was saved. I am a firm believer in the oxy-acetylene flame whenever practical or when the interests of economy demand its use, but I am also of the opinion that in present-day practice we are relying on it too much and ignoring the old-time methods, some of which come out with a clear lead if costs are taken into consideration. Take the making of a flanged head, for example, no matter what shape, however irregular, a good boiler maker would form the head at the fire with very little trouble, and very little expense. As to angle rings, compare the cost of making them at the forge and fire-welded against the cost of fabricating an oxy-welded ring made from steel plate. I have recently completed a steam exhaust pipe and cowl made from ⅛-inch steel plate with angle rings entirely acetylene welded throughout. The job was a simple layout, consisting of a conical pipe tapering from 1 foot 5 inches diameter at the base to 2 feet 1½ inches at the top, with a vertical height of 21 feet. This was made up in three lengths of 7 feet with angle connecting rings. The cowl consisted of two cones, one 2 feet 1½ inches at the base and 4 feet 3 inches at the top; vertical height, 4 feet 6 inches; the other joining on the 4-foot 3-inch diameter up to 2 feet 3 inches at the top, vertical height, 1 foot 6 inches. When finished, the job looked very neat and the welding looked perfect and, while admiring it, I compared it in my mind to a similar construction only with single riveted lap seams and neat snap rivets, and I must confess that it would still look as neat in appearance as the welded job and equally as serviceable.

From the constructional point of view, the marking off of the plates would have been the same. The shearing of the plates—the riveted construction need not be as exact as the welded one. Rolling and plating the riveted job would score heavily, owing to the holes connecting any little twist in rolling the conical sections, and the riveting would certainly be finished a good time ahead of the welders. The costs of the oxygen and acetylene used would be far heavier than the drilling and rivets used, and the time wages of the welder would be greater than the riveting. So in this particular instance the old-time method would have been cheaper. Other points can be similarized, for example oxy-acetylene cutting versus shearing. On certain work each method would score over the other and so we go on. The real point is this, that when approaching any job and keeping the oxy welding plant and other modern improvements in mind, we must not forego all the older methods which are really the fundamental principles of our craft.

Brighton, Sussex, England. C. H. Whapham.

Repairing Boiler Cracks

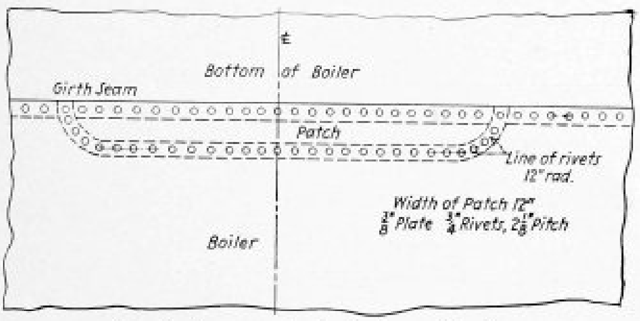
Methods suggested by readers

On the following pages appear several more answers to the question "How do you repair boiler cracks?" which appeared in the January issue. Answers from readers were published in both February and March. There are yet one or two additional answers that are well worth publishing and these will appear in a later issue. We assume that all those who desire to discuss this question have done so, although any further contributions on this subject that have merit will be used.

Repairing Fire Cracks

By C. S. Handlee

One of the most frequent problems confronting the boiler maker is fire cracks in shell plates of horizontal return tubular boilers, which usually develop in girth seams over the fire. When applying patches they must be carefully designed so that the pressure of the boiler will not be reduced and the patch will give good service



Steel plate repair in horizontal boiler

under severe operating conditions, due to being directly over the fire.

The sketch shows a patch 12 inches by 52 inches long thus applied at the girth seam. This patch covers a defective section of the plate, which was cut out due to fire cracks. The average length of cracks being 2 inches to 2½ inches long, under these conditions the patch should not be made more than 12 inches wide.

To lay out the proposed patch on the boiler, draw a line around the boiler, spacing the rivet line 12 inches from the girth seam; run the line up as far as you wish the patch to go around the boiler, then square this line to connect with the rivet in the girth seam. Having done this, take the dividers and draw a curved line which, in this patch would have a 12-inch radius. Then carefully space the rivet holes. If the boiler shell is ⅜-inch thick, and you will use ¾-inch rivets, space the rivets 2⅛-inch pitch. After this is done, develop the necessary lap, which should be about 1¼ inches. Then drill the rivet holes 13/16 inch. Then the old plate and the rivets in the girth seam can be cut out.

The patch can now be put up and several holes marked, and the plate pulled up into place. When all slack is pulled out of the patch, all the holes can be marked off and drilled; outside lap holes in the patch countersunk, and the patch then chipped for calking, scarfed and cleaned. The holes in the boiler should also be countersunk on the outside lap.

The end of the patch should be scarfed very thin and slipped between the old shell plates, then carefully fitted up and the holes faired. The riveting should start on the bottom, and, if using an air hammer, a Liverpool set should be used, as this method draws the sheets up good, makes a tight job and absorbs less heat than high rivets.

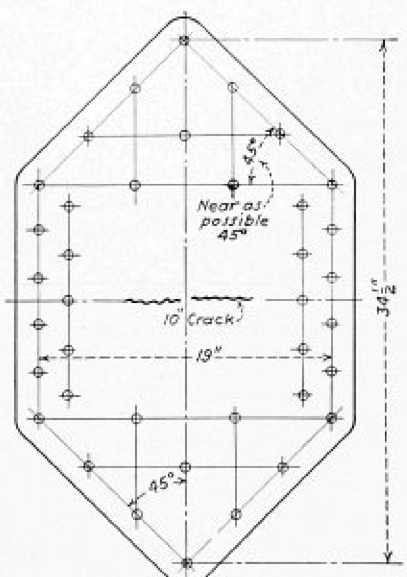
Always use the same thickness of material and patch as the boiler plate, and, wherever possible, apply the patch on the inside, thereby eliminating mud pockets.

Barrel Sheet Cracks

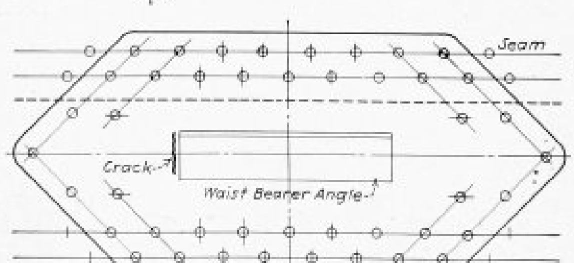
By E. J. Lloyd

The illustrations show our method of applying patches to cracks in the barrel of a boiler. The patch must never be less in thickness than the shell to which it is applied. The diameter and pitch of rivets must be the same as those existing at the circumferential seam, and the pitch of rivets in the diagonal portion of the patch should be governed by conditions but must be close enough to make good calking.

The patch is laid out as near as possible to 45 degrees.



Left—Patch over 10-inch crack in third course, right side



Patch over waist bearer angle; diameter and pitch of rivets same as seam

Cracks in Locomotive Boiler Barrels

By R. W. Barrett

Methods of repairing cracks in locomotive boilers are governed by the nature and location of the cracks. These may be classed roughly under stayed and unstayed surfaces. On no account should cracks be welded on unstayed surfaces. In locomotive repair work,

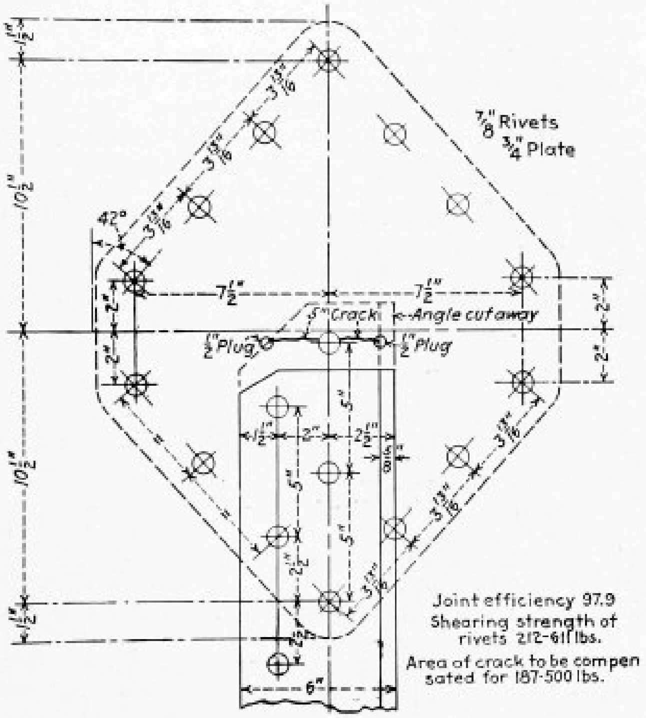


Fig. 1.—Repair to crack at end of spectacle plate angle

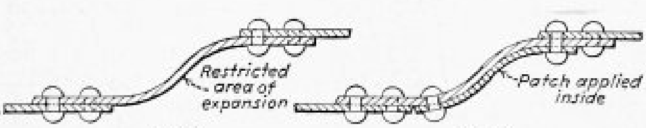


Fig. 2 Fig. 3

Figs. 2 and 3.—Restricted expansion causes throat sheet cracks

experience has taught us that there is, in a general way, a common location for boiler cracks. One class of power will develop cracks in the barrel of the boiler at the end of the motion plate angles or spectacle plate angles where fastened to the boiler, while another class of power will develop cracks at the pump bracket studs, and still others will show extensive grooving inside of the barrel at the bottom, where the heel of the spectacle plate angle is located.

The following are examples of the common forms of cracks at the various parts of the boiler and the methods of repair.

Cracks in locomotive barrels.—As shown in Fig. 1, the example given is a crack in the barrel at the end of a spectacle plate angle. This crack usually extends from 1 inch to 3 inches each side of the top rivet hole.

The patch, which should at least equal in thickness the cracked course, should be applied to the inside of the barrel. If this is not possible at the time of repair, apply the patch outside of the barrel with patch bolts, and, on the first shopping for tube renewal, remove the outside patch and apply the patch inside with rivets. Small plugs should be applied at each end of the crack to prevent the crack extending.

In designing the patch, as shown, three things must be considered:

1. That the patch be designed to take in existing holes in the spectacle plate angle, and take in any boiler studs which may be in the locality of the patch.

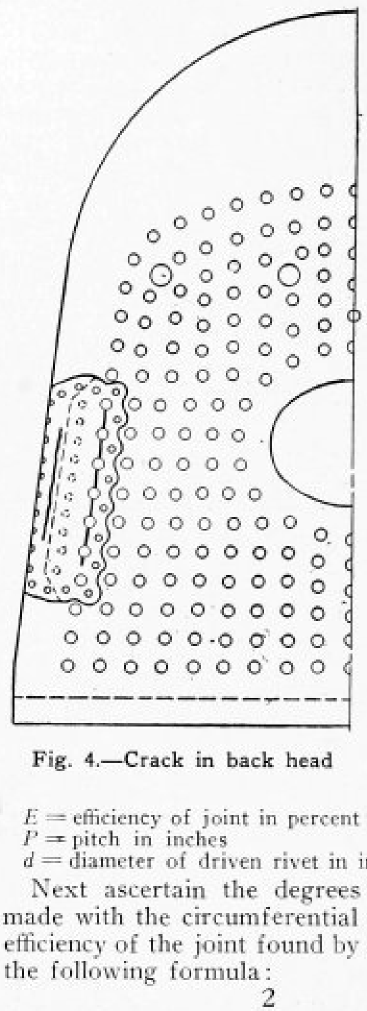


Fig. 4.—Crack in back head

2. That the shearing strength of the rivets or patch bolts on each side of the crack will at least slightly exceed the value of the metal lost due to the crack, which is the length of the crack, times the thickness of the barrel at the crack, times the tensile strength of the material in pounds per square inch.

3. That the strength of the diagonal joint equal the efficiency of the longitudinal joint of the course.

To obtain this, first calculate the efficiency as of a longitudinal joint, which is:

$$E = \frac{P - d}{P}$$

where,

E = efficiency of joint in percent
P = pitch in inches
d = diameter of driven rivet in inches

Next ascertain the degrees of the angle the joint made with the circumferential seam; then multiply the efficiency of the joint found by the factor obtained from the following formula:

$$\frac{2}{\sqrt{\text{Sine of angle}^2 \times 3 + 1}} = \text{Factor}$$

The following table of factors is handy for reference:

Angle, degrees	Factor
30	1.51
35	1.42
40	1.34
45	1.27
50	1.20
55	1.15
60	1.11
65	1.08
70	1.05

When cracks develop in the throat sheets they are usually found in the knuckle of the throat wings, or in the ligaments between the staybolt holes of the outside row of staybolts. Apparently the cause is restricted expansion. The close proximity of the joint of the throat sheet to the barrel and the firebox casing sides limits the area of expansion between these two joints, Fig. 2.

We find the same condition and cause at the lower part of the throat sheet, but as there is only one joint at the junction of the throat sheet and casing side, the restricted area is more extended. The outside row of staybolt holes, offering the line of least resistance, we find the checking and cracking taking place between these holes.

When the wing knuckles are cracked, the application of a small patch either inside or outside of the boiler (inside preferred) over the crack between the two joints, as shown, Fig. 3, will prevent any further cracking during the life of the sheet. This would make the wing of equal thickness throughout, and would have the tendency to make the expansion more general than local.

Methods of repairing throat wings are as follows:

(a) If checked to a depth of 1/4 inch, vee out and weld with electric arc process; chip off any reinforcement.

(b) When cracked halfway or more through the sheet, vee out and weld and apply the patch, inside if tube sheet is removed, if not, apply outside.

When applying the patch inside, take in the front row of rivets at the firebox casing sides, Fig. 3. The rivets in the patch should be staggered between those of the joint at the barrel and casing sides.

(c) If the sheet is heavily cracked, it may be advisable to renew the throat sheet wings. For convenience, these long patches can be flanged at the hydraulic press in one piece and split in two with the acetylene torch. A good method is to make a 3/8-inch square iron skeleton gage both as to shape and outline, and very little difficulty will be experienced in fitting in the new section. Some railroads prefer to lap the new section at the bottom and make a riveted joint. However, an adequate joint can be made by welding, care being taken that the part that takes in the joints of the throat at the barrel and firebox casing are cut in a diagonal direction.

For cracks between the staybolt holes at the bottom of the throat sheet, veeing out and welding with 25 percent reinforcement is all that is necessary.

Cracks in back head sheet.—The cracks in the back head of locomotive boilers are usually found in the heel of the flange and between the staybolt holes, as shown in Fig. 4. Although this might be called a stayed area, yet it is safer to apply the patches over these cracks.

In Fig. 4, the dotted line shows the style of the patch applied when the cracks are between the staybolt holes only. The other style is used when the cracks are in the heel and between the holes.

If flexible staybolts are in the patched area, it will be well to seal the calking edge with a small roll of electric welding owing to the wide pitch between the patch bolts or rivets between the staybolt holes.

Cracks in front tube sheet.—The cracks in the front tube sheets usually occur in the heel of the flange either at the sides or bottom of the sheet. Cracks up to 15 inches long have been vee'd out and welded, and have not given any more trouble for years. If the crack is more than 6 inches long it would be well to remove the flange rivets before welding to allow for contraction of the weld, then ream the holes and replace the rivets. When the sheet at the bottom is corroded, as well as cracked, a flanged patch should be applied, extending up into the tube area in a triangular shape. Corrosion on the outside of the sheet and bottom may be built up with electric welding.

Firebox cracks.—Small cracks in lower area of tube sheet, side sheets and door sheets can be vee'd out and welded. The electric-arc process is preferred for this class of work. It is not advisable to weld the cracks extending more than 8 inches except as a temporary measure. Patches should be applied at the first opportunity, taking in the cracked area. These patches should have a dish or roll to take care of contraction while welding. When the cracks occur in the heel of the flange at the top of the firebox tube sheet, as a temporary measure between shopping, the crack can be vee'd out and welded. Reinforce the weld inside of the boiler, if possible. At the next shopping, provided the rest of the tube sheet is good, a patch should be applied at the top of the sheet, taking in all the weld.

A common location for cracks in the crown sheet is between the first row of the crown bolts at the front end. This can be taken care of by the application of a flanged patch at the top of the tube sheet, extending into the crown and taking in the first row of crown bolts, or, if necessary to renew the tube sheet, have the sheet flanged wide enough at the top to take in the defective area of the crown. Occasionally the holes in the first three or four rows of crown bolts are checking from the holes. In this case apply a patch six rows of bolts wide extending down the sides to at least 15 inches below the center of the crown sheet.

When cracks develop in the center of the crown sheet, the only safe method of repair is to renew the crown sheet.

Oxweld Steel Welding Rod

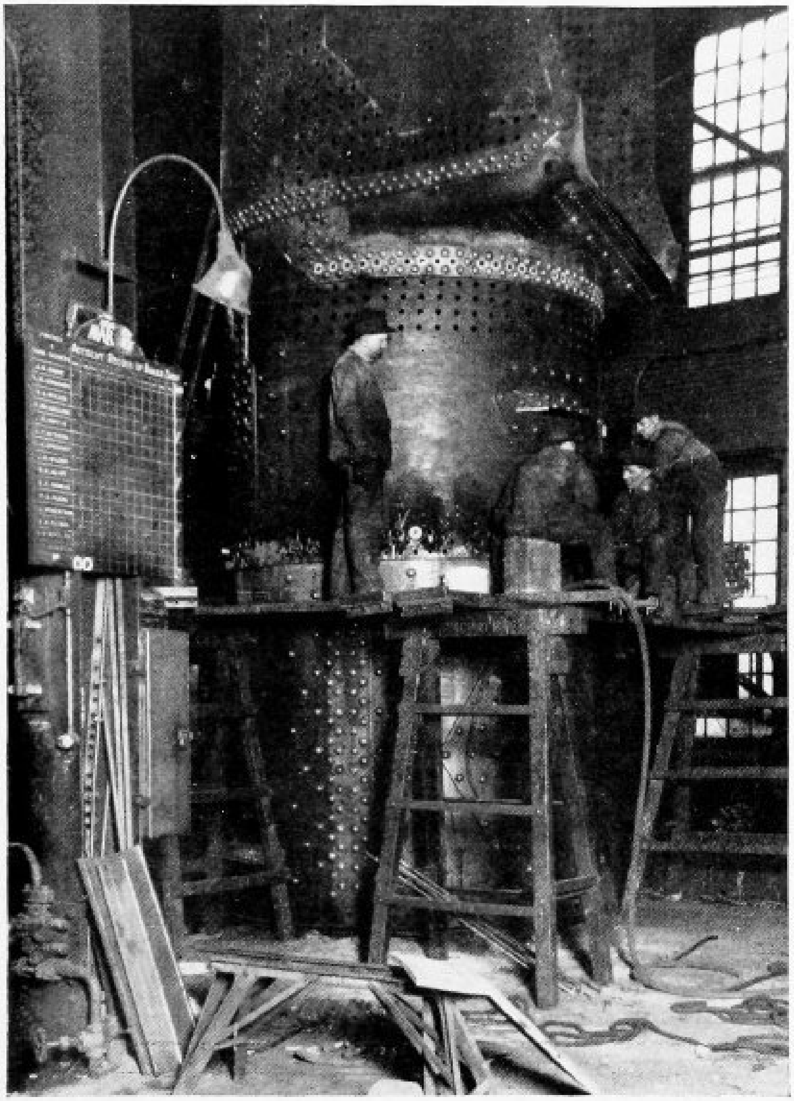
Oxweld Acetylene Company, New York, N. Y. has placed on the market a welding rod for making extremely strong welds in steel, designated Oxweld No. 22 S. D. (strength and ductility) steel welding rod. This rod is self-fluxing and deoxidizing, and sparks very little. It forms a fusible slag that rises to the surface where it serves as a protective coating which, although extremely thin, protects the surface of the molten bath from the oxygen of the air and thus prevents oxidation. The composition of this rod also prevents the strengthening element, carbon, from burning out during the welding operation. It has the ability to fuse easily into the base metal at both the sides and the bottom of the vee, which is another reason for the great strength of the weld produced. This rod is available in 3/16-inch and 1/4-inch diameters in 36-inch lengths.

Charles R. Turn, treasurer and general manager of the International Boiler Works Company, East Stroudsburg, Pa., died on Thursday, April 10.

Frederick Alan Schaff has been elected president of The Superheater Company, 17 East 42nd street, New York, George L. Bourne, retiring president, having been elected chairman of the board of directors. Mr. Schaff was born at Nelsonville, O., and he spent several years in the mechanical department of the Boston & Albany Railroad and New York Central Lines.

George H. Clymer, has been appointed district sales manager, at 732 Commercial Trust Building, Philadelphia, Pa., for the Wrought Iron Company of America, Lebanon, Pa. He succeeds the late Albert P. Loesch, and for the past two years has been covering eastern Pennsylvania outside of Philadelphia, the upper part of New Jersey and the State of Maryland.

Norfolk & Western Build

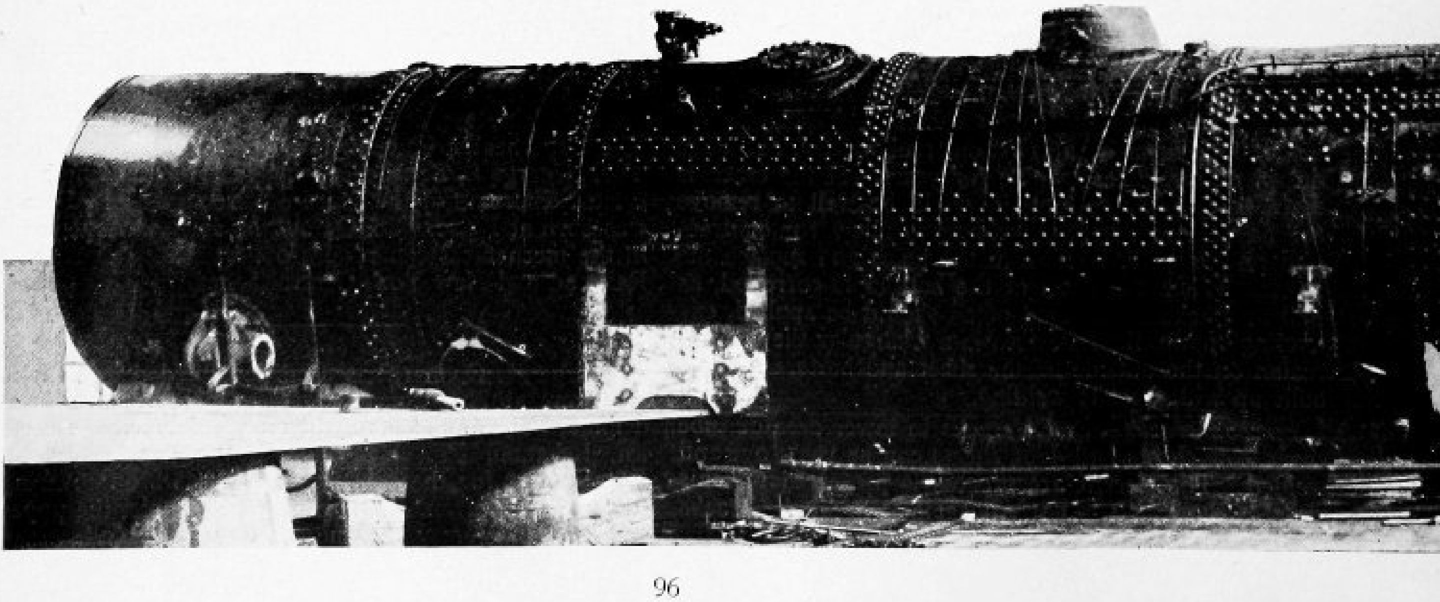


Riveting a circumferential seam

Railroad shop - built locomotives feature welding methods and reduction of flanging

What may be safely considered as the largest locomotive boilers ever constructed in a railroad shop are now being built at the Roanoke, Va., shops of the Norfolk & Western Railroad. These locomotives, ten in number, known as the Y-4-A type, are to be designated, when completed as Nos. 2090 to 2099, inclusive. They are of the compound Mallet 2-8-8-2 type and are built for a working pressure of 280 pounds per square inch. The boilers of these locomotives are remarkable for two reasons; first, for the large amount of welding employed in their construction, and second, for the methods of reducing the number of flanged surfaces.

These boilers, built under the direct supervision of R. G. Henley, superintendent of motive power of the Norfolk & Western shops, and J. A. Doarnberger, master boiler maker, present many interesting problems. The grate area is 106.3 square feet. The total heating surface is 5997 square feet, and the total superheating surface is 1582 square feet. The heating surface is divided as follows: The firebox has a heating surface of 392 square feet. The flues comprise 5540



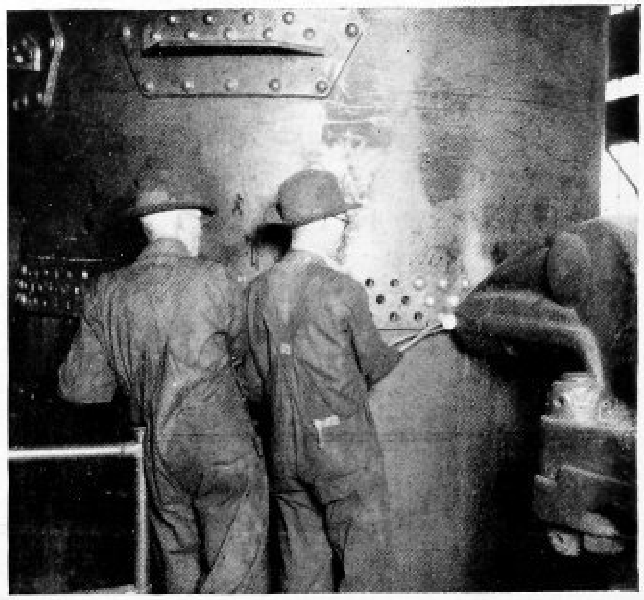
Ten Mallets

square feet of the heating surface, while the five 3½-inch arch tubes, located in the firebox contribute 65 square feet to the total heating surface.

The total length of the boiler is 50 feet ¼ inch, while the firebox and combustion chamber combined are 17 feet 7⅞ inches long. At the front end, the boiler has an inside diameter of 95 9/16 inches, while at the throat connection the outside diameter is 104¼ inches. The firebox has a length between sheets of 170⅛ inches and a width of 106¼ inches, with a water space on all sides of 7 inches. The combustion chamber has a depth of 36 inches, while the water space under the combustion chamber is 6 inches.

The firebox construction is entirely welded, with the exception of the attachment of the firebox to the mud-ring. The crown, sides and combustion chamber sheet is of ⅜-inch carbon steel and is the largest width of plate, which can be produced by the Lukens Steel Company. The firebox was originally designed as a four-piece firebox, one piece comprising the crown sheet, two pieces comprising the side sheets and the fourth piece being the lower sheet of the combustion chamber. As the design of the boiler neared completion, however, it was decided to manufacture the firebox in one piece, employing the largest sheet available.

The size of plate required to roll the crown, sides and combustion chamber sheet in one piece would have a length of 262 inches, a width of 214 inches, and a thickness of ⅜ inch, but due to the limitations of rolling mill facilities, such a plate was not available. It was then decided to order a plate having the largest width which could be produced, and to weld triangular pieces at the rear corners of the sheet in order to obtain the necessary shape for rolling the sheet in one operation. The plate as ordered from the steel mill had a length of 262 inches, a width of 196 inches, and a thickness of ⅜ inch. Triangular pieces, cut from the original plate, were welded to the rear end of the firebox by means of what is termed a scalloped weld. This weld is clearly indicated in illustrations of the firebox sheet, and the development of the firebox that is also included.



Bull riveting

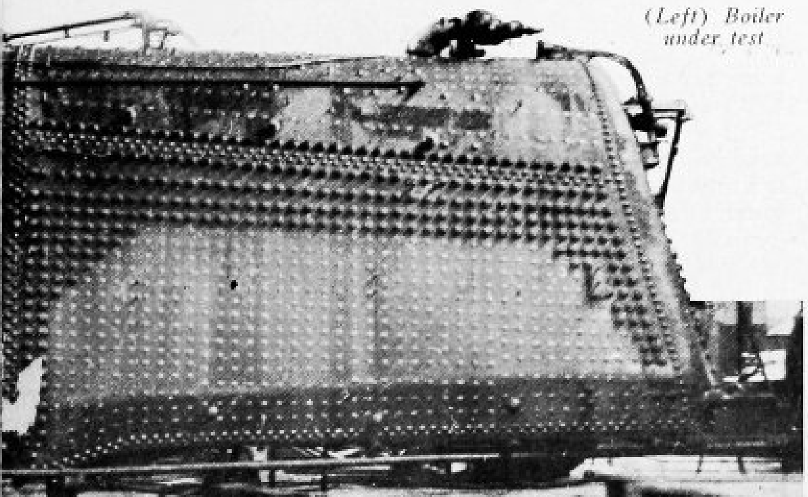
The inside throat sheet is electrically welded with a V weld to the firebox and combustion chamber sheets. Reinforcements in the welded joints between the inside throat sheet and the combustion chamber sheet consist of ½-inch rounds welded across the joint. This feature also is shown in the illustrations.

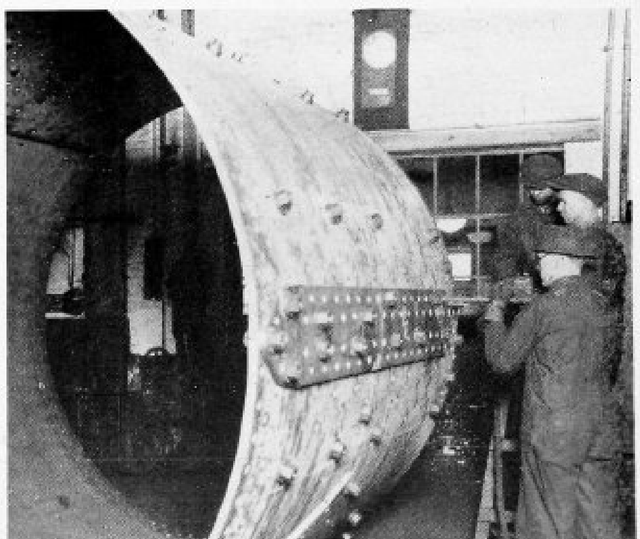
The firebox door sheet also is welded to the crown and side sheets by a V weld, the V being located on the fire side of the sheet. The back tube sheet, however, is of novel construction.

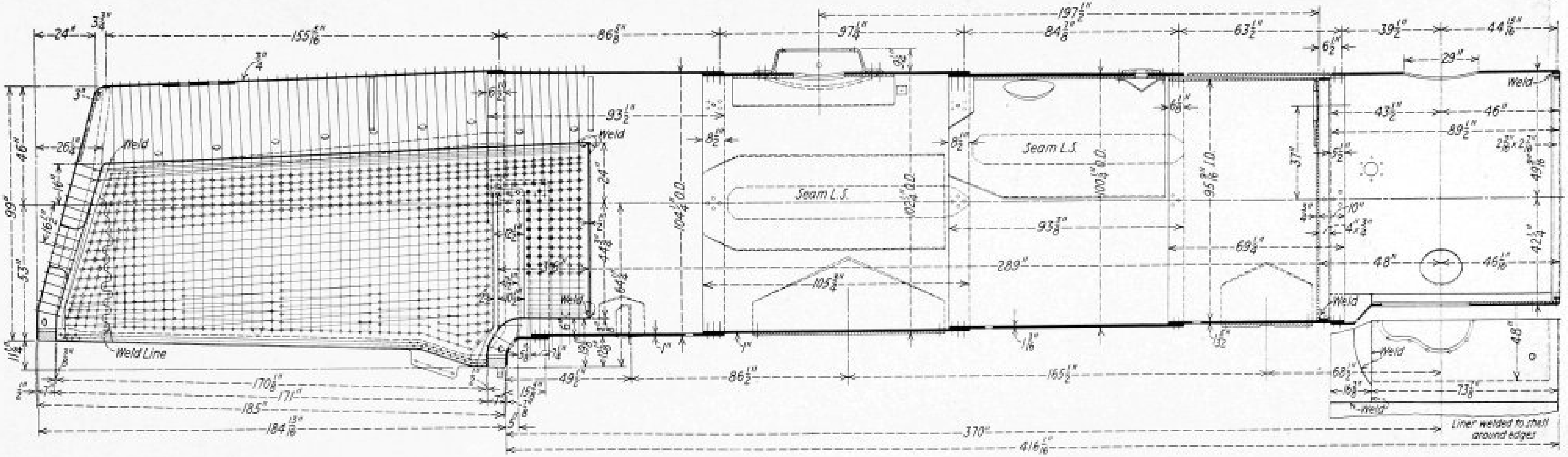
This company has eliminated all flanging in the back tube sheet construction, the sheet being fabricated in the flat condition and trimmed to exact size. This sheet is then held in place in the combustion chamber sheet by clamps and welded with a continuous fillet weld on each side of the back tube sheet. This is further reinforced by a number of ½-inch rounds 3 inches long, welded to the lower section of the combustion chamber adjacent to the back tube sheet. This sheet is termed a set-in, electrically welded sheet and is further reinforced by a

(Right) Reaming rivet holes

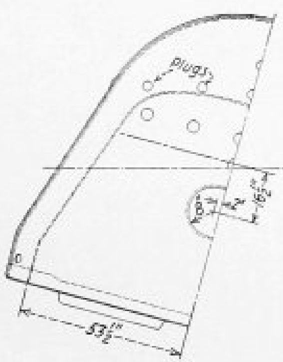
(Left) Boiler under test



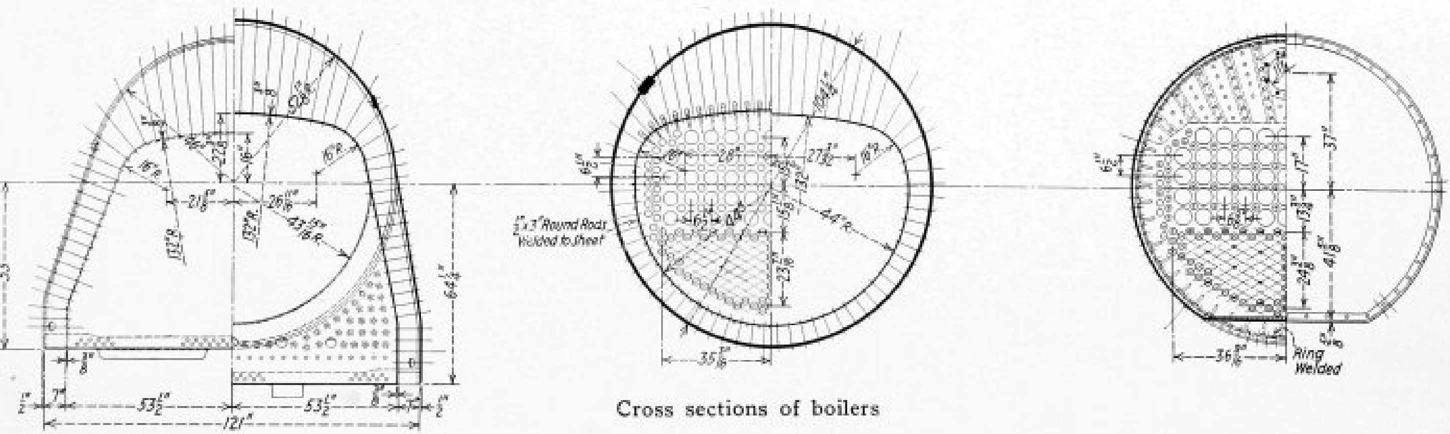




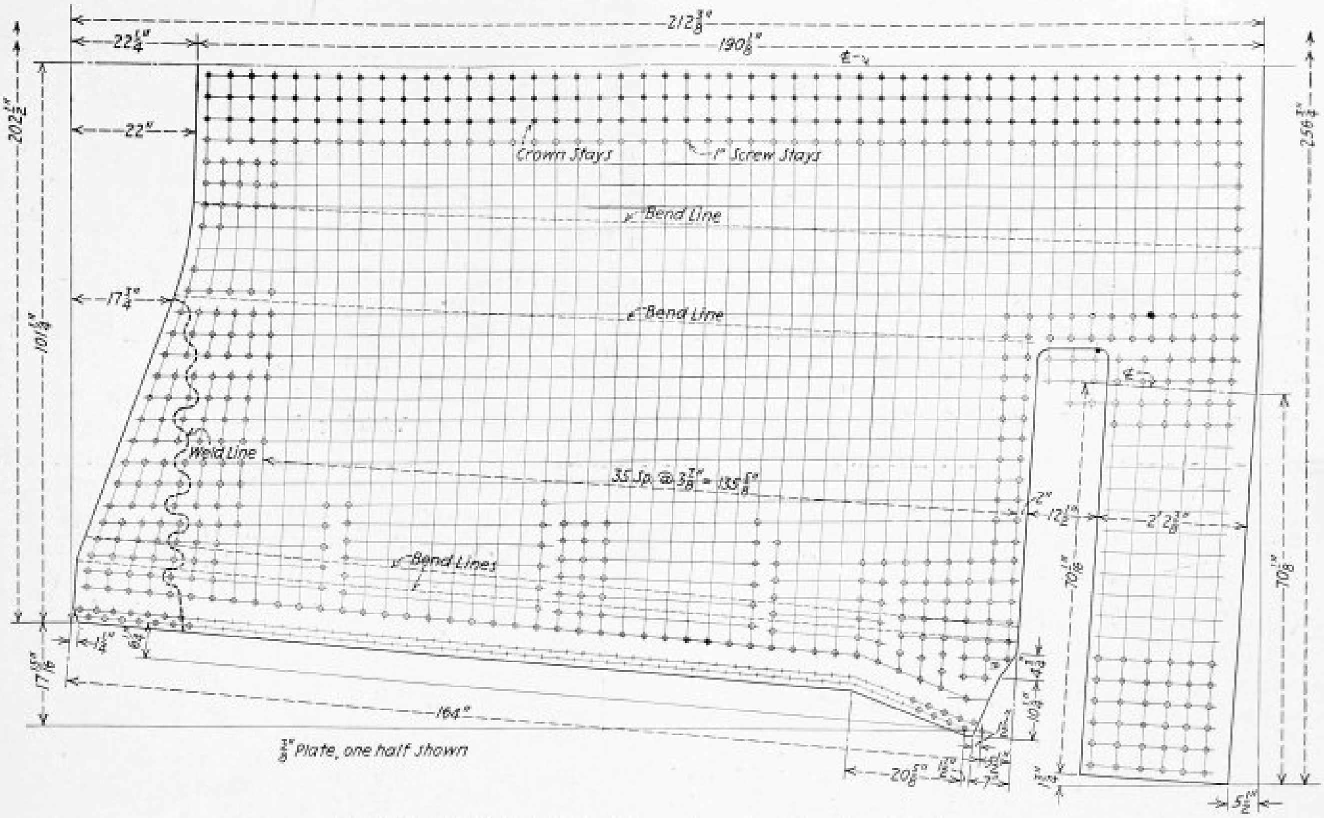
Longitudinal section of class Y-4-A boilers



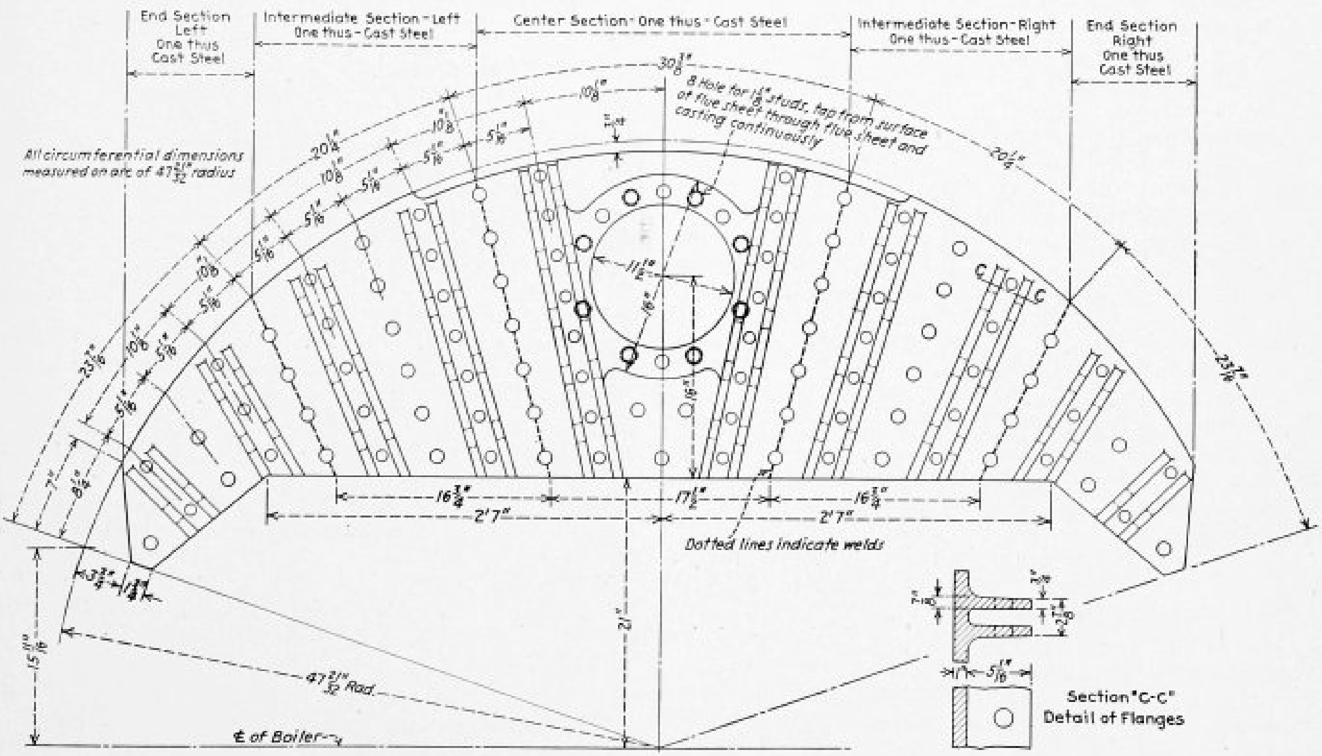
Projection of backhead



Cross sections of boilers



Development of crown, sides and combustion chamber sheet

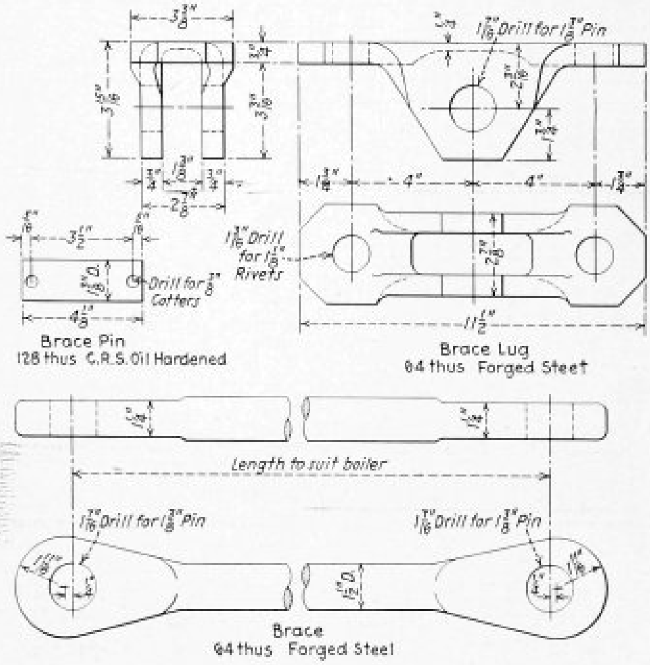


Front flue sheet attachment for boiler braces

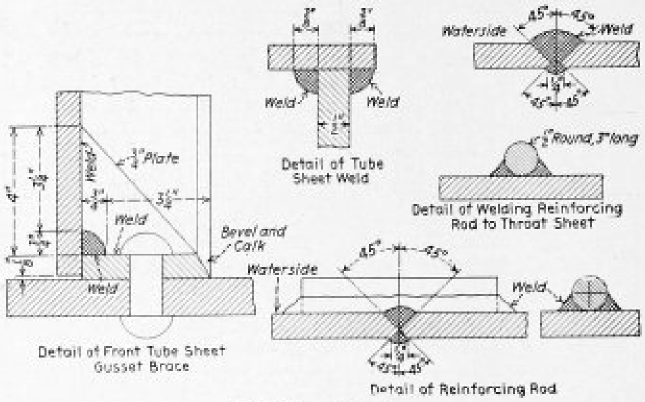
series of drop-forged ribs located at the top of the crown sheet at the back tube sheet joint.

There are 23 of these ribs employed in the construction of each boiler and these are of dropped forged construction, one leg being of a constant length, while the vertical leg varies according to the position of the lug on the tube sheet. There are 11 such braces having a vertical leg 5¾ inches long; 4 lugs with a vertical leg of 5 inches; 4 lugs having a vertical leg of 3½ inches, and 4 lugs having vertical legs of 2¾ inches.

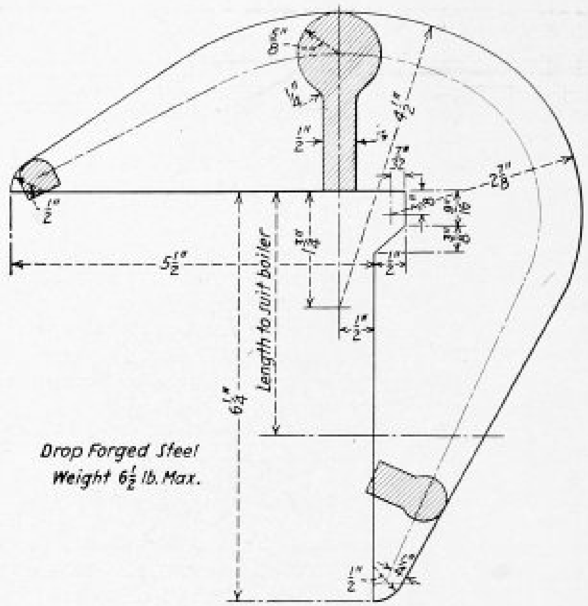
This type of reinforcing rib has been used for a number of years and was developed to remedy a great deal of cracking which occurred in the top knuckle of the back tube sheet flange. The rib was originally de-



Details of braces and brace pads



Welding details



Bracing rib for combustion chamber crown sheet and back flue sheet

signed as a repair measure and since the adoption of the lugs in January, 1927, it has been found that the trouble of cracking at the flanged joint of the flue and crown sheet has been practically eliminated.

The use of the completely electrically-welded locomotive firebox in either new boiler construction or replacement has long been a practice at the Roanoke shops of the Norfolk & Western. So far as is known, the first completely welded firebox was built at Roanoke in July, 1914, and the engine in which this firebox was applied, is yet in service. At the last inspection, it was shown that the seams in the firebox were as good as the day the engine left the shop, and it is because of the performance of this firebox that the Norfolk & Western has gradually discontinued the use of riveting and has substituted electric welding.

The fire door sheet is of carbon steel and is ordered as a rectangular sheet, having a length of 120 inches, a width of 78 inches, and a thickness of ⅜ inches. The back tube sheet is of nickel steel, ordered in rectangular form, 89 inches by 70 inches by ½ inch in thickness. The inside throat sheet is of carbon steel, ½ inch in thickness, ordered 120 inches by 88 inches in size. The outside throat sheet is of ⅞-inch carbon steel, 151 inches by 96 inches. The firebox ring has a total length of 15 feet 4 13/16 inches and a total width of 10 feet 1 inch and is of cast-steel construction.

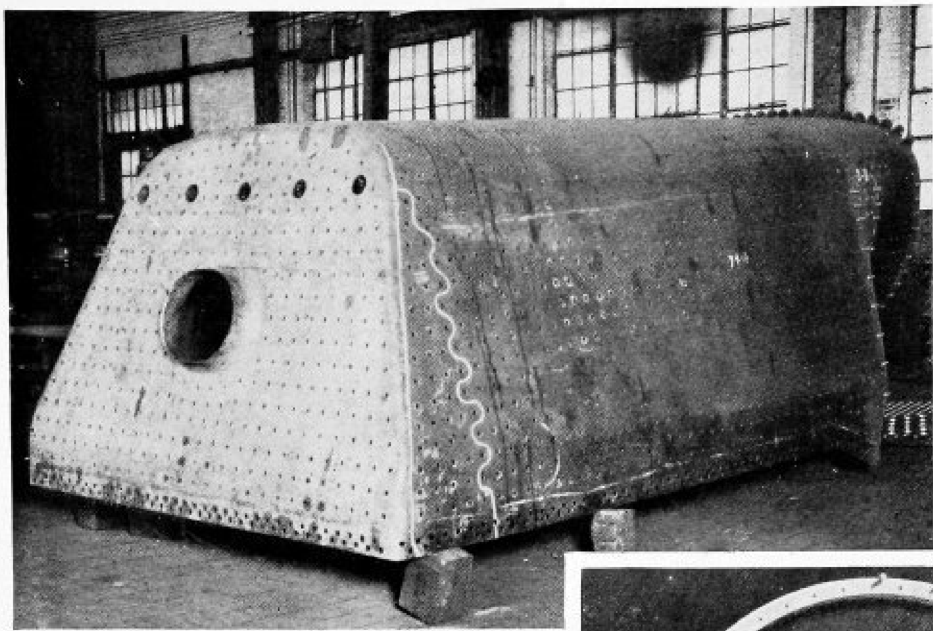
The door hole in both the firebox back sheet and the door sheet are flanged toward the water space to provide a clear opening of 16 inches in width by 20 inches in length. The back sheet and door sheet were welded together at the door hole with a continuous 45-degree V weld.

The first course of the boiler barrel is of carbon steel and has a length of 69¼ inches. It was made of plate having a length of 306 inches, a breadth of 70¾ inches, and a thickness of 1 5/32 inches. When rolled, the first course has an inside diameter of 93 3/16 inches. The second course has a finished length of 93⅜ inches and is made of carbon steel plate, having a length of 313¼ inches, a width of 95½ inches, and a thickness of 1 3/16 inches. Its outside diameter, in the finished boiler, is 100¼ inches. The third course is of nickel steel, having a length of 105¾ inches and an outside diameter of 102¼ inches. It is rolled from a rectangular plate, having a length of 320 inches, a width of 107¼ inches, and a thickness of 1 inch. The fourth course also is of nickel steel with a length of 93½ inches and an outside diameter of 104½ inches. The rectangular plate from which this sheet was cut had a length of 326½ inches, a width of 93½ inches, and a thickness of 1 inch.

The roof sheet is of nickel steel made from a plate 168 inches by 130 inches by ¾ inch, while the side sheets are of carbon steel, having a length of 180 inches by 100 inches by ½ inch.

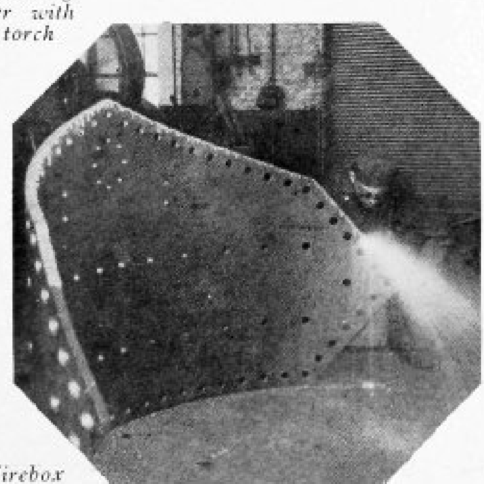
The use of nickel steel in boiler construction decreases the weight of the finished boiler. Because of its high tensile strength, the thickness of plate to withstand a given pressure can be materially reduced, thereby lowering the thickness of the boiler sheet or increasing the strength of the material for the same thickness as carbon-steel plate. The edges of all straight plates are placed, while the circumferential seams of the courses are calked inside and out. The circumferential seams between the second and third and the third and fourth barrel courses are triple riveted while the circumferential seams between the first and second barrel courses are double riveted.

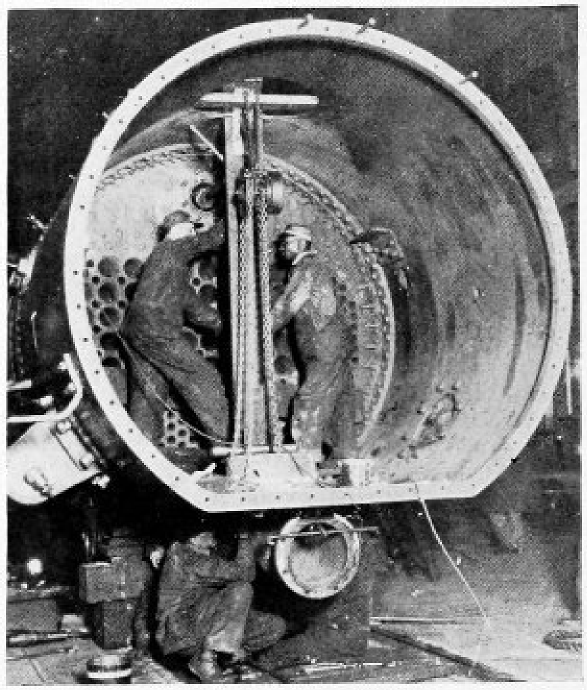
(*Left*) *Firebox showing application of scallop weld*



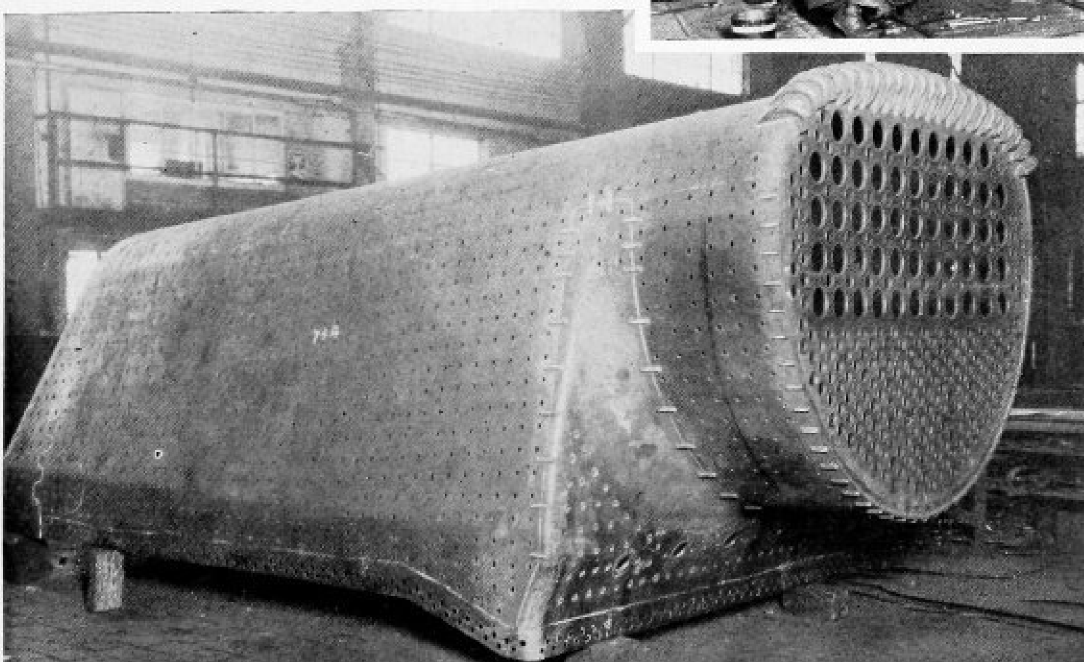
(*Below*) *Grinding dry pipe in front tube sheet*

(*Right*) *Trimming saddle liner with acetylene torch*





(*Below*) *Firebox showing tube sheet construction*



In each boiler there are 2914 rivets, of which 2749 were manufactured in the Roanoke shops. These vary in size between 7/8-inch diameter and 1 1/4-inch diameter. One hundred and sixty-five rivets of 1 5/16 inches in diameter were purchased from an outside source.

The construction of the smokebox for these boilers is unusual, the smokebox barrels being constructed in five pieces of 5/8-inch plate. The usual method of smokebox construction is to flange the plate in order to offset the lower smokebox barrel at its lower side. In the case of constructing these barrels, however, no flanging was used, the offset being formed by specially shaped plates welded together.

The smokebox has a length of 89 1/2 inches and the material for its construction, with the exception of the smokebox ring, was ordered in three pieces, the smokebox having a length of 241 inches and a width of 91 inches, and the liner having a length of 82 inches and a width of 73 inches. The throat of the smokebox was cut from plate having a length of 95 inches and a width of 74 inches.

In the construction of this smokebox, the plates were laid out complete and developed in the drafting room. The top sheet was laid out with a length of 229 7/8 inches and a width of 89 1/2 inches. The bottom plate was flat with slightly curved bends at the edges. The throat of the smokebox or transition piece was made in two pieces, the entire pieces, including the liners, being electrically welded together.

The smokebox ring was welded at the front end of the smokebox, a continuous fillet weld being employed on the inside of the smokebox at the rear side of the ring. No rivets were used, the ring being held in place by clamps. The ring, however, was manufactured with holes along the circumference to take the bolts of the smokebox door plate.

The front tube sheet also is of interesting construction, being of the unflanged welded type. This front tube sheet is fabricated in the flat and is cut to size, the layout being taken from the cross section drawing of the boiler. A ring 4 inches wide by 3/4-inch thick is riveted inside of the first course. To this is welded the front tube sheet, a continuous fillet weld being employed. The sheet, however, is reinforced at the weld with a number of gusset plates, each plate being 4 inches by 4 inches and right triangular in section of 3/4-inch plate. These gussets are located around the lower portion of the tube sheet below a brace casting and are welded on all sides to the front tube sheet and the front tube sheet ring. A 3/4-inch weld is used between the tube sheet and the tube sheet ring. This type of front tube sheet with reinforced gussets has been used by the Norfolk & Western Railroad for the past four years.

The rigid staybolts are the hollow drilled iron type and are machined at the Norfolk & Western shops. The flexible staybolts, however, are of the U-W welded sleeve type.

There are 252 open-end, hot-rolled seamless steel 2 1/4-inch outside diameter tubes, having a length of 289 inches over the tube sheets. There are 53 superheater flues, 5 1/2-inch outside diameter and 289 inches long. These flues are set with copper ferrules in the firebox end. There are five 3 1/2-inch arch tubes and six 3-inch combustion tubes running from a cast-steel support frame to the top of a Gaines arch, which is applied in the firebox.

The fire wall is 20 1/2 inches in height and 10 inches in width, running transversely the full width of the firebox.

The cast-steel auxiliary manhole was manufactured by the foundry at the Roanoke shops and the guide yoke angles are made of standard steel shapes ordered 6 inches by 6 inches by 3/4 inch.

Attached to the front tube sheet and the back head are brace pad castings, for the attachment of the boiler braces. These castings are made in five pieces and welded together to form one-piece castings covering the upper sections of both the front tube sheet and back head. These castings when constructed are first laid on a jig which has been developed from the back head or front tube sheet and with the castings on the jig, the holes in the castings are scribed, with the exception of those falling on the weld seams. The holes thus laid out are centered and another jig is employed for laying out the pad-bolt hole locations. All these holes are drilled as well as a lead hole for the mud plug holes. Then the castings are bolted to the jig and the seams welded. Following this, the castings are bolted to the back head or front tube sheet and rivet holes reamed. The rivet holes falling on the welded seam are drilled full size and the casting is riveted to the back head or the front tube sheet, whichever the case may be, and the mud plug holes are drilled full size. This type of brace pad acts also as a reinforcing plate and adds to the strength of the tube sheet and door sheet. With this casting, unequal stresses on the tube sheet and back sheet are reduced and are taken up in the large casting.

The braces are of the single-jawed type, made possible by the cast-steel rib in the brace castings. The pins connecting the braces with the castings are of oil-hardened steel and are retained in position by the use of 1/4-inch cotter pins of cold-rolled steel.

Lugs in the roof sheet and in the boiler courses are of the solid forged type made of 3/4-inch boiler plate. The length of all braces are taken after the front flue sheet and back head are bolted in place. These lengths are measured and a table is made, the braces being ordered accordingly for all locomotives. A sketch of the brace design is included in the details of the boiler as shown.

In addition to the large amount of welding and small amount of flanging used on these boilers, it is interesting to follow the methods employed in the shops. In the design of these boilers, the drafting room not only draws the usual boiler plans but also produces a detailed layout of each sheet, including welt strips and liners in the boiler. One exception to this, however, is the front and back tube sheets previously mentioned, which are laid out from the cross sections of the boiler.

The first boiler is used as a template for all of the boilers and while the first sheet is laid out from the development plan and used as the template, it is actually the last plate to be installed, inasmuch as it is used as the template for all boilers of that class. The final boiler of that class is made up of the first plates to be laid out. Each boiler is an exact duplicate, all holes and plate dimensions being exactly specified on the layout plans. This practice aids the railroad in producing duplicate boilers and also in replacing parts which become worn in service. For instance, if at any time in the future it is necessary to supply a firebox of the Y-4-A type, it will not be necessary to take dimensions from the boiler in which the firebox is to be installed. The plans, as prepared by the designing department are complete in every detail and the duplicate part is known to fit exactly.

The experience of the Norfolk & Western Railroad indicates the advantage of interchangeability in boiler construction. Years after the boiler is built, the savings in time and repairs are in evidence.

Some pointers to follow in

Bending Boiler Sheets

By Phil Nesser

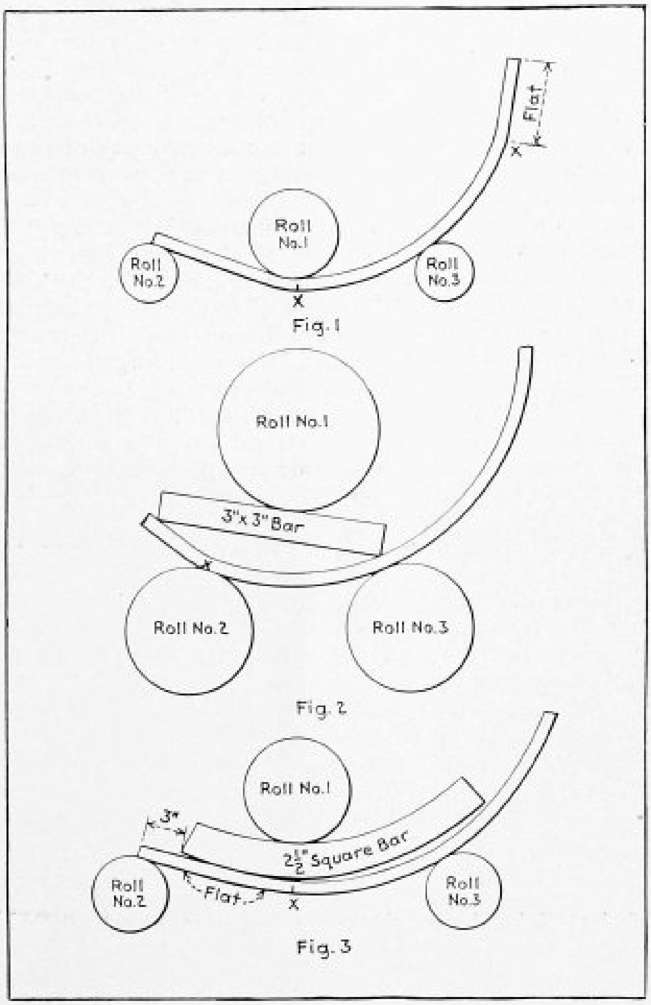
A bending roll for heavy plate is usually of the type shown in illustrations below; that is, two rolls at the bottom, and one slightly larger and central above. When bending sheets with this type of roll, we find that it bends up to a certain distance from the end of the sheet, or the point *x*, in Fig. 1, then leaves a flat surface from this point out of the edge of the sheet at both ends.

The object of this lesson is to endeavor to explain why the flat end always remains, and why it bends too sharply at the point *x*; then to give a remedy or a method of overcoming the difficulty by straightening out the place where it bends too sharply, and by bending the flat out to the very edge.

When the flat sheet is put through the rolls, the pressure of the top roll bends only the point at the bottom center, as *x*, in Fig. 1. Now imagine the sheet passing through from left to right in Fig. 1. The rolls have been drawn small and out of proportion, so as to exaggerate what happens. The first time through, there is flat surface always following from the left, while to the right it has been bent from the bottom center of the top roll to the contact point of roll No. 3, with the exception of the flat surface that remains at the right end at starting. It will also remain at the left end, whenever the edge gets to the contact point on roll No. 2.

Now consider the next time the sheet passes through, partly bent to the left and a little more bent as it passes over the bottom center; then when it comes to either end, there is no bent part to follow and consequently the flat ends make a sharper bend at the point *x*.

The method of straightening out the sharp bend is illustrated by Fig. 2. This is drawn nearly to proportion as to size, etc., and it shows the point *x*, or the sharp bent place. Then on the contact point of roll No. 2 place a bar of iron about 3 inches square (a railroad iron or larger bar will be O.K.). You must be sure however that the roll feed screws will permit raising the roll this high, for you will ruin the roll, if the feed screws come nearly out and strip the threads.



Schematic diagrams showing what happens in rolling sheets

The bar of iron is placed as shown in Fig. 2. The right end must be over the contact point of roll No. 3 and the left end about 1 inch or so from the edge of the sheet. Now, when the top roll is brought down upon this square bar, it will straighten out the sharp bend at *x*. We usually make 3 bars and place them about 8 inches apart along the edge, then raise and lower the rolls and move them along until the whole edge has been formed to the proper curvature at the point *x*. This must be done at each end.

We are now ready to start bending the end. Fig. 3 shows a bent bar placed on the top of the bent sheet. The end of the bar, where the flat is to be bent, is held about 3 inches from the end as shown. In our shop we keep 3 bars of 2½-inch square bar iron, about 24 inches long and bent to a radius of about 36 inches; that is, they just fit into a 72-inch shell sheet. We use these when working on larger diameters and get very good results. For a narrow patch, that is about 24 inches wide, we place the three bars side by side, doing it all in one operation, and for anything longer, as a whole barrel sheet, we take a little at a time, raising and lowering the roll each time. When rolling a barrel sheet for a boiler, we roll the full circle and work out the two ends afterwards, by the method given in this lesson.

For regular sizes we have templates cut to the curvature of the sheet. However, it is best to bend a piece of bar iron to this curvature, as we can try the bar iron along the edge, where the flat template would not go in.

A good plan is to draw an arc on a flat sheet or face plate and bend a piece of bar iron to conform to this arc, then try this against the edge of the bent sheet.

In these sketches we have shown only a sectional view of the bending rolls; the housings and machinery have been left off.

German Station Has Boiler Designed for 1500 Pounds

By G. P. Blackall

At the power station Mannheim, Germany, a boiler has been installed which works at 1500 pounds per square inch pressure, the theory being by increasing the boiler pressure so much above the normal, and also raising the superheat it is possible to gain considerably in efficiency. The question of high first cost has been raised and also the technical difficulties which may be encountered. Certainly the cost rises considerably with the pressure, but, on the other hand, the firing arrangements and boiler equipment, excluding the superheaters and economizers, remain the same. The boiler-feed system is also more costly at the higher pressures, but this does not apply to the steam pipes.

High-pressure generators possess a very small water content, and for this reason the question of the method of firing required extremely careful consideration. It is essential that if the feed system fails, overheating must be prevented, and, therefore, should the feed fail it must be arranged so that the fuel can be cut off immediately. Consequently pulverized fuel was decided upon, as the supply can be cut off by pressing a button and the only damage likely to occur in the case of feed failure is from the radiant heat of the brickwork.

Special consideration was also given to the selection of the type of boiler. Finally, two Stirling-type boilers were chosen in preference to the sectional type of boiler, as more suitable both technically and economically. Reliable water circulation was essential, and in the double-drum type of generator the conditions are superior to those of the multi-drum design. Moreover, the cost is lower, as the boiler proper and the drums are kept as small as possible. The drums are 1½ percent nickel steel, which metal allows of a saving of weight at high temperatures, while its hardness insures a reduction in deformation due to tube expansion.

Ordinary carbon steel tubes are used. The superheater is in two sections, nickel steel headers and ordinary steel tubes being used in the section exposed to the lower temperature and nickel-steel tubes and chrome-nickel steel headers being used in the hotter part. A de-superheating jet with automatic temperature regulation is introduced between the two sections, in order to protect as much as possible the superheater from temperature variations. Two boilers are installed, and in each case the upper drum is suspended from the framework and the boiler as a whole is suspended from the tubes.

The various parts of the boiler are so supported that any expansion resulting from heat is taken up by the curved tubes. The superheater, partially exposed to radiation, is suspended between the tubes. The airheater is of the usual plate-type pattern. The economizer is so arranged that the water is always ascending, and therefore no steam pockets can be formed. It consists of cast iron tubes expanded into headers, the feed regulating valves being fitted at the economizer outlet. Ash and slag are removed hydraulically, and cyclone separators trap the grit in the flue gas.

Owing to the low visibility of the water illuminated gage glasses are fitted, with the usual ball device for isolating the boiler should a glass break. Gravity gages are also fitted, these containing no glass. The joints of the economizer tubes are packed with metallic packing in place of copper packing, the latter having caused trouble through electrolytic action. The main high-pressure steam pipes are solid drawn tubes of Siemens-Martin steel, the expansion bends being of chrome-nickel steel.

The pipes have flange connections, the flanges being provided with gas threads and welded on to pipes in order to prevent the flanges turning while usual stresses are taken up by the thread. The flanges are of Siemens-Martin and the flange bolts of chrome-nickel steel. The packing between the pipe ends is so arranged in the flange that it is impossible for it to blow out. The stop valves, of cast molybdenum steel, are of the quick-acting type, the greater part of the opening being closed after a few turns of the wheel have been given. The steam traps are controlled by slide valves. Reducing valves are of electrically produced steel, the seatings and branchings being of Krupp steel.

Feed water is first raised to a pressure of 300 pounds per square inch, passed through a feed heater, and reaches the main feed pumps at a temperature of approximately 390 degrees F. The pumps are connected to duplicate forged-steel distributors, the pipes in duplicate running direct to the boilers. It is intended at a later date to install pumps with double the present output and a working efficiency of 66 percent in place of the present 55 percent.

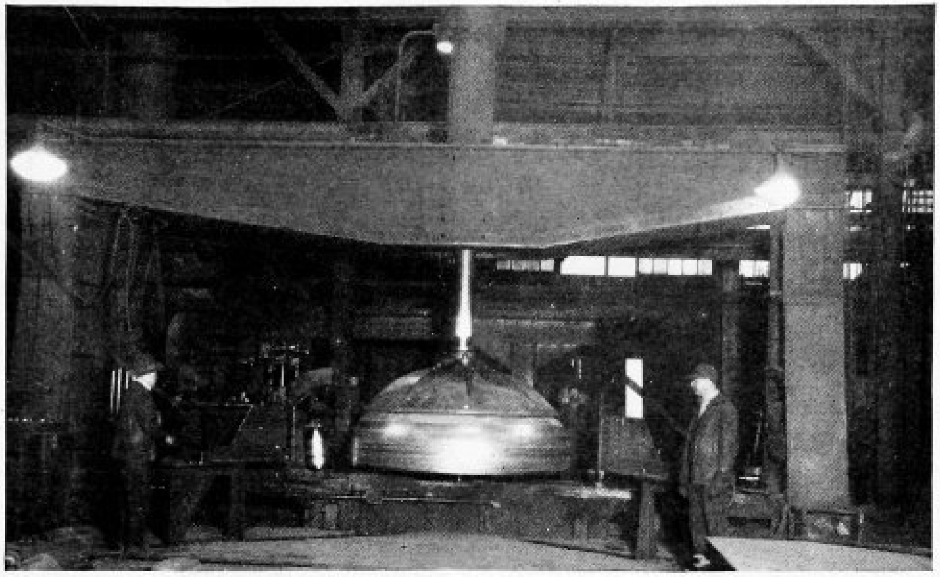
Fusion Welding Rod

Weldite C-No. 6 Fluxed, a new rod designed for carbon-arc welding is announced by the Fusion Welding Corporation, this rod is particularly adaptable for the welding of mild steel plates and castings. Welding speed, it is claimed, has been substantially increased and the deposits made with the usual filler rod used with the carbon-arc process.

The ease of manipulating the arc, due to the influence of the flux coating which causes the arc to pull from the hottest part of the weld puddle rather than jumping to the colder edges as is usually the case with the carbon arc process, has enabled operators to attain welding speeds considerably higher than is possible with the usual bare filler rod. Heavy section welding of mild steel furnishes a very favorable application for this rod as the weld deposits are sound and strong.

Samples and prices of this rod may be had by addressing the Fusion Welding Corporation, 103rd street and Torrence Avenue, Chicago, Ill.

PLATE SHEARS.—Catalogue No. 3, describing type SN plate slitting, trimming and beveling shears has been issued by the United Machine Tool Corporation, 75 West street, New York. These machines cut plates with a rotary upper knife against stationary lower blades, while the material lies flat and is held fast in the machine. This machine is manufactured in three models available in 15 sizes to shear, trim and bevel plates up to 1 3/16 inches in thickness.

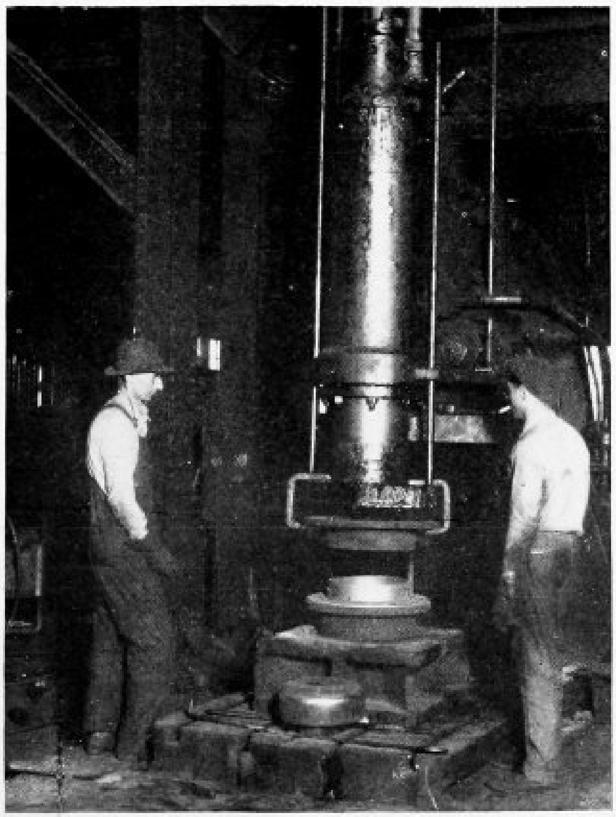


Elliptical head in large spinning machine

Flanging

In the construction of boilers and pressure vessels, the use of cylindrical surfaces as far as possible is known to increase the resistance of the material employed to the pressure set up in the vessel. Cylindrical courses are stronger than shapes having straight sides and so it follows that in the case of a tank, the ends of that vessel are its weakest element due to the tendency of the object to take a spherical form because of the pressure exerted. For this reason it has been learned, in the construction of boilers and pressure vessels, that it is more advantageous to employ dished heads as a feature of construction. This type of head, whether hemispherical, elliptical, or with a standard dish, has found favor in tank construction and in boiler construction, particularly for the use of headers in watertube boilers.

Difficult as they may seem, the methods of dishing heads and flanging steel plates are indeed simple, provided that the proper machinery and proper conditions of working are employed. It is interesting, in this respect, to review the methods employed at the Lukens Steel Company, Coatesville, Pa., where, in addition to the manufacture of boiler plates and various alloy steel plates, this company is able to perform a genuine service to the industry at large in the manufacture of flanged shapes for various applications. Many of the products manufactured by this company assist the boiler maker in the ultimate fabrication of boilers; this is particularly true in the case of the dishing of heads by either the spinning, pressing or special flanging process. This company has been in the business of flanging boiler heads and drawing flue holes since 1885.



Sectional flanging machine

While the equipment employed by this company for die flanging, sectional flanging, and hand flanging is not out of the ordinary, the spinning machines of the type employed by the Lukens Company are rarely seen in the boiler shops of this country. These machines have certain advantages over the usual flanging machines in that the resulting heads have smooth, round flanges. The corner radius, which is drawn out in the case of hydraulic flanging, is generally the weakest point in a flanged plate, but in the case of heads flanged by the spinning process, the material at the corner radius is not materially reduced.

The radius of flange formed on these machines is not limited by dies and may be varied to suit the work for which the head is intended. Unlike the flanging process generally in vogue, it is unnecessary in the case of spinning to punch a hole in the center of the plate to be flanged. The spinning machine employs a hydraulic plunger or clamp which holds the plate rigidly in place on the machine, thus eliminating the necessity of a hole in the plate as an aid in centering. The spinning machines will flange or flange and dish heads from 12 to 192 inches. The finished diameter of a flanged or dished head that can be made is limited by the size blank which can be rolled on their 206-inch mill which is the world's largest plate mill. These heads can be furnished with practically any size flue hole required.

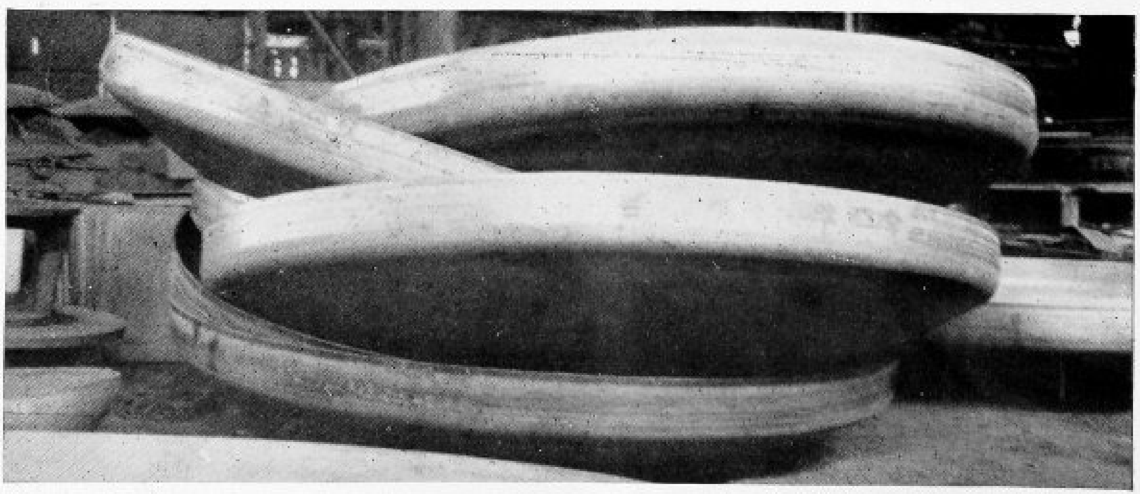
Largest one-piece flanged and dished head ever made

In the March issue of THE BOILER MAKER, we followed the order for flanged material through various departments in the plant, reviewing the making of steel in the open hearth, rolling the plate and its inspection and trimming to size. Thus, the plate to be flanged having passed through the various departments of the mill, now is sent to the flanging bay where the finishing processes are performed. The flanging department is housed in a building, approximately 430 feet in length and 250 feet in width. This building is divided by a line of pillars extending approximately through the center of the building, dividing the department into two bays known generally as the flanging bay and the loading bay.

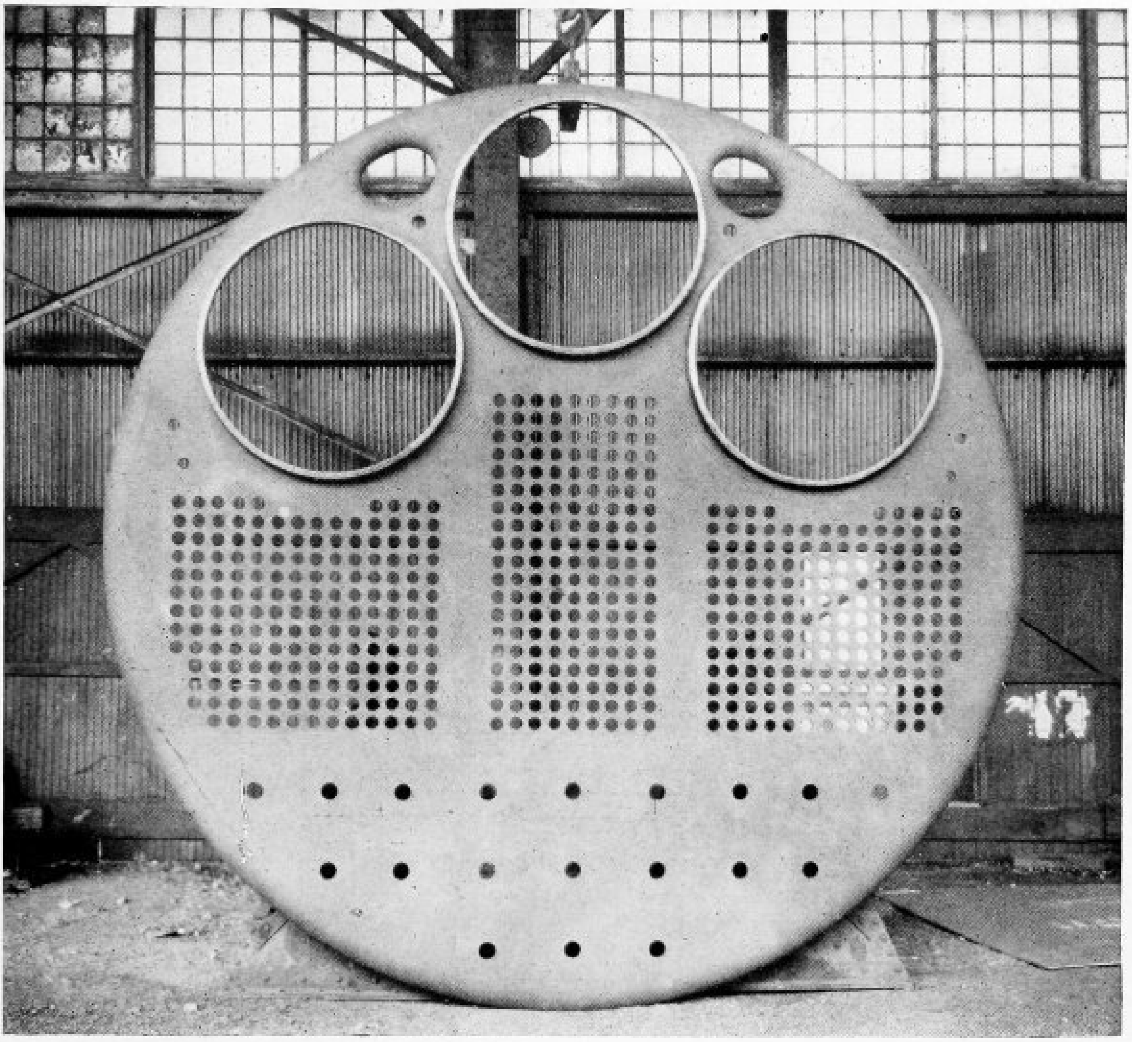
The major flanging operations are performed in the flanging bay or the north side of the shop. At the west end of the flanging bay is located a Southwark 4-post flanging press which may exert a maximum pressure of 1500 tons on the upper ram. Its framework forms a square, there being a 76½-inch clearance between the posts. The bottom ram is capable of exerting a pressure of 190 tons with a stroke of 31 inches. The top ram has a stroke of 48 inches. The distance between plattens is adjustable and has a maximum clearance of 10 feet. This press is served by an 18-foot by 18-foot oil-fired furnace.

Adjacent to the Southwark press is located a 1000-ton Morgan 4-post flanging press which has a clearance between posts of 12 feet from left to right and 7 feet 6 inches front and back. The bottom platten on this press is capable of exerting a pressure of 1000 tons. The top ram can exert a pressure of 350 tons, while the bottom ram exerts 190 tons pressure. The plattens, as in the case of the Southwark press, are adjustable in regard to clearance, having a maximum clearance of 11 feet. An 18-foot by 18-foot oil-fired furnace serves this press.

These flanging presses are operated under hydraulic pressure from the shop-line pressure system. A Dean hydraulic pump supplies pressure for the presses. This pump is electrically driven and is capable of exerting a pressure of 1500 pounds per square inch. Two hydraulic accumulators, each having a 15-inch bore by a 16-foot stroke, stabilize the pressure in the hydraulic system throughout the entire department.



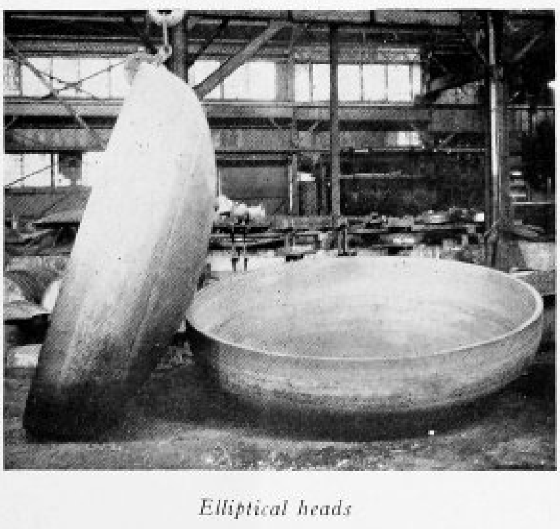
Flanged and dished heads having 162-inch outside diameter



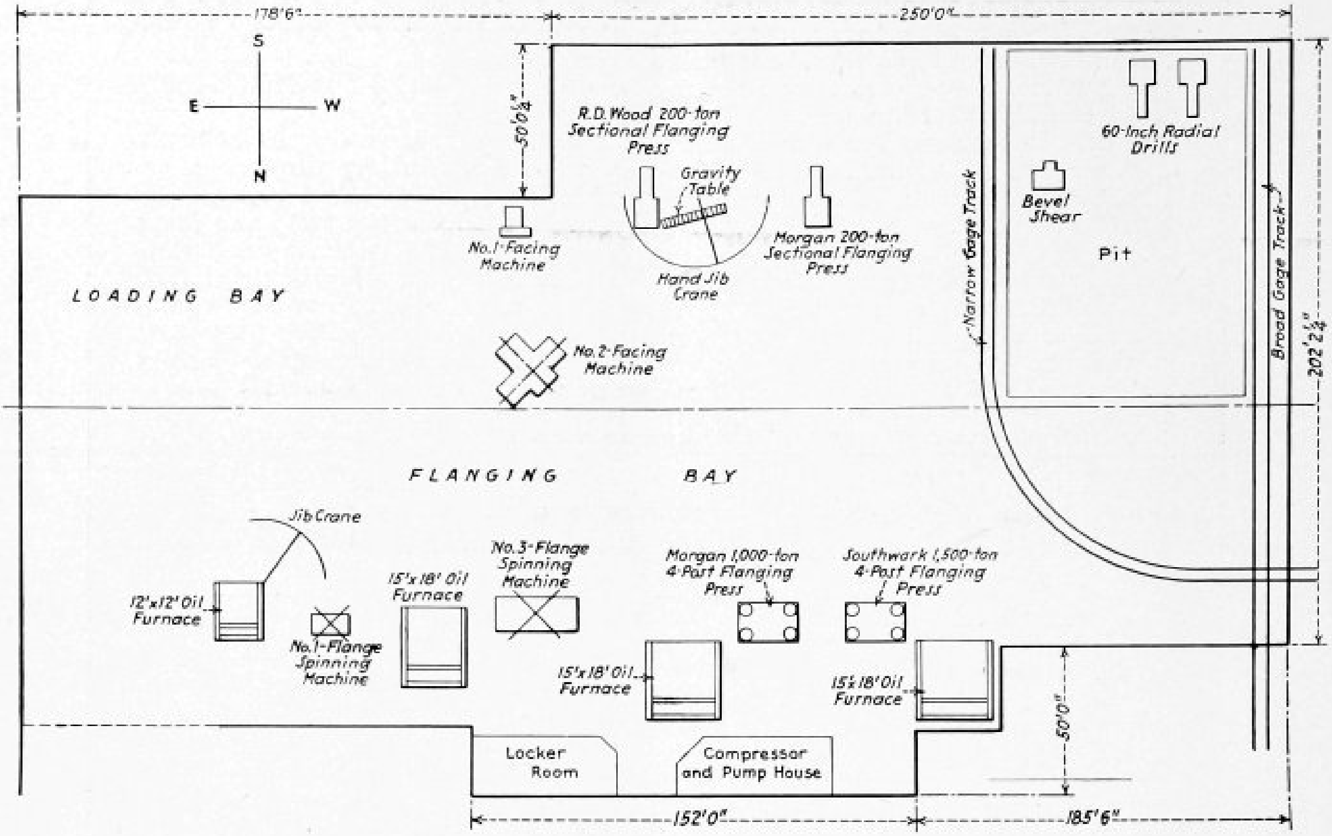
One-piece flanged head for Scotch marine boiler

Adjacent to the Morgan 1000-ton 4-post flanging press are two flange-spinning machines designed by the Lukens Steel Company. The larger of these, known as No. 3, is designed to take a 201½-inch plate, the limit of the plate mill. The spinning machine is electrically operated and consists mainly of a machine table of approximately 20 feet in length. At each end of this table is a steel column supporting a plate girder at a height of about 12 feet above the table. In the center of this girder is located an hydraulic clamp which, with a driven spindle on the lower table, is able to hold the plate in position during the process of spinning. The upper clamp is free to turn on its axis while the lower spindle is machine-driven and rotates at sufficient speed to enable the satisfactory completion of the flanging process.

A movable machine head is located at the left center of the turntable. This is operated from electric controllers and may move toward and away from the center along the machine table. This machine head includes a flanging roller which may be tilted to any desirable angle with the work. Centering on the machine is accomplished by four radial guides each running in a track. The guides operate together, moving in and out along the track so that at any time the faces of the guides are equidistant from the center of the spindle. A forming saddle roller, which is located between the spindle and movable head, is shaped to the desired curvature of the knuckle radius. It is over this roller that the plate is formed, being shaped by the passage of the tilting roller in the machine head. At the right of the machine is a conical roller. Its use is to lift the edge of the plate after it has been rolled by the tilting roller and thereby prevent any tendency toward buckling. The upper ram and lower spindle may be fitted with dies to suit the shape of the work.



Elliptical heads



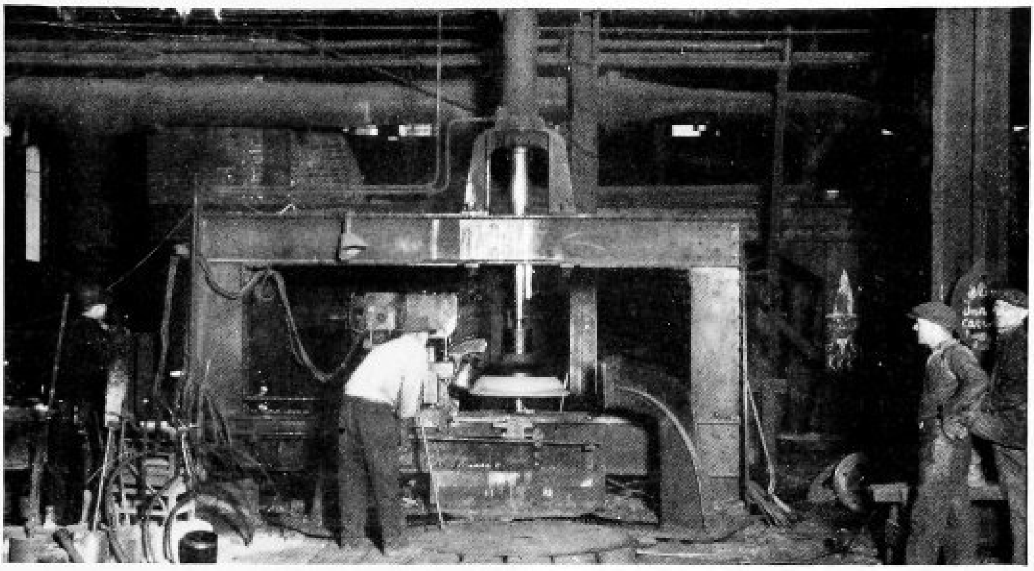
Layout of flanging department

In the case of ordinary flanged heads, these dies are flat. In the case of standard dished heads, they are spherical in shape while in the case of elliptical heads, they are formed in the shape of a true ellipse. Dishing is generally performed in two operations, first the flat plate, being heated and placed on the machine, is centered in the device by means of the four radial guides, and sufficient skirt is turned down by means of outside roller to prevent buckling in the dishing operation. Second, the head is again heated and when centered, the upper clamp is lowered in position, not only holding the plate firmly between the upper and lower dies but also dishing the plate to conform to the shape of the dies. The radius roller is located to the left and placed in such a position as to form the correct diameter of the dished head. Thus, when the plate is rolled to fit the radius roller, it is also rolled to the correct inside diameter. The machine is set in motion, the lower ram rotating, causing the plate to revolve. With the plate rotating, the tilting roller in the machine head is placed in a horizontal position and lowered on to the plate. The tilting roller is gradually moved around the radius roller until the tilting roller has assumed a vertical position. The dished head is then removed by means of cranes and allowed to cool. Thus, flanging and dishing are performed in two operations. This machine is served by an 18-foot by 18-foot oil-fired furnace.

The smaller flange spinning machine, No. 1, is operated in a similar manner. It is, however, limited to plates of small diameter. This spinning machine is served by a 12-foot by 12-foot oil furnace which is equipped with a hand jib crane located at its corner in such a position that material can be transported from the furnace to the spinning machine without the necessity of crane service. For this service, special lifting forks are used, the prongs being placed under the material to be transported, while one man, or more than one as the load requires, balances the material to be transported by bearing his weight on the handle of the fork. This tool is supported near its center by the jib crane.

The flanging-bay is served by three Morgan traveling cranes. A 5-ton Morgan traveling crane serves the small or No. 1 spinning machine. A 10-ton Morgan crane with a 5-ton auxiliary trolley serves the No. 3 spinning machine, while a 10-ton Morgan crane with a 5-ton auxiliary hoist serves the two 4-post flanging presses. Each of these machines travels the entire length of the aisle. The material is brought into the flanging department by cars on two railroad tracks, one, a broad gage, and the other a narrow gage, located at the extreme west end of the department. Adjacent to the flanging bay and one end of the loading bay a section is set aside for the storage of dies for the final inspection and grinding, if necessary, of the heads. There is also in this section of the loading bay a bevel shear and two 60-inch radial drills for special work when required.

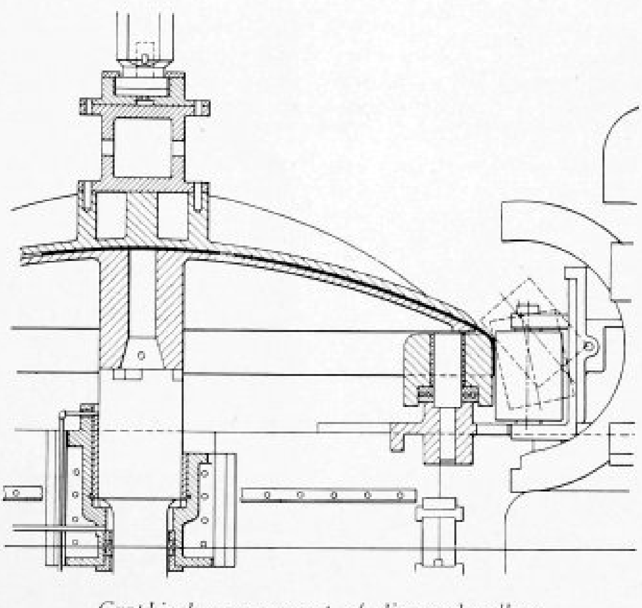
Two sectional flanges are located about midway in the length of the loading bay, one, a Morgan 200-ton sectional flanging press, has two top rams, each capable of exerting a pressure of 115 tons, with a 3-foot 6-inch stroke. The side ram exerts a pressure of 84 tons with a stroke of 2 feet 10 inches, while the bottom ram is capable of a pressure of 84 tons with a stroke of 1 foot 9 inches. This machine has a 5-foot 3½-inch clearance between table and top ram. It is employed for various types of small flanging operations such as the formation of manheads, manholes, flanged flue holes, door holes, and in many cases combustion chamber and end plates for Scotch marine boilers. Adjacent to this machine is an R. D. Wood sectional flanger, having the same ca-



Small spinning machine

pacities as the Morgan sectional flanger with the exception that the clearance is 3 feet 9 inches. This machine is served by a gravity table and a hand jib crane. Completing the equipment in this department are two facing machines for machining the edges of manholes after flanging.

The organization of the flanging department is extremely simple, a superintendent being in charge of the entire work. Under his supervision are three men—the foreman in charge of press work, the foreman in charge of the flange spinning machines and the die designer. The foreman in charge of press work is responsible for four gangs of men, two gangs of five men each being employed on the 4-post presses; and two gangs of four men each are employed on the sectional flangers. The flange spinning department is divided into two gangs—one of eight men and the other of five men. The night organization is similar in many respects to the day organization with the exception that in place of the foremen, superintendent and die designer, there is one general foreman. The gangs, however, are of the same size. In addition to this organization, there is one man employed as a chaser or material provider whose duty it is to see that all material is supplied to the various departments when needed and also to keep track of production schedules. In this department there is one inspector assigned to each of the spinning machines and to each of the various machines with the exception of the presses. Two inspectors are assigned to the flanging presses.



Graphical arrangement of dies and rollers on flange spinning machine

With the exception of the plates to be flanged by the spinning process, all others are centered by counterbore or stops.

The equipment and methods employed in the flanging department of the Lukens Steel Company are of the most modern with respect to the spinning methods. It is in this type of work that the Lukens plant excels, the general flanging methods being employed merely as a convenience to boiler shops throughout the country whose facilities are so limited that this service is of value. For many years this company has been flanging plates by the spinning process and has been dishing heads with the standard dish with considerable success. In recent years, however, this company has developed a method of dishing elliptical heads so that the resulting head will have true ellipsoidal characteristics, that is, where the major axis is twice the minor. This type of head is able to resist pressure in a greater degree than the standard type of head.

This company has in its stock a complete set of dies for flanging throat sheets, back heads, tube sheets, manholes and domes. Each special order requires the manufacture of dies which are kept in store for each individual customer.

The boiler shop generally considers the steel mill as a factory for the manufacture of plates alone. From this outline, however, it may be seen that the steel mill, due to its facilities, may perform many of the functions of the boiler maker and thereby assist the small boiler shop whose limited equipment renders the service of the steel mill of great value.

Welded Water Grate Solves a Repair Problem

Heating contractors are often called upon to solve some maintenance or repair problem on a boiler installation which has served many years of usefulness. It is only natural that parts must wear and that replacement is sometimes necessary. This is especially true of parts such as water grates or water grate headers which are subject to severe corrosive action.

Recently the water-grate header of a large return tubular boiler in a factory sprang a leak due to excessive corrosion. When the question of repair came up it was found that the entire water grates would need renewing. As the company manufacturing the boiler could not promise immediate shipment of new grates and header, the suggestion was made to have a heating contractor, experienced in welding, fabricate and install an all-welded unit. This plan met with the approval of the steam boiler inspectors after they had satisfied themselves that the welder was qualified to do this type of work both by experience and equipment.

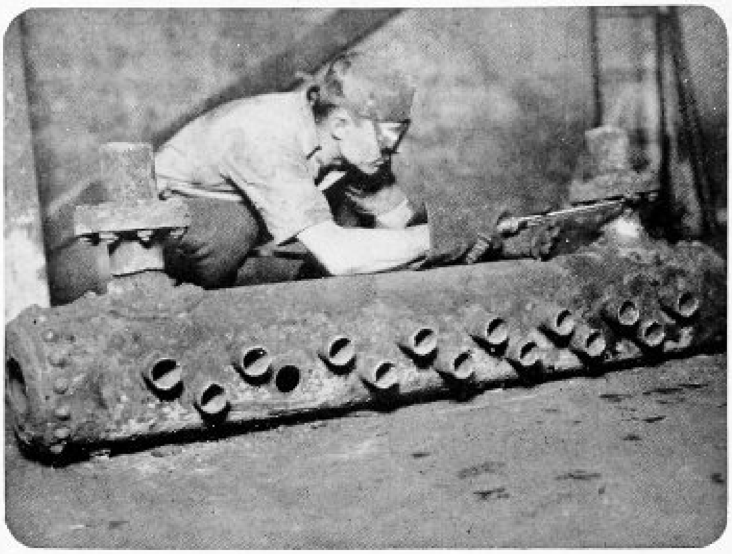


Fig. 1.—Grates and header easily removed with cutting torch

The water grates consisted of two steel headers, the front 8 inches and the rear 10 inches in diameter, connected by seamless drawn steel tubes screwed into the rear and expanded into the front header. These tubes from the upper grate surface, which is connected to the shell in such a manner as to draw a supply of cool water from the bottom of the boiler and then discharge heated water near the water line, thus promoting circulation.

The grates and header were first removed from the boiler with the aid of the cutting blowpipe, Fig. 1. It took slightly over an hour for the welder to do this. Next the header and grates were laid on the furnace room floor for accurate measurement, in order that an exact duplicate could be fabricated by welding. A header was first constructed of steel plate rolled and welded longitudinally. The ends were beveled and the end plates welded in place. At one end of the header a 4-inch by 6-inch hand hole was cut for clean-out purposes.

The upright connecting nipples were next fabricated. They were threaded at one end where connection was to be made to the fittings below the boiler shell and cut according to templates at the header end for welding to the latter unit. When the nipples were finished, the welder entered the boiler and connected them to the boiler shell. The header was then placed in position and the nipples welded to it, Fig. 2.

The holes in the header were then carefully cut according to template, beveled and the grate tubes welded in place. There were 17 of these tubes, each 54 inches long. The manner in which they were spaced and welded to the header is shown in Fig. 3.

After the welding installation had been completed, a firebrick bridge was constructed from header to boiler shell. Refractory brick construction was also replaced wherever it had been torn out originally in removing the old water grates and header to make way for the replacement parts.

This is but one example of the every-day uses to which the welding processes are being applied, to save time, labor and expense. Better technique, greater skill on the part of operators and greatly improved equipment have all had a part in bringing this advance about.—*Oxy-Acetylene Tips.*

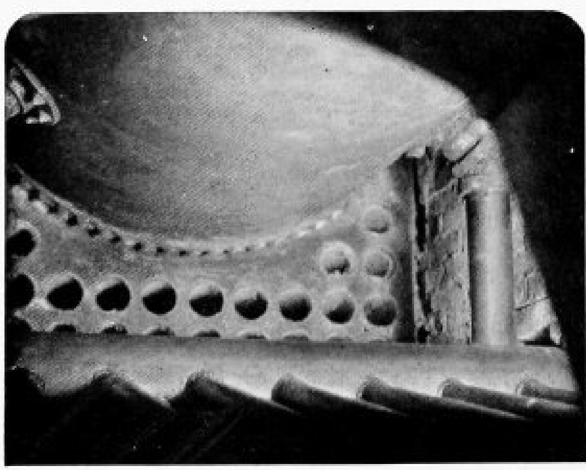


Fig. 2.—Nipples welded to header

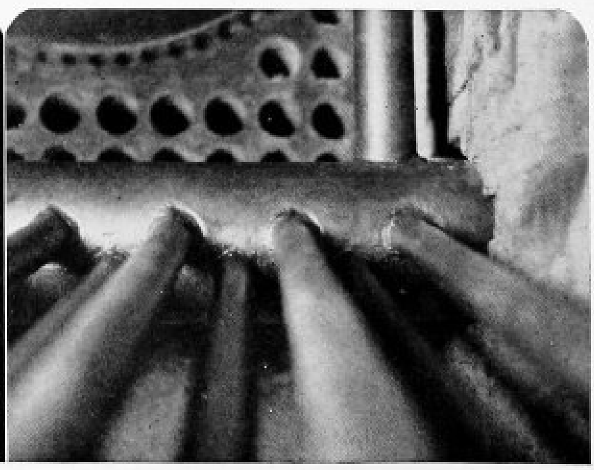
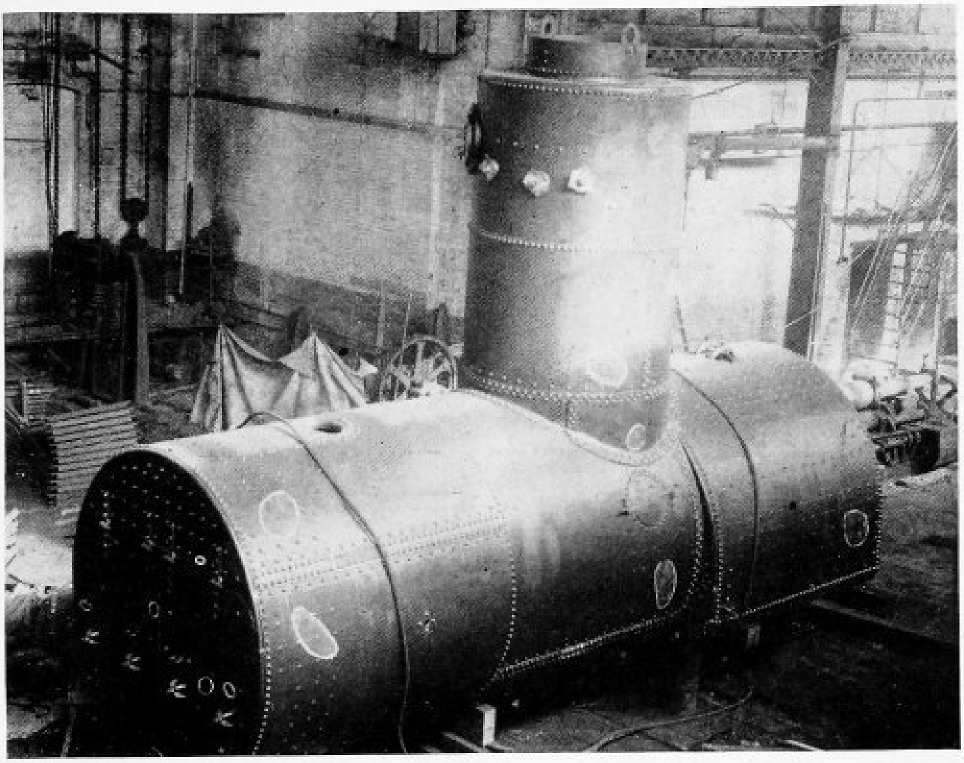


Fig. 3.—Tubes properly spaced and welded to header



Boiler for ferryboat Ashburnham, completed March 1, 1930

Shipyard Builds Lobsterback Boiler

In the boiler shop of the Atlantic Works Plant of the Bethlehem Shipbuilding Corporation, Ltd., East Boston, Mass., there is rapidly nearing completion a steam boiler of a type apparently belonging to the last century. This "lobsterback" low-pressure boiler, as it is known, is being constructed for the paddle wheel, ferryboat *Ashburnham* belonging to the Boston, Revere Beach & Lynn Railroad Company, and its service is plying between Rowes Wharf in Boston and the terminal of the Narrow Gauge Railroad at Jeffries Point, East Boston. This type which is a combination of a leg boiler, a flue boiler and a return-tube boiler has been used extensively in the past in conjunction with single-cylinder, walking-beam, low-pressure engines on paddle wheel steamers.

In comparison with the horsepower developed by these engines, the cylinder, due to the low speed of the paddle wheels, is very large and a large "gulp" of steam is drawn from the boiler at each stroke. Because of the exceptional steam space required, a large steam drum is fitted through which the hot gases from the tube section of the boiler are conducted to the stack by means of a cylindrical tube. Incidentally, this arrangement also provides a certain amount of superheat to the steam. On account of lack of height under the main deck on these shallow draft vessels no other type of boiler has been developed which can deliver the great amount of low-pressure steam required by the type of engine employed. The exceedingly complicated nature of the construction as compared with the ordinary Scotch boiler will be noted from the illustration of the assembly of the leg and flue portion of the boiler.

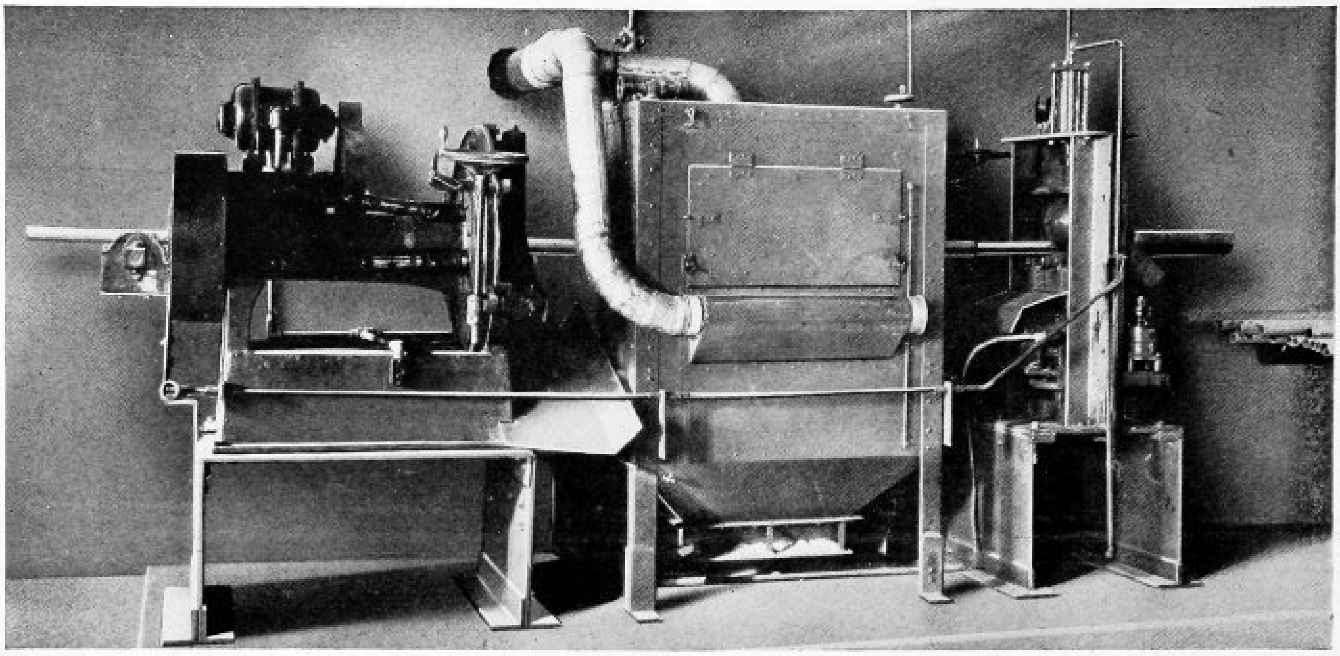
The boiler operates at a pressure of 52 pounds per square inch and is constructed of 5/16-inch plates which appears very strange to engineers familiar with the heavy construction of the modern high-pressure boilers. The many flat surfaces in this type of boiler must be supported by a complicated arrangement of braces since, due to the design, stay rods and strongbacks cannot be employed. A total of about 400 braces are used, many of which consist of three parts forged from heavy flat bars. There are also about 800 one-inch staybolts used in the boiler, the fitting of which in the 5/16-inch plates calls for a high class of workmanship.

The entire operation of assembling this boiler and riveting the numerous stays and almost inaccessible plate seams and laps, requires very careful planning and exceptional care in the fabrication of the different parts. Certain parts, such as the front sheet of the drop leg, are fine examples of the boilermaker's art.

It would appear that a boiler of this type would be very difficult to keep clean, and, because of the light plating, the life of the boiler would be short; but the boiler has been in the vessel since it was built by William McKie in East Boston, Mass., 26 years ago.

It is of interest to note that the boilermaker who is attending the fires and operating the hydraulic presses used in the construction of the new boiler performed the same duties when the old boiler for the *Ashburnham* was constructed 26 years ago. This old faithful employee has been continually employed by the Atlantic Works for 54 years.

This type of boiler is rarely seen today although there are many old timers who can clearly remember when this type of boiler was the best for the floating power plant.



Ryerson-New Haven sand blast for cleaning flues

Sand Blast Flue Cleaning System

There has long been a need for a flue cleaner which would remove scale, not only on the surface of flues, but also in the pitted holes. Scale remaining in these holes conceals the actual damage by corrosion, and flues have frequently been put back into service that were unfit for further use.

By combining an old as well as an entirely new method, Joseph T. Ryerson & Son, Inc., Chicago, Ill., has developed a new type of cleaner which is arousing considerable interest in railroad flue shops. The Ryerson-New Haven sand blast flue cleaning system completely removes every particle of scale, thus permitting an accurate inspection. Heavily pitted flues may be easily detected and prevented from adding further expense to railroad flue shop maintenance.

This cleaner consists of five units, the scale cracking unit, sand blast cabinet, flue puller, dust arrester, and exhauster. Any standard or superheater size flue is handled by this one cleaner, the capacity ranging from 1½ inches to 6 inches, outside diameter. Only one flue is put through the cleaning system at a time. Two-inch flues are cleaned at the rate of one per minute. The output for this machine of 6-inch superheater flues is twenty per hour.

The scale cracking unit is sturdily constructed throughout for heavy duty service. The cracking rolls have replaceable rims of a special hard steel, with rugged teeth which bear against the outside of the flues and crack the scale. These rolls do not mark or damage the flues in any way. They are mounted on an angle so that as they remove the scale, they also feed the flues into the sand blast cabinet. A set of guides is furnished to handle the complete range of flues from 1½ inches to 6 inches. A large hand wheel provides an easy means of adjusting the rolls for any size flue.

As a flue leaves the cracking unit, it automatically enters the sand-blast cabinet. A battery of nozzles force sand at high velocity against the flue while it is revolving, thoroughly scouring out every particle of scale. The sand drops to the bottom of the cabinet where it is sucked up through rubber tubes to be used again.

As the sand is passing to the bottom of the cabinet, all dust is drawn off through the dust manifold and exhaust tube by means of a strong suction. This dust is then carried on to the dust arrester. Here by means of cloth bags it is caught and retained while the clean air passes through another exhaust tube to the fan or exhaust and out into the shop. The dust which has been collected is removed by means of a trap door at the bottom of the cabinet.

After the flue has been sand blasted it is brought out with the same revolving motion by the flue puller, and is then ready for the next operation.

Several of the leading railroads in this country have installed this new type of cleaner, and they report highly satisfactory results in its thoroughness for cleaning, low operating cost, and high rate of output.

Fiftieth Anniversary of Cleveland Punch and Shear Works

The Cleveland Punch and Shear Works Company, Cleveland, O., now celebrating its fiftieth anniversary was established in the year 1880 and has grown from an organization whose products had little more than local recognition to one of the largest machine tool builders in the country.

W. D. Sayle, president of the company, took over the affairs back in 1904 and while in recent years he has turned most of the responsibilities over to his son, W. C. Sayle, he still retains a very active interest in the business.

W. C. Sayle, vice-president and general manager received his business training under the able tutorship of his father. After leaving college, he started to work in the machine shop in order to get a thorough knowledge of the manufacturing end of the business. After successfully completing his training in this branch, he took over the management of what is known as, the small tool department where punches, dies, rivet sets and other small tools, used by fabricators, are manufactured. Additional duties were added until he eventually assumed the duties of general manager of the entire organization.

While the company functions as one complete unit, there are in reality three distinct divisions known respectively as small tool division, machine tool division and power press division.

The power press division has, under the capable direction of R. J. Pardee, a recognized authority on power press design and application, developed very rapidly.

The fabricating tools such as punches, shears, plate planers, rotary planers, bending rolls, wall radial drills, etc., built by the machine tool division have an entirely different application. These are used for punching, shearing, planing and bending plates and structural sections used in shipyards, boiler works, structural shops and similar plants.

A. L. Bechtel who has complete charge of this division, has been with the company for over twenty-five years and many of the more important developments in this line of tools have been initiated and carried to completion under his guidance.

The small tool division was originally more or less an outgrowth of the machine tool division. At the beginning of the company's history small tools such as punches, dies, coupling nuts, etc., were furnished as a part of the standard equipment of their machines, and, recognizing the fact that it was primarily because of the quality of the tools that repeat orders kept coming in, the company decided to manufacture only the same quality of tools in this department that they had previously furnished with the machines.

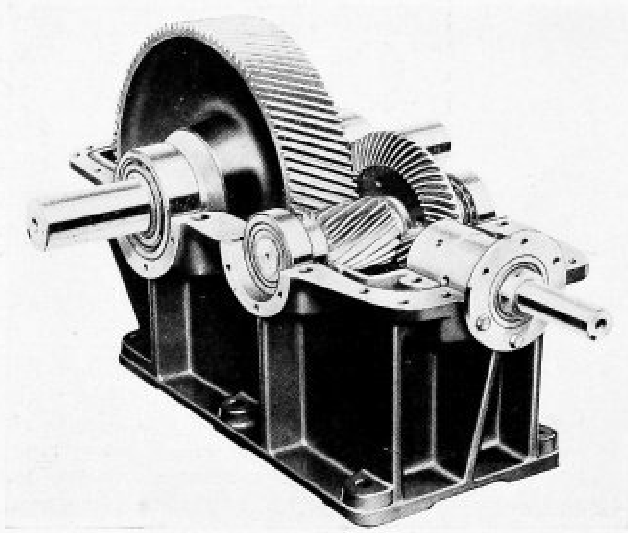
The small tool division, under the supervision of J. T. Bischoff, is furnishing probably more small tools of this type than any other manufacturer in the country.

Right Angle Speed Reducers

The Falk Corporation, Milwaukee, Wis., has brought out a line of right-angle drive speed reducers to supplement its well known line of parallel shaft drives. This new series includes both horizontal and vertical shafts.

One feature of the Falk right-angle drive is a combination of single-helical and spiral-bevel gears. It is pointed out that single-helical gears for the final reductions are easier to assemble than herringbone gears and that their efficiency is practically the same. An accurately cut single-helical gear in combination with a high-grade spiral-bevel makes a quiet, cool-running reducer which has an initial efficiency of well over 95 percent. Furthermore, this efficiency is said to be maintained throughout the life of the unit.

Another significant feature is the reversible construction of gears and shafts. If the gears become worn after years of service, shafts can be turned end for end



Falk speed reducer for right-angle drive

to permit using the opposite and unworn sides of the teeth. This type of construction has proved very successful in the past in Falk parallel shaft drives.

Ratings on the new line range from 1/16 horsepower per 100 revolutions per minute on the smallest unit to 565 horsepower at 100 revolutions per minute on the largest. Ratios are from 15 to 1 up to 518 to 1.

As in Falk parallel-shaft reducers, the lubricating system of the right-angle units is simple and self-contained. A continuous splash system keeps a film of oil on the working faces of the gear teeth at all times. Rapid circulation of oil through the bearings results in remarkably cool operation and long life.

A complete line of welded-steel motor beds has been developed to accommodate all motors coming within the capacities of the reducers.

New Safety Latch Company

The DeWaters Automatic Safety Latch Corporation, 122 East 42nd street, New York, N. Y., announces the purchase of all patents and assets of the DeWaters Safety Latch Company, Inc., formerly located at 110 West 40th street, New York City. The new company will continue to manufacture and distribute the DeWaters automatic safety latch. L. A. DeWaters has been elected president and will be the active head of the corporation.

The safety latch is a device that has been tested and listed as standard by the Underwriters Laboratories of Chicago, and has been approved by the labor departments of a number of states, as well as by the National Board of Boiler and Pressure Vessel Inspectors. It has been on the market for several years and is claimed to be the only positive automatic latch for the prevention of boiler room accidents due to tube ruptures, back drafts and gas explosions. The A. S. M. E. Boiler Code calls for an automatic positive locking device for boiler doors and nineteen states already have incorporated paragraph 328 of the code which specifies it.

At the annual meeting, March 12, the directors of the Independent Pneumatic Tool Company, Chicago, Ill., elected Frank B. Hamerly of Aurora, Ill., vice-president, in charge of manufacturing.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Staybolt Heads as Heating Surface

Q.—I am a subscriber to The Boiler Maker and find many interesting and beneficial articles. Would you kindly answer me this question? In order to obtain accurate results in calculating boiler heating surface, should the area of staybolt heads be deducted? W. H.

A.—The following rule can be used for computing the heating surface of a locomotive type boiler:

(1) Tubes and Flues: Use wetted (outside) surface between the tube sheets.

(2) Arch Tubes: Use wetted (inside) surface, length measured on center line between sheets.

(3) Firebox: Use wetted (outside) surface from top of firebox ring. Deduct firedoor hole and tube and flue holes.

It will be noticed that in Item (3) of the above, no mention is made of deducting the area of the staybolts. I do not believe it would be correct to deduct this area, for while the staybolts would not conduct the heat as readily as the firebox sheet itself, they cannot be considered as non-conductive and therefore some of the heat on the head of the staybolt is carried to the water surrounding the staybolt, thus being considered heating surface.

Pattern for Elliptical Head

Q.—Would you please publish in your next issue the best method for finding the radius to make the pattern of a ten piece 16-foot diameter elliptical head. Also a hemispherical head. I made one of this size and used the neutral center of the plate for my elliptical head. The center of the piece was all right, but both sides fell short by about 2 inches.

Have you any method or formula for figuring the size of angle iron and number of rivets in the various pieces of a truss or bridge to support a conveyor from one building to another? The span is 100 feet. My idea is to make a number of diagonals and determine the number of pounds per foot. C. H. H.

A.—The sketch submitted showing pattern of elliptical head was not clear as to the method used to obtain it, making it impossible for me to offer any comments upon the reason for the resulting pattern falling short on each side.

The following methods can be employed for developing elliptical and hemispherical heads.

The half-plan and elevation of an elliptical tank head to be made up of ten plates is shown in Fig. 1.

To lay out the ellipse with *D-F* and *D-E* as the semi-axis, construct arc *E-H* and lay off distances *H-F* along *E-F* as *E-G*. Now, through the center of *G-F*, draw a right line by cutting arcs *m* and *n* about *G* and *F* with any convenient radius. Extend the line *m-n* so drawn until it cuts the axis of the tank as at *A*, giving both *A* and *B* as centers for the arcs forming the ellipse; i.e., arc *F-t* about *B*, and arc *t-s* about *A* with respective radii.

The same is done for the other side, giving *C* as a center for the remaining portion of the ellipse.

Dividing the Surface.—In this work the first step is as in Fig. 2, the outline of the surface is shown with *A-C* as the axis of the tank and *A-C* the extent or depth of the bottom. The extreme bottom is formed of a circular, dished plate, which in this case may be made as large as is convenient in handling. The dished plate is formed from a flat, circular plate with radius equal to *A-m*. The layout of this plate is shown in Fig. 3 as a circle about *A* as a center.

In Fig. 2 the remainder of the surface is divided into nine equal parts by radiating straight lines in the plan to the points *1, 2, 3,* etc., and by the corresponding curved lines projected into the elevation, as shown clearly by the construction and projection lines in the figure. All of these parts of the surface are similar in size and shape to the rivet line, so that the layout of one will be sufficient. Through the center *A* of the plan, a radius *A-g* is drawn as a center line of one of the plates. This line is shown in its true length and form as the arc of the ellipse in elevation as *1-m-A*.

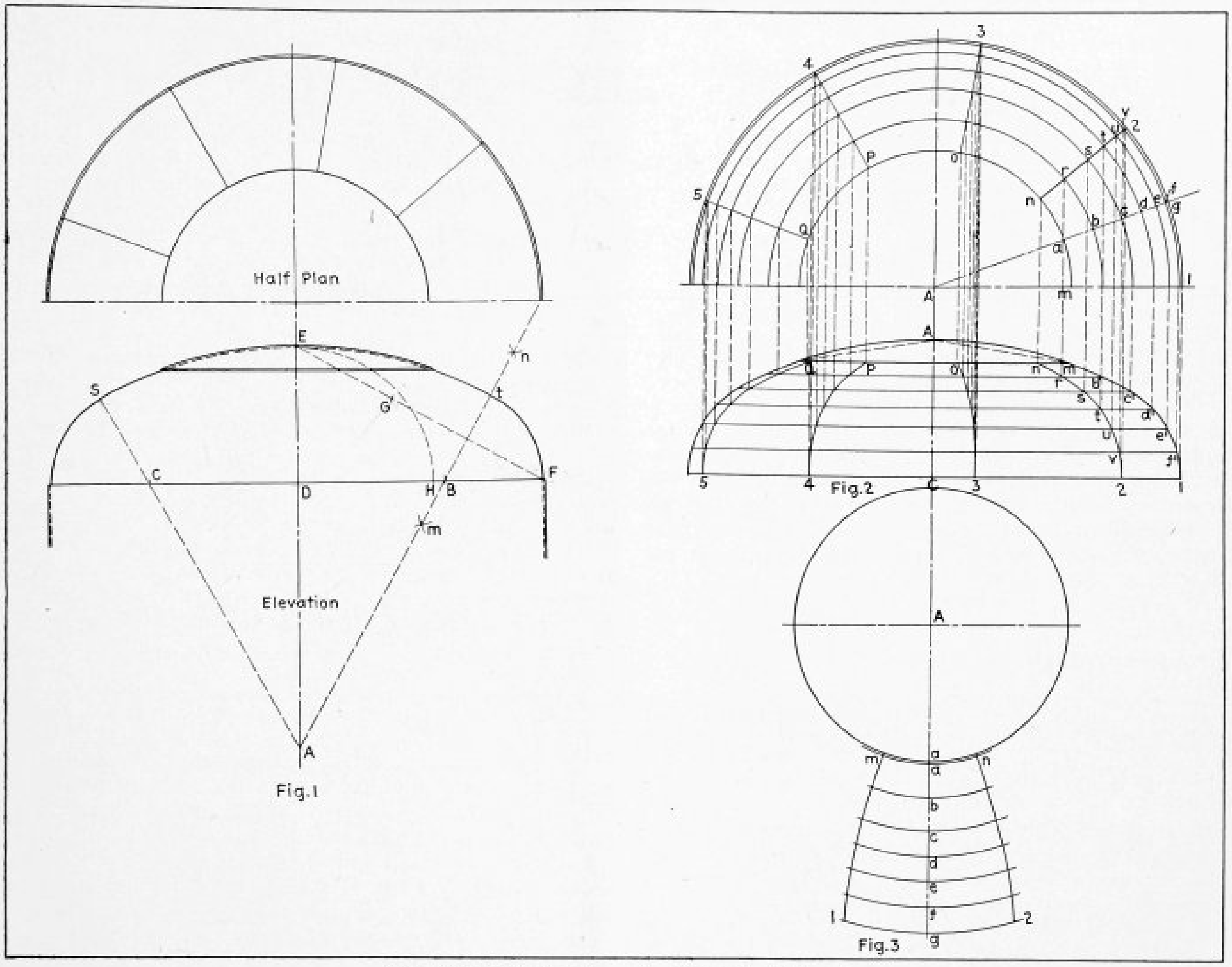
In Fig. 3 a straight line, *A-g,* is drawn equal in length to the arc *1-m-A* in the elevation, Fig. 2. The length of this arc may be found by spanning it with the spanners set at a small distance apart and counting the number of spans to complete the arc.

Along the line *A-g*, Fig. 3, corresponding points are marked off for points *m, b', c', d', etc.*, measured along the arc in the elevation, Fig. 2. Through these points in Fig. 3 arcs are drawn as shown about *A* as a center. Then about the center line *A-g* the widths of the pattern are laid off on these arcs by transferring them from the corresponding points on the center line in the plan, Fig. 2. In each case the width is measured along the arc by spanning, or some convenient method, and laid off along the arc, as shown in Fig. 3.

Joining the points so found gives an outline of the layout of the plate as *1-2-n-m* in Fig. 3.

It is seen in Fig. 3 that the arcs, where the two plates join, have different radii, but an inspection of the elevation Fig. 1 explains the difference, since the straight line *A-m* is the radius for the dished plate and length of the arc *A-m* is the radius for the lower edge of the curved plate.

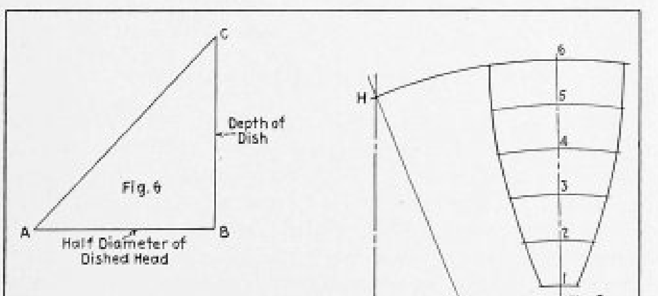
Sufficient allowance must be made at the upper and lower edges of all side plates where they join inside of the tank and dished plate. The other joints will probably be formed with butt straps.



Half plan and elevation of elliptical tank head

Layout for Hemispherical Head for Tank

For laying out tank heads much depends upon the manner in which the different sections of the head are to be worked up. Where the sections are heated and pressed to shape in dies, a pattern can be struck out for the sections with a good degree of accuracy. Where the sections are to be made by hand, it would be a difficult matter to bring out each section alike. Another point to be considered is the number of sections forming the head. The greater the number of sections, the better uniformity the finished head will present.



Hemispherical tank head

To lay out the hemispherical head shown in Figs. 4, 5 and 6 strike diameter of the head as at *E* and *O;* erect center line, dividing into two parts, *A* and *B*. Part *A*, can be assumed at the elevation of the head. Divide the arc in part *A*, into equal parts, in this case six, and number as shown. Strike lines from these points to center line, as shown. Then with dividers set to where these lines intersect the center line, and at point *D* strike arcs to line *O-E*. Part *B* can now be taken as a plan view of head. As the head is made up of eight sections, divide *B* into two parts. Bisect the angle *C-D-E* by the line *F-D*; *C-D-E* will give the section from which to develop the pattern. Set square to line *F-D* at point *F*, and strike line to base line as shown. Extend this line upward to intersect center line at *H*. Now erect any line from *J*, as shown; then with trams set to points *J* and *H* strike an arc across line *J*. Where the arc intersects line *J* step off the distances *6-5-4-3-2-1* from part *A* along the line. Now from point *J*, with trams set to the different points, strike arcs as shown. Going back to section *C-D-E*, measure the length of each arc and transfer half of distance on each side of line *J* at their respective numbers. A line traced through these points will give the pattern lap to be allowed.

The lengths of the different arcs can be verified by taking the different radii in part *B* and figuring the circumference of the circle of which they form part and dividing by eight; this should give the same distance as found on the arcs in section *C-D-E*.

Care should be taken to strike neutral diameter of head. Quadrant *G* represents the dished plate at top of tank. Erect right angle *A-B-C*, as at Fig. 3; upon *A-B*, set off half diameter of head desired; on line *B-C* set off depth of head required; at center of head strike a line intersecting points *A* and *C*. The length of this line will give the radius required for marking off the circular plate. This rule has been figured to allow for shrinkage in bringing the plates to shape.

The answer to the last part of this question involves the design and theory of trusses, which would be too lengthy a discussion for this department. I would refer you to Marks "Mechanical Engineers Handbook," "The Design of Simple Steel Bridges," by Usborne and the "Cyclopedia of Civil Engineering," Vol. VI, American Technical Society, as sources for this information.

Specifications for Vertical Boiler

Q.—I would be much obliged if you would supply me with specifications for a vertical boiler, height, 8 feet 2 inches; diameter, 4 feet 4 inches with steel mud ring and 2-inch tubes. The boiler should be designed for a steam pressure of 150 pounds per square inch. N. A. McL.

A.—The following are specifications for such a boiler:

Boiler: Vertical type; inside diameter, 52 inches; height, 98 inches. Material of shell, homogeneous boiler steel; boiler to be well designed, thoroughly stayed, of best workmanship, and capable of carrying, with a factor of safety of 5, a pressure of 150 pounds per square inch. Boiler to be tested with steam to 20 percent above pressure and with hot water to 50 percent above pressure. Boiler to be built to the A. S. M. E. Code—requirements Part I Section 1. Vertical seam to be butt jointed, double riveted, with welt strips inside and outside. Plates planed at edges and calked. Rivet holes reamed after plates are assembled to insure uniform holes, and slightly countersunk under heads of rivets. Rivets driven by hydraulic or pneumatic pressure wherever possible. Shell thickness, 7/16 inch; welt strips, inside, 3/8 inch; outside, 3/8 inch; head, 1/2 inch.

Firebox: Firebox of homogeneous firebox steel, inside diameter, 45 5/8 inches; height, 26 1/2 inches. Furnace sheet thickness, 5/16 inch; head thickness, 1/2 inch. Vertical seam to be lap jointed, single riveted.

Mud ring: Mud ring accurately fitted and substantially single riveted. To be of wrought iron or steel, or cast steel Class A or B.

Staybolts: Staybolts of wrought iron, 7/8-inch diameter; screwed and riveted to sheets, and placed not over 4 1/4 inches from center to center, with tell-tale holes drilled in outer ends. Staybolts pneumatically driven.

Tubes: Tubes of seamless steel No. 13 B. W. G. minimum thickness; 130 in number; 2 inches outside diameter 6 feet 0 inches long. Ends of tubes to be firmly rolled and beaded; or rolled, beaded and welded around the edge of the bead.

Cleaning Holes: Suitable handholes and covers shall be furnished and located as follows: Three handholes to be provided directly over mudring, spaced equally around the boiler. Three handholes to be provided directly over the top of the firebox and spaced equally around the boiler. One handhole to be provided directly in line with the fusible plug.

Firedoor Hole: Firedoor hole to be 12 inches by 16 inches or with an equivalent area; 11 inches to be least dimension in any case. Firedoor frame shall be of wrought iron or steel, or cast steel of class A or B grade. The O. G. or other flanged construction may be used as a substitute.

Accessories: Boiler to be equipped with fusible plug—to be located in a tube, not less than one-third the length of the tube above the lower tube sheet.
Water glass complete with cocks and drain.
Three gage cocks.
One safety valve—2 3/4-inch diameter opening.
One blowoff cock—1 1/2-inch diameter opening.
One steam gage—complete with cock.
Firedoor—Suitable cast-iron door.

Stamping: Boiler to be stamped in accordance with the A. S. M. E. Code instructions.

A Revised Welding Encyclopedia

The Welding Encyclopedia, seventh edition, compiled and edited by L. B. Mackenzie and H. S. Card. 540 pages; 670 illustrations; flexible imitation leather binding. Published by The Welding Engineer Publishing Company, 608 S. Dearborn street, Chicago, Ill. Price $5.00

This book contains 200 pages of definitions and discussions of words and terms used in welding literature. This is followed by treatises on gas, arc, resistance and thermit welding, which include instructions for welding all of the commercial metals by each of these processes. Separate chapters are devoted to such important applications of welding as pipe, tanks, boilers and structural steel. The subject of cutting and the subject of training operators are also given separate treatments. In the new edition extensive additions have been made to include up-to-date information on some of the newer applications of welding, such as aircraft welding, welding of machine parts, and structural steel welding. Other important additions to the previous edition deal with the welding of special alloy steels and the welding of non-ferrous metals and their alloys.

An Editorial Omission

Attention has been called by one of our readers to an omission in the facts stated in the editorial "Boiler Inspection and Politics" which appeared in the February issue. According to this reader's statement, Governor Davis of Ohio in 1921 appointed a Mr. Stehmeyer of Cincinnati as chief of the division of boiler inspection. His incumbency lasted about 15 months until Governor Donahey in 1922 preferred charges of incompetency against him, at which time he resigned. With the exception of this period of 15 months, C. O. Meyers, as noted in the editorial, held the office of chief inspector from 1917 to 1929.

W. B. Kochenderfer, formerly in charge of engineering and sales for the Lake Erie Engineering Corporation, Buffalo, N. Y., has recently been appointed chief engineer of the hydraulic machinery department of R. D. Wood and Company, Philadelphia, Pa., (Works at Florence, N. J.).

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.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

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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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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.

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International President—J. A. Franklin, suite 522, Brotherhood Block, Kansas City, Kansas.

Assistant International President—William Atkinson, 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—John J. Dowd, 142 Pearsall Ave., Jersey City, N. J.; M. A. Maher, 2001 20th St., Portsmouth, O.; R. C. McCutchan, 226 Lipton St., Winnipeg, Man., Canada; H. J. Norton, Alcazar Hotel, San Francisco, Cal.; C. A. McDonald, Box B93 Route 2, Independence, Mo.; J. N. Davis, 1211 Gallatin St., N. W. Washington, D. C.; M. F. Glenn, 1434 E. 93rd St., Cleveland, O.; W. J. Coyle, 424 Third Ave., Verdun, Montreal, Canada; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; J. F. Schmitt, 25 Crestview Rd., Columbus, O.

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Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.

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Vice-President—Irving H. Jones, Central Alloy Steel Corporation, Massillon, Ohio.

Treasurer—George R. Boyce, A. M. Castle & Company, Chicago, Ill.

Secretary—Frank C. Hasse, Oxweld Railroad Service Company, Chicago, Ill.

American Boiler Manufacturers' Association

President—H. E. Aldrich, The Wickes Boiler Company, Saginaw, Mich.

Vice-President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, O.

Executive Committee—Homer Addams, Fitzgibbon Boiler Company, Inc., New York, N. Y.; G. W. Bach, Union Iron Works, Erie, Pa.; H. H. Clemment, Erie City Iron Works, Erie, Pa.; J. R. Collette, Pacific Steel Boiler Corp., Waukegan, Ill.; F. W. Chipman, International Engineering Works, Framingham, Mass.; E. R. Fish Heine Boiler Company, St. Louis, Mo.; C. E. Tudor, Tudor Boiler Company, Cincinnati, O.; A. C. Weigel, Walsh and Weidner Company, Chattanooga Tenn.; S. G. Bradford, Edge Moor Iron Company, Edge Moor, Del.

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

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	

Cities

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

Selected Boiler Patents

Compiled by

DWIGHT B. GALT, Patent Attorney,

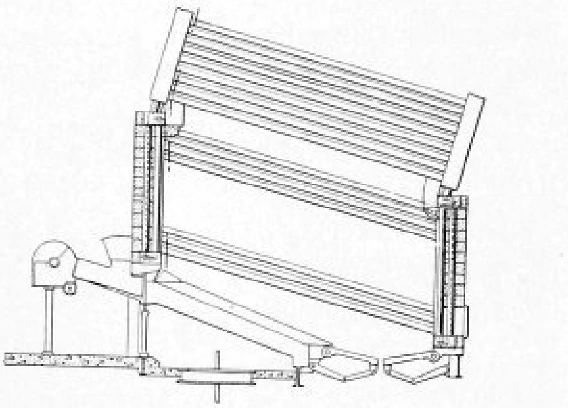
Washington Loan and Trust Building,

Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,734,683. ART OF STEAM GENERATION. EDWIN LUNDGREN, OF FREDERICK, MARYLAND, ASSIGNOR TO COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

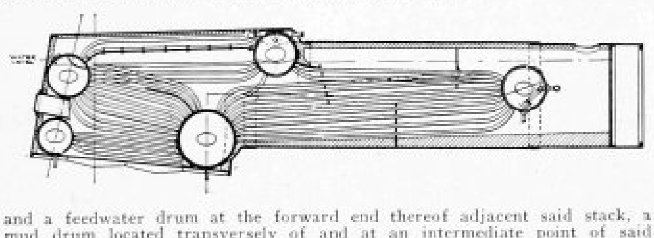
Claim.—A boiler and furnace including two sets of substantially horizontal tubes, a pair of headers for each set, two sets of upright tubes, a pair of headers for each set, each upright set comprising a double row of tubes having refractory material therebetween, one row being shaded by the



other and by said refractory material and all defining the four upright walls of the combustion chamber, a boiler located above said chamber, connections between the first mentioned headers and the boiler, connections between the upper headers of the second mentioned pair of headers and the boiler, and means for admitting fuel to the combustion chamber.

1,726,234. WATER-TUBE BOILER. GEORGE J. MOG, OF CLEVELAND, OHIO.

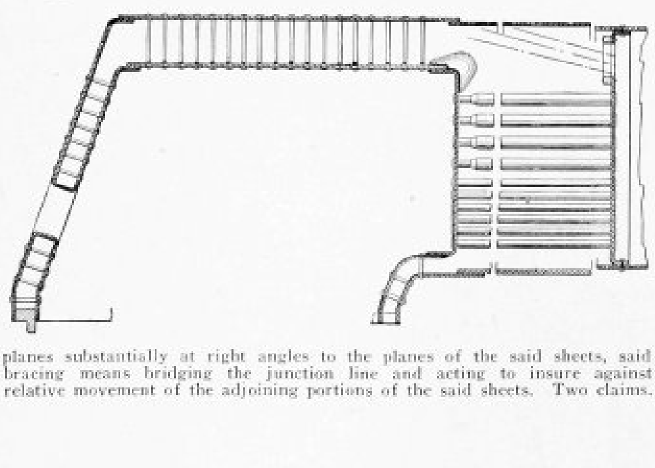
Claim.—A watertube locomotive-type boiler comprising a cylindrical shell provided at its rearward end with a firebox and at its forward end with a smokebox and stack, baffles and gas passageways located between said firebox and said stack, a pair of drums at the rearward end of said shell



and a feedwater drum at the forward end thereof adjacent said stack, a mud drum located transversely of and at an intermediate point of said shell, a steam drum positioned transversely of said body above said mud drum and at a point intersected by the waterline of said locomotive, and banks of tubes interconnecting said several drums. Nine claims.

1,737,385. STEAM BOILER. JOHN A. PILCHER AND JOHN A. DOARNBERGER, OF ROANOKE, VIRGINIA.

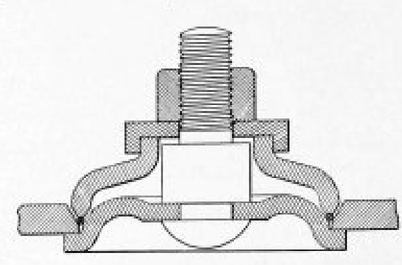
Claim.—In a steam boiler, the combination of a flue sheet and a crown sheet, means rigidly securing said sheets to each other; said means including bracing means disposed at intervals on the water side of said sheets and in



planes substantially at right angles to the planes of the said sheets, said bracing means bridging the junction line and acting to insure against relative movement of the adjoining portions of the said sheets. Two claims.

1,735,126. HANDHOLE PLATE. AMAZIAH J. MOSES AND FRANK H. WRIGHT, OF CHATTANOOGA, TENNESSEE, ASSIGNORS TO THE CASEY-HEDGES CO., OF CHATTANOOGA, TENNESSEE, A CORPORATION OF OHIO.

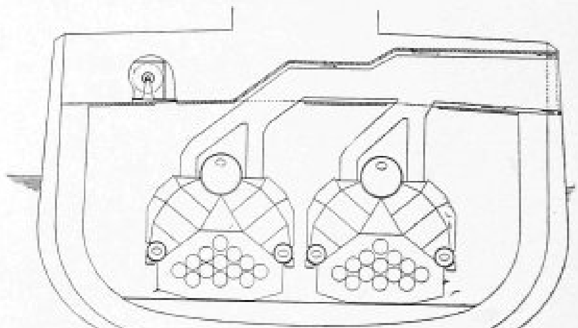
Claim.—The combination with a shell having an opening therein, of a plate having a flange adapted to engage the inner face of the shell adjacent the opening, a cap having its edges cooperating with said plate and an outer surface of said shell to seal said opening, a central and outwardly projecting open boss on said cap, said boss having interior and exterior



angular walls, a bolt carried by said plate and projecting centrally through said boss, an enlargement on that portion of said bolt disposed within the boss conforming in size and shape with the interior of said boss to hold the bolt and cap against relative rotation, a cover plate for said boss, a flange at the edges of said cover plate to fit over said boss and having walls corresponding in size and shape with the exterior of said boss to hold the cover plate and cap against relative rotation, and a nut on the outer end of said bolt.

1,735,884. BOILER UPTAKE. THOMAS B. STILLMAN, OF SOUTH ORANGE, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

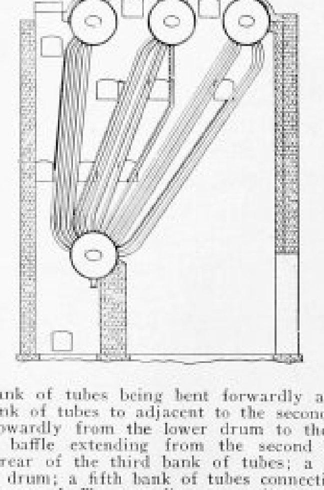
Claim.—A ship having a boiler room in which super-atmospheric pressure is maintained, a smoke-stack extending from the boilers in said room



to the outside, means comprising a casing spaced from said stack to prevent leakage of gases from said stack, and means to maintain boiler room pressure in the space between said stack and casing. Eight claims.

1,736,898. BOILER. GEORGE W. BACH, OF ERIE, PENNSYLVANIA, ASSIGNOR TO UNION IRON WORKS, OF ERIE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

Claim.—In a boiler, the combination of a front upper drum; a second upper drum to the rear of the front drum; a lower drum; first and second banks of tubes connecting the front drum and the lower drum, the second bank of tubes extending in approximately a direct line between the drums; third and fourth banks of tubes connecting the second drum and the lower



drum, the third bank of tubes being bent forwardly and out of parallel with the fourth bank of tubes to adjacent to the second bank of tubes; a baffle extending upwardly from the lower drum to the rear of the first bank of tubes; a baffle extending from the second drum downwardly along and to the rear of the third bank of tubes; a third drum to the rear of the second drum; a fifth bank of tubes connecting the third drum and the lower drum; a baffle extending upwardly from the lower drum along the rear of the fourth bank of tubes; a baffle extending downwardly from the third drum along the fifth bank of tubes; and tubes connecting the upper drums.

The Boiler Maker

Name registered U. S. Patent Office

Volume XXX May, 1930 Number 5

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

Chicago: 105 West Adams St. Cleveland: Terminal Tower
Washington: 17th and H. Sts., N. W.
San Francisco: 215 Market St.

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THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

Request for change of address should reach us on or before the first day 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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Forty-Second Meeting of Boiler Manufacturers

This year the American Boiler Manufacturers' Association will again hold its annual meeting, the forty-second, at Skytop Lodge, Cresco, Pa. It will, however, be at an earlier date than usual, May 26, 27 and 28, having been selected as the most convenient time for the majority of members, and one which would cause the least conflict with other important association meetings.

The program of the meeting, which as yet has not been issued, will, in general, follow that of previous years. Standing committee reports, technical matters pertaining to the industry and special group meetings for the consideration of problems applying to the various subdivisions of the organization will occupy most of the business sessions.

So successful was the meeting last year in the pleasant surroundings of Skytop that undoubtedly the best attendance in recent years will result at the present one.

Convention Suggestions

At this late hour little remains to be said of the Master Boiler Makers' Association convention which will shortly assemble at the William Penn Hotel, Pittsburgh, Pa. Members who have been able to arrange to be present, already will have made their final plans, and supply companies will have their exhibits on the way. Everyone connected with the two associations seems confident that this year's effort will result in the best convention the association has ever held.

In the past, this word "best" has been used many times in describing conventions and it may have meant the greatest attendance, the keenest interest, the most instructive exhibits or many other things that go to make up a really good convention. So far as it is possible to estimate now, all these features show promise of living up to expectations. The physical arrangements for the instruction, entertainment, convenience and comfort of those in attendance have certainly been well provided; for the officers and committee members of both associations have worked hard and ceaselessly for several months to insure the success of the program. Topic committee reports are excellent and should develop considerable valuable information in the discussions.

One thing remains on which the ultimate value of the convention depends, and that is the unlagging interest of members from the time the first meeting opens until the closing session, Friday, May 23.

THE BOILER MAKER, from the days of the International Railway Master Boiler Makers' Association, has taken a keen interest in the organization as individual members and as a group. The editors and business staff constantly have worked with the ever changing officers of both the Master Boiler Makers' Association and the Boiler Makers Supply Men's Association to develop the greatest possibilities of good for the industry that lie in their power. This support will be continued and the work of the conventions will be made known in every boiler shop in the country.

The point of all this is that a complete report of the proceedings of the convention, published in the June issue, will go to every corner of this country and to most foreign countries for anyone interested in boiler work to determine for himself the practical value of the meeting. The effects, therefore, of whatever information is developed through discussions are not confined to the association alone but are transmitted as the best judgment of the leaders of the trade to the industry at large. For this reason, the most careful thought and study should be given to all statements made from the floor of the convention and, whenever possible, discussions should be well prepared in written form and all facts to be presented should be accurately expressed. If these suggestions are followed, the actual productive value of the convention to all the members and to the boiler industry as a whole will be successful.

National Board Meeting

The National Board of Boiler and Pressure Vessel Inspectors will hold its eighth annual meeting at Chattanooga, Tenn., June 17, 18 and 19. At this time the arrangements have not been completed nor has a hotel been selected as headquarters. The tentative program is, however, published in this issue. In addition to the business sessions held, interesting trips to nearby manufacturing plants will be a feature of the meeting.

The work of this organization goes along quietly from year to year, and the evidence that it has been successful in its function of establishing uniformity in boiler construction and maintenance throughout the important centers of the country lies in just this inconspicuousness. Members who will come from all states and cities operating under the A. S. M. E. Boiler Code are to be given great credit for smoothing out a problem which in days not so far distant was one of concern to nearly every community, namely, the safeguarding of lives and property from possible boiler failures. Other factors have, of course, entered into the improvements in this direction. More thought is given by operators to insurance protection and accompanying inspections of their plants; better boilers are being built by the established manufacturing concerns; legislation is more strict but, without the authority vested in the hands of the National Board members, uniform enforcement requirements could not be realized.

A complete report of the eighth meeting of this organization will appear in an early issue.

Firebox Renewals

Several letters describing methods of renewing locomotive fireboxes have been received, but too late for publication in this issue. Our readers are urged to again read over the question "How do you renew fireboxes?" which appeared on page 91 of the April issue, and then describe the methods which they use and send them to the magazine for publication.

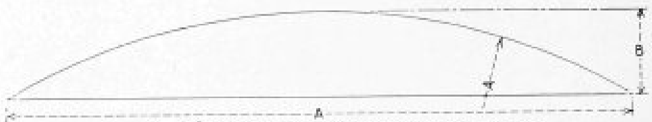
Communications

Capacity of Dished Ends

TO THE EDITOR:

I have pleasure in enclosing herewith a drawing of a dished end showing the corresponding capacities for various sizes up to 10 feet diameter. This should be useful for draftsmen, estimators and foremen and other folks interested in determining tank capacities.

The formula has been developed step by step and, as shown below, is reduced to its simplest form. The first



Formula: $\frac{A^3}{13\frac{1}{2}}$ "C"- Cubic Capacity of Dished Ends in cu. ft.

A	3'0"	3'6"	4'0"	4'6"	5'0"	5'6"	6'0"	6'6"	7'0"	7'6"	8'0"	8'6"	9'0"	9'6"	10'0"
B	4.82"	5.63"	6.43"	7.24"	8.04"	8.84"	9.65"	10.45"	11.25"	12.06"	12.86"	13.67"	14.47"	15.27"	16.08"
C	2.	3.2	4.74	6.74	9.26	14.31	16.	20.2	25.4	31.43	38.	45.5	54.	67.3	74.

Formula for capacity of dished ends

step revealed that 1/54th of a sphere of which the end is a part equaled the capacity of the end itself when the diameter of the end and the radius of dish is the same. As the capacity of a sphere is:

$$D^3 \times 0.5$$

where D is the diameter of the sphere, then,

$$\frac{D^3 \times 0.5}{54} = \text{capacity of the end.}$$

Reducing this, we get:

$$\frac{D^3}{108}$$

and still further reducing the formula, we get:

$$\frac{A^3}{13\frac{1}{2}}$$

where A is the diameter of the end. The capacities are found from this formula.

Batley, York, England. JOHN G. KIRKLAND.

Tests for Welding Rods

TO THE EDITOR:

It goes without saying, that a welder on boiler work is anxious to turn out the best welds possible, and that such welders are constantly bringing to their work the limit of their skill and experience. The most perfect oxy-acetylene welds are those in which every detail of the welding process has been carried out to the limit, without a single point being overlooked or slighted. The welding torch flame has been adjusted to proper size and shape and it is neutral without the possibility of either oxidization or carbonization.

The surfaces to be welded have been most carefully planed or chipped to the proper angle and they have been most carefully adjusted to their proper positions in regard to each other. Next, the welder begins the welding at a carefully considered point in order that as the welding proceeds, the possible distortion, caused by the stresses set up will be a minimum. However careful may have been both the welding and the preliminary work, a welder often fails in regard to the welding rods used in the welding operation.

How is it in your case, Mr. Welder? Are you using welding rods best suited to the work you are doing, or are you selecting rods "catch as catch can" and using whatever fusion metal you can lay hands upon? Are you using the best fusion rods in the market? How do you know that such rods are best adapted to the work you are doing? Have you ever attempted to prove, to your own satisfaction at least, that certain fusion rods are the best for certain kinds of work? Or, do you procure welding rods on the merit of fetching advertisements, use such rods until they are gone, and then finish a welding job with pieces of black steel from the scrap pile or the stockroom? If you do this, do you know whether the fusion rods or the scrap steel makes the best weld? When you are called upon to weld a piece of cast iron, what kind of a welding rod will you use? Will you use steel fusion rods or will you coax a machinist friend to plane off from a strip of thin, soft gray cast iron, long narrow strips which you can use for welding rods on cast iron welding? The writer once knew a welder who procured from a machine shop, narrow rings, turned from the edges of cast iron pulleys as occasion required; these rings were always saved for making welds on cast iron.

Now, Mr. Welder, whatever material you may be forced to use for welding rods, let's test out the various kinds of welding rods and determine what each fusion rod can, or cannot accomplish.

The experiments and tests described in the following paragraphs will go far toward demonstrating what each kind of fusion material will accomplish, and the tests and experiments can be carried out in your shop with little expense save for some scrap material, and a little time. The welding rod tests are made by making welds with each kind of rod, and then testing the welds to destruction. It is best to weld several test pieces with each sample of welding rod, so that an average of the endurance of the several test welds may be obtained. It will be well to go into this test business systematically, and to make up a number of test pieces, all of the same width and thickness, and from the same kind of steel plate. Therefore, it will be well to select scrap plate of the thicknesses used in boiler welding, then shear the scrap pieces from 5 to 7 inches in width and plane the edges of the strips to such an angle, that, when the planed edges are placed together, they will form the desired shape of groove for a good weld. Next, shear the planed strips crosswise, making the smaller strips 1½ to 2 inches wide with a length of 5 to 7 inches. Both ends of the small test pieces snould be planed, so that after a pair of pieces have been welded and the weld torn apart in a test, another weld may be made by using the ends of each test piece.

Place in position for welding from two to six pairs of pieces, then make as perfect a weld as possible with the fusion rod to be tested. Next, place one of the welded pieces in a stout vise with the weld 2 inches above the vise jaws. Apply a stout 18 or 24-inch monkey wrench to the top end of the projecting welded strip. Or, slip on, in place of the monkey wrench, an ordinary plate bar (anything in fact) to permit pressure being applied to the upper test piece so as to bend it back and forth, thereby placing stress upon the weld.

Bend the test piece back and forth until it breaks—in the weld or elsewhere, noting the number and amplitude of the bendings made. Repeat the test with other pieces welded with the same rod and take an average of the several tests for the value of the fusion rod.

Make similar tests with all other varieties of welding rods which you can lay hands upon, including black steel from scrap, and cast-iron strips from a machine shop or elsewhere. Keep as careful a record as possible of each test—and set of tests made, as they will be useful for future reference.

Indianapolis, Ind. JAMES F. HOBART.

Locomotive Boiler Firebox Renewals on the S. P.

By J. B. Becker

The following outlines the method of how locomotive boiler firebox renewals are performed at the Southern Pacific Railroad Company shops, San Francisco, Cal.

The first operation is to remove the fire pan, and cab, also all piping, jacket and asbestos covering and running boards. In fact the boiler is stripped complete of all its appurtenances. While this work is going on a man with an acetylene torch cuts the side, crown, and door sheets into strips between every two rows of staybolts for the purpose of convenient handling and easier access for burning off the staybolts between the sheets in the water leg even with the outside wrapper sheet. Radial bolts are burnt off on the waterside of the crown and wrapper sheet. All rigid bolts are chipped flush with the outer sheet then drilled ¼ inch smaller than the required standard diameter of staybolts. Care in drilling is exercised to maintain the true center of old staybolts for the purpose of using the old stub as a bushing on any over-sized staybolts and radials. This method eliminates various diameters of bolts, saves time and expense and enables a full standard size bolt installation to be maintained.

After the tubes and firebox are removed, the boiler is taken off the frame and the mudring is knocked out; thereafter the boiler is transferred to the sand blasting department and the entire interior is sand-blasted, which removes all scale from the plates. After this operation the interior is given a thorough inspection to ascertain whether any cracks or defects have been disclosed.

The next move is to the boiler shop where all necessary repairs are made before applying the new firebox.

During the time the aforementioned work is in progress, the new firebox is laid out, punched, sheared, flanged, and fabricated complete, ready to put in the boiler. After this is done the mudring is riveted in place; all staybolt holes are tapped out and bolts applied including riveting, electric welding of flexible staybolt sleeves, and all other work pertaining to the application of a new firebox, except applying the tubes. This work is done after the boiler has been transferred back to the erection shop and reset on its frame and cylinders. While the boiler is being remounted, the tubes and fire pan are re-applied, the former having been cleaned and safe ended. After all remounting work is done, the boiler is subjected to a hydrostatic test 25 percent in excess of its working pressure. At this time all leaks which appear are calked up tight under pressure. This constitutes about all of the boiler work pertaining to renewing of a firebox to a locomotive boiler.

Boiler w

American Loco watertube a the De

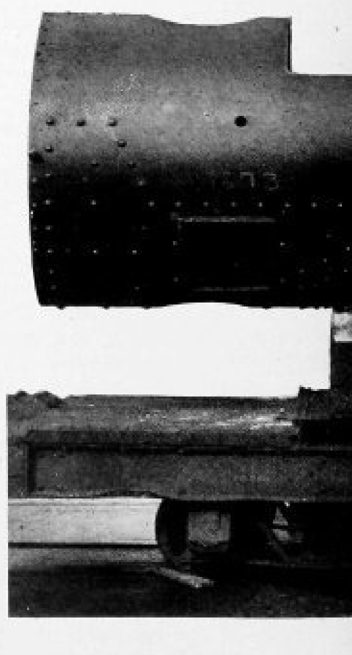
Front end of new D. & H. locomotive

A little more than six years after the first combined watertube and firetube boiler locomotive of the Delaware & Hudson Railroad was placed in service, the third locomotive of the same general design was completed by the American Locomotive Company, Schenectady, N. Y. As in the case of its predecessors, the *Horatio Allen* and *John B. Jervis*, the *James Archbald*, designed by John E. Muhlfeld, consulting engineer, and the mechanical staff of the railroad, the boiler and the boiler pressure are the principal features of the locomotive. The original design carried a working pressure of 350 pounds per square inch; the second, 400 pounds and the third has been increased to 500 pounds per square inch working boiler pressure. The external appearance has been considerably changed by totally enclosing the boiler with an outside casing that effectively insulates and also streamlines the upper part. As in the predecessors of the present locomotive the cylinder arrangement is cross compound with a maximum tractive power, simple, of 84,300 and compound, 70,300 pounds. The total engine weight in working order is 356,000 pounds.

The firetube boiler barrel is of the straight-top design in two courses having an inside diameter at the front end of 68 1/16 inches, an outside diameter at the throat of 68 1/16 inches and a length over tube sheets of 15 feet. The boiler was built with a safety factor of four. Plate 1 1/32-inch thick for the boiler shell as well as for welt straps is of silco manganese steel supplied by the Lukens Steel Company. Other plates used in the boiler are low-carbon nickel steel with flange quality being used when necessary. Horizontal seams in the barrel are designed with 12 rows of rivets, the seams having an efficiency of over 93 percent.

In developing the design, it was found necessary to shorten the front steam drums of the watertube firebox about 2 inches to permit locating the circumferential seam of the cylindrical courses between the header and the front tube sheet. With this change it was possible to obtain plate from the mill that would give the required length of courses as well as to locate the top steam drums to obtain a satisfactory depth of throat sheet.

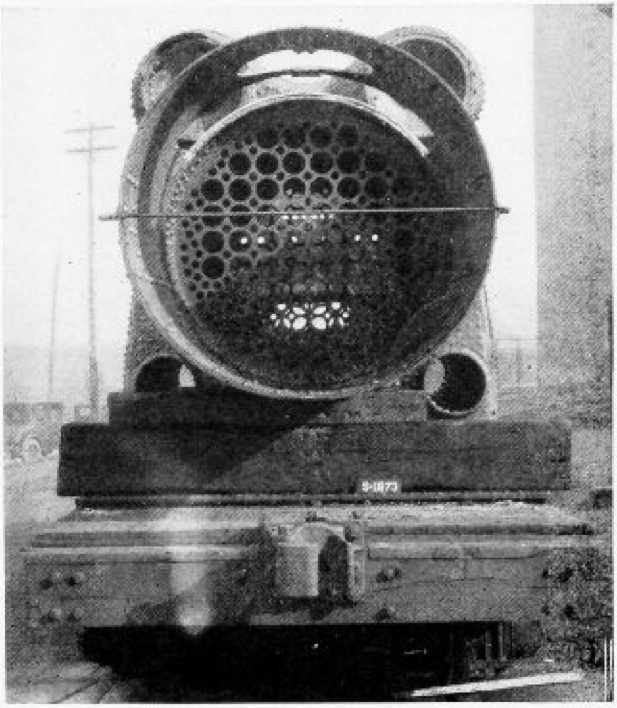
In the locomotive as finally built, the front sections of the steam drums have an outside diameter of 29 inches, a length, right and left, of 156 inches and 151 inches respectively and are of 17/32-inch plate. The rear sections of the steam drums have an inside diameter of 29 inches, a length of 151¼ inches and a thickness of 1 inch. Steam drums are fitted with cupped-in heads containing corrugated forged steel manholes 11 inches by 15 inches in the front ends only, the back heads being solid. A waterleg-type rear header is employed, made of ⅝-inch and ½-inch thick plates, stayed and riveted to connect the rear ends of the upper steam and the



Combined firetube and watertube boiler ready for installation

Novel Firebox

mpany delivers third combined e boiler locomotive to Hudson Railroad



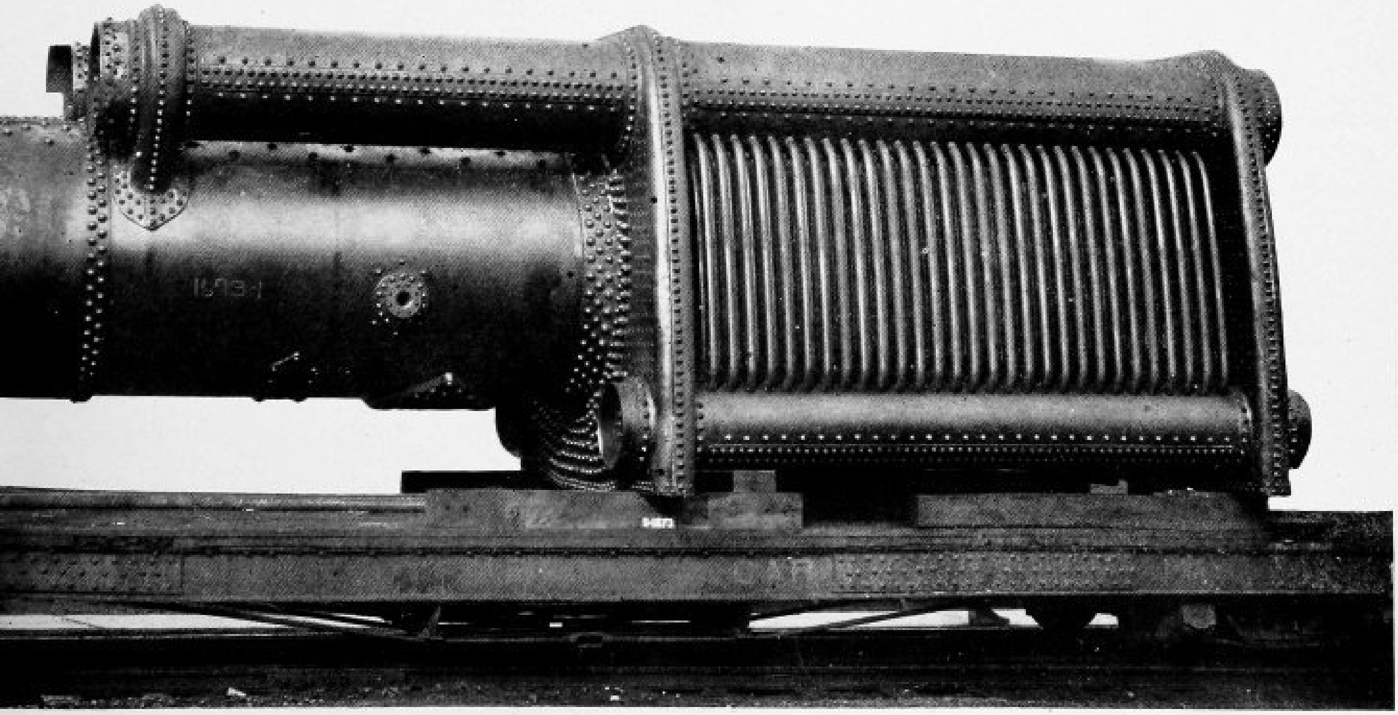
Shell and firebox assembly from front end

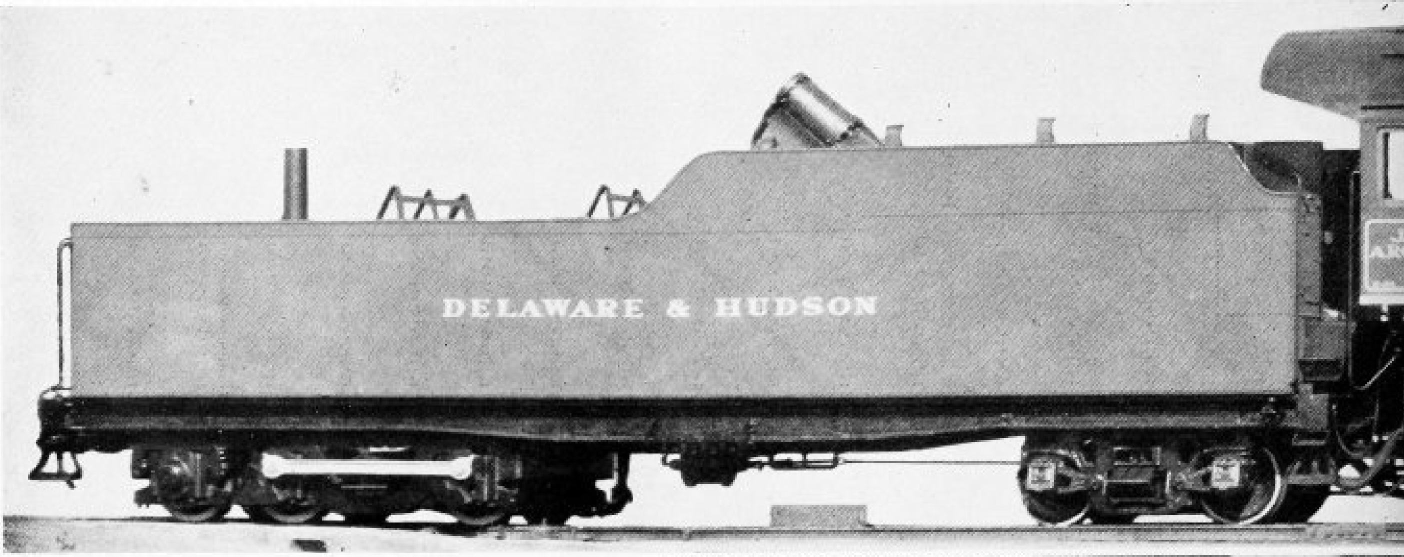
lower water drums. The water drums have an inside diameter of 20¼ inches, a length of 151 15/16 inches and are made of 11/16-inch plate. At the lower end of the headers a 4-inch deep cast-steel foundation rail is applied with extended lugs for connecting the boiler and engine frames with the waist plates.

The center combination header is of 9/16-inch and ⅞-inch thick plates flanged, stayed and riveted to connect the firetube barrel with the central portion of the upper steam and front ends of the lower water drums. This header is fitted with a firebox flue sheet ½-inch in thickness. As in the rear header a uniform 9-inch water space is provided. The lower end of this header is also fitted with a cast-steel foundation rail 4-inches deep, having extended lugs for attaching the boiler bearing supports to the engine frames.

The front combination header and dome is of 9/16-inch thick material of the same type construction as the center and rear headers and is used to connect the firetube barrel with the front ends of the steam drums. A uniform water space of 9 inches is also maintained between sheets. Special attention was paid to the design of the header and water and steam drum connections to provide for an adequate circulation of water and sufficient steam outlet, at the same time giving amply strong construction.

The watertube firebox is 152 inches long and 77⅝ inches wide inside of the sheets. In the rear header is a 36-inch by 12½-inch fire hole with riveted seams sealed by welding. The O'Connor type fire-door flange is employed. The flexible staybolt application in the inner or middle header is much the same as on the previous locomotives of this design with the addition of two circular rows of flexible bolts next to the tube sheet, terminating below the top steam drums. In general, the bolt spacing is such as to permit a maximum diameter of 1¼-inches. There are a few 1½-inch and 1⅜-inch diameter bolts, however. Staybolt spacing was determined on the basis of a maximum stress of 7500 pounds per square inch.

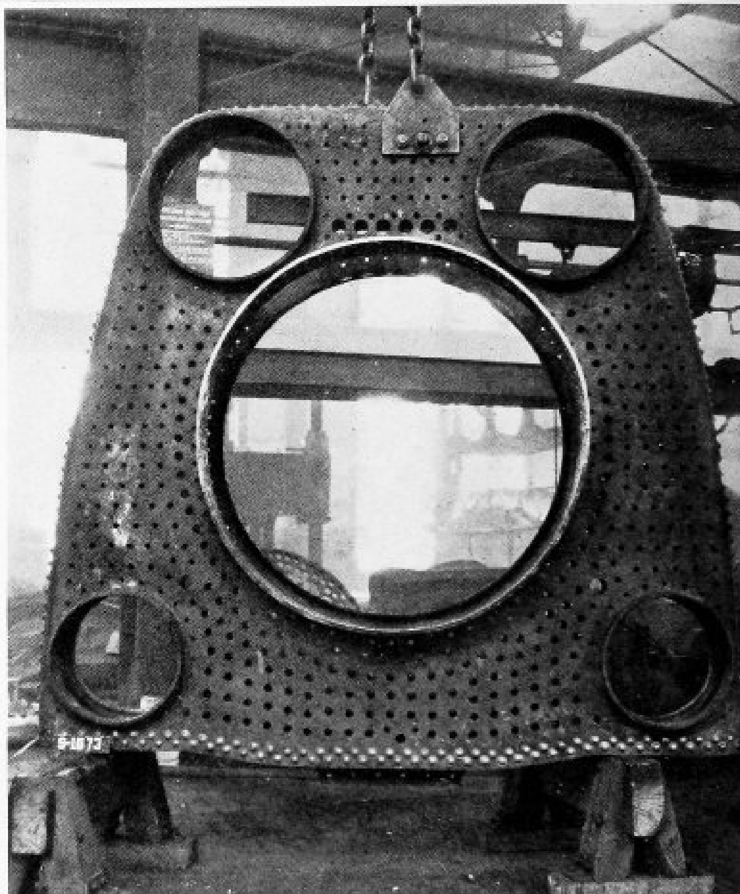


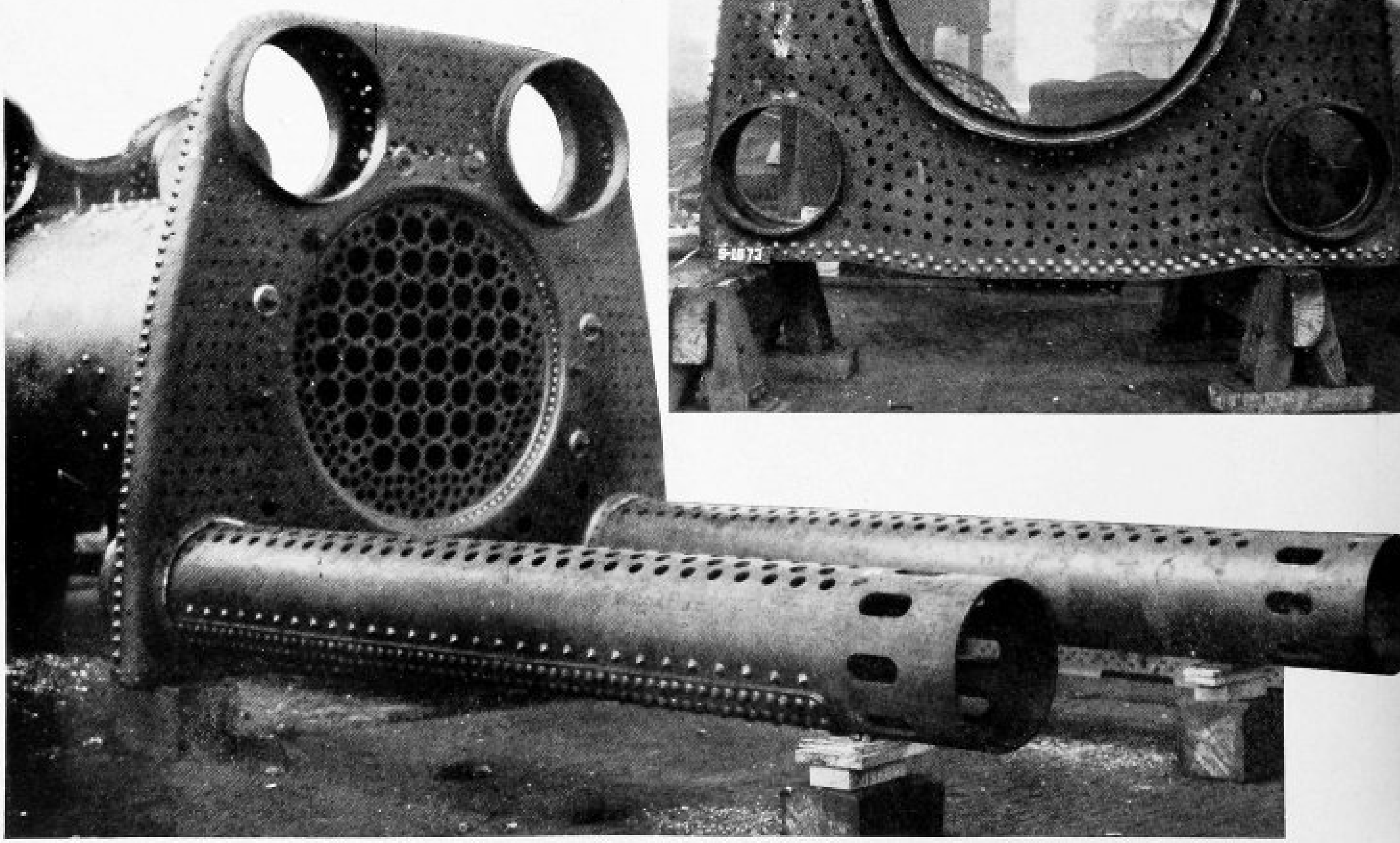


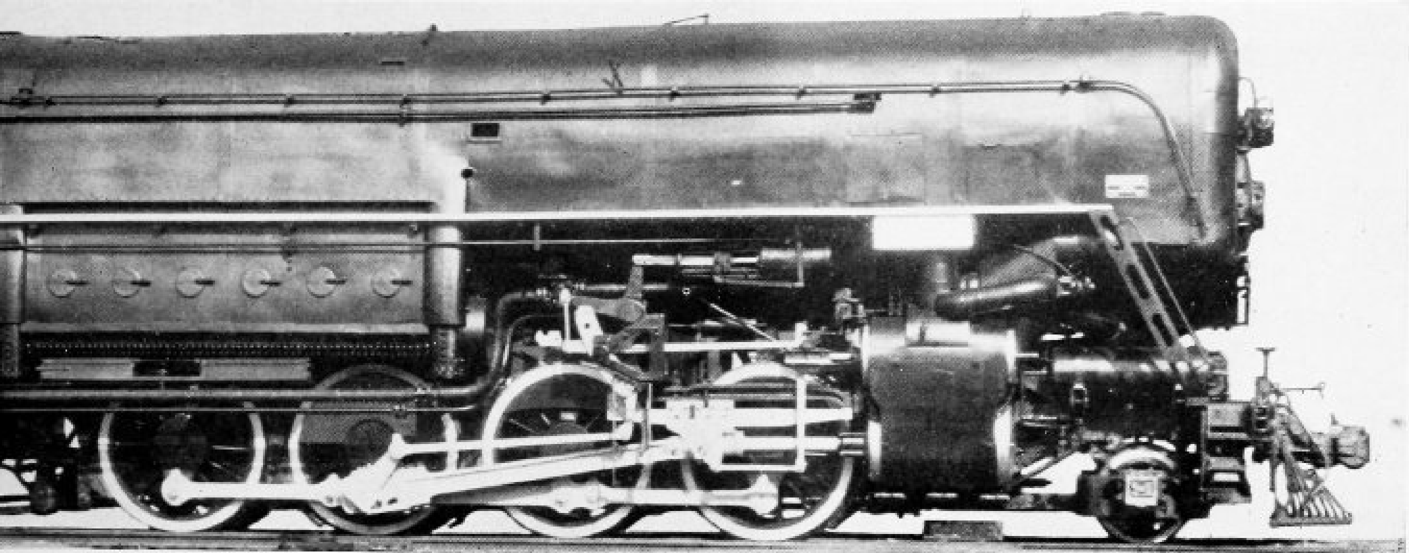
The locomotive James Archbald of the Delaware & Hudson Railroad, third of a design by John E. Muhlfeld, consulting engineer, with combined watertube and firetube boiler.

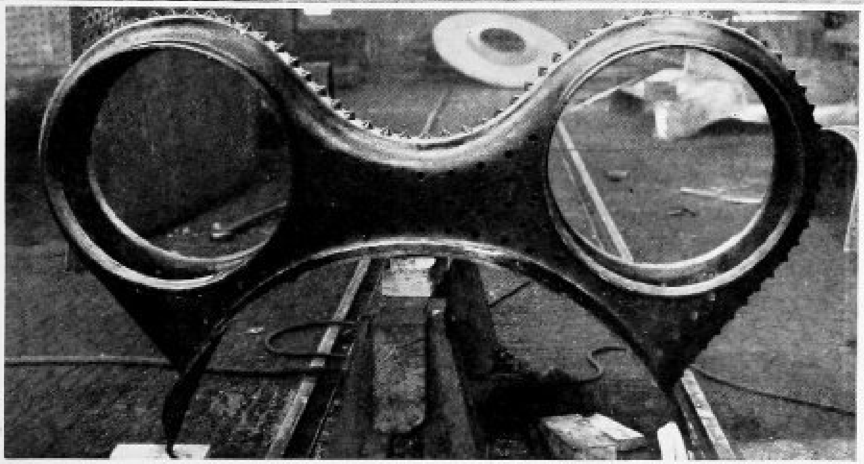
(Below) Front header, second course, center header, tube sheet and water drums assembled in the shop. The water drums are of interest as showing the circulation openings provided.

(Right) Center header assembly, with connections for water and steam drums, which occupies the same relative position as the throat sheet does in boilers of the conventional type.





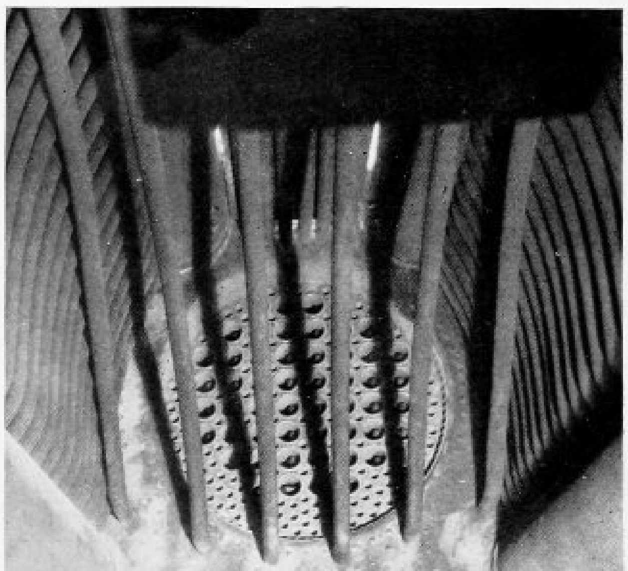


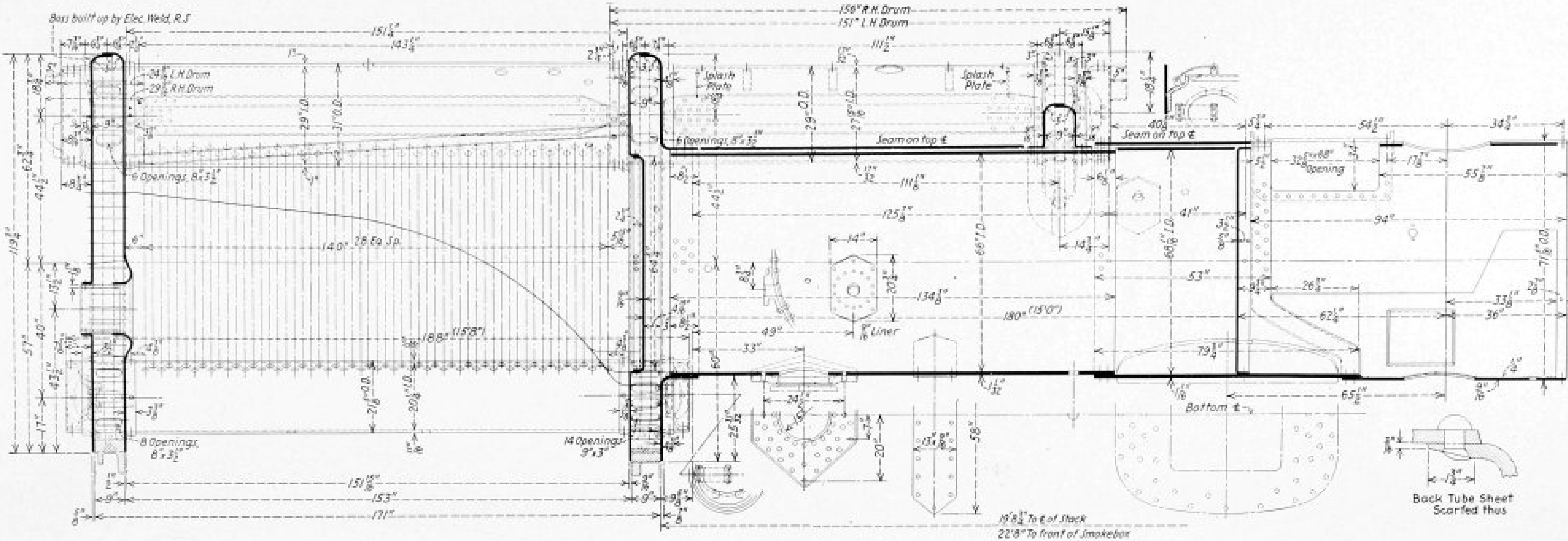


(Center) Front header as it appeared ready for installation in the shell of the new locomotive boiler.

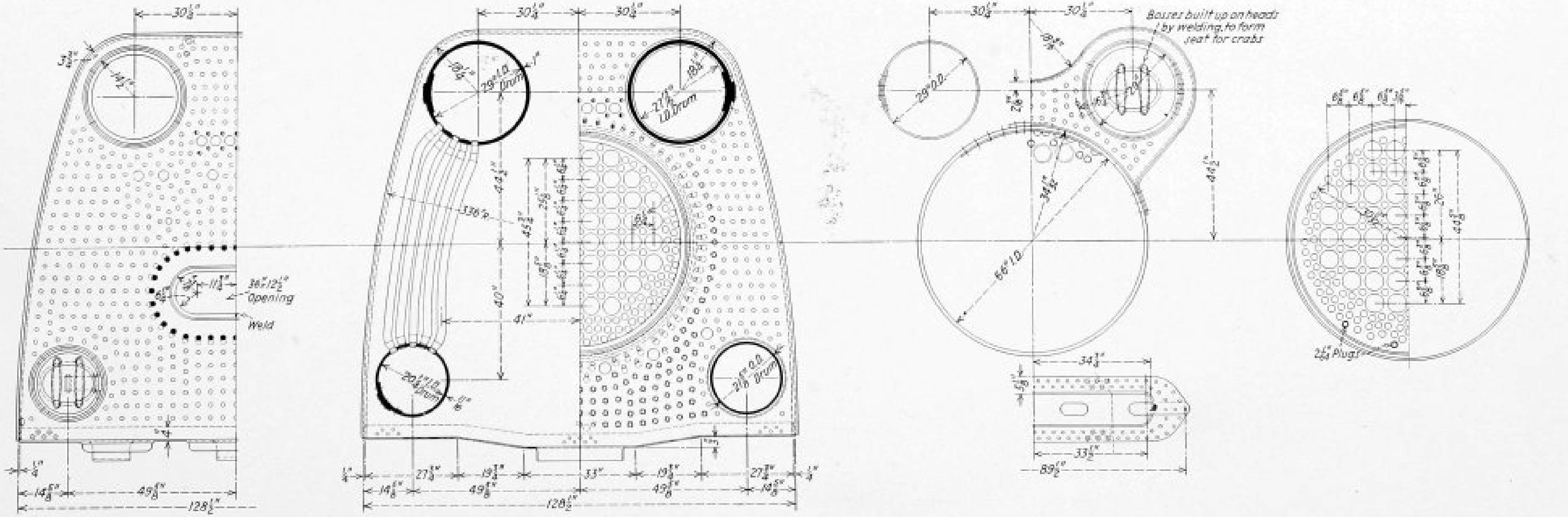
(Lower Left) The rear header is similar to the center header with the exception of the firedoor opening.

(Lower Right) Looking forward into the completed watertube firebox, showing the arch tube arrangement.

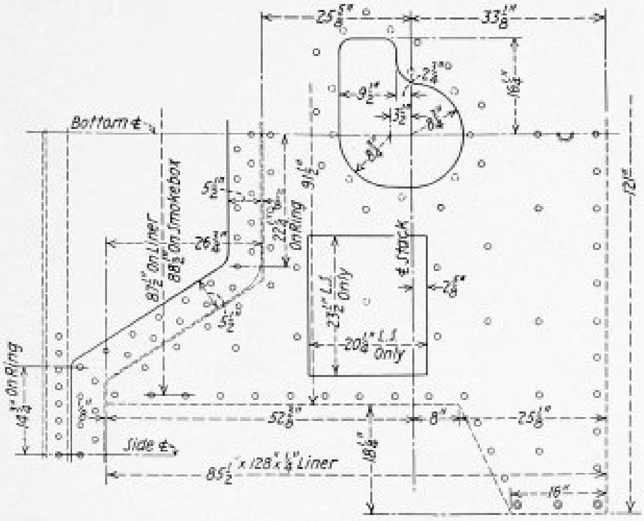




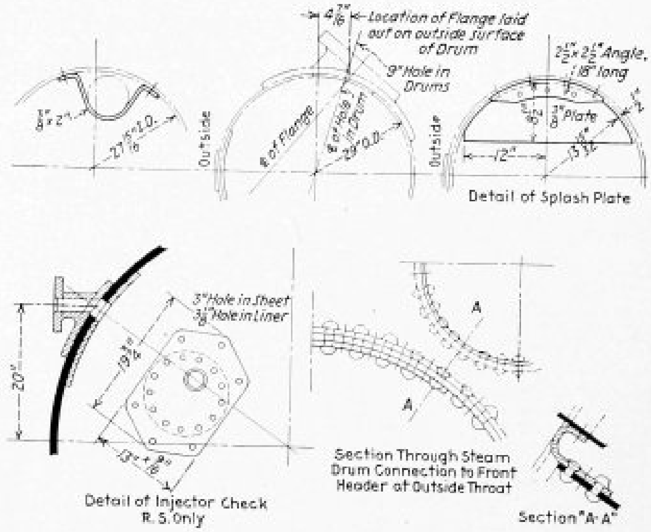
Longitudinal section through D. & H. boiler



Cross sections of boiler through firebox and barrel



Smokebox liner



Details of boiler

Hollow-drilled rigid staybolts used in this boiler are of Ewald or Ulster special iron. Flexible staybolts are of the Alco solid type made of Ewald or Ulster special iron.

The first vertical row of water tubes, both right and left, are of Allegheny steel while other vertical water tubes and horizontal water tubes are cold drawn seamless steel. As in other construction details, great care was exercised, in applying tubes, to insure tight connections. The staggered arrangement of water tubes is the result of experience with previous installations. The inside row of vertical firebox water tubes has a bend radius of 90 inches. In detail the following tubes have been installed in the firebox:

Row	Outside Diameter Inches	Type Tubes
Vertical Water Tubes		
1 (outside)	2½	No. 6 B.W.G. min.
2	2½	No. 6 B.W.G. min.
3	2½	No. 6 B.W.G. min.
4	2½	No. 6 B.W.G. min.
5 (inner)	2½	No. 6 B.W.G. min.
Horizontal Water Tubes		
Six	3	No. 6 B.W.G. min.

Adequate firing clearance and combustion volume at the front of the firebox have been provided by giving ample distance from the grate surface to the under side of the baffle wall. The watertube firebox has a total of 1048 square feet of heating surface, while the arch tubes installed have a heating surface of 66 square feet.

Plating of Allegheny metal has been fit over the outer water tubes and is retained in position by a skeleton framework of metal between the steam and water drums. This covering makes air and smoke-tight joints with the center and rear headers and top and bottom drums under all conditions. Dusting doors are located in the fireproof metal covering insulation and jacketing on each side of the firebox so that ash, which may accumulate on top of the water drums and in each of the right and left banks of water tubes, can be blown off from the outside of the boiler.

The ash pan, fitted with two sliding covers, is made of steel plate 3/16-inch thick, well braced to prevent warping and burning and substantially supported at the water drums, rear header and bridge wall support and from the expansion plates and engine frames. It is made with approved lap joints and is dust proof except at the side air openings immediately below the water drums. Air opening of 100 percent is provided by the netting in the sides of the pan, but with a plate over the air openings so arranged as to prevent fire from dropping. The ash-pan dampers are automatically operated. The ash-pan flushing or washout arrangement is steam operated with a ¼-inch perforated pipe located at the top slope of the ash pan sides.

In the firetube section of the boiler, there are 155, 2-inch tubes having a length of 15 feet and 52, 5½-inch superheater flues with a length over sheets of 15 feet. All tubes and flues are of hot-finished seamless nickel steel. The fire tubes have a heating surface of 1209 square feet, while the fire flues have 1116 square feet heating surface. The total heating surface of the boiler, including fire tubes and flues, water-tube firebox and arch tubes is 3439 square feet. The superheater heating surface is 1037 square feet. The grate area is 81.90 square feet. The tubes and flues are set according to the railroad's standard practice with beads at the back tube sheet sealed by fusion welding and with beads rolled at the front tube sheet not welded. Superheater flues are spaced in vertical rows on 6¼-inch centers and are reduced at the firebox end, while the fire tubes are spaced on 2¾-inch centers.

In order to insure that the steel tubes would be sufficiently strong for the pressure under which the boiler will operate, specifications called for 5½-inch flues having an elastic limit of 40,000 pounds per square inch, a tensile strength of 60,000 pounds per square inch and were required to meet a hydrostatic test of 1500 pounds per square inch. The 2-inch tubes also have a strength of 60,000 pounds per square inch.

Washout plugs and arch tubes are applied in the same locations as on the previous locomotives.

The superheater is made up of 52 units, the four in the bottom transverse row being of the single-loop type, while all others are of the double-loop type, having cast-steel return bends of D. & H. standard. Holes in the back flue sheet for superheater flues are of 5¼-inch diameter in order to obtain ¾-inch or better bridges between tubes and flues.

The superheater is of the improved outside top-header type, having straight-tube elements fitted with full ball joints, loose-joint seat collars, equalizing bars and inverted retaining bolts, one between two inlets and between two outlets of two elements. The top header is of cast-steel solid pattern with integral extension top and ribs so that joints, bolts and nuts can be removed and applied from the outside and without interfering with header insulation. Arrangements are made in the header for saturated steam inlet and superheated steam outlet connections suitable for an outside steam throttle valve, and cross-compound system steam pipe connections of adequate size to avoid any reduction of velocity pressure of the steam movement from the steam throttle valve to the steam chest due to wire drawing or frictional resistance. The header is tightly secured to the top of the smokebox by means of intermediate cast-steel connections, machine fitted and riveted to the shell.

Vertical type boiler check valves with a shut-off valve between the check and the boiler are fitted, one located on the right side of the first parallel course and one on the left side of the second parallel course. These valves are fastened to the boiler with a riveted flange so that the water opening can be closed and the check removed without blowing off the boiler. The non-lifting injector is suitable for 500 pounds saturated steam pressure against a boiler pressure of 500 pounds and has flanged connections. The feed-water heater is of the Dabeg DOP type and delivers feed water of 75 degrees F. temperature to the boiler when operated at minimum capacity and from 250 to 300 degrees F. temperature at maximum.

The smokebox is of the extended type having a shell thickness of 9/16-inch tank steel with a 1/4-inch liner. The smokebox front is of cast steel with a 1/2-inch cast-steel door. The front end is arranged for a 22-inch stack and basket type netting.

Some of the instructions given to the boiler shop for the construction of the boiler are of interest since they give a definite picture of the methods and workmanship that go into a boiler of this character. For example, so far as the design permitted, provision has been made for expansion and contraction in every direction, particularly for steam drums between the front and center headers. Adequate protection has been provided against overheating of any sheets or parts due to insufficient circulation of water under any and all normal working conditions. All plates used in the boiler are of as large dimensions as practicable, while seams and joints of these plates were carefully designed to insure the highest possible efficiency. Wherever practicable, seams were calked inside and outside. Flanges were turned in the hydraulic press with uniform heating in one operation whenever possible. Where flanged sheets showed abnormally cooled spots when removed from the dies, they were reheated before annealing in order to eliminate all strains and stresses.

All rivet and staybolt holes in front, center and rear header sheets were drilled and reamed to size and to exact alinement. No punching or drifting was permitted. Holes in the front and back tube sheets were punched to one diameter and then pin-drilled, after which they were accurately reamed to gage and slightly countersunk on both sides to insure all sharp edges being removed. Particular attention was given to joints between steam and water drums and firetube barrel and the connecting headers to prevent the liability of leakage and to provide maximum stiffness throughout.

Seams in laps and joints at connections were scarfed to fit, the scarfing being well set when heated to insure full bearing for the entire width of the joint and lap. The majority of the rivets were hydraulically driven and were swelled in the heads according to the builder's standard practice. In the firebox, rivets exposed to the furnace heat were half countersunk on the fire side.

All header foundation rails were machine smoothed on the faces against which the boiler plates were riveted. The calking edges of plates were planed or milled where possible before application. Fusion welding was resorted to only as an auxiliary means to seal a joint and not for the purpose in this boiler of providing strength. Flanging radii were made as large as practicable for all sheets in order to reduce unstayed flat surfaces. Plates for the two upper steam drums and the two lower water drums and bottom water drum welts were of low-carbon, nickel steel of firebox quality with a minimum tensile strength of 70,000 pounds per square inch.

Testing Steel Sheet for Weldability

One of the fundamental considerations for successful oxy-acetylene welding of steel sheet is the careful selection of good material. Inferior sheet is bound to produce an unsatisfactory result. It does not matter how skilled the welder may be or how high grade his welding equipment is, if he is handicapped by poor grade material, the finished product will not be up to standard.

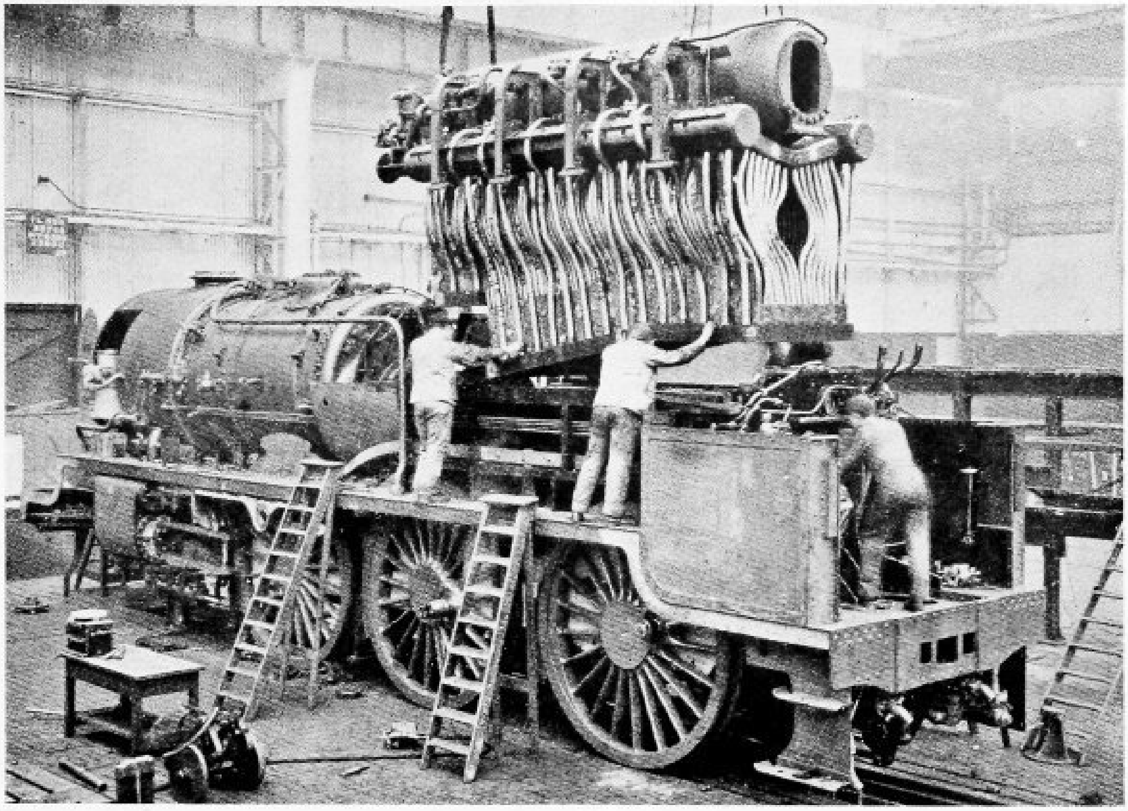
Chemical composition alone is not sufficient indication of the quality of steel sheet. Welding qualities are determined to a great extent by the presence or absence of minute amounts of impurities in the steel. This holds especially true for thin sheet steel. Through lack of proper supervision in manufacture, steel sheet may at times contain a variety of non-metallic inclusions or impurities, most of them the product of the furnace work. These impurities are sometimes so small that it requires a good microscope to detect them. They do not show up in the chemical analysis but they have a very decided effect on the behavior of the steel under the welding flame. It is always advisable, therefore, to specify that the steel shall be suitable for welding and as a further check to test lots of steel as they are received from the mill. Such a test is easily made in the following manner:

Select a piece of sheet from the lot, about 6 inches square and place it flat on the welding table. Fit a welding tip to the blowpipe of a size smaller than that prescribed for work on your welding chart. Light the blowpipe and adjust the flame to neutral. Hold the blowpipe so that the tip of the inner cone of the flame is about 1/8 inch away from the sheet. Move the flame slowly along a straight line so that the sheet will be melted without burning clear through. After a strip about 3 inches long has been melted in this way, hold the blowpipe still until a hole is burned through.

If the sheet is high grade the path followed by the blowpipe will be free from an excess of oxide or scale and regular and smooth on the upper side. The under side of the test sheet will show a slight sag of smooth metal, free from oxide. The hole will be round and have smooth, rounded edges.

Sheet of inferior quality will show an oxide deposit on the upper side, part of which will be porous or flaky scale. There will also be a succession of irregular ripples, higher in the center than on the edges. The under side will show a sag that is covered with oxide. There may even be a series of small holes blown through by the sparking action of the impurities. In poor sheet the metal will be burned through very soon after the blowpipe is held stationary, and in much less time than is necessary to put a hole in good sheet. When the test sheet cools, examination will disclose porous, spongy looking globules of oxide on the edges of the hole.

These tests give assurance that the sheet is of the proper quality.



L. M. S. R. locomotive in process of erection

What is the Boiler Pressure Limit?

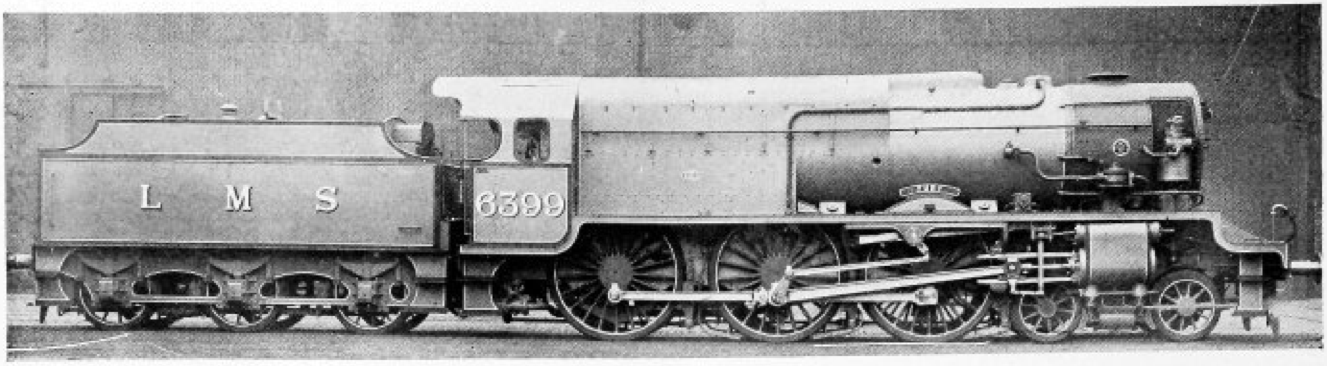
The London, Midland, Scottish Railway operates locomotive at 1800 pounds boiler pressure

Late in December, 1929, an experimental locomotive generating steam at 1800 pounds, 900 pounds and 250 pounds in three sections of the boiler was placed in service by the London, Midland & Scottish Railway of England. This novel locomotive was designed by engineers of the company in conjunction with The Superheater Company, Ltd., by the North British Locomotive Company, Glasgow. The locomotive was built under the direct supervision of Sir Henry Fowler, K. B. E., chief mechanical engineer of the L. M. S. R.

In general, the locomotive is of the standard three-cylinder, simple, 4-6-0 type, but with the high-pressure boiler features mentioned above. This boiler is similar to the Schmidt high-pressure boiler built by Henschel & Sohn of Kassel, and which underwent considerable trials in a 4-6-0 locomotive of the German Railways converted from a standard type with ordinary boiler. Some idea of the general characteristics of the L. M. S. R. boiler may be gathered by reference to the illustrations taken during erection at the builders' works. The boiler consists of three portions, generating steam at 1400 to 1800 pounds, 900 pounds and 250 pounds per square inch. The 1400 to 1800-pound section consists of a watertube firebox forming a closed circuit. The vertical tubes are connected at their lower ends to a foundation ring, and the ring forming the base of the combustion chamber. At their upper ends they are expanded into two horizontal cylindrical equalizing drums from which coils pass to the interior of a large steam drum arranged partly between and partly above the drums of the closed circuit. The steam circulating in these coils evaporates the water in the large steam drum, and generates steam at a pressure of 900 pounds per square inch. The material employed for this larger drum, which is not in contact with the fire, is nickel steel. It is a machined forging and was supplied by John Brown & Company, Ltd., of Sheffield, who specializes in the manufacture of high-pressure boilers and drums. The steam there generated, after passing through a superheater, is used in the high-pressure cylinder.

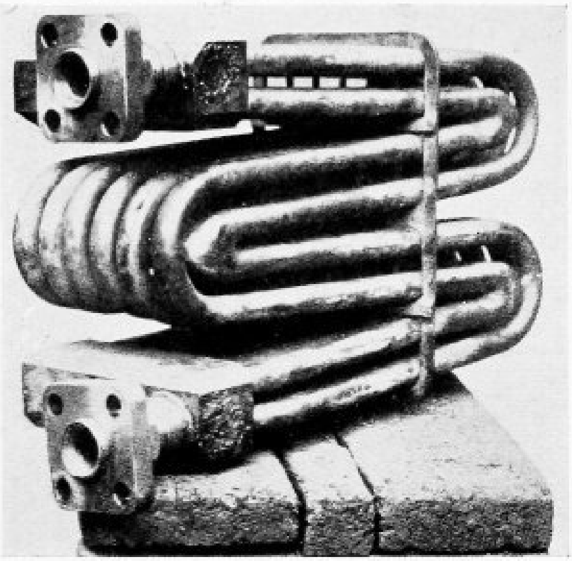
The forward portion of the boiler corresponds generally to the orthodox locomotive boiler barrel, and consists of a nickel-steel barrel with front and back tube sheets of mild steel, through which the flue tubes carry the hot gases to the smokebox. Steam is generated in this portion at 250 pounds per square inch.

For feeding the high-pressure drum, a pump is provided which takes its supply from the low-pressure boiler. Water is supplied to the low-pressure boiler by a live-steam injector located on the driver's side and an exhaust steam injector on the fireman's side. As



High-pressure locomotive with novel boiler

steam is raised much more quickly in the high-pressure drum than in the low-pressure boiler, arrangements are made to by-pass, by means of an intercepting valve, any excess steam from the high-presure drum into the low-pressure boiler, thus avoiding waste through blowing-off.

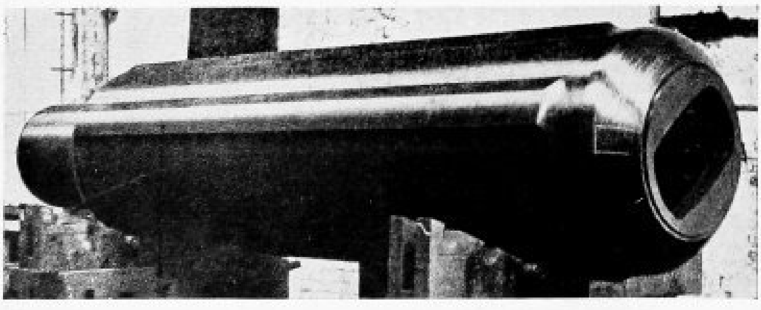


Evaporating coils ready for installation

The regulator handle works both the high-pressure and the low-pressure regulators simultaneously. On opening the regulator, steam is admitted into the high-pressure cylinder, after passing through the high-pressure superheater situated in the lower boiler tubes. Exhausting from the high-pressure cylinder, the steam enters a mixing chamber, where it is met by steam at 250 pounds pressure, which has previously passed through a low-pressure superheater situated in the upper boiler tubes. From the chamber in which it is mixed the steam enters the two outside chambers.

The locomotive has been introduced experimentally for the purpose of working the heaviest main-line express trains, and, according to report, it is intended to test it on trains running between Glasgow and London. As in the case of the contemporary high-pressure engine now being tried out on the L. N. E. R., the results obtained in actual service with the new design will be watched with considerable interest.

At the completion of the trials of this interesting locomotive, when it was entering Carstairs station in London, without warning a cylinder exploded. An inquiry into the explosion has been held and should this result in the blame being attributed to faulty design, a number of alterations will be made before the locomotive is again tested. The company is confident, however, that the general design constitutes a marked advance in locomotive engineering.



Nickel-steel drum before assembly

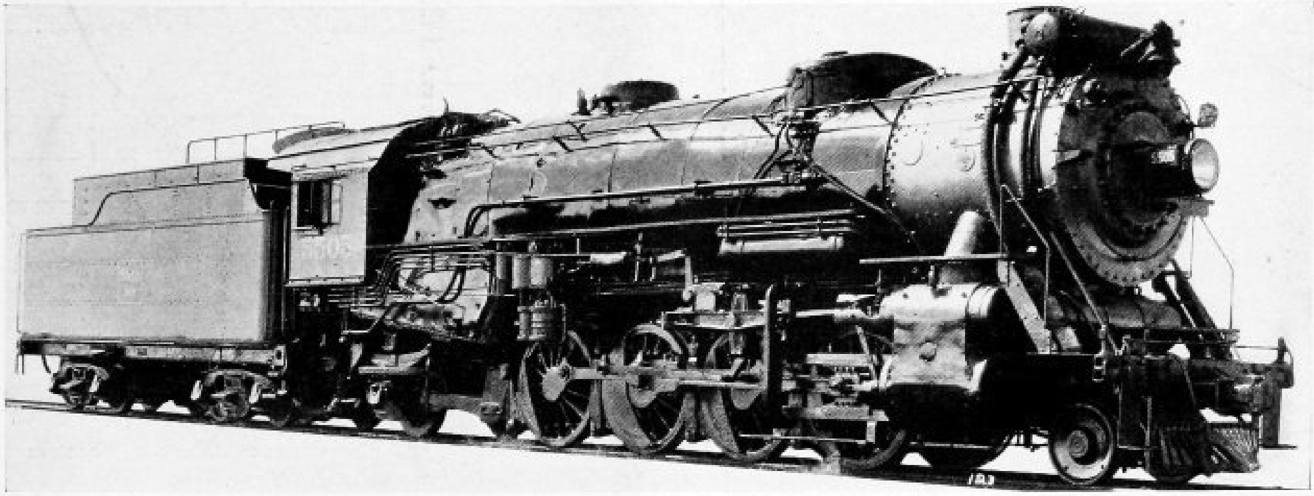
Fatal Boiler Explosion

Two owners of the Blue Ribbon Laundry at Dallas, Texas, were killed almost instantly and an employe had both legs broken, when, on Sunday, January 19, a Scotch-type boiler used for heating water, exploded and completely demolished the sheet-iron building in which it was housed.

Purchased second-hand about five months previous to the accident, the boiler had a patch 36 inches wide running along the bottom of the shell from head to head. This patch was secured by electric welding, and in the explosion both longitudinal welded seams were torn apart for their entire length. The shell itself was hurled about 150 feet into the yard of a residence, while parts of the boiler and the iron shed landed on housetops, a block away. Firemen pulled the victims from beneath the wreckage.

The boiler had been washed out and had been under pressure only a short time when it failed. Apparently the pressure at which the explosion occurred was around 100 pounds, for the steam gage, found amid the debris, stood at that pressure. The safety valve could not be located.—*The Locomotive.*

The Lincoln Electric Company, Cleveland, Ohio, has opened three new offices as follows: J. D. Luter is in charge of a new office at 338 Barnard street, Saginaw, Mich.; D. H. Carver at 225 E. Columbia street, Ft. Wayne, Ind., and E. D. Anderson at Oil City, Pa.

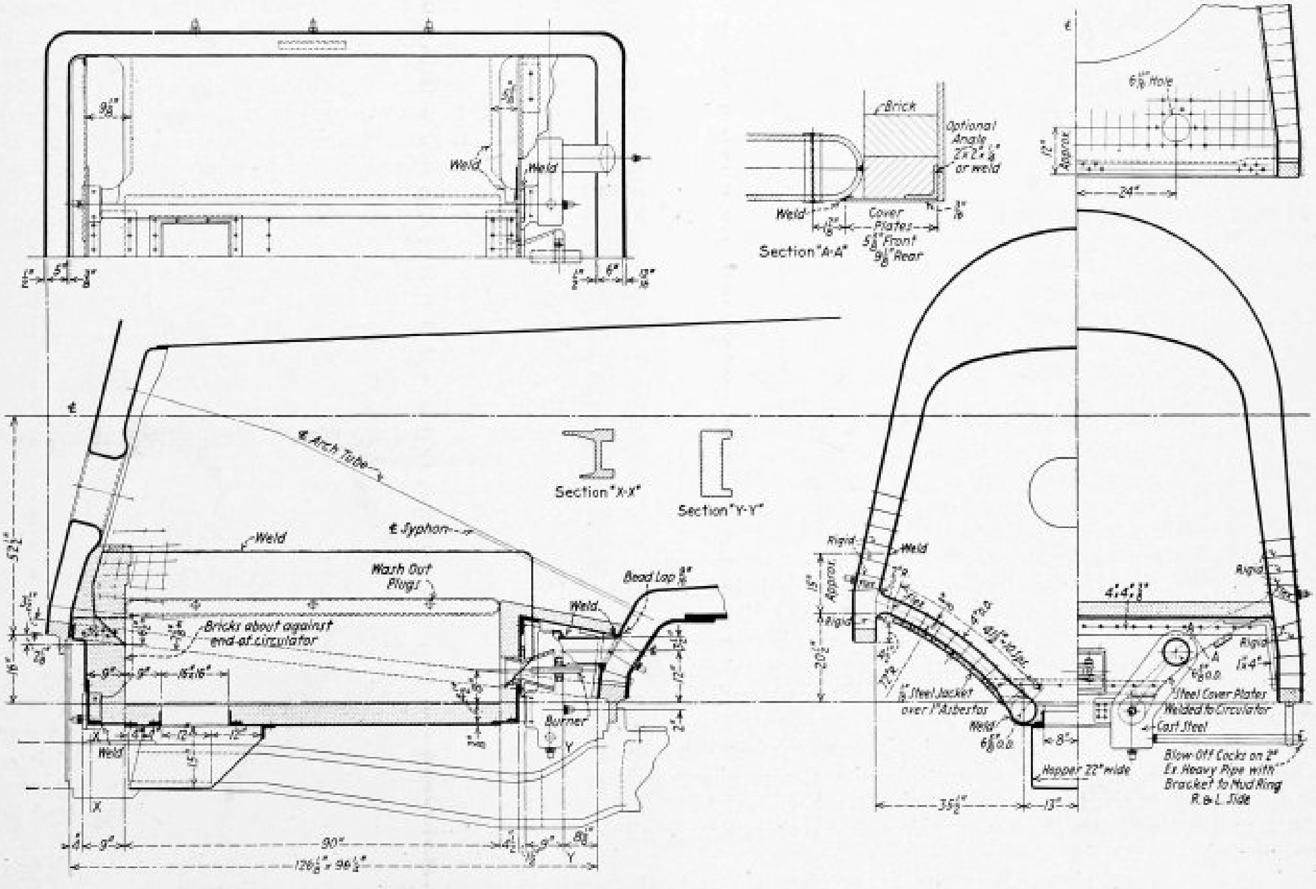


Chicago, Burlington & Quincy locomotive equipped with Martin circulator

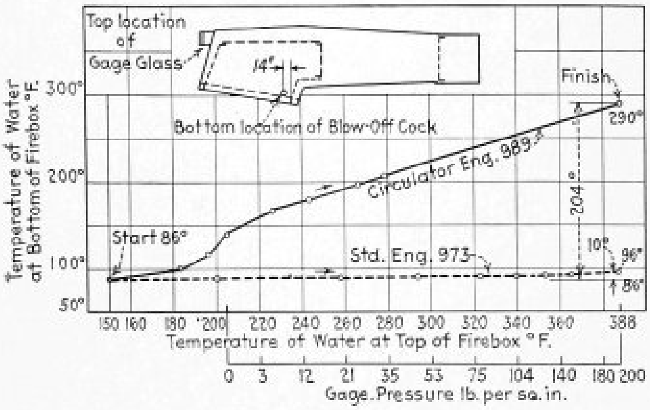
Martin Circulator Undergoes Tests

In September, 1928, a Texas & Pacific 2-10-2 type locomotive, No. 541, burning oil, was put into service after being equipped with a Martin circulator manufactured by the Locomotive Boiler Economizer Company, Los Angeles, Cal. Since that time it has gone from shopping to shopping and is now back in heavy pooled freight service. The locomotive was placed in the Marshall (Texas) shops for Class 3 repairs after making 76,477 miles during a period of 23 months over all divisions of the railroad so that its performance might be observed under widely varying conditions of service.

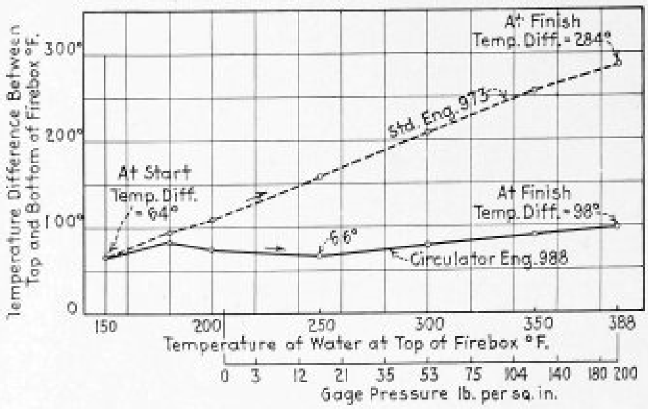
On removal of the tubes a careful interior examination of the boiler and firebox sheets was made and the surfaces of all the sheets were found to be in good condition, with no indication of corrosion or pitting. Normally an engine of the same size and class and under the



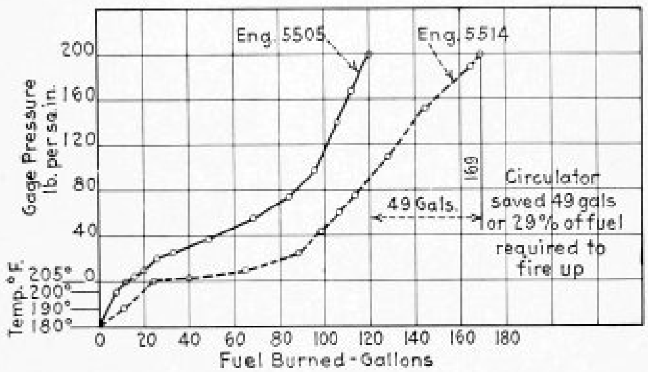
The Martin Circulator designed with throat-sheet connections



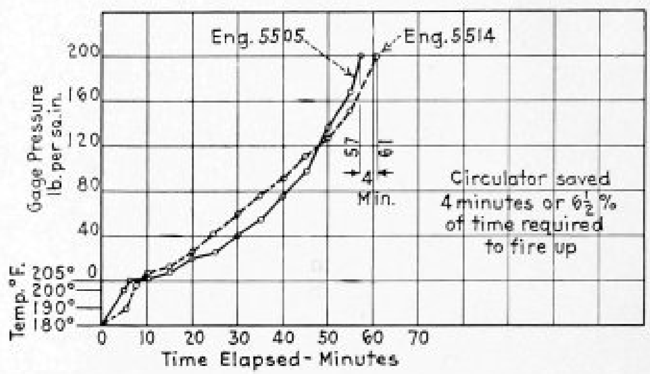
Water temperatures at the top and bottom of the firebox while firing up



Differences in water temperatures at the top and bottom of the firebox while firing up



A comparison of the fuel oil burned in firing up locomotives with and without the Martin circulator



A comparison of the time required to fire up locomotives with and without the Martin circulator

same operating conditions requires a full tube renewal at the end of 50,000 miles.

After receiving Class 3 repairs the locomotive was again placed in regular service in September, 1929, and as of January 1, 1930, has made a total of approximately 90,000 miles. The circulator as originally installed is at present in the locomotive in good condition, and records show that its cost of maintenance has been a negligible factor, justifying fully its installation as a means of protecting the firebox sheets, tubes and shells at a minimum cost. The low cost of maintenance of the circulator is accounted for by the continuous and rapid circulatory movement of the water which it occasions, being the means of not only circulating water through itself, but effecting a decided stimulation of water movement through the water legs of the firebox and the dormant spaces of the boiler shell surrounding the tubes.

From the condition of the firebox and boiler disclosed by the interior examination of locomotive No. 541 and experience with other 2-10-2 locomotives of the Texas & Pacific subsequently equipped with the circulator, it is expected that the circulatory movement of the water effected will double the life of fireboxes and boiler tubes. While offering this protection to the firebox and boiler, the generation of the rapidly moving water into steam has consistently shown a fuel saving of approximately 10 percent on locomotive No. 541 and all other locomotives equipped.

As now applied, the steel feed pipes supplying the circulator with water are secured in the throat sheet by beading over their ends against the inner side of the sheet and welding to the outer side of the sheet in a manner similar to the application of arch tubes. The feed pipes are entirely without the firing chamber and consequently are not subjected to the heat of combustion.

The effect of the water movement created by the circulator is illustrated graphically by the curves showing the results of a test made on the Southern Pacific, Texas and Louisiana Lines, under the direction of J. A. Power, superintendent of motive power and equipment. Two locomotives of the same size and class and in like physical condition were fired up on adjoining pits. Thermometers recorded the water temperature at the gage glass and at the blow-off cock. No change in temperature of the water in the bottom of the leg of the standard locomotive was made until the boiler pressure reached 150 lb. per sq. in. and when the locomotive popped there was a difference in temperatures of 284 deg. F. between the top and the bottom of the firebox.

In the locomotive equipped with the circulator the temperature of the water started to change quickly, being 140 deg. F. at zero gage pressure and rising rapidly so that when the locomotive popped at 200 lb. pressure there was a temperature of 290 deg. F. in the bottom of the leg, or a difference in temperature between the top and the bottom of the firebox of only 98 deg. F.

Another graphic illustration shows the fuel saving effected by the circulator in firing up in enginehouses. These curves cover tests made on Chicago, Burlington & Quincy oil-burning locomotives at Casper, Wyo., under the direction of H. H. Urbach, superintendent of motive power. The fuel saving is 49 gallons, or 29 percent in bringing the locomotive up to the popping point of 200 lb. pressure. Tests on other lines are said to show a consistent fuel saving for firing-up which can generally be taken as 25 percent of the fuel required in the conventional type of oil-burning firebox.

Road tests have determined that circulator-equipped locomotives carry their water well even though objectionable priming conditions exist.

During the past two years it has been demonstrated that, by eliminating the fire brick of the conventional fire-pan arrangement from the side sheets and bottom of the firebox, locomotives can be turned in three hours quicker time at terminals. There is no brick against side sheets to cool down before water can be safely removed from the boiler for washing. Locomotives equipped with the circulator do not pop from excessive heat energy stored in the fire brick when the throttle is closed after a heavy pull. On booster-equipped locomotives having the circulator, the booster may be cut in for a longer period of time.

Cleaning Threads on Boiler Washout Plugs

Where locomotive boilers are equipped with a number of brass washout plugs they are usually threaded 12 threads per inch, with a taper of ¾ inch in 12. It is important that these plugs be maintained steam tight, which means that the threads must be in good condition. Each time the boiler is washed out, all plugs must be removed, inspected and cleaned.

Various methods are employed for cleaning the threads on these plugs, but the device shown in the accompanying illustration does this work in a very efficient manner. The device consists of a frame *A*, a die holder *B*, and a die adjusting plate *C* as the principal parts. To use the device the plugs are inserted in the socket attached to the driving rod by a universal joint. The plug is entered in the die holder, the dies of which are adjusted by the use of the handle *1* attached to the die-adjusting plate. After the dies have been adjusted to take the size of plug needed, the plug is run into the die by turning the crank *2*. About one minute is required to re-chase or clean the threads on the ordinary washout plug.

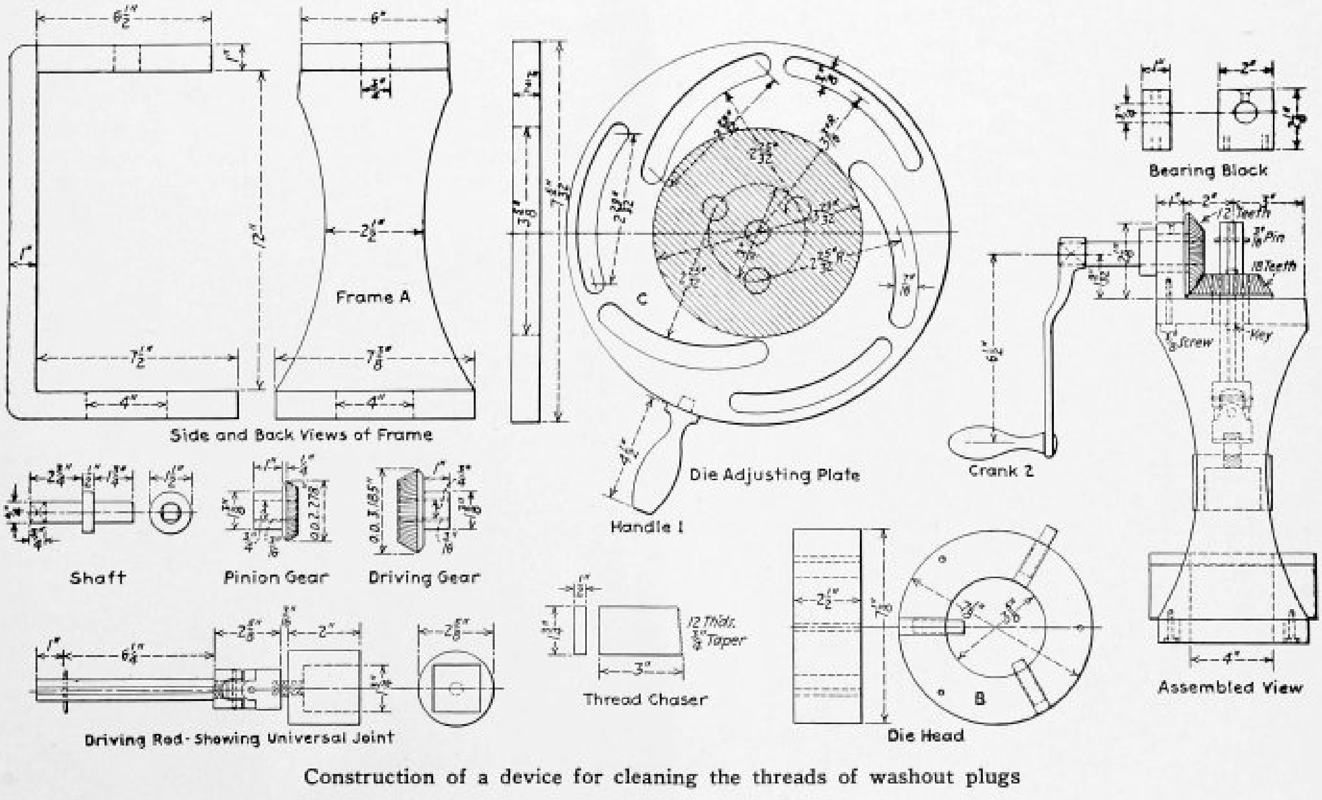
For convenience the device can be mounted on a small two-wheeled truck and placed near the locomotive from which the plugs are to be removed. The dies used in the device have the taper ground on them, with the result that all plugs run through them will have the correct taper. Many plugs that would otherwise be thrown away can be reclaimed and used again by being run through this device.

The illustration also shows the method used in laying out the die-adjusting plate *C*. A disk is pressed in the die-adjusting plate and all centers are located on this disk as shown. After the machining operations have been completed the disk is then removed. The shaded portion of the die adjuster is not cut out until after the slots have been milled out. Roller bearings are fitted in the slots.

E. R. Fish Joins Hartford Steam Boiler Company

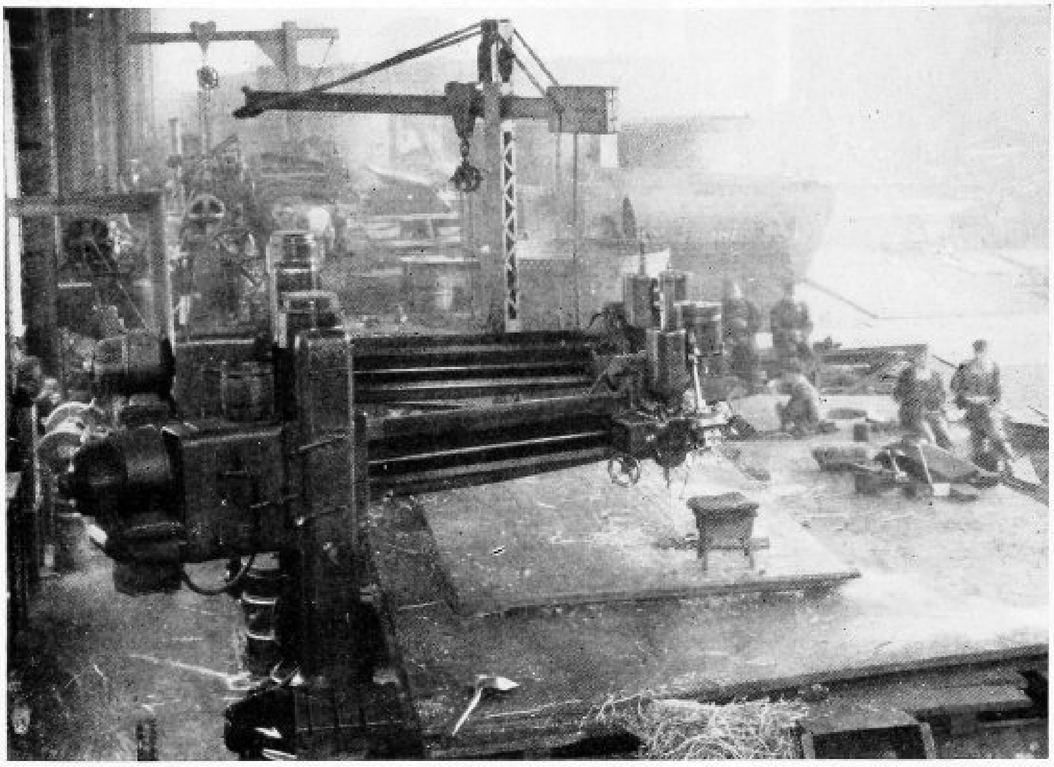
On May 1, Edwards R. Fish, prominent in the engineering field and active on various committees of the American Society of Mechanical Engineers, joined the engineering department of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., as chief engineer of the boiler division.

Mr. Fish is a native of Georgia, receiving his early technical education at the St. Louis Manual Training School, and graduating with the degree of mechanical engineer from Washington University. For some time he has been consultant to the boiler engineering department of the Combustion Engineering Corporation, New York, and previous to that was vice-president of the Heine Boiler Company, St. Louis, Mo., which has been merged with the Combustion Engineering Corporation.



Construction of a device for cleaning the threads of washout plugs

Boiler Shop Standardizes



General view of the N. & W. boiler shop located at Roanoke

The Roanoke boiler shop of the Norfolk & Western Railroad Company, located at Roanoke, Va., offers an example of the degree to which standardization in boiler construction may be carried for successful and economical operation. This plant has produced a number of locomotive designs and, through its standardization of boiler parts, has been able to reduce not only the cost of construction, but, which is more important, the cost of maintenance of locomotive boilers after the locomotives have been in service.

Complete interchangeability of all parts of each type of boiler enables the company to maintain a complete set of stock parts. Thus when replacements are required, these may be supplied in the shortest time, thereby reducing the lay-up requirements for shop repairs and overhauling. Because the parts of each type of locomotive are interchangeable, it is possible to supply fireboxes or tube sheets completely drilled and fabricated and ship them to an outlying shop on the road with the knowledge that, when assembled in the locomotive, these parts will fit exactly. There is no waiting for the locomotive to arrive at the boiler shop nor need of measurements taken from the locomotive in order to fabricate the parts for replacement. This advantage is the basis upon which the activities of the Roanoke shops are regulated.

The boiler shop has applied the principles of centralization and standardization to an extent that it is difficult to visualize without a visit to the shop in order to view the results of years of experience. The advantages of these principles may be seen in the comparatively small number of locomotives undergoing repairs in the erection shop, and after viewing the plant in operation, it is realized that the success of this system is due to the careful planning of the work from the preliminary design of the locomotive throughout its entire service on the road.

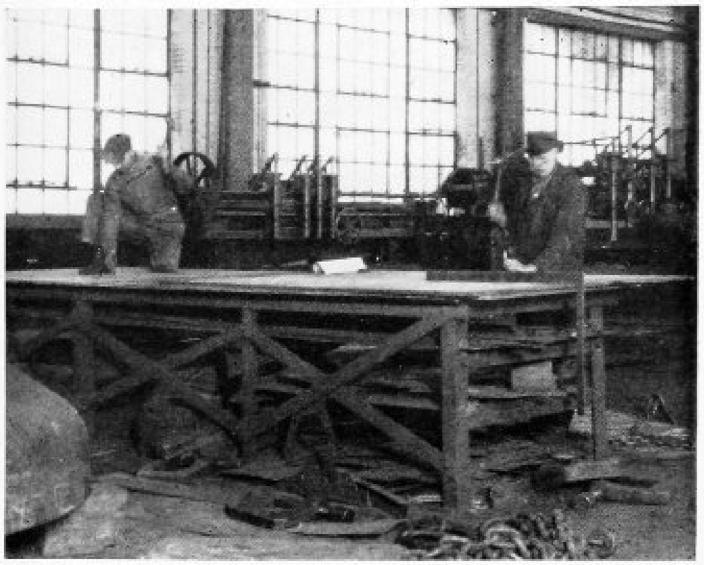
The shop organization is made up of approximately 230 men, this force being maintained nearly intact year in and year out. The men are trained as a general rule in the railroad's own apprentice schools and are sufficiently versatile to handle various types of work. When one gang is given the job of preparing a back head, for example, this gang can carry out the entire job, can lay out the work, drill the plates, trim the edges, and flange if necessary. This practice eliminates a good deal of lost time in transferring the work from gang to gang where each group of men specializes in one class of work. Furthermore, due to this system, it is possible in slack times to maintain the entire organization by transferring the men from one class of work to another where the activity of the shop is more in evidence.

Welding the ring of a tube sheet

The boiler shop is housed in a building approximately

Construction

Interchangeability of parts found economical at the Roanoke shop of the Norfolk & Western



The layout table at the Roanoke shop

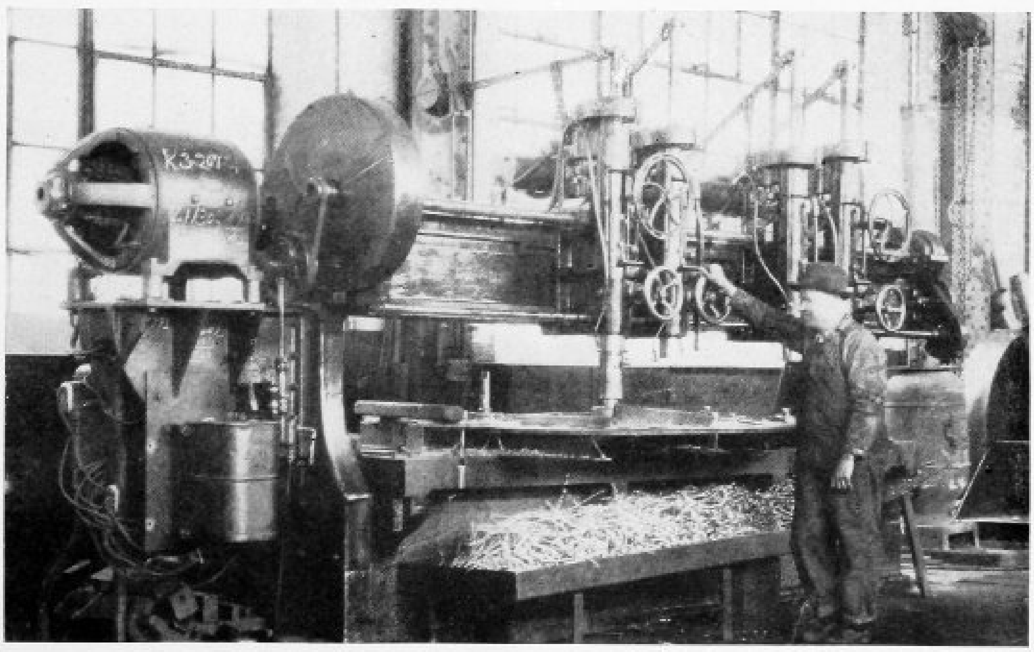
370 feet long by 72 feet in width. This shop is of steel and brick construction with large windows permitting the entrance of light on each side of the structure. The building has a height of 50 feet to the roof trusses and the floor is paved with creosoted wood blocks. The entire department is served by two traveling cranes, one of 80 tons and the other of 30 tons capacity. For use at the various machines, six portable hand-operated jib cranes are available.

At one end of the shop is located an hydraulic bull riveter which has a 17-foot stake and is capable of exerating pressures of 50, 100 and 150 tons. Hydraulic pressure is supplied by a pumping machine, which is operated by a 105-horsepower continuous current motor. The bull riveter is served by an overhead crane, controlled from the bull riveter platform and rivets are heated in an oil-burning rivet heater.

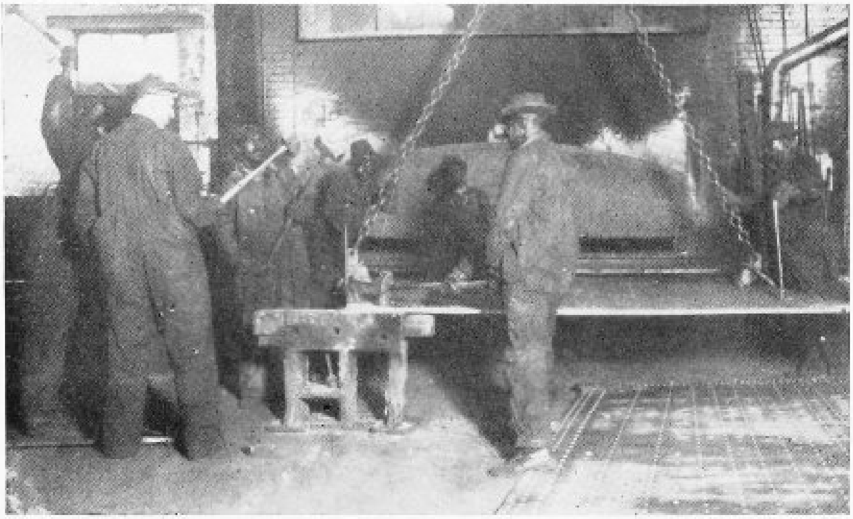
Other equipment at the lower end of the department includes a 2-stake sectional flanger and a flanging press, both of which, together with the hand-flanging slabs, are served by an oil-burning furnace having a width of 15 feet and a depth of approximately 12 feet. This furnace is situated at one side of the building, its doors being fitted in the wall and the main portion of the furnace located outside of the shop. In addition, three coal-burning flanging fires serve the hand-flanging department. A cold flanger is included in the equipment.

Two plate rolls, both electrically driven, are located at the side of the bay about one-quarter of the distance from the bull riveting end of the shop. The larger of the two rolls is capable of rolling 1⅜-inch plate and consists mainly of three cylinders, having a width of 16 feet 2 inches. Two lower rolls are 18 inches in diameter, while the top roll has a diameter of 24 inches. The smaller plate roll has a top roll 14 inches in diameter and two bottom rolls 12 inches in diameter. The machine is capable of rolling plate from ⅝ to ¾-inch in thickness. The width of the rolls is 12 feet 3 inches.

The drilling equipment includes two 72-inch radial drills, having a three-rail movable carriage. The motor is directly mounted on the machine, driving the drills without the use of belts. Adjacent to this machine is a double-faced grinding wheel. Additional drilling



Drilling flue holes on a four-spindle machine



Scarfing the corners of a side sheet

equipment includes a 4-spindle multiple drill, with motor on the machine. This machine is employed mainly for the drilling of flue holes. Another 4-spindle multiple drill is used for drilling mud rings. This machine is direct-driven by an electric motor.

Punching equipment, which is not generally used due to the fact that it is the practice to drill all holes for boiler work includes a horizontal punch. This is belt-driven, the motor being located on the building column. A vertical punch, is also included in the equipment, the motor being located on the machine. This machine is served by a hand jib crane. Additional punches include a motor-driven punch, having a 4-foot gap, capable of punching holes in ½-inch plate and a horizontal punch for use on shapes. The latter machine can accommodate ½-inch material and can punch ¾-inch holes.

The remaining equipment includes a shear which can accommodate 1-inch plate in cuts of 8 inches; a plate planer which can plane in cuts of 16 feet, plates up to 1¼ inches in thickness, and an angle and shape cutter, located at the far end of the shop, capable of taking angles up to 6 inches by 6 inches by ¾ inches in thickness. Adjacent to this equipment is located a multiple shear, bevel and punch for use in tank work. A pneumatic riveter is employed on tank work at the upper end of the shop. This machine has a 3-foot gap and will drive rivets up to 1-inch in diameter.

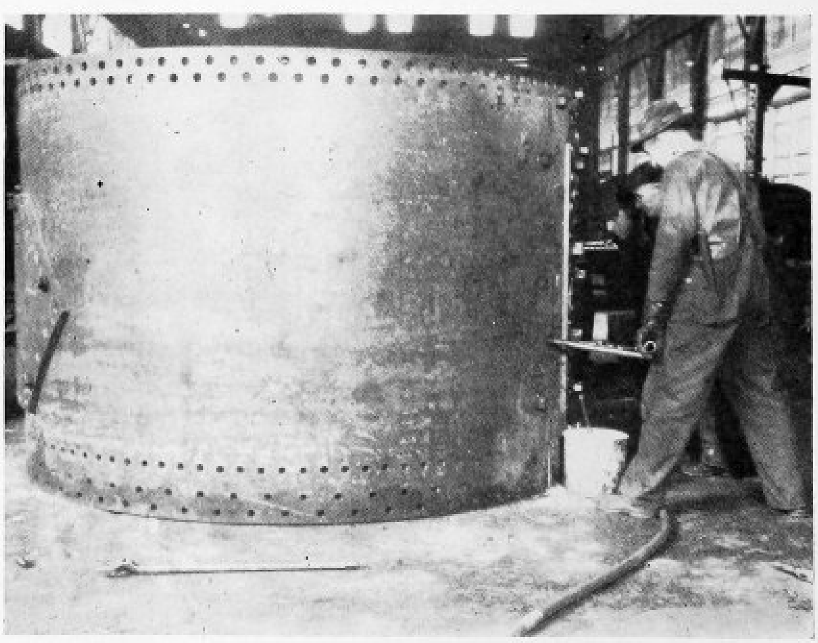
Adjacent to the main boiler shop is located a staybolt shop where all rigid staybolts and many flexible staybolts for the railroad are made; flexible bolts, however, for new construction, are usually purchased outside. Those purchased outside are of the type having electrically welded sleeves. This department manufactures for stock, maintaining a complete supply of bolts for all types of work. The shop is lined with bins on two walls. These are divided into 161 compartments in each of which is located a different size of bolt. The equipment of the department includes one double head emery wheel, electrically driven, the motor being located on the machine, and one grinder or chaser.

Three other machines are included in this department as follows: One 4-spindle staybolt machine which has its motor located on the building column; a special bolt machine, having six spindles, and a 4-spindle machine, employed for drilling telltale holes in rigid staybolts. The latter tool drills holes and countersinks the end of the bolt in one operation, a centering mandrel being employed with this machine to start the tool in the work.

Adjacent to the staybolt shop is located a staybolt cutting and squaring room, which is equipped with a shear having a 5-hole cutting jaw and a bolt squaring and upsetting machine. Both machines are motor-driven. The latter machine finishes bolts in three operations and is equipped with a shop-designed die having three slots; the first slot is employed to pinch the end of the bar stock; the second operation upsets the end of the bar, and the third operation squares the end of the bolt. This machine is served by an oil-burning furnace, having a length of 5 feet, a width of 3 feet, and a depth of 2 feet. This furnace is shielded with asbestos and is capable of heating 14 bolts at one time.

In addition to these machine tools, the plant is fully equipped with hand tools of the pneumatic type in addition to oxy-acetylene torches and arc-welding sets. Power for arc welding is obtained from a direct current power line supplying current at 250 volts, which is reduced to 80-volt direct current by means of a motor-generating set. For welding on boiler work, bare electrode wire of ⅛-inch and 5/32-inch diameter is principally used.

While it is interesting to note the equipment employed at the Roanoke shops, the methods of procedure, both in new construction and repair work, are worthy of comment. In new construction, every effort is made to insure the exact duplication of every locomotive of



Reaming longitudinal seam rivet holes

each class. In order to obtain such similarity and to enable interchangeability of the parts in each class of locomotive, each plate of the boiler is completely developed—not in the boiler shop as is the general practice throughout the country—but in the drafting room where all measurements are given exact.

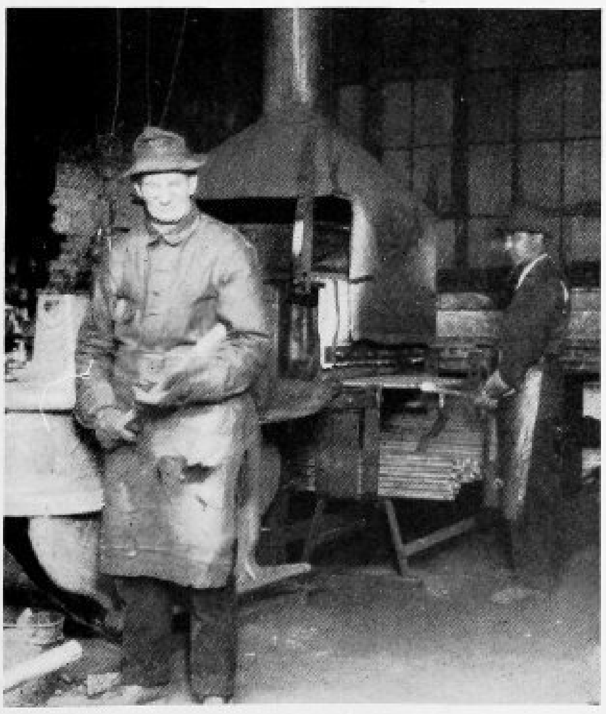
After the drawings have been sufficiently developed so that the sizes of the various plates are known, the bill of material for ordering square plates from the steel mill is made up. This is true in all cases—even in the case of the special one-piece firebox which has recently been developed at the Roanoke shops and was described in the April issue of the magazine. As soon as the preliminary plans have sufficiently progressed, the number of feet of staybolt iron for rigid staybolts is computed and ordered. The lengths, diameters, and number of flexible staybolts, if ordered from an outside manufacturer, are determined at this time and the order placed.

Following the preliminary determination of material from the general plans of the locomotive, the final developments of the boiler sheets are made in the following order: First, the flange sheets are prepared. This type of sheet includes the back head, firebox, door sheet, inside and outside throat sheet, and the steam dome. It is desirable to obtain the developments for these plates at first, due to the fact that more work is required on these plates than on others and due to the desirability to complete the fabrication of all material at approximately the same time.

A corner of the staybolt machine shop

(Right) Drilling rigid staybolt tell-tale holes

(Below) Squaring and upsetting staybolt ends

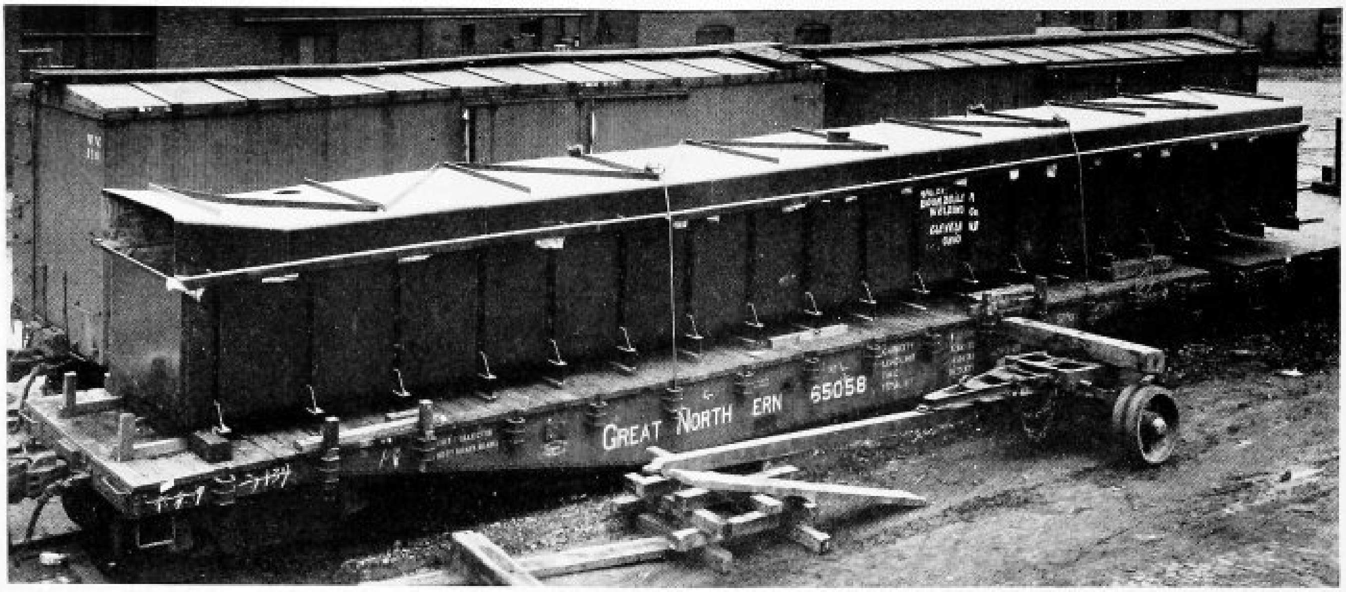


The mud ring is developed second and, being of cast-steel construction, is generally ordered from an outside source. The firebox, crown, sides, and combustion chamber, whether in one piece, three or four pieces, is completely laid out, following the layout of the mud ring and the several flanged sheets.

The fourth development includes the roof and outside side sheets, this development being followed by that of the back flue sheet. The development drawing of the fourth barrel ring, together with butt straps and guide yoke angle plate comprises the sixth in the series of the complete layout plans. This is followed by the development of the third barrel ring with the high-pressure cylinder liner, the steam dome liner, butt straps, and the steam-pipe support.

Eighth in the series of developments is the second-barrel course, together with the auxiliary manhole, welt strip, baffle for the dry pipe and the second course liner. This is followed by the development of the first course with its inside and outside butt straps and reinforcing liner for the main boiler slide bearing. The front tube sheet, together with the dry pipe cast-steel flange, the flue sheet band, and gussets, are next developed. This is followed by the complete development of the smokebox, together with its liner and finally, the front ring of the boiler.

Further descriptions of the Norfolk & Western boiler shop at Roanoke will appear in later issues of The Boiler Maker. Additional articles will contain methods of construction and kinks successfully employed.



Lead-lined welded steel pickling tank loaded for shipment

Manufacturing Pickling Tanks

The Boom Boiler and Welding Company, Cleveland, O., has recently completed the manufacture of eleven large steel tanks, such as shown in the illustration. These tanks are to be used in the dipping process of a large eastern steel mill, the first of their kind to be thus employed.

Eight of the eleven are 60 feet long, and the remaining three are 50 feet long. All of the tanks are 6 feet 6 inches wide, and 4 feet 6 inches deep. They are manufactured of 3/8-inch steel plate, and are lined with a coating of lead 1/8-inch thick. This lead lining acts as a resistance to the acid and is applied by a new process which originated with this company.

The tanks are made up in 10-foot sections, of 3/8-inch steel plate, and are reinforced by I-beams and angles. The sections are made by bending the steel plate into a U-shape so that the sides and bottom of each section are formed from a single plate. These sections are then joined by arc welding, making the completed tank one homogeneous unit of steel, exclusive of the cover. The current for welding was furnished by Stable-Arc welders manufactured by The Lincoln Electric Company, Cleveland, O.

The weight of the large tanks, including the cover, is approximately 20 tons. The cover is made of the same material as the tank itself, and is 24 inches high. It is reinforced across the top by angles arc welded in place to prevent buckling, when being removed from the tank.

The combination of arc-welded steel construction and the homogeneous lead lining is expected to eliminate any difference in contraction and expansion that may result from the action of heat.

The Lewis Asphalt Engineering Corporation has moved its Chicago office from 100 North La Salle street to 740 Rush street.

The Pacific Steel Boiler Corporation, manufacturers of Pacific steel heating boilers, has moved its general office from Waukegan, Ill., to 1056 First National Bank Building, Detroit, Mich.

Charles R. Turn Dies

Charles R. Turn, treasurer and general manager of the International Boiler Works, East Stroudsburg, Pa., and president of the Stroudsburg National Bank, died on April 12 at Stroudsburg, Pa. As general manager of the International Boiler Works, he was instrumental in the rapid growth of the industry which grew from a small business to a million-dollar concern.

Born on August 16, 1865, Mr. Turn was reared on a farm in Smithfield Township, Pa. He received his schooling in the township school and at Blair Academy, Blairstown, N. J., completing his education at the Eastman Business College, Poughkeepsie, N. Y. In 1885 he started in business in the East Stroudsburg Glass Com-

Charles R. Turn

pany, but after five years went with the International Boiler Works.

Learning the business from the bottom, Mr. Turn was made general manager at the age of 35 when the company was incorporated in 1900. He showed great ability as a leader and especially in selecting competent men to handle the various departments of the company.

In 1902, the company bought out the business of Sider & Company, and this plant was incorporated with the company. In 1910, Mr. Turn was elected treasurer of the corporation and has filled that position, as well as general manager, up to the time of his death.

On January 13, 1914, he was elected a director of the Stroudsburg National Bank and was elected president of the bank on January 14, 1920, and was filling that position at the time of his death.

In addition to these major interests, he was treasurer of the Roseto Company, Roseto, Pa., and a member of the board of trustees of the East Stroudsburg State Teachers College.

Looking Backward

A glance back over twenty-five years in the history of the Master Boiler Makers' Association to the time of the fourth annual convention of the International Railway Master Boiler Makers' Association, from which the present organization is an outgrowth, will recall, in the minds of many members, old friends and incidents that have faded into the dim past. In 1905 the International Railway Master Boiler Makers held a convention at the Hotel Brozel, Buffalo, N. Y., May 16, 17 and 18 which was presided over by the present treasurer, W. H. Laughridge. Fifty-seven members were in attendance and 13 supply companies were represented.

At that convention J. T. Goodwin was elected president of the association for the year 1906 and the Supply Men's Association which was formed at that time, elected G. H. Williams as president.

Program of Twenty-First Master Boiler Makers' Convention

Below is published the official program of the twenty-first annual convention of the Master Boiler Makers' Association which will be held at the William Penn Hotel, Pittsburgh, Pa., May 20 to 23.

First Day

Tuesday, May 20, 1930

Registration of Members and Guests
7:30 to 9:50 A. M.

In order to participate in entertainments badges will be required. None will be issued unless your dues are paid and you are properly registered. No deviations from this rule.

Business Session

Convention called to order .... 10:00 A. M.

Invocation:
Rev. Thomas P. Coakley.

Address:
Hon. Charles H. Kline, Mayor of Pittsburgh, Pa.

Response:
E. S. FitzSimmons.

Address:
M. W. Hasset, assistant superintendent motive power, New York Central R. R.

Response:
Kearn E. Fogerty, first vice-president.

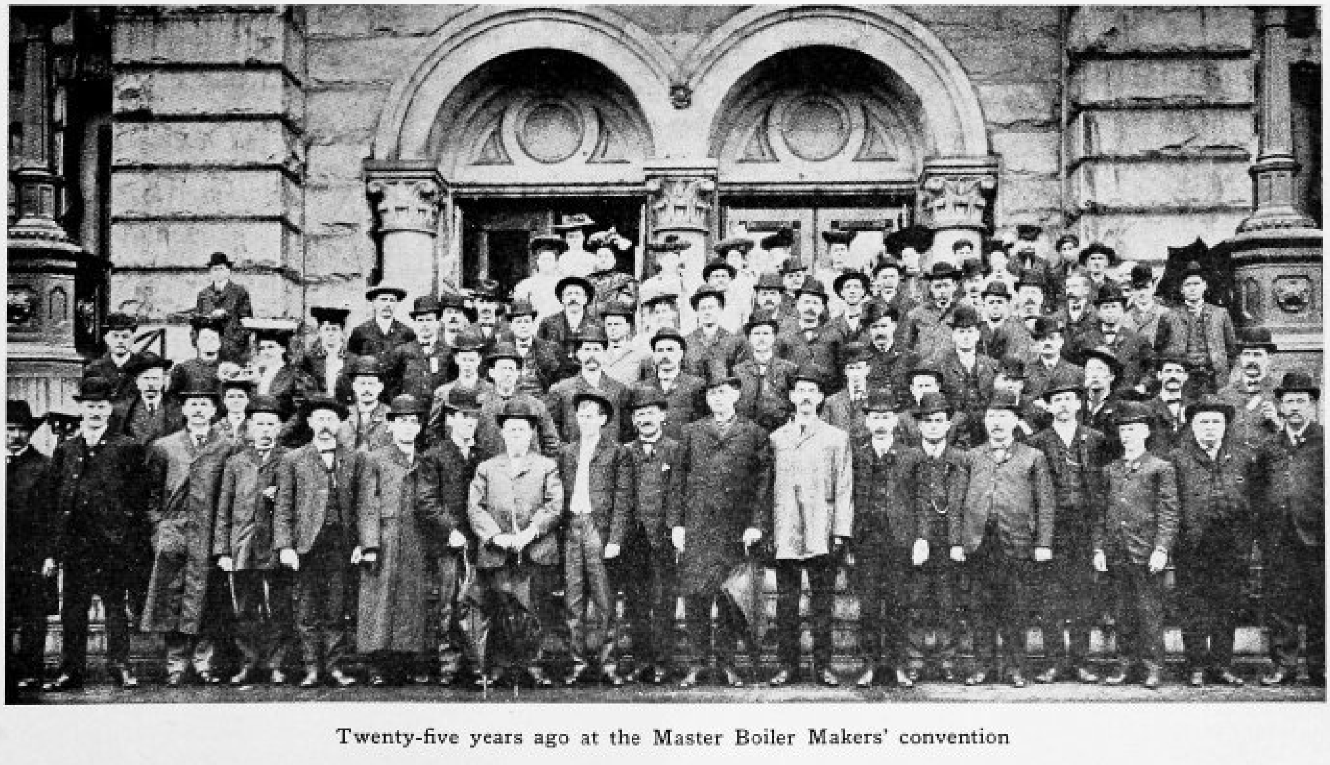
Annual address:
George B. Usherwood, president of the association.

Routine Business:
Annual report of the secretary, Albert F. Stiglmeier.
Annual report of the treasurer, W. H. Laughridge.

Miscellaneous business:
New business.
Appointment of special committee to serve during convention.
Resolution.
Memorials.
Announcements.

Committee report on topical subjects:
No. 9. "Law." Committee: L. M. Steward, chairman; J. F. Raps, W. J. Murphy .... 11:45 to 12:00 M.

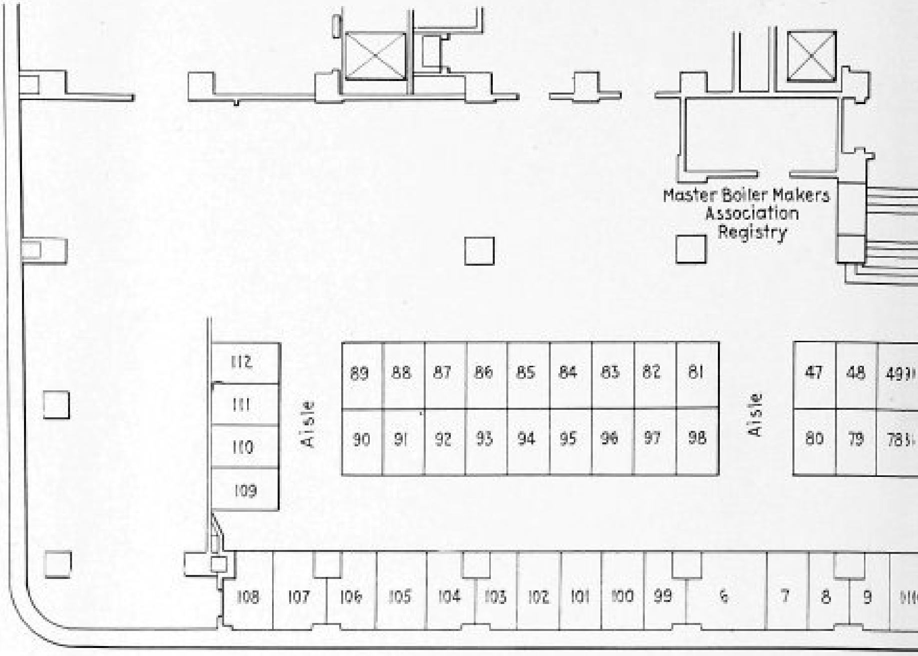
Recess.



Twenty-five years ago at the Master Boiler Makers' convention

Exhibitors at Convention

Company	Booth No.
Air Reduction Sales Company	99-100-101-102
American Arch Company, Inc.	46
American Locomotive Company	72-73-74-75
Arrow Tools, Inc.	21
Bethlehem Steel Company	71
The Bird-Archer Company	62-63
THE BOILER MAKER	71
W. L. Brubaker & Bros. Co.	19
The Burden Iron Company	18
A. M. Castle & Company	53
The Champion Rivet Company	54
Chicago Eye Shield Company	55
The Cleveland Steel Tool Company	17
Dearborn Chemical Company	6-7
Detroit Seamless Steel Tubes Company	22-23
Electro-Chemical Engineering Corp.	95
Ewald Iron Company	48
The J. Faessler Mfg. Co.	..
Falls Hollow Staybolt Company	84
Firebar Corporation	67-68-69-70
Flannery Bolt Company	43
Garratt-Callahan Company	97
General Refractories Company	15
Globe Steel Tubes Company	64-65
Huron Manufacturing Company	59
The International Nickel Co., Inc.	94
Lima Locomotive Works, Inc.	26



Arrangement of Exhibit Hall

AFTERNOON SESSION

Convention called to order .... 2:00 P. M.

Film picture and lecture. "RECENT DEVELOPMENTS IN ARC WELDING." Presented by G. H. Koch, M. E., of the Westinghouse Electric and Manufacturing Company 2:00 to 2:30 P. M.

Response:
Franklin T. Litz, second vice-president.

COMMITTEE REPORTS ON TOPICAL SUBJECTS:

No. 1. "RECOMMENDED PRACTICE AND STANDARDS: FUSION WELDING AS APPLIED TO STEAM PRESSURE." Committee: John F. Raps, chairman; H. H. Service, L. M. Steward, J. J. Mansfield, W. H. Laughridge .... 2:30 to 3:00 P. M.

No. 2. "BOILER AND TENDER CORROSION AND PITTING AND WHAT CAN BE DONE IN THE BOILER DEPARTMENT TO RELIEVE THE CONDITION." Committee: L. H. Kurlfinke, chairman; C. W. Buffington .... 3:00 to 4:00 P. M.

Invitations to discuss this subject have been extended to representative engineers, those accepting being as follows:
W. L. Curtiss, eng. water service, New York Central R. R.
R. C. Bardwell, superintendent water supply, Chesapeake & Ohio Railway Company, Hocking Valley Railway Company,
A. B. Pierce, eng. water supply, Southern Railway System.
R. E. Coughlan, superintendent water supply, Chicago and Northwestern Railway Company.
J. B. Wesley, eng. water service, Missouri Pacific R. R. Company.
R. N. Speller, Director, Department of Metallurgy and Research, National Tube Company.
R. N. Foster, water engineer, Wabash Railway Company.
Howard L. Miller, metallurgist, Central Alloy Steel Corporation.
D. W. Whitmer, corrosion testing department, Central Alloy Steel Corporation.
Dr. C. H. Koyl, eng. water supply, C. M. St. P. & P.
C. A. Seley, consulting engineer, Locomotive Firebox Company.
F. B. Horstman, chemical engineer, Dearborn Chemical Company

Announcements:
Recess.

EVENING

Reception and Dance .... 8:30 P. M.

Second Day
Wednesday, May 21, 1930

Convention called to order .... 9:00 A. M.

Address:
Alonzo G. Pack, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission.

Response:
O. H. Kurlfinke, third vice-president.

Unfinished business:

COMMITTEE REPORTS ON TOPICAL SUBJECTS:

No. 3. "WHAT CAUSED THE RECENT EPIDEMIC OF CRACKED SIDE SHEETS AND LEAKY STAYBOLTS IN THE FIREBOX OF MODERN LOCOMOTIVES, WHERE PREVIOUSLY UNDER THE SAME ROAD CONDITION AND SAME WATER CONDITION NONE WAS EXPERIENCED?" Committee: L. E. Hart, chairman; George Austin, John Harthill .... 9:45 to 10:30 A. M.

No. 4. "WHAT IS THE MOST ECONOMICAL METHOD OF REPAIRING CRACKED MUD RINGS OR CORNERS, WITHOUT REMOVING THE RING? ALSO THE BEST METHOD OF KEEPING CORNERS TIGHT?" Committee: W. N. Moore, chairman, John A. Glas, E. J. Reardon .... 10:30 to 11:00 A. M.

No. 5. "WHAT IS THE BEST AND MOST ECONOMICAL METHOD OF APPLYING FIREBOXES WITH BOILER ON OR OFF THE FRAMES? EXPLAIN IN DETAIL AS TO METHOD, COST AND MAN HOURS." Committee: Leonard C. Ruber, chairman; Albert F. Stiglmeier, John McGowan .... 11:00 to 11:45 A. M.

Announcements:
Recess.

AFTERNOON

Ladies, inspection and luncheon at the H. J. Heinz Plant.
Men members visit to Ellwood City Works, National Tube Company.

EVENING

Theater party and dance. Tickets for theater will be furnished by courtesy of Flannery Bolt Company.

Third Day
Thursday, May 22, 1930

On account of having to adjourn at an earlier hour to visit the Carnegie Steel Mills, convention will convene at 8:30 A. M.

Convention called to order .... 8:30 A. M.

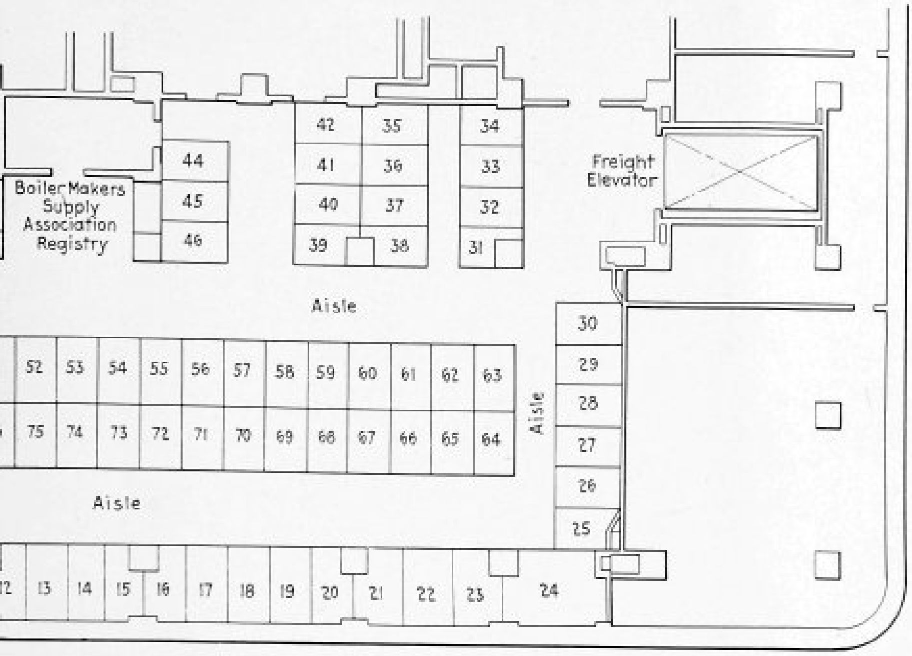
Address:
W. G. Black, mechanical assistant to the president, Chesapeake and Ohio Railway Company, Hocking Valley Railway Company, Pere Marquette Railway Company.

Response:
Ira J. Pool, fourth vice-president.

COMMITTEE REPORTS ON TOPICAL SUBJECTS:

No. 6. "MOST EFFICIENT METHOD USED IN WASHING AND CLEANING ALL TYPES OF BOILERS, BOTH LOCOMOTIVE AND STATIONARY." Committee: Ira J. Pool, chairman; Kearn E. Fogerty, W. E. Bell .... 9:15 to 9:45 A. M.

No. 7. "WHAT IS THE CAUSE OF OUTSIDE THROAT SHEET CRACKING AND WHAT CAN BE DONE TO OVERCOME IT? ALSO



Master Boiler Makers' Convention

Exhibitors at Convention

Company	Booth No.
Lockhart Iron & Steel Company	93
Locomotive Firebox Company	39-40-41-42
Lovejoy Tool Works	56
Lukens Steel Company	52
McCabe Manufacturing Company	92
National Tube Company	49-50-51-76-77-78
Old Dominion Iron & Steel Works, Inc.	98
The Otis Steel Company	20
The Oxweld Railroad Service Company	24-25
The Paulson Tools, Inc.	96
Penn Iron & Steel Company	81
Pittsburgh Screw & Bolt Corp.	104
Pittsburgh Steel Products Company	60-61
Pratt & Whitney Company	66
The Prime Manufacturing Company	45
Reading Iron Company	8
Republic Steel Corporation	27-28-29-30
John A. Roebling's Sons Company	85
Joseph T. Ryerson & Son, Inc.	82
W. J. Savage Company, Inc.	13-14
The Superheater Company	16
Torchweld Equipment Company	80
Ulster Iron Works	57
Water Treatment Company of America	58
Westinghouse Elec. & Mfg. Co.	31-32-33-34-35
Willson Products, Inc.	87
Wrought Iron Company of America	79

Give the Best Method of Making Repairs Going Into Detail of Flanging and Applying Patch and Rivets." Committee: G. M. Wilson, chairman; M. V. Milton, E. E. Hilliger .... 9:45 to 10:15 A. M.

No. 8. "The Training and Developing of Apprentices." Committee: Walter R. Hedeman, chairman; T. E. Lowe, T. J. McKerihan .... 10:15 to 11:15 A. M.

Announcements:

Dr. J. S. Unger, of the Carnegie Steel Company, will outline trip to their Homestead, Pa., mills...... 11:15 to 11:30 A. M.

Recess.

Afternoon

Ladies and members will make trip by boat to Carnegie Steel Mills at Homestead, Pa., where men will disembark while ladies continue up the river. On return, boat will stop at Homestead. Men will again embark for Pittsburgh.

Evening

Banquet, dancing and entertainment .... 7:00 P. M.

Fourth Day
Friday, May 23, 1930

Convention called to order .... 9:00 A. M.

Address:

C. A. Gill, superintendent motive power, Balimore & Ohio R. R.

Response:

L. E. Hart, fifth vice-president.

Committee report on topical subjects:

No. 10. "Topics" for 1931 Convention." Committee: C. H. Browning, chairman; J. M. Stoner, Louis R. Porter .... 9:45 to 10:15 A.M.

Good of the association .... 10:15 to 10:45 A.M.
Report of the executive board .... 10:45 to 10:55 A.M.
Report on committee on resolutions .... 10:55 to 11:10 A.M.
Memorials .... 11:10 to 11:20 A.M.
Committee on persident's address .... 11:20 to 11:30 A.M.
Election of officers .... 11:30 A.M.

Adjournment:

Afternoon (Special)

Tickets will be furnished on request by secretary, Boiler Makers' Supply Men's Association, through courtesy of Flannery Bolt Company, to baseball game—Pirates vs. Cubs.

As noted in the program, excellent entertainment and instructive inspection trips have been arranged by the Boiler Makers' Supply Men's Association. Great credit is due all the officers of this association for their hard work and the close co-operation of all the members. Arrangements were under the direction of Harry Loeb, of the Lukens Steel Company, president and Irving H. Jones, Republic Steel Company, general chairman of the various committees in charge of details.

Eighth Meeting of National Board of Inspectors

The eighth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors will be held at Chattanooga, Tenn., June 17, 18 and 19. Hotel headquarters have not been selected as yet, but it is expected that complete arrangements will be made shortly. An interesting program has been prepared for this meeting in which problems on welded and riveted boiler drums will be discussed. A complete report of the proceedings of the meeting will appear in a later issue of The Boiler Maker. The details of the program are given below:

Tuesday, June 17, 1930

Address of welcome—Mayor or other prominent citizen of Chattanooga.

Address—C. D. Thomas, chairman, chief boiler inspector, State of Oregon.

Report—C. O. Myers, secretary-treasurer, consulting engineer, Columbus, O.

Report—L. C. Peal, statistician, city boiler inspector, Nashville, Tenn.

Afternoon Session

Sightseeing in and around Chattanooga, Tenn.

Wednesday, June 18, 1930

Symposium—Welded Boiler Drums and Riveted Boiler Drums.

Discussion by members of the National Board, visitors and guests.

Afternoon Session

Visit to boiler manufacturing plants.

Evening Session

Informal banquet.

Thursday, June 19, 1930

Business meeting—(visitors and guests invited)

Afternoon Session

Executive session of the National Board of Boiler and Pressure Vessel Inspectors.

Committee reports.

One of the class rooms used by Canadian National in apprentice work

Training Apprentices*

By M. A. Humber†

Semi-annual examinations feature five-year training course of Canadian National

The apprenticeship system on the Canadian National (Central Region) commenced in a small way 26 years ago with night classes in one of the main shops and has grown until it now includes instruction by competent instructors during working hours at every shop, roundhouse, and car outstation where apprentices are employed. The officers of the company are entirely in charge of all work pertaining to the apprenticeship system. All text books, with revisions, are compiled by the supervisor of apprentices and his staff and these, with all material and equipment used in the class room (with the exception of drawing instruments) are supplied by the company free of charge.

The object of the apprenticeship system is to develop carefully selected young men for the purpose of supplying leading workmen for future needs, with the expectation that those capable of advancement will reveal their ability and take places in the organization for which they are qualified. The number of apprentices employed is governed by the need of the company for new men to replace those who reach the age of retirement, those who leave the service and to take care of any enlargement of shop forces that may be necessary to handle the shop work.

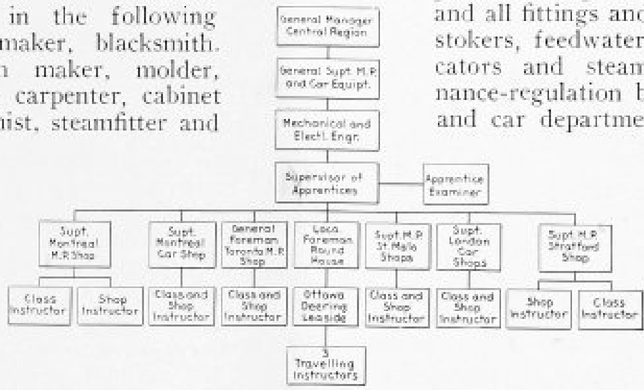
The training of the apprentices embodies two distinct phases—the shop training and school training. The shop training follows a definite shop schedule. The tour of duty of the apprentice in the various departments covers a variety of work which will give the apprentice an all-round knowledge of shop practice, will develop in him the necessary skill in operating the standard machines and make him proficient in bench and erecting work. Certain machines are set aside to be operated at all times by apprentices. the school training plays a very important part in the success of all apprentices and covers mathematics, practical geometry, projection and intersection work, mechanical drawing, sketching, model work, tracing and blueprint reading.

All applicants for apprenticeship are examined by an apprentice examiner in arithmetic, grammar, spelling, 75 percent in each subject being considered as a passing mark. The first six months of apprenticeship are considered as a probationary period, during which time the work of the apprentice is watched by the foreman and shop and class instructor with a view to ascertaining whether or not the boy is adapted to the work which he has chosen. If the apprentice proves satisfactory during this period he is indentured, the indenture being pre-dated six months.

* Abstract of paper presented at a meeting of the Central Railway Club held at the Hotel Statler, Buffalo, New York, Thursday, March 13, 1930.

† Supervisor of Apprentices, Central Region, Canadian National.

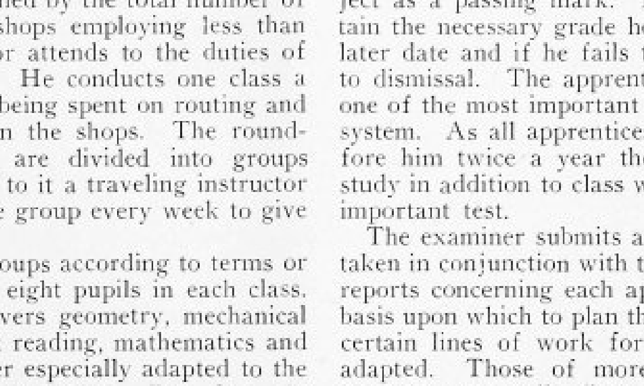
The apprenticeship term is of five years duration and is divided into ten periods of six months each. If the number of days worked by the apprentice during each period, including overtime, does not equal the shop days for that period, the apprentice must make up the number of days lost before being granted the next period rate of pay. Throughout their apprenticeship all apprentices must attend instruction classes during working hours for a period of two hours a week, receiving their regular hourly rate for the time in class. Apprenticeship is offered in the following trades: Machinist, boiler maker, blacksmith, tinsmith, pipefitter, pattern maker, molder, electrician, welder, carman, carpenter, cabinet maker, painter, wood machinist, steamfitter and plumber, brass finisher and upholsterer.



Organization chart of the apprentice system on the Central Region

At main shops employing 50 or more apprentices, two instructors are employed, one for shop instruction and the other for classroom instruction. The shop instructor devotes all his time in routing apprentices through the shop and instructing them in their trades while the school instructor conducts three classes daily, the number in each class being governed by the total number of apprentices employed. At shops employing less than 50 apprentices, one instructor attends to the duties of both school and shop work. He conducts one class a day, the balance of his time being spent on routing and instructing the apprentices in the shops. The roundhouses and car outstations are divided into groups and each group has assigned to it a traveling instructor who visits each station in the group every week to give the necessary instruction.

Classes are divided into groups according to terms or years and vary from five to eight pupils in each class. The course of five years covers geometry, mechanical drawing, sketching, blueprint reading, mathematics and theory, presented in a manner especially adapted to the needs of each particular apprentice. The first six months of his drawing course are spent largely in practical geometry, followed by projection and intersection work which extends over a period of one year. Mechanical drawing is then commenced and approximately six months is spent on simple model work and freehand sketching. Then follows the more advanced and difficult model work, including detail and assembly drawing of all descriptions. In addition to the course in mechanical drawing there is a five-year course in sheet-metal drafting for boilermaker and tinsmith apprentices, the work studied being directly applicable to the work in the shops. All methods of development are thoroughly covered and to make the work more interesting the developments are cut out by the apprentice and put in paper model form.



A group of Canadian National apprentices

From the beginning of the course the teaching of mathematics plays an important part and, starting with the study of elementary work such as mensuration, the apprentice is gradually instructed in the more advanced forms of this subject that deal with the mechanical side of the work such as the calculation of horsepower and tractive force and the study of hydraulics and physics. Instruction is given on the subject of locomotive theory from specially prepared text-books pertaining to practical shop work, valves and valve setting, and all fittings and appliances such as boosters, stokers, feedwater heaters, superheaters, lubricators and steam-heating systems. Maintenance-regulation books for both motive-power and car departments are on hand in all class rooms.

The apprentice examiner, in addition to examining all new apprentices before entering service, examines all apprentices before they receive their semi-annual increase in pay. The examinations are given on the three main subjects taught in class room—namely: Drawing, mathematics and shop theory—and all are required to make 50 percent in each subject as a passing mark. If an apprentice fails to obtain the necessary grade he is given a second trial at a later date and if he fails the second trial he is subject to dismissal. The apprentice examiner is undoubtedly one of the most important factors in the apprenticeship system. As all apprentices realize they must come before him twice a year they all do considerable home study in addition to class work to fit themselves for this important test.

The examiner submits an annual report which, when taken in conjunction with the class and shop instructors' reports concerning each apprentice, makes an excellent basis upon which to plan the selection of apprentices for certain lines of work for which they seem especially adapted. Those of more than ordinary ability and character are easily discernible through their work and are given particular attention. The information thus brought to light is used by the management when selecting men for promotion. In fact, the Canadian National apprenticeship system has made it entirely unnecessary for the management to go outside of the company when selecting mechanical foremen or departmental officers.

In serving the five years' time for the machinist's trade, the apprentice spends two years and nine months in the machine shop and two years and three months in the erecting shop. In the machine shop he is assigned to the nut facer, drill press, slotter, boring mill, shaper, bolt lathes, general lathes, rod bench, motion bench and air brake. In the erecting shop he becomes familiar with the eccentric, shoe, guide bar, frame, cylinder, motion, front end, and boiler mounting.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Unit Section of Seam

Q.—Can you please define more clearly the phrase "unit section of seam" and "number of rivet sections" used in the "formulas for stresses" in your book "Inspectors Questions and Answers?" I do not know the exact meaning of these or just what the figure "nine" in said formulas stands for or where it is taken from. If you can enlighten me on this question I will be very much obliged. M. J. P.

A. The formula referred to in the question as found in the "Locomotive and Boiler Inspectors Handbook" is as follows:

$$\text{Tension on rivets} = \frac{P \times D \times p}{2 \times a \times n}$$

where:
- P = Boiler pressure in pounds per square inch.
- D = Diameter of boiler in inches.
- p = Pitch of unit section of seam.
- a = Area of rivet hole in square inches.
- n = Number of rivet sections.

The value of p (pitch of unit section of seam), when considering the longitudinal seam, is taken as the pitch of the rivets on the outside row.

The value of n (number of rivet sections) is taken

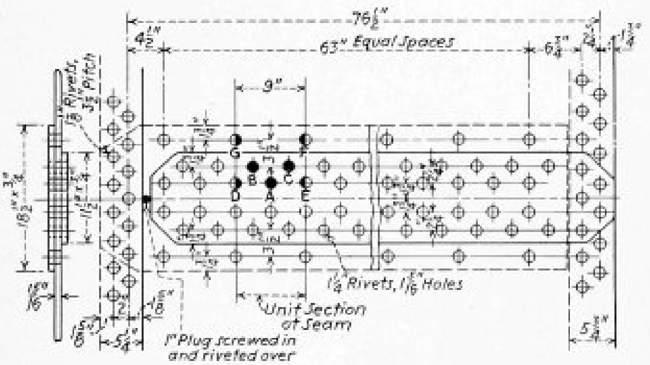


Fig. 1.—Longitudinal seam showing unit section

as the total number of rivet sections in single shear in a unit section of seam.

Fig. 1 shows a triple riveted butt and double strap joint. The pitch of the rivets in the outer row being 9 inches; thus p = 9.

Rivets A, B and C are in double shear.
½ rivets D and E are in double shear.
½ rivets F and G are in single shear.

The total number of rivet sections in single shear in a unit section of this seam would then be:

Rivets A, B and C	6
½ rivets D and E	2
½ rivets F and G	1
Total	9

Thus n = 9.

The unit section of seam is that part of the seam included in one pitch of the rivets in the outside row as illustrated in Fig. 1.

Riveting Fire-Door Flanges

Q.—What methods are employed for riveting the firedoor flanges in a locomotive boiler when the joint lies in the water side of the door? W. L.

A. The firedoor flanges are riveted together immediately after placing the firebox in the boiler. The firebox is secured with sufficient temporary bolts to hold same in place, the firedoor flanges being riveted before applying the mudring on the staybolts.

The boiler is placed on its side and the rivets along the bottom half of the firedoor hole secured with the use of long tongs and a long holding-on bar, the rivets being driven on the outside.

The rivets along the top half of the firedoor hole are passed through the roof sheet at any convenient hole, as the stuffing box or washout plug holes. The rivet passer who is inside the boiler between the crown and roof sheets takes the rivets and with the use of long tongs places them in rivet hole in the firedoor flange. The holder-on stands on the floor and with the use of a special holding-on bar, sometimes known as a half-moon bar, holds the rivets in place while they are driven from the outside.

The practice of riveting firedoor flanges where the joint lies in the water side of the boiler has become obsolete. The firedoor flanges are secured either with patch bolts or welding.

Calculation of Vacuum Tanks

Q.—We would like very much to know if you have any data or information available on thickness of material for cylindrical vacuum tanks with flanged and dished heads. The only information we have been able to locate on collapsing pressures is in "Kent's Handbook," but that does not cover anything except boiler tubes. T. M. P.

A.—The following formula can be used for computing the thickness of material for cylindrical vacuum tanks with flanged and dished heads:

$$P = c\left(\frac{t^{2.25}}{L \times D}\right)$$

where,

P = the collapsing pressure of a cylindrical shell in pounds per square inch

t = thickness of shell plate in inches

D = outside diameter of the shell in inches

L = length of cylinder in inches

c = a constant determined from experiments and given as 11,600,000.

The above formula is for tanks whose lengths do not exceed six diameters. The reason for basing this formula on shells whose length did not exceed six diameters is because tests proved that the collapsing pressure is unaffected when the lengths of shells are increased beyond that ratio.

In using this formula when L is greater than six diameters the value of L may be taken as $(6 \times D)$.

Dimension L refers to the length of the plain section of the shell which may be either the center-to-center distance between the circumferential seams or else the distance between the reinforcing bands, whichever the case may be.

From the above we infer that any cylindrical vessel subjected to external pressure may actually be greater in length overall than six diameters, provided the shell be built up in sections and reinforced at intervals by means of angles or bands riveted to its circumference.

For the required factor of safety of 5, the constant c in the formula reduces to:

$$\frac{11{,}600{,}000}{5} = 2{,}320{,}000$$

Values to be used in solving problems by means of formula are as follows:

TABLE I

Thickness of Shell Plate—Inches Fraction	Decimal Equivalent	Corresponding value of $t^{2.25}$
1/4	.25	.0853
9/32	.28125	.1024
5/16	.3125	.1292
11/32	.34375	.1604
3/8	.375	.1950
13/32	.40625	.2345
7/16	.4375	.2755
15/32	.46875	.3236
1/2	.5	.3716
17/32	.53125	.4266
9/16	.5625	.4842
19/32	.59375	.5496
5/8	.625	.6166
21/32	.65625	.6870
11/16	.6875	.7585
23/32	.71875	.8414
3/4	.75	.9247

Fractional powers of numbers like the expression $t^{2.25}$ are most conveniently found by means of logarithms. For the convenience of those not sufficiently far advanced in mathematics as to be capable of solving such expressions, Table I has been prepared which gives the value of $t^{2.25}$ for plate thickness from ¼ to ¾ of an inch varying by 1/32 of an inch.

The heads can be calculated according to the following formula: Convex Heads (pressure on concave side):

The thickness required in an unstayed dished head with the pressure on the concave side, when it is a segment of a sphere, shall be calculated by the formula:

$$T = \tfrac{1}{8} + \left(\frac{5.5 \times P \times L}{2 \times TS}\right)$$

where,

T = thickness of plate in inches

P = maximum allowable working pressure pounds per square inch

TS = tensile strength, pounds per square inch

L = radius to which head is dished in inches.

Where the radius is less than 80 percent of the diameter of the shell or drum to which the head is attached, the thickness shall be at least that found by the formula by making L equal to 80 percent of the diameter of the shell or drum.

Concave Heads (pressure on convex side):

Dished heads with pressure on the convex side shall have a maximum allowable working pressure equal to 60 percent of that for heads of the same dimensions with pressure on the concave side.

Calculation of Braces

Q.—If I am not imposing too much upon your question and answer department, I have the following question that I would like to have answered at your earliest convenience. I am enclosing sketch of the calculations on a boiler head above the tubes. The net area to be braced is 689.15 square inches. Paragraph P-221 of the 1927 A. S. M. E. Boiler code is used. Your comments as to the correctness of the enclosed sketch is requested. T. C. E.

BRACE CALCULATIONS ON W-6000-B 100 H.P. 300 LBS. W.P. BOILER

Back Head

Net area = 689.15 square inches

Total load = 689.15 × 300 = 206,745 pounds

It is proposed to use 19 stays.

Par. 223

$$\text{Required sectional area of direct stay} = \frac{206{,}745}{9500 \times 19} = 1.1454 \text{ square inches}$$

However,

19 1¼-inch diagonal stays are to be used.

Then—

$$\text{Par. 221} \quad A = \frac{a \times L}{l} \text{ or } l = \frac{a \times L}{A}$$

Where—

A = Sectional area of diagonal stay = 1.2272 square inches

a = Sectional area of direct stay = 1.1454 square inches

L = Length of diagonal stay, Fig. P-12

l = Length of line drawn at right angles to boiler head, Fig. P-12.

Therefore—

$$l = \frac{a \times L}{A} = \frac{1.1454 \times L}{1.2272} = .933L$$

Then if l (the straight length of diagonal stays) equals $.933L$ (the diagonal length of stays), all that is necessary, is to keep this ratio for each length of brace in order to use 19 1¼-inch diagonal stays.

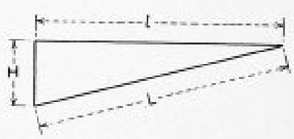
Now—

In layout of braces see to it that the following table is adhered to:

$\frac{L}{l}$	L	H Not over	Actually Used
1.02%	24"	8 5/8"	4¾"
	30"	10 13/16"	
	36"	12 31/32"	
1.02%	42"	15 1/8"	9½"
	48"	17 1/4"	
	54"	19 7/16"	
1.02%	60"	21 13/32"	13¾"
	66"	23 3/4"	
	72"	26 15/16"	

Where—

$$l = .933L$$
$$H = \sqrt{L^2 - l^2} = \sqrt{L^2 - (.933L)^2} = \sqrt{L^2 - .870489L^2} = \sqrt{L^2(1 - .870489)} = L\sqrt{.1296} = .36L$$



Note—

Maximum distance between rivets and edges of tube holes or staybolts and centers of rivets = 5⅛ inches.

Maximum distance between inner surface of shell and centers of rivets = 6⅝ inches.

From table it is seen that the H actually used is well under the allowed H.

Finally—

By using the ratio above obtained from Par. 221 it follows that 93.66 percent of the allowable stress from table P-7 is permissible.

Hence—

$$W.P. = \frac{\text{Area of stay} \times \text{number of stays} \times 93.66\% \text{ of allowable stress}}{\text{Net area}}$$
$$= \frac{1.2272 \times 19 \times (9500 \times 93.66)}{689.15}$$
$$= \frac{1.2272 \times 19 \times 8897.7}{689.15}$$
$$= \frac{207{,}465.89}{689.15}$$
$$= 302.5$$

A.—I have reviewed the attached calculations and method of determining the vertical offset in terms of the diagonal length of the brace for a given boiler and find the same to be correct in itself, although I will have to admit I do not see the purpose of this method of procedure.

You first assume an unknown quantity such as the diameter of the stay along the diagonal and from this assumption determine the vertical offset *H* which is not actually used after determining same.

Par. 223—Part 1, Section 1 of the A. S. M. E. Code, Item 1 is as follows:

1. Determine the "required cross-sectional area of the brace" by first computing the total load to be carried by the brace, and dividing the total load by the value of allowable stress for unwelded stays or braces given in table P-7.

From this paragraph it can be seen that each brace must be calculated independently and unless the 19 stays are so located that each one receives 1/19 of the load, there is a possibility that one stay may be carrying more load than the other. Therefore, the diameter of each stay is dependent upon the load it carries and the working pressure of the boiler, in so far as braces are concerned, should be figured on the basis of the stay which is carrying the greatest load per square inch.

It would seem more practicable to work out the most suitable arrangement of stays to support the area to be stayed and then compute the stay, which is carrying the greatest load per square inch in order to determine the working pressure of the boiler.

Oil-Burning Rivet Furnace

Q.—Will you kindly send me a sketch for a portable oil-fired rivet forge? I have several plans but would like to make the best forge at the least cost. W. B. S.

A. An oil-burning rivet furnace or forge should be properly designed so that it can do its work well within the shortest possible time and with practically no attention.

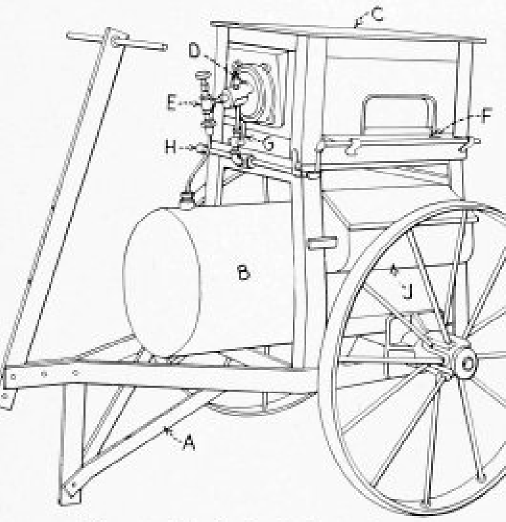


Fig. 1.—Typical oil-fired rivet forge

It should be economical in its use of fuel and produce all the heat there is in it. So many conditions arise in a design of this kind that it is cheaper to buy one of the standard makes and save time, work, and worry. The proper heating of rivets is an important factor in boiler construction. They should be heated economically by a soaking, non-scaling heat. Some home-made furnaces, no doubt, are giving good results in this respect, but the writer advises that such a question of shop equipment be left with a company that fully understands the conditions and is competent and prepared to meet the needs of such heating problems.

Fig. 1 is an example of a typical modern portable oil-fired rivet forge. The reference key is as follows:

A—is the carriage
B—is the oil tank, capacity 20 gallons
C—is the furnace, 9-inch by 3½-inch opening
D—is the oil burner
E—is the regulating valve
F—is the air screen for deflecting heat from operator
G—is the air operating valve
H—is the air hose connection
J—the rivet container.

W. T. Kyle Joins Welding Engineering and Research Corp.

William T. Kyle, formerly sales manager of the Page Steel and Wire Company, New York has resigned to become president of the Welding Engineering and Research Corporation with offices at 30 Church street, New York, and Engineering and Research laboratories, Long Island City, N. Y. The Welding Engineering and Research Corporation is organized to cooperate with industry in the safe and economical application of welding and cutting of metals, and in the more rapid growth and development of the industry.

William T. Kyle

Mr. Kyle was born on October 18, 1883, at Baltimore, Md. He was educated in the high schools and took courses in various academies, specializing in civil engineering. In 1901 he became an apprentice with the Bell Telephone Company at Philadelphia, Pa., and two years later went with the American Pipe & Construction Company, Philadelphia, as district superintendent on general railroad construction work remaining there until 1908 to go to the Duplex Metals Company as sales manager of its New York office and later became general sales manager, a position he held until the company was discontinued in 1915. He was then associated for two years with the Okonite Company as special representative at New York. He then entered business for himself with offices in New York and Chicago and had various accounts on a commission basis. When the Page Steel & Wire Company, Monessen, Pa., which manufactured the Copper Clad Steel Wire and Armco Wire products, was purchased and taken over by the American Chain Company, Bridgeport, Conn., Mr. Kyle with his entire sales organization entered the American Chain Company under the Page Steel & Wire Company as general sales manager with headquarters at Bridgeport. During the World War he served as a member of the Emergency Fleet Welding Committee and he has been active in the American Welding Society since its organization in 1919.

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.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—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.

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, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, suite 522, Brotherhood Block, Kansas City, Kansas.

Assistant International President—William Atkinson, 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—John J. Dowd, 142 Pearsall Ave., Jersey City, N. J.; M. A. Maher, 2001 20th St., Portsmouth, O.; R. C. McCutchan, 226 Lipton St., Winnipeg, Man., Canada; H. J. Norton, Alcazar Hotel, San Francisco, Cal.; C. A. McDonald, Box B93 Route 2, Independence, Mo.; J. N. Davis, 1211 Gallatin St., N. W. Washington, D. C.; M. F. Glenn, 1434 E. 93rd St., Cleveland, O.; W. J. Coyle, 424 Third Ave., Verdun, Montreal, Canada; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; J. F. Schmitt, 25 Crestview Rd., Columbus, O.

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President—George B. Usherwood, supervisor of boilers, New York Central Railroad, Syracuse, N. Y.

First Vice-President—Kearn E. Fogarty, general boiler inspector, Chicago, Burlington & Quincy Railroad, Aurora, Ill.

Second Vice-President—Franklin T. Litz, general boiler foreman, Chicago, Milwaukee, St. Paul & Pacific Railroad, Milwaukee, Wis.

Third Vice-President—O. H. Kurlfinke, boiler engineer, Southern Pacific Railroad, San Francisco, Cal.

Fourth Vice-President—Ira J. Pool, district boiler inspector, Baltimore & Ohio Railroad, Baltimore, Md.

Fifth Vice-President—L. E. Hart, boiler foreman, Atlantic Coast Line, Rocky Mount, North Carolina.

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, foreman boiler maker, Meadow Shops, Pennsylvania Railroad, Elizabeth, N. J.

Boiler Makers' Supply Men's Association

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Vice-President—Irving H. Jones, Republic Steel Corporation, Youngstown, Ohio.

Treasurer—George R. Boyce, A. M. Castle & Company, Chicago, Ill.

Secretary—Frank C. Hasse, Oxweld Railroad Service Company, Chicago, Ill.

American Boiler Manufacturers' Association

President—H. E. Aldrich, The Wickes Boiler Company, Saginaw, Mich.

Vice-President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, O.

Executive Committee—Homer Addams, Fitzgibbon Boiler Company, Inc., New York, N. Y.; G. W. Bach, Union Iron Works, Erie, Pa.; H. H. Clemens, Erie City Iron Works, Erie, Pa.; J. R. Collette, Pacific Steel Boiler Corp., Detroit, Mich.; F. W. Chipman, International Engineering Works, Framingham, Mass.; E. R. Fish, Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn.; C. E. Tudor, Tudor Boiler Company, Cincinnati, O.; A. C. Weigel, Walsh and Weidner Company, Chattanooga, Tenn.; S. G. Bradford, Edge Moor Iron Company, Edge Moor, Del.

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

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	

Cities

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

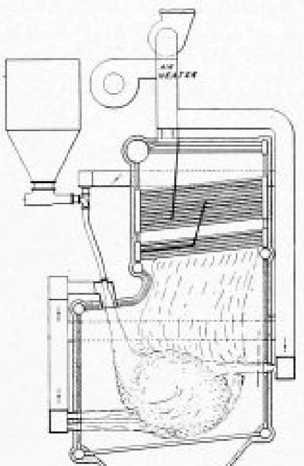
Selected Boiler Patents

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,734,669. PULVERIZED-FUEL-BURNING FURNACE. MARTIN ING, NEW YORK, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, A CORPORATION OF DELAWARE.

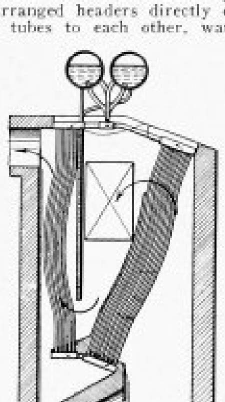
Claim.—In combination, a substantially unobstructed combustion chamber having an outlet at the top, said chamber being of approximately rectangular cross section and of a volume sufficient to permit of the combustion in space therein of the desired amount of pulverized fuel, means for admitting the pulverized fuel with air in a downward direction adjacent an upright wall of the chamber and to one side of the outlet thereof, whereby



the fuel and flame stream takes U-shaped course through the combustion chamber, means for admitting a current of air through said wall in a substantially horizontal direction at a level approximately at the bottom of the turn in the flame stream, and means for supplying a current of air through the opposite upright wall in a substantially horizontal direction at a level approximately midway of the point of fuel admission and the point of admitting said first current of air, said coal and air and said currents of air having velocities such that heavier particles of fuel gravitating toward the bottom of the chamber are caused to rotate about a horizontal axis approximately midway of the combustion chamber and parallel to said two walls, without impingement on the walls of the chamber.

1,733,644. WATERTUBE BOILER. GOTTLOB BURKHARDT, OF HERRENALB, GERMANY, ASSIGNOR TO JULIUS M. BURKHARDT, JOHN FRED BURKHARDT, AND LANCE NICHOLSON, ALL OF BUFFALO, NEW YORK.

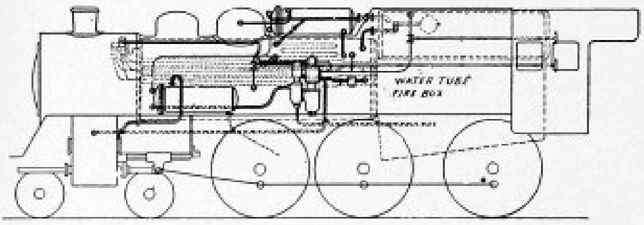
Claim.—In an upright watertube boiler, a circulatory system comprising highly and less highly heated sets of ascending and descending curved watertubes, parallelly arranged headers directly connecting the upper and the lower ends of the tubes to each other, water and steam containing



means above the upper headers, one of said upper headers being arranged below the level of the other, tubes connecting the headers, tubes directly connecting the water and steam containing means with the upper header arranged at the higher level, and tubes connecting the water and steam containing means with the tubes connecting the upper headers at a point between said headers.

1,714,505. LOCOMOTIVE BOILER AND METHOD OF OPERATING THE SAME. OTTO H. HARTMANN, OF CASSEL-WILHELMSHOHE, AND WILHELM JUNG, OF CASSEL, GERMANY, ASSIGNORS TO SCHMIDT'SCHE HEISSDAMPF GESELLSCHAFT M. B. H., A GERMAN CORPORATION, OF CASSEL-WILHELMSHOHE, GERMANY.

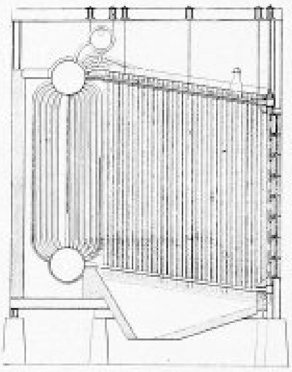
Claim.—A locomotive boiler having a high-pressure boiler section which includes a water-tube firebox, a low-pressure section formed by a longitudinal smoke flue boiler, said sections being normally out of communi-



cation so as to enable different steam pressures to be maintained therein for supplying live steam at different pressures, a conduit for supplying feedwater to the high pressure boiler section in excess of the normal demand of such section, and a normally sealed connection for delivering the excess feed-water from the high-pressure section to the low-pressure section. Eleven claims.

1,733,474. BOILER FURNACE. JOHN VAN BRUNT, OF FLUSHING, NEW YORK, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, A CORPORATION OF DELAWARE.

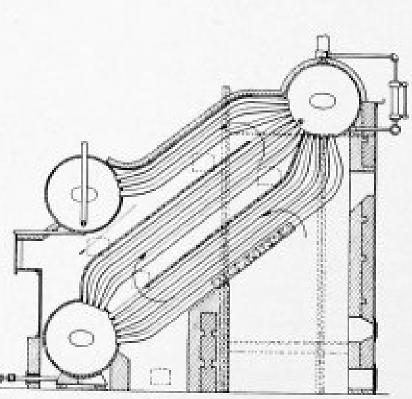
Claim.—In a boiler of the radiant heat type defining its own combustion space, the combination of an upper and lower drum at the rear of the boiler, a bank comprising a multiplicity of tubes connecting said drums, side water walls in advance of said bank and each comprising a row of upright tubes having headers at their upper and lower ends, a front water



wall comprising a row of upright tubes having headers at their upper and lower ends, a roof water wall comprising a row of tubes connected at one end to the upper drum and at the other end to the upper header of the front water wall, a row of spaced tubes defining the bottom of the combustion space connected at one end to the lower drum and at the other end to the lower header of the front water wall, enclosing sheathing for the boiler providing an ash pit and an offtake, the headers for the side and front walls being exterior of said sheathing, structural work, and means whereby said upper headers are suspended therefrom, together with means for admitting fuel to be burned in space in the combustion space defined by the boiler. Two claims.

1,733,808. STEAM BOILER. GEORGE LASKER, OF CHICAGO, ILLINOIS.

Claim.—A boiler having a front drum, a pair of rear drums at different elevations below said front drum, said rear drums being spaced from each



other to permit the passage of gases of combustion therebetween, banks of tubes directly connecting the front drum with the rear drums, means for introducing feedwater into the upper of said rear drums, and baffles for directing the gases over said tubes and between said rear drums in a predetermined manner. Seven claims.

The Boiler Maker

Name registered U. S. Patent Office

Volume XXX June, 1930 Number 6

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

Chicago: 105 West Adams St. Cleveland: Terminal Tower
Washington: 17th and H. Sts., N. W.
San Francisco: 215 Market St.

H. H. BROWN, Editor
L. S. BLODGETT, Managing Editor
WARNER LUMBARD, Associate Editor

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

Request for change of address should reach us on or before the first day 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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For the Good of the Master Boiler Makers' Association!

This year's convention at Pittsburgh finds the Master Boiler Makers' Association in a flourishing condition both financially and in its membership. Certain phases of the meeting indicate lines along which further progress for the good of the association can be made.

For several years past there has been an increasing number of delinquencies in membership. A number of those who have not been able to attend one or two of the conventions have allowed their membership to lapse. Until an equable method for reinstating the members to the active list was incorporated in the by-laws at this meeting, such delinquents were lost to the association. By the payment of a small penalty fee and current dues these members may now again enter into the work of the association. Under the new ruling, the coming year will find a great many of the two hundred odd delinquents back in the association. Some of these will voluntarily take advantage of the opportunity for reinstatement, while the great majority will first have to be informed of the change in the by-laws and then require personal solicitation by friends who are in good standing.

One thought bearing on the value of the work of the association was brought out by the president, George B. Usherwood, who conducted the convention, as well as by railroad officers who addressed the meeting. The locomotive is entering a period of severe competition with other means of motive power on the railroads. To hold its major position as a prime mover, every man from designer to boiler maker, who has to deal with the efficient and economical operation of the steam locomotive must be informed of the best practice developed for the care and maintenance of this machine. When the best brains of the boiler division of the industry assemble to discuss these problems and to make available their proceedings for the good of the art, certainly no individual holding a responsible position in the boiler department of any railroad shop can afford not to be numbered in the membership of the association.

New members are being added to the active list—twenty-six having been enrolled this year. This, however, constitutes only part of the effort necessary if the association is to grow. The older members must be retained and not be allowed to drop out if they are unfortunate enough to miss a convention and those who have been delinquent should take steps to be reinstated.

In order for its work to grow in value, the continued and increasing support of the Boiler Makers Supply Men's Association is essential. If the members, or those who should be active, do not show interest in the work of the organization, the supply companies will be less inclined to give of their time and to carry expensive exhibits to the place of meeting. The supply men this year were lavish in their efforts to make the convention successful. Every possible provision was made to instruct and entertain the master boiler makers present, with exhibits of the latest in tools, materials and methods, and by arranging inspection trips to nearby manufacturing plants where boiler materials are made. Details of the supply program are given in reports of the two associations in this issue.

Next in importance to the personal interest of members comes the published proceedings which because it is a permanent record cannot be of real practical value, unless hard-working committees develop, in a broad way, such subjects dealing with boiler work, as will best inform the industry of how to meet the problems of maintaining modern locomotive boilers. This year both the reports and discussions accomplished just that purpose. The newly elected officers of the association should strive to select an equally good program for 1931 and appoint only those members to the topic committees who will have time and facilities available to do as good a job on their reports as did the 1930 committees. The information brought out in the discussion should cover not only current maintenance problems but should also forecast the trend in developments of design and practice that will become current in the near future. The program for the next convention should be arranged with this thought in mind.

As can be said of most conventions of this association in the past, the present one was a success from every angle and the foundation should now be laid so that the convention at Chicago in 1931 will be more successful.

Boiler Manufacturers' Meeting

Serving as a group to correct the evils of the industry, the American Boiler Manufacturers' Association recently held its forty-second annual meeting at Skytop Lodge, Cresco, Pa., and while in session, this organization, one of the oldest trade associations affiliated with the steel industry, continued in its constructive efforts to build up a profitable business in the boiler field. Due to the present decline in sales of boilers the association is particularly interested, not only in increasing the markets for the products of its members, but in formulating ways and means of reducing the costs of boiler construction and eliminating wasteful practices throughout the industry.

During the past year the association has carried out a beneficial program through its co-operation with the A. S.M.E. Boiler Code Committee, the American Uniform Boiler Law Society and the National Board of Boiler and Pressure Vessel Inspectors. Its members have supplied sales statistics in an effort to exchange information of value in forecasting business conditions.

Because of the success of the group organization of the association and the diversified aims of each of the groups, it is evident that this is the time to specialize in the activities of the various groups. A highly trained staff under the head of a manager for each group could further the activities of the industry in the lines of research, cost accounting, engineering, education and promotion.

The American Boiler Manufacturers' Association is well on the way toward success in its career as a trade association. It has created a better understanding in the industry and has been able to reduce to a large degree the practices which have been detrimental to the art of boiler making.

Through the activities of the organization many unfair practices and uneconomical methods, evident in the past, have been corrected, to the advantage of industry at large.

Rivet Economy

Few structures exist in which the careless application of workmanship or materials carries a heavier penalty than the construction of boilers and pressure vessels. The basis on which riveted structures has securely rested since their first application is the accurate determination of their efficiency. If sections of plate of a known tensile strength are combined in any one of the accepted forms of joint by rivets of a known composition and strength in tension and shear, it is inevitable that every joint so formed will have the same ultimate strength and efficiency within extremely close limits. Theoretically the efficiency would be exactly the same. Every standard of design, construction and maintenance in boilers or other structures of metal is based on this fact.

There are, however, certain essential factors involved, any one of which, if overlooked, will immediately destroy the efficiency of the riveted structure. Aside from the plates themselves, which in all reliable work must meet rigid specification requirements and bear the stamp of an approved authority, the trouble lies in workmanship and the often unconsidered rivet. Workmanship is a matter that can be controlled by careful supervision and high shop standards. Fortunately uniform requirements for boilers and pressure vessels must be lived up to.

Rivets should be required to meet the same rigid standards of composition, manufacture and application as any other of the materials going into the boiler. A weak rivet, a burned rivet, a scaly rivet, or an inaccurately made rivet will affect the efficiency of the strength joints. If all the rivets in the structure are below par in any or all of these qualities, then that structure may look perfectly secure, but it is actually a weak and a dangerous thing indeed.

One element, burning, is controllable by the workman and its presence may be detected by a visual inspection. The three remaining defects and they usually occur together in rivets, weakness, scale and inaccuracy, can be eliminated by the proper specification of rivets that must meet the requirements of chemical and physical analyses, and that must be made within true tolerance limits.

In these days of rigid service demands, when corrosion, pitting and caustic embrittlement seek for their starting point every crack and crevice in a boiler, which means every riveted joint, the maintenance problem can be appreciably lessened, if such joints are tight. Only if good rivets, properly driven to fill every hole and bring every plate up tight to every other plate, will this desirable result be realized. Many defects are caused by driving scaly rivets into clean, round holes. A clean rivet hole was never intended for any other than an accurately made rivet—as clean as the hole into which it is driven.

Fortunately the vast majority of boiler manufacturers, railroad officials and the men in the shops themselves appreciate this fact, and the rivets used are given the same careful consideration as every other piece of material. There are still a few builders of power and pressure equipment as well as offenders in other fields who believe that because one rivet has the same general appearance as another it will function with equal efficiency.

Untold lives since the day the first rivet was driver have depended upon its strength—give it the consideration it deserves.

The Old Chief Talks About Caustic Embrittlement*

"Chief," said the Department Manager, sticking his head in through the door of the old fellow's office, "what have you been up to now? They tell me you went ahead and ordered repairs on one of the Metropolitan Utility Corporation's high-pressure boiler drums in spite of the fact that two representatives of the manufacturer, a metallurgist, and even the plant's own engineers didn't think it could be done."

The Old Chief turned and regarded his caller for a moment in silence.

"It wouldn't have been a very keen piece of work if I had let them throw away a perfectly good drum, would it?" he asked.

"Apparently not, under the circumstances," laughed the other, slapping the old fellow affectionately on the shoulder. "As a matter of fact, Vice-President Berkman just had me on the 'phone a few minutes ago and said you'd saved him something like $65,000."

A slow smile appeared on the Chief's face. "Well now, it's not up to me to dispute that point with Mr. Berkman, but I don't think we saved him that much. Fifty thousand is my estimate."

"Anyhow," insisted the other, "he's tickled with the way you handled the job. From what he said, the stories he'd been reading in the technical papers for the past year or two had just about convinced him that when caustic embrittlement once made its appearance the boiler was as good as gone."

"Well," said the Chief meaningly, "just because we got him out of a big repair bill this time he shouldn't get the idea that it's not a serious thing. As a matter of fact, caustic embrittlement is about the worst ailment a boiler can contract, excepting a lap seam crack. And we don't find so many of them nowadays since most of the new boilers are being built with butt strap joints. However, we do run into quite a lot of embrittlement cracking and there's only one way to keep it from ruining the boiler—catch it just as soon as the first symptom appears.

"Take Berkman's case as an example. We'd been inspecting that boiler ever since it was installed and, knowing that they were using self-purgative feed water of the kind that frequently causes cracking, our inspectors were keeping a close lookout for leakage and were tapping rivet heads at every opportunity."

"Just a minute, Chief," the younger man broke in. "I'm not right up to the minute on some of these new wrinkles of the inspecting game, so I've got to ask you to tell me just what it is the inspector finds out about the presence of caustic embrittlement when he taps rivet heads with his hammer."

"Well now," the older man explained, "there are two conditions which are absolutely necessary in order for caustic to attack boiler steel. The first is a high concentration of caustic, and the other is steel in which local stresses are pretty close to the elastic limit. The only place in a boiler where ordinarily you can have both of these conditions at the same time is in the seams, where the caustic can gradually build up to a concentrated state, and riveting pressure, along with other factors, puts high stresses in the metal. When you bring those things together you can look out for trouble, and the first thing to give way is usually the rivet shanks. Sometimes a rivet will crack in two, and then again you'll find rivets that have cracked only part way through the shank. An experienced inspector has a knack of bringing his hammer down on the head in such a way as to put a sort of twisting stress in the rivet. If the shank is broken all the way across, the rivet will start to turn out, like a screw. If it's cracked only part way, the inspector can tell it by the feel and his blow will frequently snap the rivet off.

"Up until a week ago we'd never found the slightest sign of anything like caustic cracking in the boilers up at the Metropolitan station, but when Inspector Freeman dug out a tiny, bitter-tasting buckshot from the slightest seam he knew right away there was concentrated caustic in the joint. No sooner had he started to work on the rivet heads than one of them came off.

"I went right down there after he'd 'phoned me, and we polished out two rivet holes for examination under a magnifying glass. Sure enough, there were the telltale hair-line cracks radiating from the walls of the holes—cracks so fine that you couldn't see them.

"Of course we reported the condition to the chief engineer and he called up Mr. Berkman. Feeling that an investment of about $375,000 might be involved, Berkman asked if we'd mind if he brought in some of the manufacturer's men and a metallurgist to check up on the diagnosis. Naturally, we were glad to have them, so next day we all looked over the drum and later held a conference downtown in Berkman's office. There was no question in anyone's mind but that the boiler had been affected by caustic embrittlement and, on the assumption that it was better to be safe than sorry, the boiler men and the metallurgist said they thought the wisest plan would be to discard the drum entirely and put in a new one. The plant engineer thought so too.

"However, when they got to figuring how they were going to get the old drum out and the new one in they saw it was going to be an expensive job. There was no way of doing it without cutting into two of the main building supports, a procedure involving a lot of shoring up that would make the job cost something like twice the amount it would ordinarily take to replace the drum.

"Finally, Berkman turned to me and asked my opinion. I said I wasn't ready to give one, and wouldn't be until I'd had a better opportunity to go over the drum and find out definitely the extent to which the plate had been affected. All hands agreed that such a plan would be advisable before any definite steps were taken, so we decided to adjourn the conference until the end of the week.

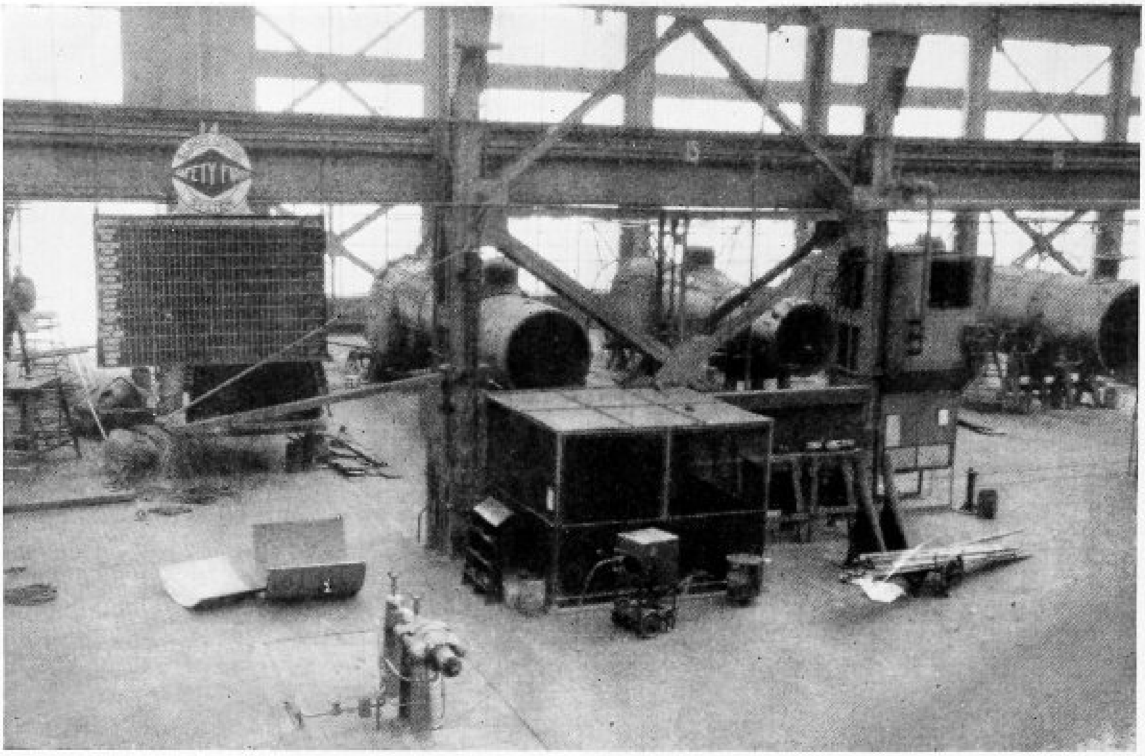
"To make a long story short, Freeman and I went right to work and within two days we had satisfied ourselves that, with one exception, the rivet hole cracks were so short that reaming anywhere from a sixty-fourth to a thirty-second of an inch of metal from the walls of the holes would eliminate the cracks entirely. The one crack that was longer ran back into the plate at such an angle that it wasn't particularly serious.

"Berkman had left the city on a business trip right after the meeting and wasn't expected back until the day of our second conference, so under our instructions the engineer went ahead with the repairs and had the boiler ready to fire up early Friday morning."

"Say," interposed the Manager, "weren't Berkman and the others surprised when you walked into the meeting and told them the trouble was fixed?"

"Well, to tell the truth," laughed the Chief, pausing to tamp down the ash in his pipe, "there wasn't any meeting. Berkman got back to the city several hours before we expected him and he showed up at the plant just as they were cutting the boiler into the line. Unknown to me, the engineer had wired him as soon as we decided the drum could be repaired, so he had 'phoned the others that the conference was adjourned."

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



Orderliness and safety are characteristics of this shop

Repairing Locomotive Boilers

at Illinois Central Paducah Shops

That a railroad is economically justified in establishing modern central repair shops has been successfully demonstrated at the Paducah, Ky., shops of the Illinois Central Railroad, since they were put in operation in 1927. A brief general article describing the plant was published in this magazine in the April, 1929, issue, but now that the operations have become well established complete boiler shop details may indicate to our readers the possibilities that modern arrangement of machines, facilities and methods offer in the way of return to a railroad.

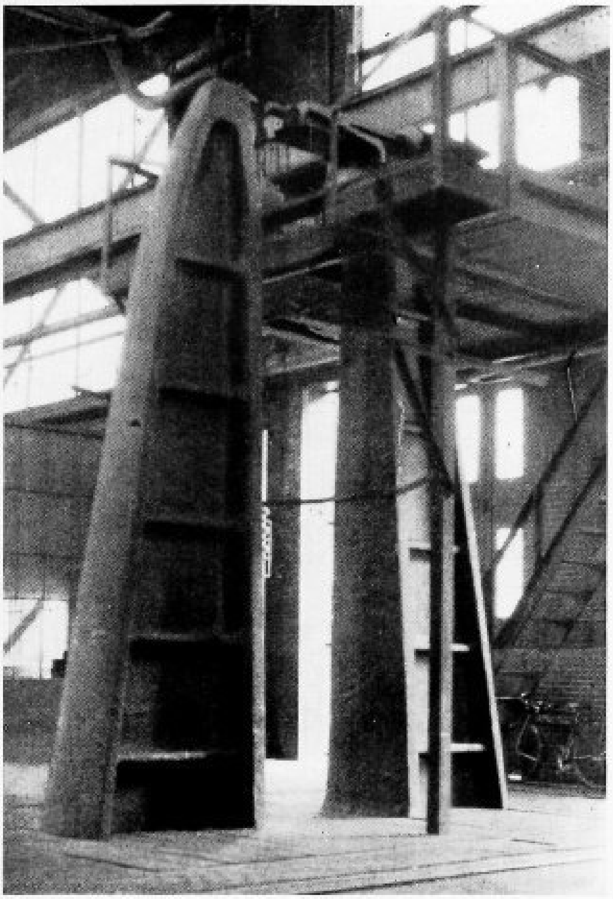
The boiler shop, as is true of the erecting shop, tank shop, smith shop, paint shop and others, will compare favorably with any industrial plant in the world. When the buildings were erected, entirely new boiler shop machinery of the latest type was installed. There are no old pieces of equipment to recall methods of a former day in boiler making. All present and future heavy locomotive repair needs of the Illinois Central can be accommodated at these shops with the assurance of ample working and material storage space. The entire physical layout of the plant has been arranged with this primary thought in mind.

The boiler foreman H. E. May

The group of buildings with which the boiler shop is principally concerned are the erecting and machine shop on one side, the northwest, and the tank-erecting and paint shop on the southeast. These three buildings lie in a northeast-southwest position, and are separated by material storage yards, serving all three shops. At the southwest end of this group is the blacksmith shop running in a northwest-southeast direction or at right angles to the fabricating shops.

Confining ourselves to the boiler shop, the building which is in two bays, has a length of 624 feet and a width of 165 feet. A centrally located riveting tower covering two panels of the shop for a width of 48 feet and over 100 feet high is the highest part of any building of the entire group. Brick and steel have been employed effectively in the construction to give permanence to the structures. Fully half the walls are steel sash windows running the full height of the building which, with a saw-tooth glass roof arrangement, provide the most excellent daylight working conditions.

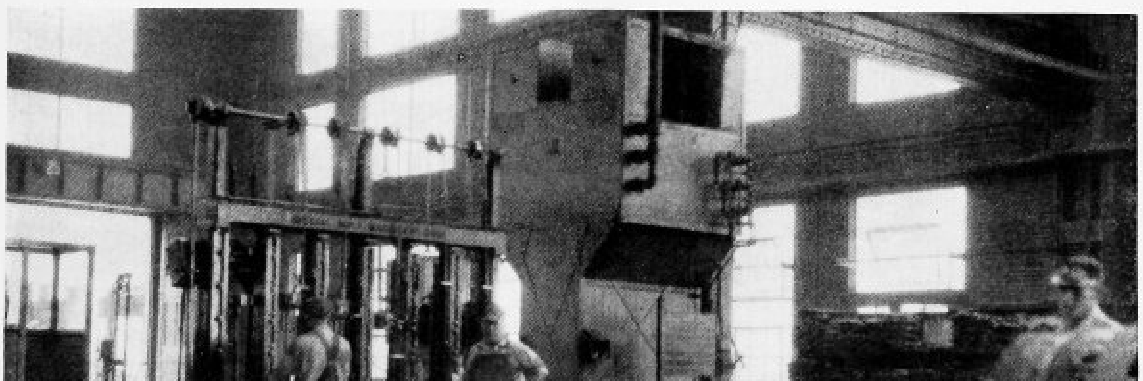
With the exception of four panels, the building is divided longitudinally by 22 panels, each 24 feet between columns. Two panels at the northeast end are each 26 feet 10½ inches, and at the southwest, there are two, one of 26 feet 1½ inches, and one of 12 feet 9 inches. Transversely there are from northwest to southeast one 16-foot 8-inch; three 16-foot; two 16-foot 8-inch; three 16-foot and one 16-foot 8-inch panels, making up the total breadth of the shop.



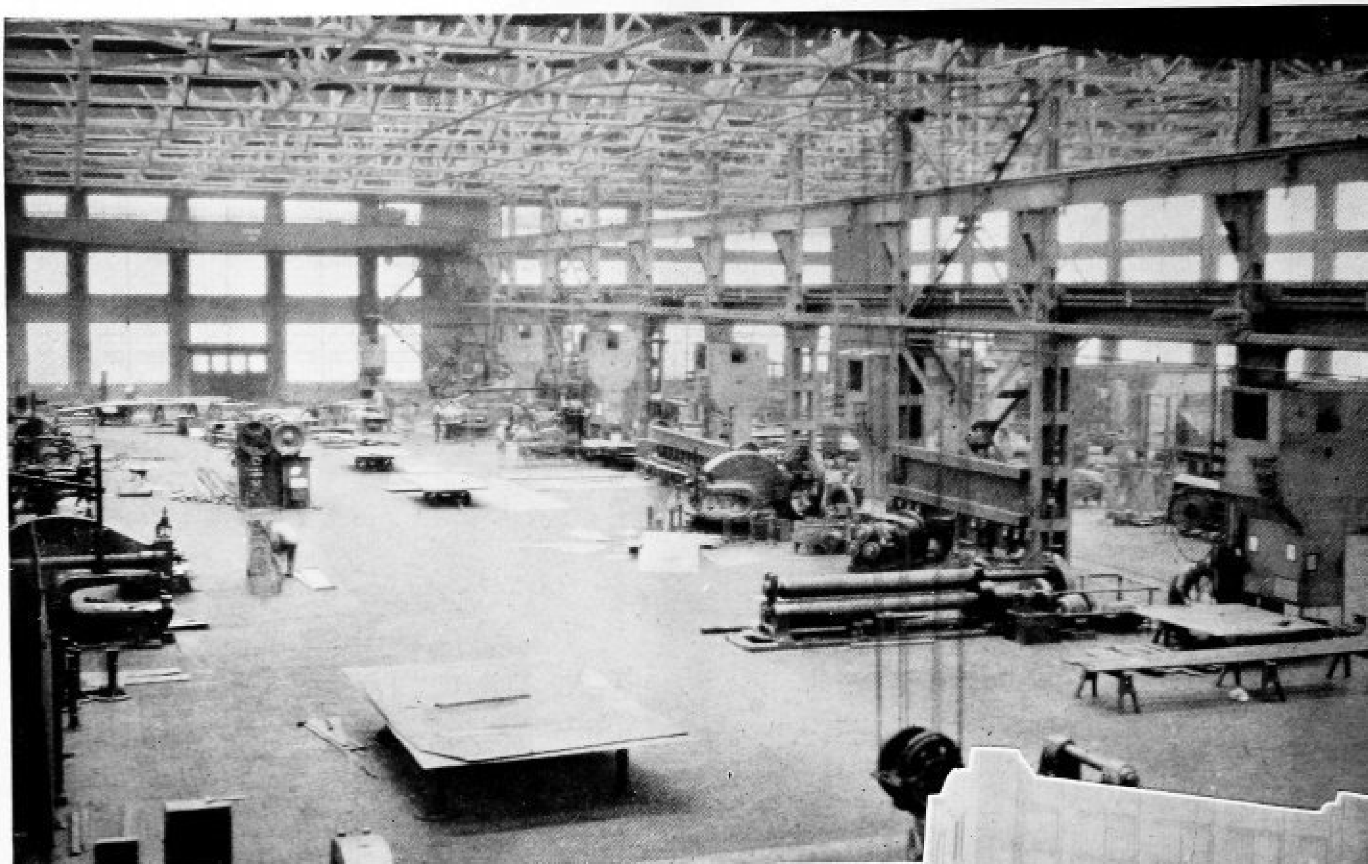
Hydraulic bull riveter for heavy work

A complete arrangement of machinery and details of heavy equipment appears on page 156. In addition to the equipment shown, the crane equipment is quite noteworthy. In the bay devoted to tank work and boiler erecting there is one 50-ton electric crane, with two 15-ton auxiliary hoists. The riveting tower is served by a 15-ton crane, having remote control from the bull riveting platform. In the bay devoted to ash pan work, boiler fabrication and flue work, there are two 15-ton cranes in operation. All of these cranes are of the latest type supplied by the Pawling & Harnischfeger Company. Heating is by steam coils and blower units located along each wall of the shop at short intervals and by several units along the center columns between bays. The system is by the Fischer Heating Company. Ample washrooms and locker facilities are provided throughout the shop. The small tool room is located between bays at the center of the shop.

As now constituted the shop handles all major boiler repairs for the system, and turns out an average of 30 class-2 and 3 repairs a month with a few class-1. These classified repairs are scheduled at the rate of about 7 class-2 and 23 class-3 a month. The class-3 jobs are completely carried out in the locomotive erecting shop, where flue work, half and three quarters side sheets, door sheets and accident repairs are handled, while



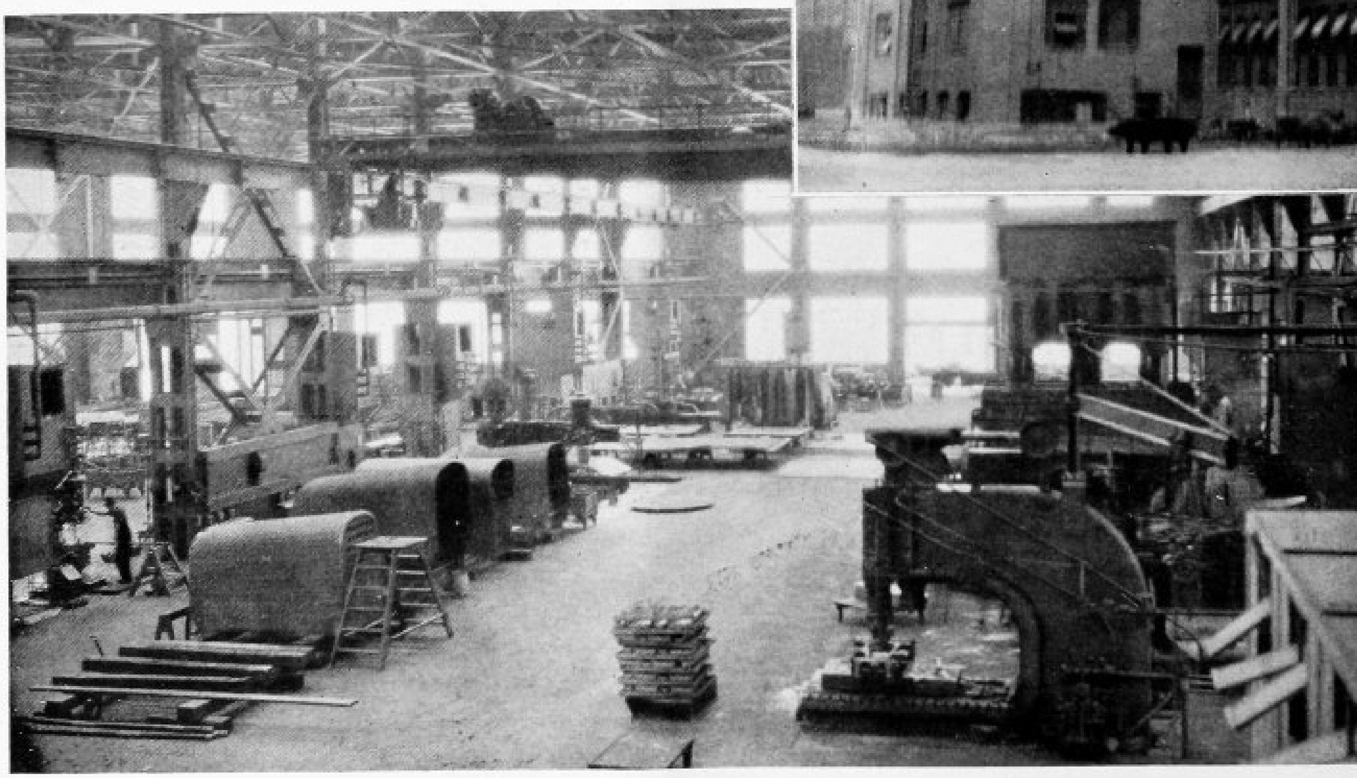
A corner of the staybolt department, with one of the shop heating units shown

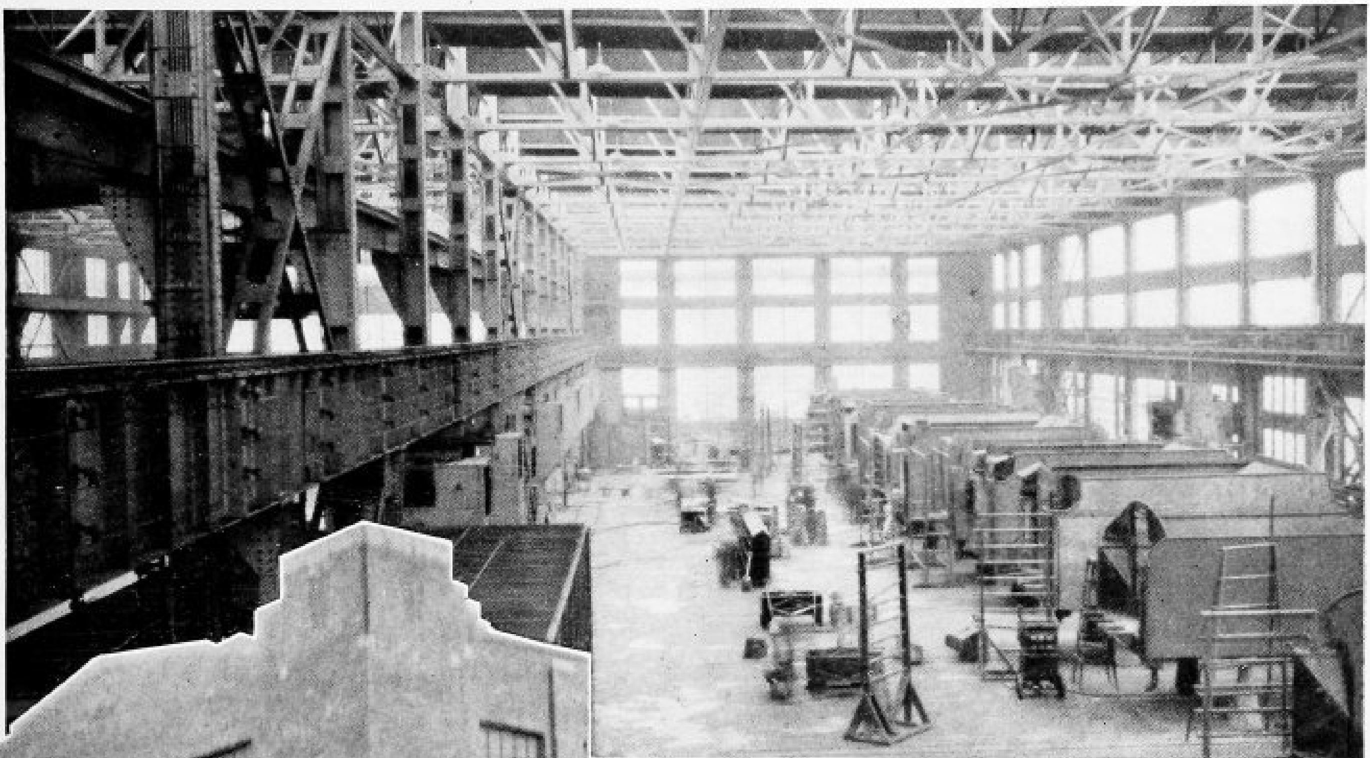


Ash pan and light sheet fabricating department, at the Illinois Central Railroad shops, located at Paducah

The Illinois Central Paducah boiler shop (right) is one of the best arranged and equipped in the country

At the end of the light sheet bay is located the flanging department and assembly for firebox and boiler work

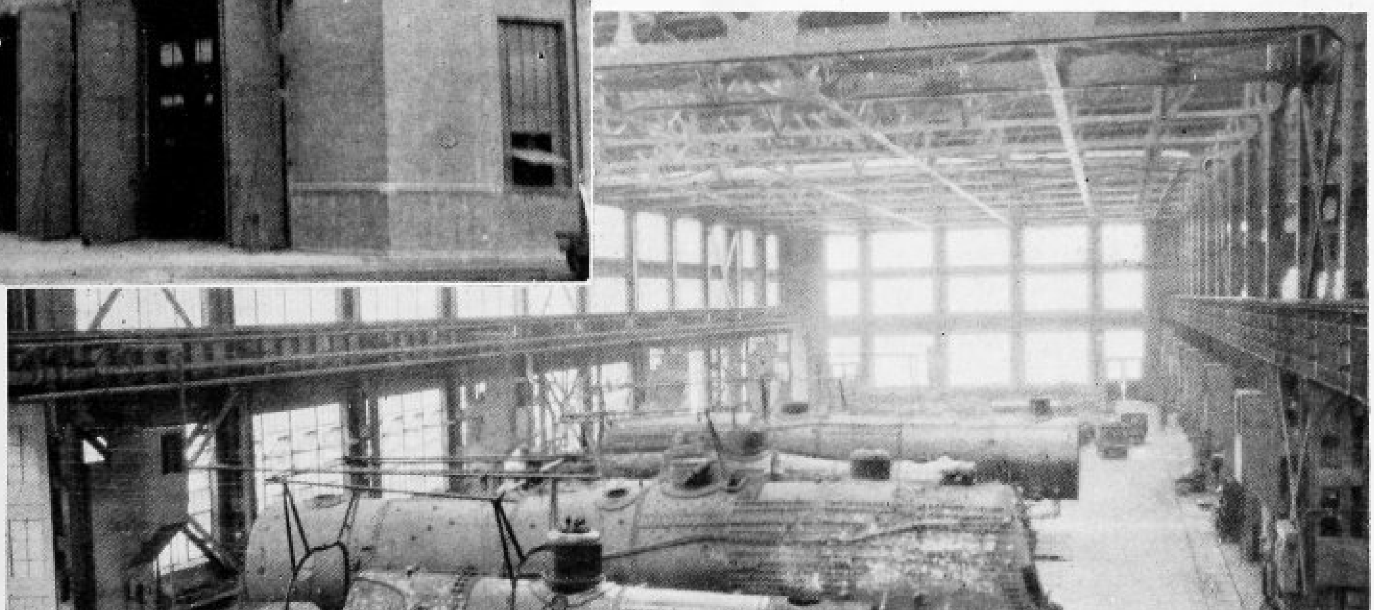


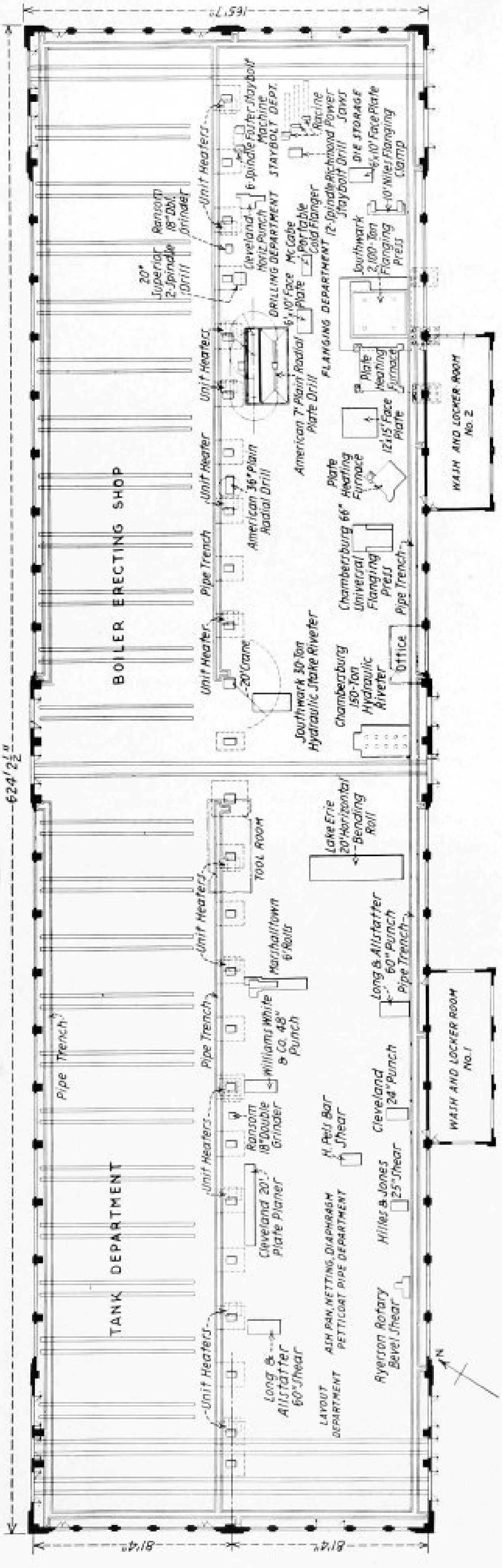


The boiler shop is an excellent example of modern brick and steel type construction

A well-equipped section of the boiler shop is devoted to the handling of tank maintenance

Bay devoted to boiler assembly indicates the possibility of increased shop efficiency, gained from ample space provision





Plan of departments and machine arrangement in the boiler shop

complete firebox renewals are brought to the boiler shop. All cistern work, ash pan, front ends, gratings and the like are handled by the boiler shop staff.

The boiler shop organization consisting of 256 men, is under direct supervision of a general boiler foreman, while under him are 5 gang foremen, 2 lead men and 3 inspectors. In groups the staff consists of 22 welders, 2 layout men, 2 flangers, 1 flange press man, 88 boiler makers, 105 boiler-maker helpers, 4 regular apprentices, 17 helper apprentices, 4 laborers, and 1 clerk.

All boiler work is handled under the gang system, each foreman being responsible under the scheduling system employed for all details of the work of his department. There are five of these departments, or gangs, the firebox gang, the tank gang, boiler and erecting shop gang, a department handling all flue work, ash pans, front ends, grates, running boards and a general night crew of 45 men who handle all rush and clean up work. This latter gang is made up from all classes of the staff, welders, boiler makers, helpers and laborers.

In the case of a class-2 repair, for example, the locomotive is brought to the stripping pit in the erecting shop, where the wheels are removed as well as the front end, grates, ash pans, cab, running boards, jacket and lagging. The boiler still on the frames is sent to the sand blast pit, where the outside of the boiler, frames and cylinders are thoroughly cleaned with the blast. After this, the boiler goes back to the stripping track where the boiler is removed from the frames and sent to the boiler shop. It is brought into the shop on central tracks and spotted by the shop crane in the boiler erection department.

Here the firebox is cut out with the oxy-acetylene torch after which a boiler maker and helper heat the staybolt heads with the torch and twist them out of their holes from the inside. Boilers are not turned for installing fireboxes. Although complete fireboxes are not kept in stock, the system for fabricating sheets allows very speedy renewals. For each class of heavy power, Pacific, Mikado, Mountain, Lima and the like, wrapper sheets, flue sheets and combustion chamber sheets are drilled three or four at a time and kept ready for immediate assembly with flanged sheets as required. The final sheet on one side is retained as a template for the next lot to be drilled so that combined with the templates and drawings for tube, door, throat and back head sheets, which are drilled after flanging, it is unnecessary to retain old sheets as templates. These are scrapped as soon as removed from the boiler. Convenient racks are used to store all sheets between operations. The sheets required on a given renewal are generally fabricated and waiting for installation as soon as the boiler is stripped.

After the new firebox is in place and a new set of flues installed, the boiler is given its hydrostatic test and finally a steam test. For the latter a special kerosene burner is used. All minor leaks that develop are corrected and the boiler is sent back to the erecting shop. About twenty days is allowed for a class-2 repair and never more than 30 days. Many repairs of this class are carried out in less time, while a class-3 job is allotted 9 to 14 days for the boiler work. Very little patching is done. Class-3 generally requires half side sheets, or quarter door sheets and knuckle patches, with sometimes crown sheets or full door sheets.

In later articles, details will be given of the material-handling methods, scheduling system, apprentice training, details of sand blasting, special methods employed and standards of welding practice.

Forty-second meeting of

Boiler Manufacturers' Association

Group organization continues to bring about improvement in boiler manufacturing industry

A continuation of constructive progress along lines of benefit to the boiler making industry is seen as the outstanding factor at the forty-second annual meeting of the American Boiler Manufacturers' Association, which was held at Skytop Lodge, Cresco, Pa., May 26, 27 and 28.

Nearly fifty members and associate members were present Monday when H. E. Aldrich, president of the Association, called the meeting to order and presented the president's annual address. An abstract of his remarks follows:

President's Address

Every organization to be successful must have definite purposes and objectives. It seems proper that I should call your attention to the objects of this Association as stated in three paragraphs under article II of the constitution, which was adopted in 1919. Paragraph I reads as follows:

"To establish such standards for materials and workmanship as will insure uniform excellence of construction of all American boilers, and thus secure safety to the lives and property of all communities where boilers are used, and to procure the passage of laws pertaining thereto."

We are accomplishing the objects stated in this paragraph through the adoption of the A.S.M.E. Boiler Code as a standard of manufacture; the support of the American Uniform Boiler Law Society to assist in a universal adoption of this Code by states and municipalities; and the support of the National Board of Boiler & Pressure Vessel Inspectors. It is difficult to conceive how anything further might be done in this direction unless to express a word of caution that our efforts in the support of these organizations should not be lessened.

Leaving paragraph 2 for later, paragraph 3 reads: "To procure and furnish to its members statistics of the trade, domestic and foreign."

The monthly report by boiler manufacturers to the Department of Census on orders for steel boilers seems to furnish our members with the necessary sales statistics. It is estimated that less than 5 percent of the total volume, largely those who are not members of our organization, do not report, so this service may be considered complete. However, this is of unquestionable value to our industry and we should continue our efforts to obtain 100 percent report of sales to the Department of Census.

Additional information is given by the yearly report of the secretary of the National Board on boilers manufactured and stamped.

As to statistics covering sales possibilties for our products, this is difficult of even rough estimate and it is unlikely that our Association can obtain or prepare information of this character. The same may be said as applying to markets in foreign localities.

Probably the most important object of our Association is stated in the second paragraph of article II. This reads:

"To concert such measures, and take such action, as shall be for the interest and advantage of its members, especially."

This is a broad statement but at the same time it is entirely definite in purpose.

I believe the group organization plan has been of considerable benefit. Whether these committees are as yet sub-divided into their proper divisions remains to be proven. It has been suggested that there be a Power Boiler Group and a Heating Boiler Group, rather than the smaller sub-divisions. This is worthy of consideration. The steel heating boiler industry has formed a separate institute in order to carry on independent trade association activities. Without information to the contrary we assume and hope that the heating boiler manufacturers will continue their support of the A. B. M. A.

Business leaders generally are calling the attention of industry to business changes—real economic changes. Some term this a new business era, while others call it business evolution. These changes, however, are affecting every industry and require that its leaders be keyed up to a new and changing situation.

We are naturally interested in the economic welfare of the United States. We are vitally interested in the economic welfare of the boiler industry. Our industry is not immune from the law of supply and demand. If the boiler industry is to be prosperous its problems must be solved through cooperative effort or it must be satisfied without ample profits. We are after practical results, and in this connection it is important to bear in mind that we are dealing with human relationships as well as economic problems.

Trade associations have become an established and important part of the national business structure. They are acting as a constructive force to promote business in each respective industry. They are bringing about self-regulation to eliminate unfair and uneconomic trade practices.

How does the American Boiler Manufacturers Association fit into the trade association structure of American business? I propose to let you answer that question. It is hoped that at this meeting constructive suggestions will be made and acted upon to bring this Association's activities to the point where the members will receive every possible benefit which they should expect from their organization.

During the last two years I have attempted to present ideas which I thought constructive, in an effort to help in making our organization more efficient. I have favored a trade practice conference by each group as a means toward fairer and better business. Considerable doubt has existed among some members as to the possible benefits of such a conference.

It now appears evident that the boiler industry, or rather each respective group, should have a paid executive staff, at the head of which is a manager or commissioner, who is competent, loyal and aggressive.

A definite program, to the purpose of which the membership is in full accord, should be adopted. The program should include trade extension activities. The solution of our problems through such a plan would surely benefit the industry.

In order to proceed in this manner sufficient funds are necessary. It seems that if an agreement can be reached, as to plan and purpose, funds can be raised without difficulty. A larger sum than this would require is annually spent by the industry in ways which comparatively promise far less in tangible results.

I believe in the American Boiler Manufacturers Association and the great possibilities of its aid in the development and progress of the boiler industry. I ask that my suggestions receive your careful consideration, and, if thought worthwhile, your action.

Auxiliary Equipment

A. C. Weigel, chairman of the Committee on Auxiliary Equipment indicated that the committee has a wide field of activity. He stated that due to the increasing magnitude of contract business, a code of standards should be set up to enable equipment manufacturers to quote properly on such equipment for boiler manufacture. G. W. Bach also mentioned that the relative responsibility of equipment manufacturers should be cleared up.

Because of his long service to the industry and because of the valuable work performed during the past years, E. R. Fish, formerly with the Heine Boiler Company, St. Louis, Mo., and now with the Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn., was elected to honorary membership.

A. S. M. E. Boiler Code

E. R. Fish, chairman of the A.B.M.A. American Society of Mechanical Engineers' Boiler Code Conference Committee, expressed the desire that boiler manufacturers keep in touch with the activities of the Boiler Code Committee. Such interest in the changes and decisions of the Code Committee may save considerable loss in time and money by taking advantage of decisions before the actual rules go into effect.

The principal activities of the Boiler Code Committee during the past year have been in connection with welding which has become an important process of construction, particularly in heating boilers. In this respect, proposed specifications, outlining the procedure and general rules for welding have been drawn up. These are both complete and drastic and two points have been observed in their formulation. First, it is necessary that the deposited metal have similar characteristics to the base metal. Men, methods and material must be chosen with care in order to prevent the production of brittle welds.

The second point to be observed is that of soundness, a point more difficult to determine than that of similar characteristics of metal. The A. S. M. E Boiler Code Committee is taking this point into consideration and will undoubtedly have specifications for the determination of soundness to offer by the end of the year.

It is indicated at this time that the 1930 Boiler Code will be ready for distribution about November. This new code will have many revisions which will be issued in the usual preliminary form in about a month's time.

C. O. Myers, secretary of the National Board of Boiler and Pressure Vessel inspectors, in his progress report of the activities of this organization stated that all arrangements have been made for the annual meeting of that organization to be held in Chattanooga, Tenn., June 17, 18 and 19. Some important matters will be presented at this meeting, foremost among which is the question of welding. All of the meetings will be open and the boiler manufacturers are invited to take part in the session.

Mr. Myers pointed out that the National Board in the past year has continued its progress, more than 20,000 boilers being registered by the Board in 1929.

George W. Bach, of the Pennsylvania State Advisory Board, announced the fact that C. W. Obert, Secretary of the Boiler Code Committee of the A.S.M.E., and William Ferguson had been appointed by the Pennsylvania Department of Labor and Industry to fill two vacancies caused by the recent death of W. L. Eals and the resignation of James Speed.

Mr. Fish, next brought up the subject of a Boiler Engineering Insurance and Service Bureau, an organization maintained by the various insurance companies as a central information bureau. This new bureau is about ready to issue a new manual of insurance rates based on the heating surface of boilers and in this connection it is requested that boiler manufacturers furnish to the Bureau the heating surface of all boilers at present in existence. This information can only be obtained from manufacturers and as a prevention of lost time, the Bureau which will deal directly between the insurance company and the manufacturers will obtain the information desired by the insurance companies and eliminate duplication of effort.

George W. Bach, chairman of the Smoke Prevention Association Conference Committee, reported that the 24th annual meeting of the Smoke Prevention Association would be held in the Hotel Robert Treat, Newark, N. J., June 24, 25, 26 and 27. In this connection, George W. Bach, Homer Addams and C. E. Bronson were appointed a committee to represent the A. B. M. A. at this convention.

Boiler Suspensions

A written report prepared by E. R. Fish, on the subject of boiler suspensions, of which committee he is chairman, was next presented. This report is in part as follows:

The report on supporting structures for boilers presented at the February meeting of the Association was sent out to the whole membership as directed. Comparatively few comments have been received, all of which were favorable and only two of which suggested any changes. Both of these suggestions have been incorporated in the report herewith submitted. Your committee presents its report and recommends its adoption as the practice of the American Boiler Manufacturers Association.

Boiler Supporting Structures

Material and stress values are to be used in the construction and design of structures for supporting boilers as follows:

Columns.—Columns shall be made of material of quality not inferior to that required by A.S.T.M. specification No. A9-24 and shall have a maximum 1/r ratio of 120 or a maximum fibre stress of 16,000 pounds per square inch. No credit shall be taken for casual connections between supporting columns nor for abutting brickwork. When cross ties are used, designed specifically for the purpose of strengthening columns, credit may be taken for such ties, which however may be designed with both a horizontal and vertical maximum 1/r ratio of 140.

Cross Girders.—Cross girders or beams shall be of material of quality not inferior to that required by A.S. T.M. specification No. A9-24 for structural steel and the maximum tensile fibre stress shall not exceed 16,000 pounds per square inch. Lateral deflection of beams shall be provided for in accordance with the practice recommended by the American Institute of Steel Construction as the minimum requirement.

Hangers.—Hanger rods when made of open hearth material of quality not inferior to that required by A.S. T.M. specification No. A9-24 for structural steel or A.S.M.E. specifications may be allowed a maximum unit tensile stress of 14,000 pounds per square inch if not bent or otherwise distorted. If bent or distorted the maximum unit tensile stress shall be 12,500 pounds per square inch. If made of higher tensile strength material in accordance with any A.S.T.M. specification for bridge or structural steel hanger rods, the maximum allowable unit stress may be increased in the same proportion that the minimum tensile strength of the range for the special material exceeds the minimum of the range of the A.S.T.M. specification herein referred to. If material of unknown quality is used the maximum unit stress shall be 8000 pounds per square inch when straight and 7500 pounds if bent or otherwise distorted.

The least area at any point in the hanger shall be used to determine the unit stress carried.

General.—The loads on all supporting members shall include all possible weights that may have to be carried when the boiler is set up filled with water for hydrostatic test and ready to operate with all piping, breechings, superheaters, etc., attached.

Any member of a supporting structure so located that any loaded part or portion thereof may be heated to a temperature in excess of 400 degrees F. shall be designed for a maximum unit stress 10 percent less than that authorized for temperatures under 400 degrees F. No part or portion of any supporting structure subject to load shall be so located or unprotected as to become heated to a temperature in excess of 600 degrees F.

The limitations herein provided are intended to apply only to the usual type of independent boiler support, or to that part of other structural work which replaces such support.

Monday Evening Session

At the Monday evening session the association was addressed by Philip P. Gott, assistant manager, Trade Association Department, United States Chamber of Commerce, who took as his subject, "Trade Association Accomplishments." Mr. Gott outlined the history of trade associations and explained the activity of the government in fostering the work of these associations. He brought out the fact that trade associations should serve as a group to correct the evils of the industry. He cited the various reasons why trade associations like various businesses failed. Lack of cooperation, improper financial arrangements, and unsatisfactory programs are in a way responsible for the failures of trade associations.

When asked for constructive criticism, Mr. Gott, suggested the employment of a capable staff with a trade association executive from outside the field. An organization made up of research, cost accounting, engineering, education and promotion departments would aid in the solution of the trade association problem.

An interesting discussion followed Mr. Gott's address. From this many facts, clarifying questions in the minds of the association members, were brought out.

Tuesday Session

On Tuesday morning, meetings for members of the various groups of the association were held. These groups include the watertube division, the firetube division and the heating boiler division.

The division committees are made up of company members and representatives as follows:

Watertube Division Committee

W. C. Connelly, Chairman, The D. Connelly Boiler Company, Cleveland, O.
S. G. Bradford, Edge Moor Iron Works, Edge Moor, Del.
Owsley Brown, The Springfield Boiler Company, Springfield, Ill.
C. W. Middleton, Babcock & Wilcox Company, New York City.
A. C. Weigel, Hedges-Walsh-Weidner Company, New York City.
E. G. Wein, E. Keeler Co., Williamsport, Penn.
Geo. W. Bach, Union Iron Works, Erie, Pa.

Fire Tube Division Committee

C. E. Tudor, Chairman, Tudor Boiler Manufacturing Company, Cincinnati, O.
Starr H. Barnum, The Bigelow Company, New Haven, Conn.
J. H. Broderick, The Broderick Company, Muncie, Ind.
Hugh Donovan, Donovan Boiler Works, Parkersburg, W. Va.
J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.
Wm. Heagerty, Oil City Boiler Works, Oil City, Pa.
J. F. Johnston, The Johnston Bros., Ferrysburg, Mich.
Sjored Mensondes, Farrar & Trefts, Buffalo, N. Y.
F. B. Metcalf, International Boiler Works, E. Stroudsburg, Pa.

Heating Division Committee

Homer Addams, Chairman, Fitzgibbons Boiler Company, New York City.
J. R. Collette, Pacific Steel Boiler Corporation, Waukegan, Ill.
R. B. Dickson, Kewanee Boiler Corporation, Kewanee, Ill.
J. T. Dillon, Titusville Iron Works Company, Buffalo, N. Y.
Jos. Doyle, Ames Iron Works, Oswego, New York.
C. W. Edgerton, Coatesville Boiler Company, New York City.
W. A. Nevin, Heggie Simplex Boiler Company, Joliet, Ill.

The annual dinner of the Association for members and guests was held Tuesday evening.

Wednesday Morning Session

At the opening of the Wednesday morning session, which is of a general character, resolutions were adopted upon the death of Charles R. Turn, president of the International Boiler Works, East Stroudsburg, Pa., and of George N. Riley, of the National Tube Company, Pittsburgh, Pa.

In the absence of W. C. Connelly, chairman of the Watertube Division Committee, George W. Bach reported informally that it was decided to change the name of the group from the Watertube Group to the Power Group which will organize at a future date under a full-time manager.

C. E. Tudor, chairman of the Fire Tube Division Committee, reported that it is the plan of this division to omit from the list of boilers, odd sizes of horizontal return tubular boilers.

Homer Addams, chairman of the Heating Division Committee, reported on the activities of that committee and expressed the opinion that members of the Heating Division would be more numerous in attendance when

(Continued on page 176)

Master Boiler Makers Me

Members of Associa
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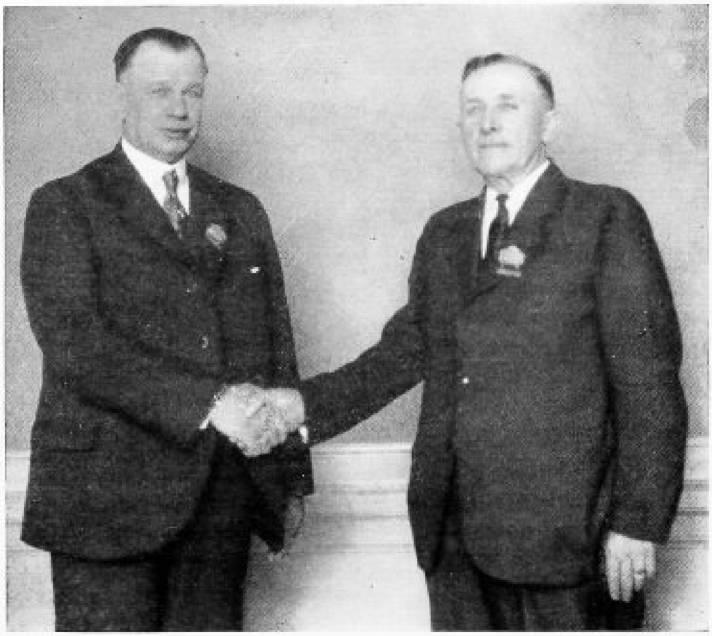


President Usherwood congratulates Kearn E. Fogerty, the new president

Modernization of shop equipment to keep pace with the rapidly changing demands being made on the motive power of the country was the keynote of the annual address of President George B. Usherwood, supervisor of boilers, New York Central Railroad, at the twenty-first annual convention of the Master Boiler Makers' Association. This convention was held at the William Penn Hotel, Pittsburgh, Pa., May 20 to 23 and was attended by nearly 600 members, guests and members of the Boiler Makers Supply Men's Association. This registration was made up of 210 members of the association of which 26 were new members; 76 guests; 94 ladies; 160 members of the Boiler Makers Supply Men's Association and 31 ladies and guests of this organization. Last year's record of attendance of past presidents was broken this year, 14 having registered at this convention, including George Wagstaff of the American Arch Company, New York; J. A. Doarnberger, master boiler maker, Norfolk & Western Railroad, Roanoke, Va.; P. J. Conrath, boiler tube expert, National Tube Company, Chicago, Ill.; W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, O.; D. A. Lucas, works manager, Prime Manufacturing Company, Milwaukee, Wis.; A. N. Lucas, district manager, Oxweld Railroad Service Company, Wauwatosa, Wis.; Thomas Lewis, formerly general boiler inspector, Lehigh Valley Railroad, Sayre, Pa.; E. W. Young, formerly mechanical assistant to general superintendent of motive power, Chicago, Milwaukee, St. Paul & Pacific Railroad, Dubuque, Iowa; T. F. Powers, assistant superintendent of motive power, Chicago & Northwestern Railway, Oak Park, Ill.; J. F. Raps, general locomotive inspector, Illinois Central Railroad, Chicago, Ill.; A. E. Brown, general foreman boiler maker, Louisville & Nashville Railroad Shops, South Louisville, Ky.; C. L. Hempel, general boiler inspector, Union Pacific Railroad, Omaha, Neb.; W. J. Murphy, division boiler foreman, Pennsylvania Railroad, Olean, N. Y.; and L. M. Stewart, general boiler inspector, Atlantic Coast Line, Waycross, Ga.

President Usherwood opened the convention Tuesday morning, May 20, at 10 A. M., and after an appropriate prayer was offered by Reverend Vincent Burke and an address of welcome to Pittsburgh by C. P. Long, city solicitor, M. W. Hasset, assistant superintendent of motive power, New York Central Railroad, was introduced who addressed the convention in part as follows:

While a century has passed since the steam locomotive came into existence, it is truly said that the last twenty-five, and more particularly the last ten years have marked the greatest development, not only in the locomotive itself but in every phase of railroad transportation. Equipped with every known device for safe and economical operation, the present day use and performance of the modern locomotive is amazing in contrast with the standard locomotive of less than a decade past. It is now possible to extend the run of the individual locomotive to whatever distance the train it hauls may be scheduled to move, be that 300, 500, 800, 1000, or more miles.

In the creation of the design of this splendid locomotive of today, quite naturally came the boiler of increased proportions and increased pressures. To what extent locomotive boilers may profitably be re-designed, with resultant increased pressures, is problematical. We feel assured that continued research and experiment, combined with your expert knowledge and valuable suggestions, will sustain the march of progress.

There have been vast expenditures of money for the purchase of these locomotives, for the enlargement and improvement of necessary maintenance facilities and for the purchase of a great number of machine tools of improved type. There have been some economies made possible through improved methods of operation in which the locomotive has had its part, but far more must be done to offset the loss to the railroad through the competition set up by other means of transportation, particularly the motor truck and motor bus. In 1904 there were 410 motor trucks and in 1929 the number had increased to 3,370,000. It remains to be seen if these new methods can survive in competition with the railroads. In the meantime, a heavier responsibility rests upon each and everyone of us than ever before. Every condition that points to improper design, weak construction or lack of thorough maintenance will neces-

or Twenty-first Convention

eting at Pittsburgh discuss maintenance problems due
ns, heavier train loading and higher pressures

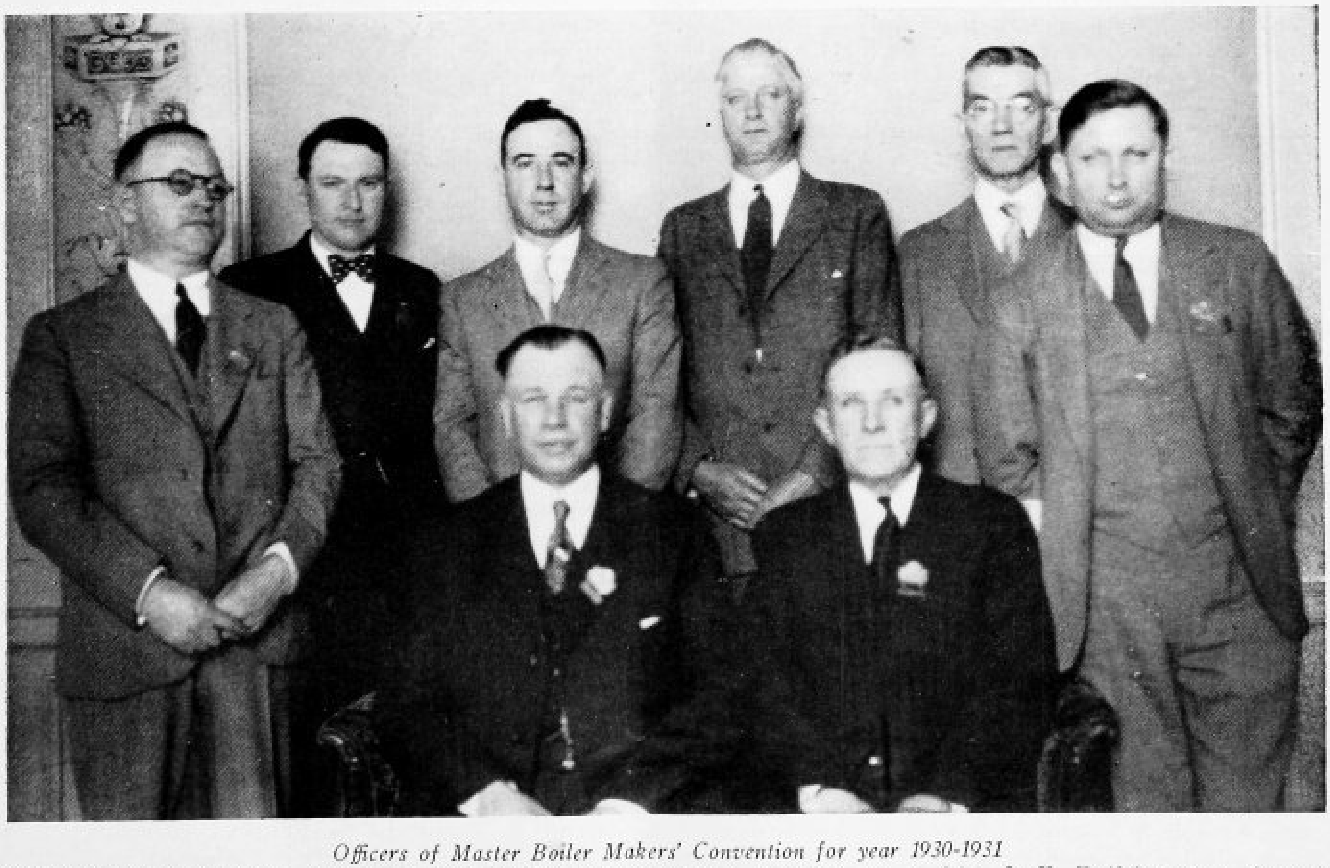
sitate immediate corrective measures, if we are to provide the very best transportation service at a minimum cost.

Of prime and foremost importance is that a locomotive, receiving classified repairs at the main shop, must have repairs made with only the highest degree of thoroughness. If a locomotive boiler, or any other part of a locomotive, is not given such repair before dispatched from the main shop, and any extensive repairs at an engine house become necessary before it can run out its term of service, due to faulty repair at the main shop, that method is positively wrong, it is false economy, there can be no slipshod methods tolerated. Any part that shows evidence of such wear or deterioration as to cause a breakdown or necessitate its renewal at an engine house will cost far more for such repair than if given deserved attention at the main shop.

For the maintenance of locomotives, the best thing I can say to you who may be chiefly interested in that regard, or partially so is this—*obey the rules.* Obedience to rules never gets a fellow into much trouble or difficulty. The disobedience of rules always merits rebuke, admonition, and very often, more severe discipline.

Railroad management has prescribed for the guidance of its employees, whether for train operation, locomotive maintenance or safe practice in the avoidance of personal injury or discomfort to themselves or co-workers, a set of instructions with drawings when required, for solving any problem that may enter our minds as to how our work is to be done.

A very heavy and serious responsibility rests upon the supervisory officer. He should not overlook even the slightest or what may on the surface appear to be the most trivial indifference or inattention to a rule. If one pleads ignorance of the prescribed rule, that is a serious reflection on the ability and qualifications of the foreman in immediate charge. If we tolerate the careless or indifferent foreman, then we assume entire responsibility and thereby bring ourselves to the same level as he.



Officers of Master Boiler Makers' Convention for year 1930-1931

(Seated) George B. Usherwood, retiring president; Kearn E. Fogerty, president. (Standing, left to right) O. H. Kurlfinke, second vice-president; L. E. Hart, fourth vice-president; Ira J. Pool, third vice-president; F. T. Litz, first vice-president; W. H. Laughridge, treasurer; A. F. Stiglmeier, secretary; W. N. Moore, not in above group, was elected fifth vice-president.

The president's annual address was next on the program and in developing his speech on modern maintenance methods he spoke as follows:

Many boiler makers, in fact most of those following this trade, do not realize the tremendous changes that are occurring in their industry. Nearly all of us are familiar with the larger power that is being added to the equipment of many railroads, as well as the adoption of longer runs with the added maintenance problems. How many realize what the possibilities will be when new materials such as nickel steel and chromium steel, steel castings, and advances in design in engineering are more widely applied. In the technical press devoted to boiler making, mention is being constantly made of isolated locomotives and stationary boilers, where higher pressures are being used. Even in locomotives of standard design, similar to those with which we have always been familiar, the boiler pressures have crept up to 225, 250, and even 300 pounds. These increases have only been possible through better materials, better workmanship, and their success in service depends on better maintenance. A few years hence these pressures will be common practice, as present locomotives are replaced and the boilers of watertube design with pressures of 500, 600, and some of 800 pounds that are experimental today will undoubtedly have been widely adopted to meet special power problems.

With the changing locomotive practice, methods and equipment are being tremendously improved. There are a number of boiler shops operated by the railroads of this country and in Canada that represent the last word in modern arrangement and facilities. Unfortunately, they are too few. The great majority of shops is plodding along with the same equipment and same building arrangement that was modern 20, 30, or even 40 years ago. Present heavy boiler operations can be handled properly only with the aid of machinery that has been designed especially to accommodate them. Of course, it is not practicable for roads to scrap the plants they have and completely modernize them overnight. Nevertheless, it is in the interest of efficiency and economy to develop some comprehensive plan of improvement and carry it out over a period of time. In the process, not only can the physical layout of a shop be brought up to date, but boiler production tools can be installed to replace obsolete equipment. In addition, the facilities for the convenience of the personnel can be modernized. Since a man's efficiency depends largely upon his surroundings and well being, such things as proper lighting, ventilation, heating, safety precautions, good lavatories, and the like, should all be taken into account. Unfortunately, there are many shops, particularly the smaller and older ones, where such things were never thought of when they were built.

Lately, the tendency on some of the larger systems has been toward the centralization of repair facilities on their various divisions. To a lesser extent smaller roads have done much the same thing with a considerable degree of success in reducing shopping time and actually saving considerable locomotive maintenance expense. This merging of facilities would seem to be quite logical and with the savings made by concentrating major repairs at a central plant, great improvements would be possible. Instead of buying replacement equipment as necessary for shops scattered all over a given division or entire road, this same expenditure would result in a completely equipped modern repair plant capable of meeting any repair schedule for the entire territory.

In the same way, modern power demands a highly-skilled personnel, and the future requirements that we as boiler makers will have to meet means that more attention must be given to adequately training the younger men coming along now. This and other points that I have briefly touched upon will be well brought out in the papers and discussions to follow.

One other matter, in which, because of my position, I am greatly interested and which is of the utmost importance to all of us, is inspection. Due to better methods and workmanship in the shops and to more careful inspection on the part of railroad inspectors combined with the excellent work of our good friend Mr. Pack and his staff of the Bureau of Locomotive Inspection, the improvement in the condition of locomotives, and particularly boilers, over the past few years has been remarkable.

The selection of boiler makers for the position of inspectors in shops and engine terminals should be given careful consideration. This is an extremely important position and in order to inspire confidence in these men, their opinions should be treated with respect. They should be encouraged to report all defects which they find when making a boiler examination. They should be instructed that if at any time they notice anything wrong with any part of the machinery or tender, such defects should be reported to the foreman, whose duty it is to see that such parts are in proper condition. In such cases, due credit should be given to the inspector for his interest. Such a practice will not only promote better conditions generally, but will aid materially in avoiding criticism from members of the Bureau of Locomotive Inspection staff.

A. F. Stiglmeier next presented the secretary's report and W. H. Laughridge, treasurer, submitted his annual statement for the approval of the association. The financial condition of the association is better now than it has been for many years, a considerable balance being available in the treasury.

The routine business of memorials for deceased members, election of honorary members and the discussion and passage of amendments to the by-laws occupied the remainder of the morning session.

Tuesday Afternoon Session

The first part of the afternoon session on Tuesday was devoted to the topic committee report "Boiler and Tender Corrosion and Pitting and What Can Be Done in the Boiler Department to Relieve the Condition." This paper was prepared by a committee composed of O. H. Kurlfinke, chairman, and C. W. Buffington. In the paper were contained practical suggestions for the boiler shop to follow in handling repairs to deteriorated parts of the boiler and tender and in assisting the water service engineers to work out successful treatments for the elimination of this condition. The discussion was entered into by a number of water service engineers and metallurgists who for the past several years have been invited to take part in the proceedings. Among these were included J. B. Horstmann, chemical engineer, Dearborn Chemical Company; C. A. Seley, consulting engineer, Locomotive Firebox Company; F. J. Jenkins, general locomotive inspector, Texas & Pacific Railroad Company; R. E. Coughlan, supervisor water supply, Chicago & Northwestern Railroad Company; J. B. Wesley, engineer water service, Missouri Pacific Railroad Company; H. L. Miller, metallurgist, Republic Steel Company; R. C. Bardwell, supervisor water supply, Chesapeake & Ohio Railway Company; Dr. C. H. Coyle, engineer water service, Chicago, Milwaukee, St. Paul & Pacific Railway Company; R. E. Hall, metallurgical department, National Tube Company and several others. The paper and discussions which followed are too lengthy for the present report and will be published fully in an early issue. As a special feature of this session, G. H. Koch, general engineer, Westinghouse Electric & Manufacturing Company, delivered an illustrated lecture on "Recent Developments in Arc Welding," material from which, so far as it applies to boiler work, will appear later.

The four prime movers of the convention
Al Stiglmeier, secretary; George Usherwood, president; (seated) W. H. Laughridge, treasurer, and Mrs. Stiglmeier.

Wednesday Morning Session

In the unavoidable absence of A. G. Pack, Chief Inspector, Bureau of Locomotive Boiler Inspection, who was to have addressed the convention at this time, R. H. Flynn, chief superintendent of motive power, Pennsylvania Railroad, Pittsburgh District, delivered an interesting and valuable talk. An abstract of Mr. Flynn's remarks follows:

Economics of the Locomotive

By R. H. Flynn

The modern locomotive is pretty largely a question of its boiler. It is the power plant and the source of energy, and unless we can improve the performance of the boiler and improve the capacity of the boiler, we can not go very far in improving the capacity and performance of locomotives.

Statistics show that in the past seven years, we have in this country something like 6000 less locomotives than we had before, and we have a total traction effort which is greater than existed seven years ago. In other words, the average tractive power is greatly increased and that means the average of locomotives and the average of locomotive boilers is greatly increased as compared with a few years ago. I think we would be rather safe in saying that the average boiler pressure today on modern power, or rather the standard boiler pressure on modern power is around 250 pounds. A great many of the modern and newer locomotives being built today are standardized for that pressure and there have been examples, experimental of course, of pressures very much higher than that, and I think we have reached the point where in the future we will hardly consider anything less than 250 pounds pressure in building a locomotive.

Furthermore, we are surrounding the locomotive boiler, in order to increase its capacity, with all of the modern fuel saving devices that we can.

We have even gone so far as to spend considerable attention on a better front end arrangement to improve the capacity of locomotives. As a result, in the boiler and in machinery as well we have a locomotive today which will produce power at a much more economical rate of fuel consumption than ever known before.

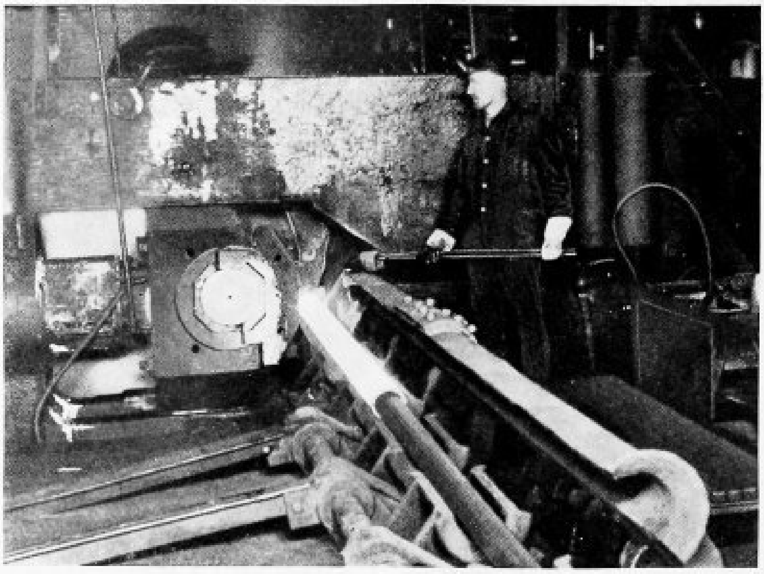
There are a great many other factors, of course, that enter into that thing which could never have been accomplished without modern locomotive and modern boiler practice as reflected in the designs we have today. In the year 1928, which is the last year for which I have any data in mind, the coal consumption of the American railroads was 1237 pounds per thousand gross ton miles. Now that may not impress you as a figure, but when you consider that is a reduction of somewhere between 25 and 30 percent as compared with five or six years ago, it becomes more impressive, and it always becomes impressive when you realize that it is the very lowest figure ever reached in American railroad performance. During the year 1928 the coal bill of the American railroads represented a lower proportion of their operating expenses than ever before in their history, and we weren't paying the lowest price per ton of coal either.

That goes to show you where the boiler and the locomotive come into the picture from the standpoint of modern railroad practice.

I read the statement the other day that the efficiency of the American railroads since 1922 had increased 25.5 percent. Now, of course, it is pretty hard to evaluate the efficiency of railroads as a whole, but this figure was calculated from a basis of thirteen of our so-called operating statistics which are generally accepted now as the measure of railroad efficiency.

This fuel consumption that I just spoke of is one of them. Gross ton miles per train hour is another. Freight train speed is another. I am talking freight statistics. Average miles per locomotive day is another. Net ton miles per car day is another. Car speed is another, and so on. Those are fundamental operating statistics which are accepted by all of the class I railroads as a proper measure of operating efficiency, and I don't know of any one of them that has a greater reflection of actual operating efficiency than this question of fuel consumption.

We are making vigorous efforts all over the country today to give better and faster and more dependable freight service, and it has reached the point, where the performance of so-called preference or arranged service freight receives just about as much attention from everybody on the railroads as the passenger trains used to receive before this service was started.


Billet coming through piercing mill at National Tube Works

Now we cannot have that sort of service unless we have dependable locomotives, and we cannot have dependable locomotives unless we have dependable boilers, because, after all, a locomotive is pretty nearly worthless out on the road, if it is not able to keep up the steam pressure and deliver the capacity necessary to move the trains the way we want them moved.

This brings to my mind the necessity of first-class construction and first-class maintenance in every particular. We can not afford to go along with anything but the very best of maintenance, not only on the boiler, but the entire locomotive. That is where you men, who are vitally interested in boilers, come into the picture. I want to leave this thought with you, that we have passed the point where we can have or put up with anything but the very best of maintenance. There can be no question of performance involved in this matter, but we must have not only the best maintenance but absolutely safe maintenance, and so performed and so taken care of that a locomotive is absolutely dependable when it is in active service when out on the road.

There has been a wonderful improvement in the general maintenance situation with regard to boilers in the last few years, but I do not believe we have reached the limit.

No one particular thing, or the efforts of any one man, but the efforts of every man connected with the railroad from the top to the bottom, all putting their shoulders to the wheel, and co-operating to get improved efficiency, will bring about a better service to the public, and that, after all, is all we have to sell. The railroads have service to sell, and they are endeavoring to improve their service. We can not very well actually reduce the price of service, but we can in effect actually accomplish this result by giving a better quality of service to the public.

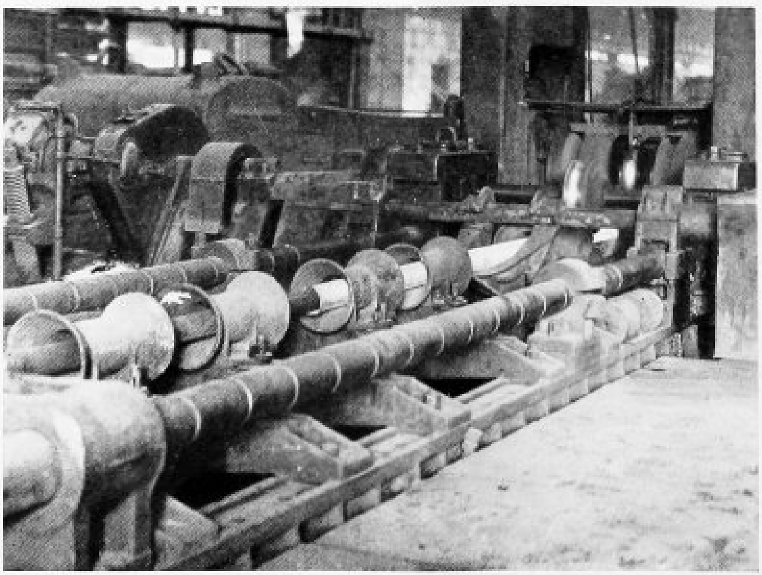
We are making vigorous efforts all over the country to give better, faster and more dependable freight service. With these improvements in service and maintenance our railroads are sure to prosper in the future. Your co-operation is necessary. The reading and discussion of the subject of fusion-welding was next taken up by the convention.

Fusion Welding Applied to Steam Pressure Boilers

In view of the comprehensive report on fusion welding submitted at the 1928 convention, your committee has endeavored to confine this report to the progress and development of the welding art.

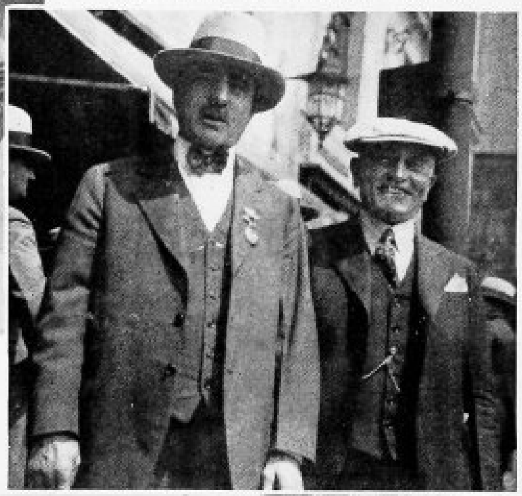
Today many methods and processes are employed in the fabrication and repairs of steel and metal parts, the most important of which are the oxy-acetylene and electric-arc processes.

The extraordinary development in welding during recent years has been responsible for the success in the construction of stationary boilers, locomotive tenders, unfired pressure vessels, high-pressure, oil-cracking stills, the fabrication of all-steel barges, bridges and buildings. Spherical containers have been built by the A. O. Smith Corporation, Milwaukee, Wis., and tested to destruction at their plant September 10, 1929. After fabrication the sphere was heated in an automatically controlled furnace to a temperature of 1200 degrees F. for four hours. Following the stress relieving operation the sphere was subjected to a hydrostatic test which involved:


Rear of National Tube rolling mill

(Above) Members of the Association at the National Tube Company plant

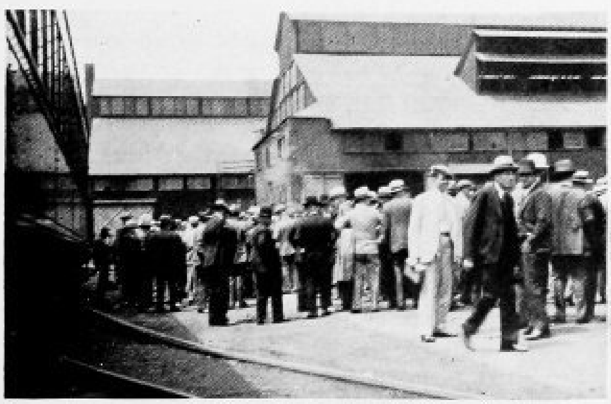
(Below) Well-known convention figures, Pete Conroth and Doc Bateman

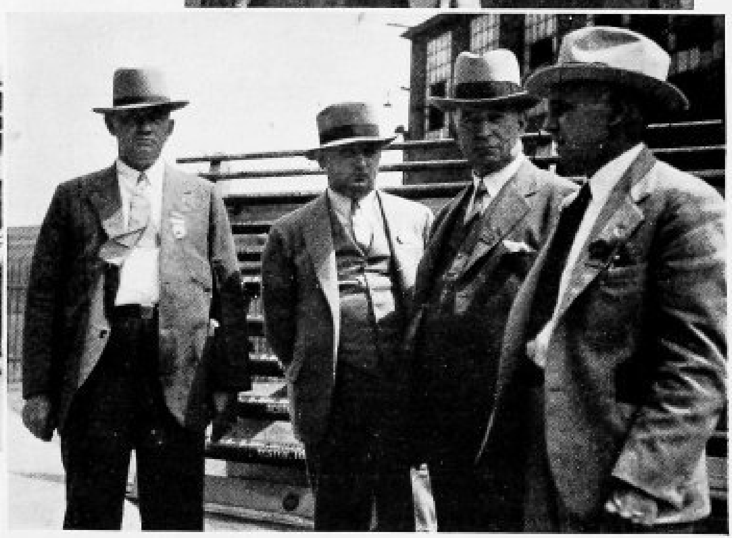


(Above) W. J. Murphy and Charlie Longacre with some of their friends

(Lower right) Lee Stewart, Al Stiglmeier, J. W. Kelly, and John Harthill at the National Tube works

(Below) Gang leaving special train





1. A repeated-stress test, during which the pressure was varied a number of times between limits corresponding to a stress in the material of 45 to 60 percent of its yield point.

2. A hammer test with the sphere under a pressure, producing a stress in the metal of 60 percent of its yield point. During this test the welded joint was hammered at intervals of 1 foot with full swing blows of sledges, having a weight equal to 10 percent of the weight of 1 square foot of the vessel wall.

3. A high-pressure test of one hour's duration in which the sphere was under a pressure producing a stress in the metal equivalent to 75 percent of the yield point.

The sphere was then subjected to a vibration fatigue test to simulate the vibration experienced in service on a tank car. Under a hydrostatic pressure of 1250 pounds per square inch, the metal was stressed to 50 percent of its yield point. It was mounted on a turntable, revolving at a rate of 1/8 revolution per minute. Four Thor S-2 air hammers were placed so as to strike the sphere at opposite points, and the hammering covered an area extending 13 inches each side of the welded joint. The air hammers were provided with bronze heads about 2 inches in diameter. The test was run for 75 consecutive hours, during which time 20,000,000 blows were struck, each representing 4 to 5 foot-pounds of energy.

It was desired to reproduce as closely as possible a train wreck so as to study the performance of the sphere under such abuse. Therefore following the vibration test, the water was emptied out of the sphere and replaced with air at a pressure of 1200 pounds per square inch, stressing the metal to 48 percent of its yield point.

The sphere was then mounted on a flat car in a manner similar to the method designed for the proposed tank car and strapped down. Two heavy steel cylinders, each weighing 14,500 pounds, were also mounted on the car, one immediately ahead of the sphere and one behind it. The car was then pushed off the end of a trestle, while moving at the rate of about 20 miles per hour, a sheer drop of some 25 feet. This test gave the sphere as severe punishment as would be experienced in a real train wreck.

The sphere was then filled with water, extreme care was taken to eliminate all free air from the vessel and piping. In carrying out the test the pressure in the vessel was first brought to 1250 pounds per square inch. It was then lowered to 1000, and once more increased to 1250 pounds per square inch. This last value represents a stress of 14,500 pounds per square inch in the steel. At this pressure it was then hammered with 6-pound sledges over the entire weld. The pressure was reduced twice in order to check the permanent deformation of the sphere, the readings showed very little change. The pressure was gradually increased to the point of failure, the sphere failing at an average pressure of 4466 pounds per square inch, corresponding to a stress of 57,000 pounds per square inch. In no instance did failure occur in or adjacent to the weld.

The remarkable results obtained from this test demonstrate conclusively that material, fabrication and workmanship and the proper normalizing of the material are important factors in the successful development of welded pressure vessels. Welding although still in its infancy can be rightly called a scientific art or occupation requiring the utmost skill and proficiency on the part of the operator.

The real reason for the reluctance of some railroad executives and associations to accept welding methods is due entirely to the lack of judgment displayed by members of the supervisory force in the assignment of welding jobs to incompetent operators, the use of improper welding wire and to the lack of judgment or knowledge in preparing the work for welding, resulting in a failure of the weld after a short period of service.

The most vital factor in the successful application of fusion welding is the human element, therefore great care should be exercised in the selection and training of the operators. They should be given special instructions regarding the apparatus and processes, the expansion and contraction of metals and should be required to pass qualification tests before being assigned to welding jobs, the success of which depends entirely on the skill and proficiency of the operator.

The members of this organization are exponents of progress and efficiency and should devote their utmost energies to the development of the welding art, so far as consistent with safety. They should further perform only such jobs as will reflect credit and establish confidence in the process.

It is the desire and recommendation of your committee that this subject be thoroughly discussed by the members of the association in order that all may become familiar with any improved method that may have been employed by the various members in the application of the welding art.

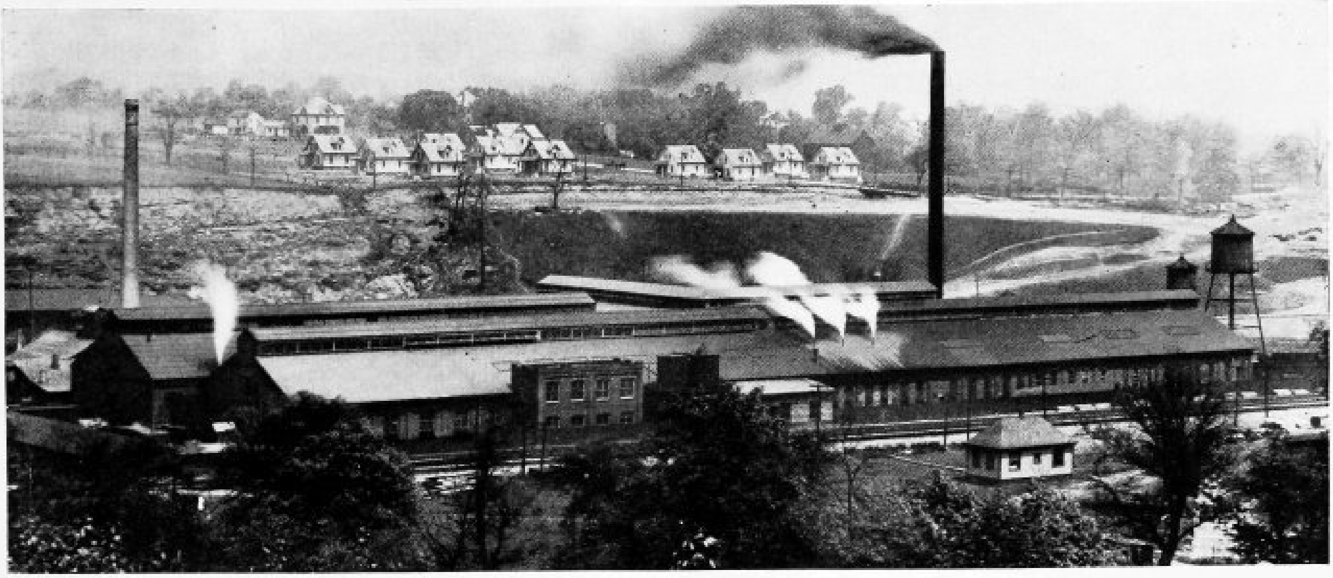
This report was prepared by a committee composed of J. F. Raps, chairman, H. H. Service, J. J. Mansfield, L. M. Stewart, and W. H. Laughridge.

Discussion

JOHN F. RAPS (Illinois Central): The majority of the members of this association are no doubt thoroughly familiar with this test which was conducted by the A. O. Smith Corporation in Milwaukee prior to the working up of this report by the committee. The idea of mentioning the results of the test on this container was primarily the fact that it brought out one very specific point and that was normalization of the material in the weld after the welding had been performed. During the discussion today we ought to bring out the facts, and I think the committee ought to work along those lines on recommended practice, as to the manner in which the welding is to be performed. I received a letter from one of our members, while we were getting up this report, and he brought out the fact that he had been investigating a low water case where some welds had been made by welding seams from both sides and they had not failed. Others welded from one side had failed. If we are going to get better success by welding from both sides, that is the thing the committee ought to recommend as standard practice. If we are getting the best results by welding from one side, then there isn't any use in our welding from both sides.

L. M. STEWART (Atlantic Coast Line): It has been our practice for several years to weld fireboxes on the floor and therefore we weld on both sides. We butt welded for several years, and then for the last five years we have been lap welding, but now we are going back to butt welding. At the time we made the change we had no reason for it, but the motive power superintendent thought we should lap weld. I am sure we will get better results from butt welding. In the building of fireboxes we should by all means weld on both sides.

H. H. SERVICE (Santa Fe): On the Santa Fe, we weld with a single bevel on most of our operations in



Most members took advantage of the inspection trips to the Flannery Bolt Company plant

the firebox. However, where crown sheet patches are applied, we weld on both sides wherever it is possible to weld them. Usually the radius is out where we cannot get at it. For instance where a syphon is applied we butt weld from the fire side, then after the weld is completed on the fire side, the boiler maker is placed inside of the water side and goes down about ⅛-inch deep and takes all the oxidized metal off of the water side of the sheet, and that is reinforced.

W. H. LAUGHRIDGE (Hocking Valley): The reason welding has been condemned, or a great many have hesitated to go into welding, I believe, is because of the haphazard methods that some have practised. I find that preparation is the foundation of good welding. Prepare your sheet properly, as uniformly as possible, and be sure your major weld is thorough. Use the sealing process on the other side where you can get at it; but in renewing sheets you cannot get at it. Therefore, I think it should be your practice to be sure you have the major weld through.

A. E. BROWN, (Louisville & Nashville): We weld our firebox plates. We prepare this weld at a double V or angle of 90 degrees, permitting ⅛-inch opening on the inner side of the weld. We draw these plate surfaces level, sand blast the seam, and do our welding on one side, where no other method is available.

C. A. SELEY (Locomotive Firebox Company): Over 10,000 syphons have been applied by welding. In fact, the welding arc brought about the development of syphons because if riveted it would involve the necessity of a double or lap seam, which in a firebox is not a good feature. Most of the roads have found butt welding superior to lap welding, and I do not think any syphons are being put in today with lap joints. As we know, the entire firebox is under pressure, and the seam in the firebox is under compression and naturally the edges of the seam coming together in direct line makes the best job.

L. E. HART (Atlantic Coast Line): On the Atlantic Coast Line we have welded fireboxes that are over fifteen years of age. We have yet to have any failures of butt welded fireboxes. We have experienced some minor troubles with lap welded ones. When we left the original butt welding process, we did not do it on account of failures, but we are going back to it because we feel it is safer and does a better job.

H. H. SERVICE: I want to illustrate what I have in mind with regard to welding of the crown sheet. About eighteen months ago we had an engine that unfortunately had a laminated crown sheet, and it was necessary to apply a patch covering the area of four radial stays. That patch was applied by the plug system, and a good job was done. However, it was right above the arch brick where the fire is concentrated against that double thickness of material, and we had a man in there constantly working on it. It was necessary to put in a new patch in there in two months' time. It was applied with plugs a little larger in diameter. It lasted two months. Finally it was necessary to go down there and put a welded patch in there and we have never heard from it since. The engine is running that way today, and it will go until it gets a new firebox, providing it doesn't get low water. We are all talking about welds in the crown sheet being unsafe. The only time that you will get failures is in cases of low water. I will say 99 percent of the cases are due to that. The heads of your bolts give way and throw the load onto the sheet, and neither you nor anyone else has ever designed a sheet that will withstand that tension.

The subject of cracked side sheets and leaky staybolts was next discussed as follows:

Cause of Cracked Side Sheets and Leaky Staybolts

This subject is one that your committee has found to be of vital interest over the majority of railroads in the United States and Canada. In our investigation we have received answers to a questionnaire distributed to nearly every railroad and in every district of the United States, also in Canada.

We received answers to the questionnaire from 17 railroads, with questions and answers as follows:—

1.—Q. On what type of locomotive is this trouble most prevalent?

A. Eleven reported Santa Fe, Mountain, Mikado and Pacific types. Six reported no recent trouble.

2.—Q. What type of firebox is used?

A. Wide firebox with and without combustion chamber.

3.—Q. What is the percentage of air opening in the grate area as compared with the total grate area?

A. Varies 14 percent to 45 percent in the United States; 40 percent to 50 percent on Canadian Pacific.

4.—Q. Is locomotive used in freight or passenger service?

A. Nearly all railroads reported in both classes of service.

5.—Q. Is locomotive being operated on encrustating-water or foaming-water districts?

A. Reported 11 encrustating, 6 encrustating and foaming-water districts.

6.—Q. Is water treatment used?

A. Water treatment 9; part treatment 4; no treatment used 4.

7.—Q. What kind of fuel is used in locomotive, oil or coal?

A. Coal 14; oil 1; both oil and coal fuel used, 2.

8.—Q. About how long after new work goes in service does this leakage begin?

A. Varies, 10 days to 24 months on eleven railroads reported; practically no trouble on 6 reported.

9.—Q. How are the leaks being handled?

A. Staybolts redriven at first appearance; later, bolts renewed until necessary to renew side sheets.

10.—Q. What boiler compounds are being used; that is anti-encrustating or anti-foaming?

A. Both are used, depending on water conditions.

11.—Q. Do staybolts develop leaks on outside of firebox?

A. No, except improperly applied bolts.

12.—Q. What is the average leaking area on the inside of fireboxes?

A. In fire line, average about 6 rows of staybolts high.

13.—Q. Do the flues leak?

A. No.

14.—Q. Are the flues welded into back sheet?

A. Practically all reported flues were welded, some the superheaters only.

15.—Q. What is the life of the fireboxes and half side sheets?

A. Varies, fireboxes 5 to 10 years on large power, 10 to 25 years on small power; side sheets, 6 months to 5 years.

Experience in the past has taught us some of the things which will contribute to the failure of side sheets, and we do not believe it justifiable to place the responsibility for the recent epidemic of cracked side sheets to such things as, improperly fitted bolts, thread sizes and form, unclean boilers; for today nearly all railroads are taking every measure of precaution to cure these defects.

Taps and staybolts are gaged for sizes and tolerances, threads are checked for form and size, boilers are being checked and washed out more thoroughly than ever before. We cannot, however, get away from the fact that with long runs and regular operations of locomotives, a schedule for washing boilers, to keep them clean, is imperative.

Unequal expansion is the primary cause of cracked side sheets, the expansion of the firebox sheet is greater than the outside wrapper sheets and, with the material hammered, the metal has not a homogeneous structure.

Contributing to the unequal expansion, the side sheet is subjected to cold air every time the firebox door is opened and, on stoker fired boilers, the air drawn through the grates is not distributed to any particular part of the firebox for there are holes in the fire and cold air enters fast. On the modern locomotive, the air enters just below the mudring and the current of air flows next to the side sheets, making it necessary to keep a hot fire or heavy body of fuel for the boiler to generate the steam desired of the power.

Another item contributing to cracked side sheets is scale or solids on the sheet on the water side, making it necessary for the sheet to be heated to a higher temperature to produce the steam desired. At the same time, this increases the difference in temperatures of the side and wrapper sheet, making unequal expansion greater.

In studying the questionnaire, it is evident that all railroads are reducing the air openings in the grate, and good results are being obtained, but the grade of fuel must also be considered. If it were possible to equip the traveling power plant (a locomotive) with a closed ash pan and utilize forced draft, distributed over the grate area regularly, as required for combustion, and take care of ashes as produced, the question of cold air contributing to cracked sheets would be removed.

The water conditions will have to be handled according to the district wherein railroad obtains the water.

To eliminate cracked side sheets and prolong the life of fireboxes of modern locomotives, the modern boiler of higher pressure, requires the best attention possible of attainment, from the making of the metal, manufacturing of the parts, assembling of them, up to and including all operations of the locomotive after it is built both at terminals and on the road.

The committee appreciates the response from the members for their information on this subject.

This report was prepared by a committee composed of L. E. Hart, chairman, George Austin and John Harthill.

Discussion

L. M. STEWART (Atlantic Coast Line): Most of our trouble has been in stoker-fired engines. I believe that where we have shallow fires and there are places on the grates not covered with coal, the cold air in the firebox is partly responsible. It is a vital subject to railroads all over the country. I have come in contact with and talked to boiler makers about it, and all of them are having this same trouble.

F. C. REINHARD, (Santa Fe): I would like to ask the members if they are experiencing any more trouble with staybolt leakage in wide fireboxes, new style, than with the straight-side boxes. We have fifteen engines on our territory, the 4101 class; six of them carry 175 pounds of steam and nine carry 210. While the leakage does not seem to be any more extreme in one than the other, still we have engines operating in the same territory under the same conditions and same appliances in every respect, and they do not show as much leakage as engines with wide fireboxes, which show considerable leakage. In fact, in one of the engines it was necessary to renew the side sheets at 100,000 miles, while with the straight-side boxes, an engine will run 500,000 miles before it is necessary to renew the sheets.

H. H. SERVICE, (Santa Fe): I have in mind a particular point on the Santa Fe railroad where I was advised by the chemist that no change had occurred in the water. The road conditions were about the same, and the staybolts started to leak. At that time we were using soda-ash treatment in the water. We were given about ten days time to clean up the condition and apparently the treatment wasn't sufficient. Mr. Austin decided that they would use a compound which was applied to the boiler, and staybolt leakage immediately stopped. He went further and made a canvass not only for that purpose but for the purpose of seeing that the furnace bearings were well lubricated. They should be given freedom for expansion with the large boilers today. Some of the furnace bearings may be located on the back head and they may be stuck, galded, and that boiler wants to expand. That may be one of the causes which produces defects, not only in the firebox but possibly on the hip of the throat sheet.

C. W. Buffington, (C. & O.): I didn't expect to say much about the cracked side sheet proposition, or leaky staybolts, but you all know you had leaky staybolts to contend with when you began forty-five to fifty years ago, and possibly some of you have been at it longer than that. And I expect you are going to continue to have it. I really haven't seen the remedy yet. In its report the committee spoke about the closed ash pan to utilize a forced draft. That looks pretty good to me. I have been thinking about old fashioned lids being put on the side, so that it is covered up when the engine comes in from a run. To my mind, the damage is done principally on the dump track, and better care should be taken of the engine from the time it is turned over to the round house forces until it is back on the road.

W. N. Moore, (Pere Marquette); We have had a condition the last year on our long run locomotives. We are getting our mileage and consequently our side sheets give out quicker. I do believe, from my experience, that the primary cause for side sheets cracking is due to an increased demand on firebox plates, without the increased non-conductor which is water. On our railroad, the Pere Marquette, we began normalizing our plates in January, 1927, a little over three years ago. I was a little reluctant to normalize the side sheets to begin with, but in time I received orders to include side sheets with firebox sheets. Of course, this is entirely new and we do not know as yet how it will work out, but we have reason to believe that with a normalization point of 12.50 degrees F. on side sheets, we will get better service than with a higher normalization point. However, in order to prolong the life of side sheets and get the mileage which we are entitled to, I believe the only thing which can be done to effect a permanent cure will be to give us two inches more water, or possibly two and a half or three, on the side sheets.

A. F. Stiglmeier, (New York Central): We renew side sheets after eight months. What is the cause? We will put steam up to 250 or 275 pounds of pressure, or perhaps up to 400 or 450 pounds. We use carbon steel in our sheets. The brittle range of carbon steel is perhaps 375. On one side we have a range of about 450; on the other perhaps 375. Carbon steel won't stop it. Sheets are going to crack with 375 pounds of steam because of the high temperature of steam on one side and the carbon steel with its brittle range at a low point. We have got to get into a different kind of steel. We have tried different kinds but have not been successful so far. I cannot tell you anything about nickel steel. We pull tonnage. Our people don't seem to pay a lot of attention to the trouble, due to the heavy tonnage they are getting. They are getting service out of the engines. Railroads that do not put on tonnage or steam pressure will not get cracked side sheets.

James Doran, (Santa Fe): We often have an epidemic of leaky staybolts, but when we have that condition we get after the chemists. I do not care how good work you do; if you haven't the proper water conditions bolts are going to leak, and if soda ash and lime will not prevent their leaking you might try something else. There are times when we have quite a lot of staybolts leaking but when we get after the chemists and check the water treatment it all stops. Then, if you have leaking staybolts, you are going to have cracked side sheets, and I believe that if you will spend your money for water treatment, you can overcome a great deal of the trouble.

George Austin, (Santa Fe): Mr. Doran, to my notion, gave the key to the cause of cracked side sheets. Pulling cars is the business of a railroad and we pull as many cars and pull them just as fast as any, and we have all kinds of water. We haven't a gallon of good water on the railroad unless it is made good by water treatment. The Santa Fe railroad has been treating water for more than thirty years. I have been on the job for twenty-seven years, looking after water, and I have had a big field of observation to judge from as to the benefits of water treatment. The Santa Fe has in the neighborhood of 150 or 160 roadside treating plants and they are still installing others. They have in addition I don't know how many supplemental plants that put into the water an anti-corrosion element. What it is I don't know, but it has greatly improved the condition of corrosion and pitting which formerly existed on locomotives running out of that territory. The epidemic of leaky staybolts is characteristic of bad water and bad water only. The water may be fairly good water when the engine starts out, but by the time you have boiled several boilers of water it begins to get bad. It keeps concentrating and getting more unfit for boiler use. Some are adopting or advocating the use of blow out directly, among other things. I have gone into the matter of blowing out very thoroughly, tested it out in every conceivable way as to the best methods. You do not get blowing out for nothing. When you are blowing out water that has been heated above temperature you are blowing away money. You can't get something for nothing. Now the question is: Does it pay for any railroad to blow away water that has been heated or blow away fuel, or would it pay you to spend money to avoid the necessity of wasting this fuel? In other words, does it pay to treat the water?

This question of leaky staybolts applies to the whole boiler and all the boilers on every railroad, and it means that the boiler is trying to tell you that there is something wrong in that firebox. It is either the water or it is improper drafting; one of those two things. Generally it is the water. When we find a bunch of bolts leaking on the outside, what is the use of saying that is all water? There is an evidence of improper drafting. Suppose we find staybolts leaking up in the top of the door sheets; what is the use of calling that water? That is poor drafting. The engine is trying to tell you what is wrong. We have put in hot water plants and we do that so that we will avoid the necessity of setting up stresses for unequal temperatures for various parts of boilers, and yet I go to the hot water plant and find it empty, and find them blowing out a hot boiler and filling it up again with water at 92 degrees. At the hot boiler washing point nobody pays any attention to it. I am just mentioning that as one of the things that is contributory to leaky staybolts.

Your locomotive engineman, when he applies the injector and puts in four to six or eight inches while standing still, having the blower on doesn't do any good.

When he has the blower on he maintains the top temperature, and maintains the steam pressure, but the lower part of the boiler is cooling off just the same, and if you watch the operation you see as that water comes up it contracts the sheet below and buckles the sheet above, and the top holes start to leak.

These things have existed ever since we have been running boilers and they will continue to exist until we are educated to the fact that it pays to put the proper kind of water into these boilers.

The final topic committee report of this session was "Repairing Cracked Mud Rings or Corners." This report which will appear later was prepared by a committee composed of W. N. Moore, chairman, E. J. Reardon and John Clas.

In the afternoon, an extremely interesting inspection trip, arranged by W. L. Schaeffer, P. J. Conrath, J. W. Kelly and other officials of the National Tube Company, was conducted at the Ellwood City Works of the company. This is the first time in many years that the association members have had an opportunity as a group to inspect a plant in which boiler materials are produced. Practically the entire membership registered took advantage of the opportunity and visited the plant.

Thursday Morning Session

At the opening of the third day's session, W. G. Black, mechanical assistant to the president, Chesapeake & Ohio Railway Company, Hocking Valley Railway Company and Pere Marquette Railway Company addressed the association. Due to the length and importance of Mr. Black's paper, it will be published quite fully in a later issue. In it he dealt with the general development of modern locomotive practice and pointed out details in which the master boiler maker can be of assistance in the solution of the maintenance problem.

The first of the topic committee reports at this session was on the subject of "What is the Best and Most Economical Method of Applying Fireboxes with the Boiler on or Off the Frames?" and was prepared by a committee consisting of Leonard C. Ruber, chairman, Albert F. Stiglmeier and John McGowan. This paper and its accompanying discussion will appear later.

The next topic to be discussed was under the title "The Most Efficient Method Used in Washing and Cleaning Boilers," prepared by a committee composed of Ira J. Pool, chairman, Kearn E. Fogarty and W. E. Bell. This report and that on the question "What is the Cause of the Outside Throat Sheet Cracking and What Can Be Done to Overcome It?" prepared by a committee consisting of G. M. Wilson, chairman, M. V. Milton and E. E. Hilliger, will also appear in later issues together with their discussion.

At this point J. O. Leach, assistant chief metallurgist of the Carnegie Steel Company, gave a descriptive talk on the plant, facilities, and production methods of this company's mills.

In the afternoon a special boat trip was made to the Homestead, Pa., works of the Carnegie Steel Mills.

Through the courtesy of the officials of the Flannery Bolt Company, provisions were made for members of the association to visit its plant at any time throughout the week. Advantage was taken of this opportunity by a great many of the members to inspect the methods employed in manufacturing flexible and other types of staybolts under the production system in operation at this plant.

Friday Session

At the closing session of the convention C. A. Gill, superintendent of motive power, Baltimore & Ohio Railroad, who had been in attendance and was to have addressed the convention at this time, was called away on business and Ira J. Pool, division boiler inspector of the Baltimore & Ohio, read the paper which he had prepared. An abstract of this paper follows:

The Human Element in Boiler Work

By C. A. Gill

Some of you, perhaps, attended the "Fair of the Iron Horse" near Baltimore in 1927, which commemorated the Centennial of the Baltimore and Ohio Railroad, and were impressed by the phenomenal progress of the steam railroads and locomotives during that period.

The science of railroading is becoming more and more exact. The original cost of a locomotive plus the cost of maintenance represents a large investment, which is expected to deliver certain definite results at all times.

Today the locomotive is a vital factor to the success of the railroads in this country. We, who have spent a number of years in the operation and maintenance of this machine should well feel proud of the position it occupies. As we all know, railroads are intended first, to serve the public, and then to earn a fair return to their owners. Regardless of a railroad's physical condition unless they have the proper motive power they cannot serve the public as they should, nor can they yield a fair return to their owner.

If steam locomotives are properly maintained at all times, there should not be a great amount of difference in operating efficiency between locomotives just out of the shop and the ones which are ready to go into the shop. There is no use of having a highly efficient motive power unit, spending most of its time in the roundhouse or back shop. To be of the utmost value, a locomotive must be utilized not only to the physical limits of the railroad, but to the limit of the machine itself. A railroad is no better than its locomotives, and a locomotive is no better than its boiler.

We who are charged with the maintaining of locomotives, in which the owner's money is invested, and which moves the traffic on which so many people, including ourselves, depend for a livelihood, should be expected to keep it in 100 percent condition as far as practicable to do so.

The position of a master boiler maker includes a double responsibility that perhaps everyone does not fully realize. In the first place he must be master of his profession, which qualification gives him his title. The other responsibility, if he is in charge of handling men and materials, is for him to be the master of the boiler makers. In other words, he must be a leader of men.

We, no doubt, in the past have been neglecting to develop to the fullest extent that branch of the service, that has to do with the human element. Railroad organizations consist in part of mechanical engineers for designing locomotives and freight cars, civil engineers for laying out railroads, electrical engineers for installing electrical machinery. To my mind, there is one other engineer which is very important to the successful operation of any railroad; that is, what I may term a human engineer, and this is where the master boiler makers can play a very important part by the proper leadership, and handling of men, since after all we operate our railroads and shops with men.

You are aware that gas-electric and straight electric locomotives are being used to a greater extent than heretofore; this is especially true of the gas-electric which is a new development and has given comparatively good results. Unless we improve the steam locomotive in every way possible, your very existence as an association and as master boiler makers will be threatened.

The necessity of improving the steam boiler is now with us, and this can be accomplished in three ways: Improve design, including material; improve workmanship when building; better care and maintenance.

Regarding improving design; some railroads have built locomotive boilers with radical departures in design, and they are proving highly satisfactory. Such locomotives as the *President Cleveland* now being operated by the Baltimore & Ohio Railroad, is a type of water-tube boiler, capable of carrying much higher steam pressure than can be practically used on the conventional type boiler. This locomotive is giving a very good account of itself, and no doubt, other locomotives of this type will be built in the future.

With the increase in size and pressures, many problems are being encountered with material and staying of boilers, the recurrent repair of locomotive boilers in late years has created a problem of extreme perplexity and bewildering expense. The boiler makers' access to these conditions gives opportunity for suggestions that will bring about improvements.

In connection with the improved workmanship, when new boilers are being built, those who are constantly in touch with the various boiler conditions, should bring to the attention of the proper authorities what troubles are being experienced and suggest ways for improvement.

In regards to better care and maintenance, no matter how well a boiler may be built, or how excellent its design may be when a repair is necessary, let it be large or small, if it is not made properly the maximum service will not be obtained. It should, therefore, be borne in mind, quality precedes quantity in making whatever repairs are necessary.

The final committee report, that on the apprentice situation, was next in the order of business. This paper and its discussion follow:

Training and Developing Apprentices

A very careful investigation of the practices in vogue today, regarding the developing and training of boiler maker apprentices on the major railroad systems of this country, reveals that there is quite a variance in the schedules of training as between the larger and more powerful systems and the smaller companies having less mileage and fewer locomotives. From the information and data gathered from the largest roads in the country, controlling 73 percent of all the locomotives in service, we have endeavored to present an average or typical course to be used as a suitable schedule for the training of boiler maker apprentices. In selecting boys for this trade there should be some minimum physical requirements specified, and all candidates should be required to pass the prescribed physical examination before being accepted.

Regarding educational requirements, these should not be too severe, but the minimum should at least be the completion of the seventh grade grammer school, preferably the eighth grade. Bearing in mind that boys selected for this course must be developed to take the place of the older men and the more proficient ones to take the place of present supervisors, it is highly desirable that additional schooling be given the apprentices while working at their trade. A school maintained by the company at which the apprentices can have from two to four hours per week on the company's time, is the preferred and most efficient method of giving this instruction. The school course should embrace mechanical drawing, mathematics, physics and related subjects, and it is very important to teach the method of calculating the strength of boilers, riveted joints, tension on plates, shear on rivets, stresses in stays and braces and other data shown on Federal boiler specification cards. Suitable instruction in an approved correspondence school would answer the purpose, but regardless of what kind of instruction is given, it should be made mandatory of the apprentice to do the work provided, and if this is not done there should be suitable penalties.

An apprentice instructor should be on duty at all of the large shops and the first day the applicant reports for work he should be given an outline of just what the course is and what he is expected to do. At the same time the instructor should impress on the boy that he will be looked after in a general way and given full opportunity to develop into a proficient workman. The instructor should keep in close touch with the apprentices at all times, maintaining regular and periodical visits to the boys during working hours, asking them questions about their work, also inquiring whether there is any helpful information which can be imparted.

An outline of a well rounded course of instruction follows:

Tool Room—*1 month*

General instructions on all tools used; names and purposes used for. Practical use of tools taught later on in actual work in different departments.

Grinding and sharpening tools.

Heating Rivets—*2 months*

Proper degree of heat for rivets in various types of riveting. Preparation of fire. Maintaining proper bed of coal or coke between air blast and rivets. Use of baffle wall in oil and gas furnaces.

Flue Works—*3 months*

Cutting out and removing flues. Applying and setting flues, rolling, prossering and beading. Applying arch tubes.

Staybolts—*3 months*

Reaming and tapping holes; importance of good threads and holes tapped to size. Measuring length and proper application of straight and radial stays both flexible and rigid type. Driving staybolts and opening tell-tale holes.

Riveting, Chipping, Calking—*3 months*

Importance of true reamed holes for riveting.

Riveting—Proper size rivets to fill holes. Proper size hammers and dolly bars.

• Chipping—Properly ground chisels and method of holding on various kinds of chipping work.

Calking—Proper angle of beveling. Properly formed calking tool to insure not scoring or damaging plate under edge or splitting sheet.

Front-End Work—*1 month*

Netting and self-cleaning fronts. Dampers and deflector plates; getting out details and assembling.

Flanging—Hand and Machine—*3 months*

Front and back tube sheets, door, back head and throat sheets, and miscellaneous flanging, both hot and cold work, machine and hand.

Ash Pan—*2 months*

Constructing and fitting up. Slides, doors and operating rigging.

Round House—*3 months*

General hot work. Light repairs. Inspection under steam for leaks, bulges, etc.

Tank Shop—*2 months*

General tank construction. Importance of water-tight joints and security of braces and gussets.

Miscellaneous light sheet work, air reservoirs, non-pressure tanks, cooling tanks, track tanks, etc.

Welding—Forge and Fusion—*3 months*

All kinds of forge welding, electric and acetylene fusion welding. Particular instructions as to which parts are permissible to weld and which not.

General Work—*8 months*

This is to include boiler shop work of any description and special work which may be necessary away from main shop such as emergency work on power plant or stationary boilers or any boilers on special equipment such as cranes, pile drivers, etc.

Inspecting—*3 months*

Important to know I.C.C. Locomotive Boiler Inspection Rules. Interior inspection of sheets, braces, rivets, staybolts for any evidence of defects, particularly those mentioned in rules. Exterior inspection for any defects or irregularities. Inspection under hydrostatic pressure. Inspection under steam. Staybolt inspection and hammer test. General inspection of all parts covered in rules, which are allotted to boiler shop.

Laying Out—*4 months*

Instructions and practice on laying out all sheets and parts of boilers. Development of surfaces.

Machine Work—*2 months*

Punching and shearing machine, beveling, rolling barrel and firebox sheets. Drilling and cutting tube and flue holes.

Cabs—*1 month*

Building steel cabs and getting out all necessary parts in tank shop.

Patching and Fitting Up—*4 months*

Boiler reinforcements to meet I.C.C. rules. All kinds of fitting up work.

The above schedule provides for a course of 48 months or 4 years which is the term used by the great majority of roads in this country, but it may be necessary to vary the individual periods of time in the various shops to suit local conditions. The main thing to bear in mind is to give the apprentice every possible opportunity to learn and develop into a proficient boilermaker, and those who take most advantage, or otherwise show evidence of being capable of assuming responsibility and acting in a supervising capacity should be given the preference when positions are available.

This report was prepared by a committee composed of W. R. Hedeman, chairman, T. J. McKerihan, and T. W. Lowe.

An independent report submitted to the chairman by T. W. Lowe will be published at a later date.

Discussion

C. H. Cross, (Supervisor of Apprentices, New York Central): The present apprenticeship plan on the New York Central Railroad has been in operation since 1906. About 3000 boys have been graduated. In the plan, no progress examinations are necessary as students are given a numerical rating each month by the school and shop instructors from the intimate knowledge obtained by close contact with the apprentices. Apprentices having low marks are given help required by student helpers, also by the school instructors to advance them to a satisfactory rating. Consideration is given to application and earnestness of purpose, when deciding the marking. Chronic incompetents are few, because of the personal instruction given to the students.

The apprentices at the large shops are given the school privilege of two periods of two hours each per week, in working hours, in the morning, for ten months, per year. Attendance and progress are compulsory. Entrance examination is required. A number of applicants cannot pass the examination. Each apprentice is given the general course in mathematics and mechanical drawing. The lesson courses in mathematics and drawing are in the language of the shop, covering New York Central methods and standard practice. Simple models are used for beginners and sketches made and approved before the drawing. There are also special courses for each craft which follow the general course including the boiler making course. These include free-hand drafting and advanced work. We have a home problem mathematics course. The advanced apprentices are given instructions on the various mechanical appliances used on locomotives and cars.

Apprentices who have shown earnestness and proficiency are given special duty for short periods in the test department, fuel department, New York drawing rooms and various special assignments. Occasionally permanent assignment results from this plan. The auxiliary features of apprenticeship described are beneficial, as the regular officers of the company have information regarding the competency and personality of individual aprentices, and therefore can utilize them to advantage. There are three grades of apprentices, special, regular, and helper.

Many men now in the service successfully filling good positions as mechanics, draftsmen, foremen, inspectors, test department inspectors and some higher positions are proof of the thoroughness of our training methods over a period of twenty-three years. All the apprentice instructors are graduates of our apprentice system, and some men in high positions were former instructors.

A. T. Hunter, (Santa Fe): The education of an apprentice is an important subject today. An apprentice should come to us, I think, with at least a second year high school education. Then the education that we can give them will be of very much more benefit to them. We have in our shops today a lot of apprentice boys who are there because their fathers and their uncles and their cousins are supervisors in that shop. Some of those boys are no good. I say get rid of them, regardless of the position that their fathers and relatives hold. There is one other item I would like to bring to your attention, and that is the practice of making a messenger boy out of an apprentice in the shop. All of you have seen it. You have an apprentice in the shop and your foreman—I've done it myself—pays very little attention to him but turns him over to some mechanic and that mechanic makes a messenger boy out of him. On our railroad we have a system of trying to take care of an apprentice boy by a meeting with the supervisory force every thirty days. That is called an apprenticeship board meeting. The apprenticeship board consists of an apprentice instructor in direct charge of the boy and the foreman under whom the boy is working at that particular time. This board will meet and iron out the troubles that the boy is having. If the boy is going behind when he should be going forward, maybe he will be called into the office and talked to in a nice way, and if this continues for a period of six months, this boy is automatically taken out of service in the apprentice school.


W. N. Moore was elected fifth vice-president

I. J. POOL, (Baltimore & Ohio): I want to respectfully disagree with the previous speaker regarding the qualifications that a boy should have before being permitted to start an apprenticeship. I know of boys who haven't had an eighth grade education, and they are serving their second and third years as apprentices today, and they have acquired enough education in the two or three years that they have been working as an apprentice to be placed in the mechanical engineer's office. Here they work alongside of other men making tracings and drawings, and it is wonderful the training and education they are getting.

A. T. HUNTER: I do not wish to leave the wrong impression with you men. It is not required that boys have a high school education or two years of high school education before they can enter an apprenticeship on the Santa Fe. It is only my opinion that he should have. I know that a boy with a high school education, or even more, with a college education, is better qualified to go into the shop and further advance himself than a boy out of the sixth or seventh grade.

L. E. HART, (Atlantic Coast Line): In the past in the selection of apprentices, there has not been as much attention given to the boiler maker apprentices as in other crafts. We have found that when there was a vacancy in the mechanical engineer's office it has always been filled by a man from another craft; very seldom from the boiler department. I am very glad to hear of positions in the mechanical engineer's office opening up for boiler apprentices. As for the education a boy has in school, some of it is partly memory. As for the fundamental foundation of his work, the boy doesn't know what it is all about. I will agree to a certain extent with the committee's report. I do not believe that we should put anything on the boy that he cannot grasp, but as fast as he can grasp it give it to him. Make the best man it is possible to make out of him during the time you have him.

A. F. STIGLMEIER: We have three boys in our shop who hold the position of gang foreman. Two other boys have made our best inspectors. They haven't had two years' high school. They have had only common school education, but their advancement was due to the fact that we have taken lots of interest in these boys, tried to help them along, and did not call them down when they made a little mistake. We would ask them if they knew this or that, and if they did not, we went out and showed them. I think that is the thing to do with these apprentice boys.

R. V. MOORE, (Union Pacific Railway): One very important question comes to my mind that has not been brought out, and that is instructing apprentice boys in safety first. When we hire an apprentice boy on the Union Pacific, the first thing that we do is to give him an examination, and then we give him instruction in safety first. He is sent up to a room to read these instructions over. Then he is taken all through the shop and instucted in all lines of work in safety first. Then, after he has passed the medical examination which is required by the company ruling, he is placed with a mechanic to be instructed in his one particular line, and so on with all the mechanics, and he is instructed in safety and he learns the routine of the work going on around the shop, and then he is put on his own hook. We have a schedule worked out to put the apprentice through the shop, and we have had only one accident in which an apprentice was injured during the last three years.

W. N. MOORE, (Pére Marquette): I am highly in favor of education in the common schools, in high school and in college, in safety first, instruction of apprentices, and so on. I say give the boy the very best start in the world. The fact that so few of us had those advantages shows that while we may have arrived, or partly arrived, had we been better educated we would probably have been there sooner. Now in the shop where I am, I would be highly pleased to get some high school boys to learn the trade. I would be highly pleased to get the son of a boiler maker, but I can't get them. I have never had boys who were sons or nephews or cousins of boiler makers, but if they were I would say that was in their favor. The class of men we get for apprentices are good hard workers, but very few of them have the education men should have, due to the fact that they all seem to want to learn something else.

Election of Officers

The latter part of the Friday morning session was devoted to the election of officers for the ensuing year: President, Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy; first vice-president, Franklin T. Litz, general boiler foreman, Chicago, Milwaukee, St. Paul & Pacific Railroad; second vice-president, O. H. Kurlfinke, boiler engineer, Southern Pacific Railroad; third vice-president, Ira J. Pool, division boiler inspector, Baltimore & Ohio Railroad; fourth vice-president, L. E. Hart, boiler foreman, Atlantic Coast Line; fifth vice-president, William N. Moore, general boiler foreman, Pére Marquette Railroad; secretary, Albert F. Stiglmeier, general foreman boiler maker, New York Central Railroad; treasurer, W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad; Charles J. Longacre, Pennsylvania Railroad, was elected chairman of the executive board. Executive committee: (one year) Charles J. Longacre; R. A. Pearson, general boiler inspector, Canadian Pacific Railway; M. V. Milton, chief boiler inspector, Canadian National Railways; (two years) John Harthill, general foreman boiler maker, New York Central Railroad; M. A. Foss, service department, Locomotive Firebox Company; George J. 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; Albert W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad.

Registration of Members at Convention

Aiken, C. H., Dept. Boiler Equip., Bourne-Fuller Co., Shaker Heights, 3628 E. 163rd st., Cleveland, O.
Ardis, L. T., Boiler Dept., P. B. & W. R. R., 225 W. 30th st., Wilmington, Del.
Atkinson, William B., F. B. M., Mo. Pacific R. R., 5016 Chippewa st., St. Louis, Mo.
Austin, George, G. B. I., A. T. & S. F. R. R., 11 Devon Apts., Topeka, Kan.

Batchman, F. A., F. B. M., N. Y. C. R. R., 1421 Krau st., Elkhart, Ind.
Becker, W. C., B. F., I. C. R. R., 7708 Lake Shore Drive, Chicago, Ill.
Bell, W. G., G. B. I., Fla. E. Coast Ry., St. Augustine, Fla.
Bergstrom, C. H., B. F., St. Louis-San Francisco R. R., 741 South ave., Springfield, Mo.
Billington, Matthew, F. B. M., B. R. & P. R. R., 72 Central ave., E. Salamanca, N. Y.
Bishop, H. K., B. M. F., C. & O. R. R., 1332 10th ave., Huntington, W. Va.
Brennan, Edw. J., G. B. F., B. & M. R. R., 56 Monument st., West Medford, Mass.
Brooks, Walter A., Div. B. M. F., Penn. R. R., 10206 Dickens ave., Cleveland, O.
Brown, A. E., G. F. B. M., L. & N. R. R. Shops, South Louisville, Ky.
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Sharp, James, Master Mechanic, McKeesport Connecting R. R., Homestead, Pa.
Sheridan, Phil, Chief Clerk to Supt. Motive Power, P. & L. E. R. R., Pittsburgh, Pa.
Smith, M., Supt. Motive Power, P. & L. E. R. R., Pittsburgh, Pa.
Smith, J. J., Supvr. Shops, B. & O. R. R., Baltimore, Md.
Speller, R. N., National Tube Co., Pittsburgh, Pa.
Stimmel, R. M., Chief Chemist Water Supply, C. & O. R. R., Huntington, W. Va.
Swope, B. M., Supt. Motive Power, Penn. R. R., Pittsburgh, Pa.

Taylor, H. L., Supvr. of Shop Tools, B. & O. R. R., Baltimore, Md.

Ulbrick, R. H., Insp., I. C. C., Buffalo, N. Y.

Wesley, J. B., Eng. Water Service, Missouri Pacific R. R., St. Louis, Mo.

Forty-Second Meeting of Boiler Manufacturers

(Continued from page 159)

the functions of that group became more normalized.

Election of Officers

The final action of the meeting was the election of officers for the coming year. Starr H. Barnum, chairman of the nominating committee, presented the following names to the association, and these were formally elected:

President—H. H. Clemens, Erie City Iron Works, Erie, Pa.

Vice-President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, O.

Executive Committee—Homer Addams, Fitzgibbons Boiler Company, Inc., New York; H. E. Aldrich, The Wickes Boiler Company, Saginaw, Mich.; George W. Bach, Union Iron Works, Erie, Pa.; Sidney Bradford, Edge Moor Iron Company, Edge Moor, Del.; F. W. Chipman, International Engineering Works, Framingham, Mass.; Robert E. Dillon, Titusville Iron Works Company, Buffalo, N. Y.; C. E. Tudor, Tudor Boiler Company, Cincinnati, O.; A. C. Weigel, The Hedges-Walsh-Weidner Company, Chattanooga, Tenn.; and E. G. Wein, E. Keeler Company, Williamsport, Pa.

Registration at A. B. M. A. Meeting

The following members and associates were registered at the forty-second meeting of the American Boiler Manufacturers' Association:

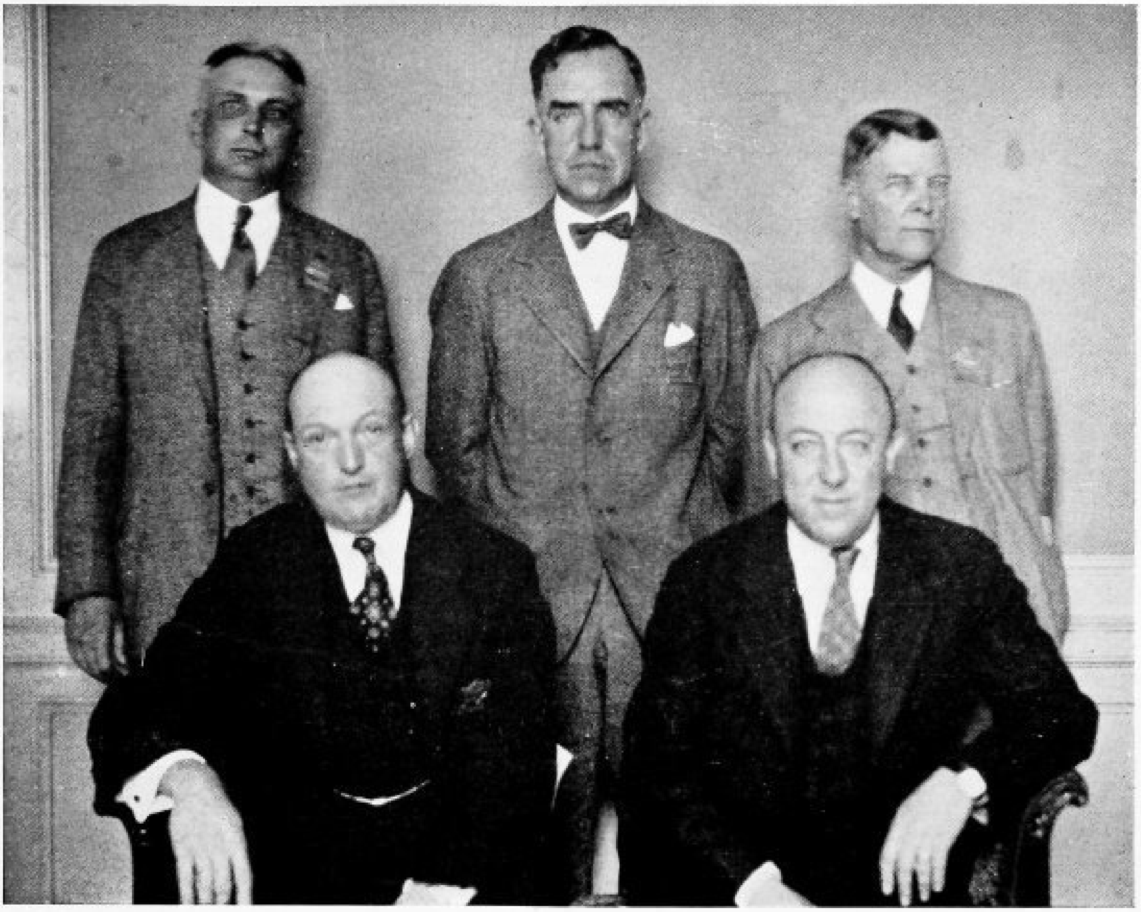
Addams, Homer, Fitzgibbons Boiler Company, Inc., New York.
Aldrich, H. E., Wickes Boiler Company, Saginaw, Mich.
Bach, George W., Union Iron Works, Erie, Pa.
Baker, A. C., Secretary A. B. M. A., Cleveland, O.
Barnum, G. S., The Bigelow Company, New Haven, Conn.
Barnum, Starr H., The Bigelow Company, New Haven, Conn.
Bateman, W. H. S., The Champion Rivet Company, Philadelphia, Pa.
Bentley, G. H., Bethlehem Steel Corporation, Ltd., Bethlehem, Pa.
Bradford, S. G., Edge Moor Iron Company, Edge Moor, Del.
Brown, C. H., Lukens Steel Company, Coatesville, Pa.
Brown, J. Roland, Reliance Gauge Column Company, Cleveland, O.
Cardwell, George A., Lukens Steel Company, Coatesville, Pa.
Carson, W. S., Globe Steel Tubes Company, Detroit, Mich.
Champion, D. J., The Champion Rivet Company, Cleveland, O.
Champion, T. Pierre, The Champion Rivet Company, Cleveland, O.
Chipman, F. W., International Engineering Works, Framingham, Mass.
Clemens, H. H., Erie City Iron Works, Erie, Pa.
Connelly, W. C., D. Connelly Boiler Works, Cleveland, O.
Coburn, J. F., J. F. Corbett Company, Cleveland, O.
Daniels, C. M., Bethlehem Steel Corporation, Ltd., Bethlehem, Pa.
David, E. Tyler, Tyler Tube & Pipe Company.
Ferguson, William, The Travelers Insurance Company, Hartford, Conn.
Fish, E. R., Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn.
Gilbert, E. F., The Dampney Company, New York.
Gorton, Charles E., American Uniform Boiler Law Society, New York.
Hammerslough, J. S., Springfield Boiler Company, Springfield, Ill.
Hunter, C. J., The Dampney Company, New York.
Huyette, P. B., Paul B. Huyette Company, Philadelphia, Pa.
Huyette, S. L., Paul B. Huyette Company, Philadelphia, Pa.
Jones, E. A., Bethlehem Steel Company, Bethlehem, Pa.
Keenan, W. F. Jr., Foster-Wheeler Corporation, New York.
Lally, R. R., Globe Steel Tubes Company, Detroit, Mich.
Lowe, F. R., *Power*, New York.
Lumbard, Warner, THE BOILER MAKER, New York.
Metcalf, F. B., International Boiler Works, E. Stroudsburg, Pa.
Morrison, J. P., Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn.
Myers, C. O., National Board of Boiler and Pressure Vessel Inspectors, Columbus, O.
Obert, C. W., Union Carbide and Chemical Corporation, New York.
Shively, J. H., Edge Moor Iron Company, New York.
Snow, N. L., Diamond Power Specialty Company, New York.
Tudor, Charles E., Tudor Boiler Company, Cincinnati, O.
Tudor, M. J., Tudor Boiler Company, Cincinnati, O.
Voelker, J. A., Pittsburgh Steel Products Company, New York.
Weigel, A. C., Walsh and Weidner Company, Chattanooga, Tenn.
Wynkoop, N. O., *Power*, New York.

National Board Meeting to be Held at Chattanooga

As this issue goes to press the third important meeting of the boiler industry, that of the National Board of Boiler and Pressure Vessel Inspectors, is about to convene at Chattanooga, Tenn. This meeting, which is the eighth annual convention, will be held at the Hotel Patten, from June 17 to 19.

One of the features of this year's meeting will be a question box, provided for the purpose of getting in written form before the board such matters pertaining to the execution of their duties as require discussion by the group. The program appeared on page 141 of the May issue.

A special feature of the program is a session devoted to a symposium on welded boiler drums and riveted boiler drums, which will be entered into by members of the board and guests who are interested in this very important subject. A complete report of the proceedings of the National Board meeting will be published in a later issue.



Officers of the Boiler Makers' Supply Men's Association

(Seated) Irving H. Jones, president-elect; Harry Loeb, retiring president. (Standing, left to right) Reuben T. Peabody, first vice-president; Frank C. Hasse, secretary; George R. Boyce, treasurer. E. S. Fitz Simmons, not shown in group, was elected second vice-president.

Supply Men Hold Annual Meeting

Through the efforts of President Harry Loeb, Lukens Steel Company, Coatesville, Pa., and the officers and members of the Boiler Makers Supply Men's Association, the annual meeting of this organization and the part played in the Master Boiler Makers' twenty-first annual convention were an unqualified success. The arrangements for the convention under the leadership of Irving H. Jones, Republic Steel Company, as general chairman of all committees were carried out in detail by committees headed by J. R. Flannery, Flannery Bolt Company, committee on arrangements; Reuben T. Peabody, Air Reduction Sales Company, exhibit committee; E. S. Fitz Simmons, Flannery Bolt Company, hotel committee; J. W. Kelly, National Tube Company, dance and reception committee; Charles J. Nieman, Penn Iron & Steel Company, entertainment committee; W. H. S. Bateman, Champion Rivet Company, ladies' entertainment committee; George R. Boyce, A. M. Castle & Company, banquet committee; W. E. Blackburn, Carnegie Steel Company, transportation committee; M. K. Tate, Lima Locomotive Company, registration committee. Each of these chairmen was ably supported by an active committee, so that the entire duration of the convention was marked by the smooth execution of all entertainment features and by the provisions made for the comfort and convenience of all in attendance.

Irving Jones and Harry Loeb talk over things as the convention closes

As noted in the report of the proceedings of the Master Boiler Makers' convention in this issue, a special feature this year was the opportunity presented by the Supply Men for the members to make instructive inspection trips to the various plants that manufacture boiler materials, including a trip to the Ellwood City Works of the National Tube Company, the Flannery Bolt Company plant and the Homestead Mills of the Carnegie Steel Company. While these trips were in progress for members, the ladies and the guests of both associations were entertained at nearby country clubs and vists to such plants as that of the H. J. Heinz Company. A reception and dance was held each of the first two evenings of the convention and the annual banquet in the ball room of the William Penn Hotel was held Thursday evening. A feature of the entertainment at the banquet was the second appearance before the group of Albert Kennedy Rowswell, known as "Rosie," who registered so effectively with his humorous stories at the Atlanta convention last year.

Supply Men Elect Officers

The business session of the Boiler Makers' Supply Men's Association took place Thursday, May 22, at which time the following officers were elected for the coming year:

President, Irving H. Jones, Republic Steel Corporation; first vice-president, Reuben T. Peabody, Air Reduction Sales Company; second vice-president, E. S. Fitz Simmons, Flannery Bolt Company; secretary, Frank C. Hasse, Oxweld Railroad Service Company; treasurer, George R. Boyce, A. M. Castle Company. Executive committee: (one year) M. K. Tate, Lima Locomotive Works; C. S. Wright, Oxweld Sales Company; George H. Raab, Bethlehem Steel Corporation; (two years) V. C. Kuhns, Burden Iron Company; H. N. Reynolds, Huron Manufacturing Company; Leslie Pyle, Locomotive Firebox Company; (three years) Thomas Mahar, American Arch Company; T. P. Champion, Champion Rivet Company; Harry Loeb, Lukens Steel Company.

Exhibitors and Supply Men at Master Boiler Makers' Convention

Air Reduction Sales Company, New York.—Oxygen and acetylene welding and cutting torches and supplies. Represented by Joe Kenefic, H. A. Hocking, G. Van Alstyne, J. A. Warfel, B. N. Law and R. T. Peabody.

American Arch Company, Inc., New York.—Pictures, etc. Represented by B. A. Clements, J. D. Brandon, J. P. Neff, Samuel MacClurkan, T. Mahar, T. F. Kilcoyne, T. M. Ferguson, M. R. Smith, W. W. Neale and George Wagstaff.

American Locomotive Company, New York.—Flexible staybolts, rigid staybolts and hollow staybolts. Represented by G. P. Robinson, W. E. Corrigan, Ross Anderson, S. W. Provost and W. J. Leisering.

Arrow Tools, Inc., Chicago.—Chisels, beading tools, backout punches, rivet-cutting tools and safety retainers. Represented by N. W. Benedict and D. R. Hughes.

Bethlehem Steel Company, Inc., Bethlehem, Pa.—Boiler tubes, bolts, engine and staybolt iron and steel and heat-treated bolts. Represented by George Raab.

The Bird-Archer Company, New York.—Blow-off cocks, sludge remover, transparency of the new locomotive water conditioner. Represented by H. C. Harragin, F. K. Tutt, J. L. Callahan, H. P. Mauer and H. K. Downey.

THE BOILER MAKER, New York.—Represented by R. E. Beauchamp, L. S. Blodgett and George Slate.

W. L. Brubaker & Bros. Company, New York.—Taps, dies and reamers. Represented by W. Searls Rose and E. J. Marx.

The Burden Iron Company, Troy, N. Y.—Samples of staybolt iron, engine-bolt iron, iron rivets, hollow-rolled and hollow-drilled staybolt iron. Represented by John C. Kuhns and William Downs.

A. M. Castle & Company, Chicago.—In connection with Lukens Steel Company and Champion Rivet Company. Represented by George R. Boyce and O. F. Olsen.

Champion Rivet Company, Cleveland, Ohio.—Rivets to meet A. S. M. E. and A. S. T. M. specifications. Toncan iron rivets, stainless steel rivets and centerless ground rivets for high-pressure work. Represented by David J. Champion, T. Pierce Champion, F. J. Lawless and W. H. S. Bateman.

Chicago Eye Shield Company, Chicago.—All kinds of goggles, including a new goggle that fits over glasses, welding glass, hand shields, helmets, etc. Represented by Robert Malcom, James H. Reid and John Liautaud.

Cleveland Steel Tool Company, Cleveland, Ohio.—Punches, dies, rivet sets, chisel blanks and compression dies. Represented by R. J. Venning and H. E. Harmon.

Dearborn Chemical Company, Chicago.—Scientific water treatment, treating plants and No-Ox-Id rust preventive. Represented by F. B. Horstmann, J. A. Crenner, L. P. Bowen and W. H. Kinney.

Detroit Seamless Steel Tubes Company, Detroit, Mich.—Seamless steel boiler and mechanical tubes. Represented by C. H. Hobbs, S. H. Worrell and H. Earle Ross.

Electro-Chemical Engineering Corporation, Chicago.—Locomotive boiler model showing installation of Gunderson Process for preventing pitting and corrosion by electro-chemical means, and detail parts. Represented by L. O. Gunderson, O. W. Carrick and C. G. Lunz.

Ewald Iron Company, Chicago.—Charcoal bloom staybolt iron, engine bolt iron, and hammered iron billets. Represented by J. P. Bourke and W. R. Walsh.

J. Faessler Manufacturing Company, Moberly, Mo.—Boiler makers' tools, flue expanders, etc. Represented by G. R. Maupin and P. C. Cady.

Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.—Solid and hollow staybolts, solid and hollow tapered radials and crown stays and solid and hollow staybolt-iron bars. Represented by C. M. Walsh, E. J. Raub and J. T. Doyle.

Firebar Corporation, Cleveland, Ohio.—Grates. Represented by M. P. Van Woert and Robert Watson.

Flannery Bolt Company, Pittsburgh, Pa.—Flexible staybolts, telltale flexible staybolts, installation tools, electrical contact staybolt tester and two-piece telltale flexible staybolts. Represented by J. Rogers Flannery, E. G. Flannery, E. S. FitzSimmons, W. M. Wilson, John H. Murrian, E. J. Reusswig, F. K. Landgraf, L. Finegan, G. R. Greenslade and Ed. S. Ryce.

Garratt-Callahan Company, Chicago.—Magic boiler preservative. Represented by A. H. Hawkinson, J. G. Barclay, W. F. Casper, H. M. Gray and Arthur Haggard.

Globe Steel Tubes Company, Chicago.—Seamless steel tubes and tubular products of carbon steels, special alloy and stainless steels. Represented by J. W. Floto, J. S. Bradshaw, J. M. Welles and W. S. Carson.

Huron Manufacturing Company, Detroit, Mich.—Washout and arch-tube plugs. Represented by E. H. Willard, P. C. Cady and George F. Morgan.

International Nickel Company, New York.—Samples of nickel steel alloys. Represented by A. L. Roberts.

Lima Locomotive Works, Inc., Lima, Ohio.—Photographs, Lima superpower steam locomotives. Represented by M. K. Tate.

Locomotive Firebox Company, Chicago.—Nicholson thermic syphon. Represented by A. A. Taylor, C. M. Rogers, E. J. Reardon, M. A. Foss, J. Baker and R. A. Carr.

Lovejoy Tool Works, Chicago.—Use-em-up drill sleeves, flexible couplings, tube expanders, flue cutters, re-cupping tools for rivet sets, setting and flaring tools, chuck for flexible bolt nuts, sleeve applicators, dolly-bars, special sockets, beading tools, backing-out punches, staybolt headers, rivet set clips, staybolt riveting dies, staybolt chucks, taper-shank sockets and thread chasers. Represented by W. H. Dangel and H. A. Lacerda.

Lukens Steel Company, Coatesville, Pa.—Test pieces, samples of various alloys in plate form and descriptive literature. Represented by Harry Loeb, W. H. S. Bateman, J. Frederic Wiese and C. H. Brown.

McCabe Manufacturing Company, Lawrence, Mass.—Literature describing the pneumatic flanging machine with a partial list of users. Represented by Fred H. McCabe.

National Tube Company, Pittsburgh, Pa.—Models showing manufacturing process of seamless pipe and tubing. National Shelby seamless boiler tubes and superheater tubes; National Shelby seamless pipe; extra heavy gages for locomotives; National copper steel pipe; National scale-free pipe for locomotives and train lines. Represented by F. N. Speller, P. J. Conrath, J. W. Kelly, J. M. Denney, C. E. Kennish, Frank Hamlett, H. G. Breckinridge, H. T. Miller, W. O. Preston, H. R. Redington, H. J. Wallace and G. T. Newman.

Old Dominion Iron & Steel Works, Richmond, Va.—Samples of special vibratory staybolt iron, solid and hollow, electric-steel staybolt bars, solid and hollow. Represented by Thos. S. Wheelwright and Dr. George Brooks West.

Otis Steel Company, Cleveland, Ohio.—Represented by George E. Sevey.

Oxweld Railroad Service Company, Chicago.—Oxy-acetylene cutting and welding equipment. Represented by F. C. Hasse, W. A. Hogan, A. N. Lucas, William Jones, T. E. Helton and C. S. Wright.

Paulson Tools, Inc., Wallingford, Conn.—Chisels, hand and pneumatic, chisel blanks, beading tools, rivet sets, backing-out punches, etc. Represented by Charles Loucks, John J. Brosman and Harry L. Burrhus.

Pittsburgh Steel Products Company, Pittsburgh, Pa.—Represented by C. V. Lally, C. H. Van Allen and W. H. Rowe, Jr.

Pratt & Whitney Company, Hartford, Conn.—Small tools such as taps, dies, etc. Represented by A. R. Gallant, A. W. Cordonna and J. J. Hebor.

Penn Iron & Steel Company, Creighton, Pa.—Samples of staybolt iron; engine-bolt iron; seamless hollow-drilled headed and threaded staybolts. Also several articles of furniture made of staybolt iron. Represented by Chas. J. Nieman.

Prime Manufacturing Company, Milwaukee, Wis.—Tank-hose strainer; square-thread washout and arch-tube plugs; double-seated gage cocks; channel drain cock; Clear Vision windows; composite fine thread washout and arch-tube plugs; all styles of grease plugs and grease-cup caps; guide oil cups; water-glass cocks, side windshield wings and cab ventilators. Represented by D. A. Lucas, T. F. Going and C. E. Murphy.

Reading Iron Company, Reading, Pa.—Samples of charcoal iron boiler tubes and staybolt and engine-bolt iron. Represented by G. H. Woodroffe, J. K. Aimer and W. Howells.

Republic Steel Corporation, Massillon, Ohio.—Toncan iron boiler tubes and pipe; stainless steel plate for firebox; nickel-iron staybolts. Represented by Irving H. Jones, H. L. Miller and Collin H. Aiken.

John A. Roebling's Sons Company, Trenton, N. J.—Welding wire, wire-rope slings. Represented by E. T. Weart.

Jos. T. Ryerson & Son, Inc., Chicago.—Samples of staybolt iron. Represented by J. P. Moses, G. L. Shinkle and A. N. Willcuts.

W. J. Savage Company, Inc., Knoxville, Tenn.—Roller-die type metal cutter, No. 2; bulletins describing new series metal cutter, a nibbling machine for working metal in flats up to 5/16 inch in thickness. Represented by John H. Murrian, W. D. Cunnyngham and K. J. Chapman.

The Superheater Company, New York.—Represented by G. E. Ryder, Bard Browne and K. E. Stilwell.

Torchweld Equipment Company, Chicago.—Gas welding and cutting equipment, acetylene generators, welding supplies and accessories. Represented by W. A. Slack, R. C. Waldie and W. E. Lyons.

Ulster Iron Works, Dover, N. J.—Special staybolt iron, engine bolt iron, special drilled hollow staybolts and wrought-iron rivets. Represented by C. Fred Barton, N. S. Thulin, W. W. Fetner and E. W. Kavanagh.

Water Treatment Company of America, Pittsburgh, Pa.—Samples of boiler compound. Represented by Harry L. Baer, George H. Neilson, Herbert Lewis, Robert C. Barker and W. E. Harris.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.—Welding set (stationary), 200-ampere; welding set (portable), 400-ampere; motor generator set, 60-volt; display board of welded samples. Represented by C. A. Ferguson, F. M. Bernard, A. B. McKelvey, W. W. Reddie, L. L. Clore, A. P. Lesnick, C. E. Swift, A. M. Candy and G. H. Koch.

Willson Products, Inc., Reading, Pa.—Goggles, both clear and welding; respirators; welding-protective equipment, etc. Represented by Donald Charlton.

Wrought Iron Company of America, Rome, N. Y.—Samples of staybolt iron, engine-bolt iron, spikes, nuts, rivets, bolts, etc. Represented by C. C. Osterhout.

A Correction

In the May issue of THE BOILER MAKER, there appeared on page 120 a communication from John G. Kirkland under the title of "Capacity of Dished Ends." On checking Mr. Kirkland's figures it is found that the formula $\frac{A^3}{13\frac{1}{2}} = C$ is basically wrong, being computed under the assumption that the volume of a dished end whose diameter is equal to the radius of dish, is 1/54th the volume of a sphere of the same radius.

It is found, however, that 1/78th of a sphere of which the end is a part equals the capacity of the end itself when the diameter of the end and the radius of dish is the same.

Under these conditions and following Mr. Kirkland's method of reduction, the correct formula becomes:

$$\frac{A^3}{18.6} = C$$

where, A is the diameter of the end and radius of dish in feet and C is the capacity of the end in cubic feet.

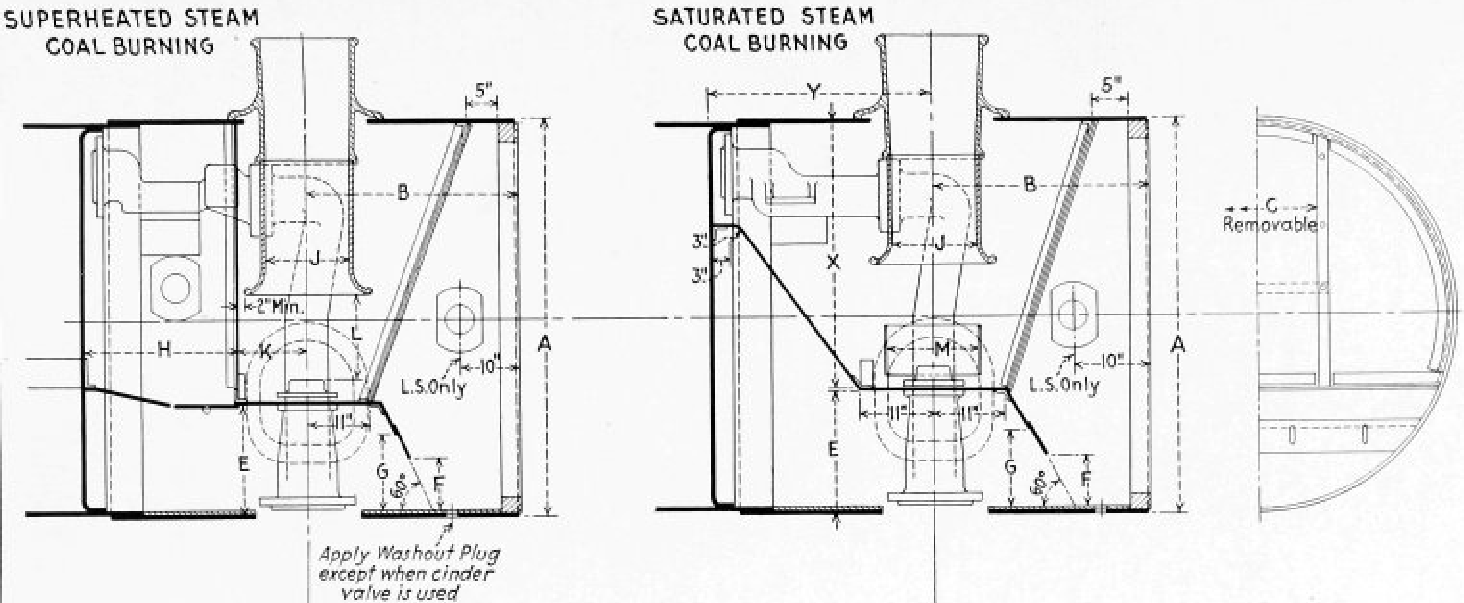
Business Notes

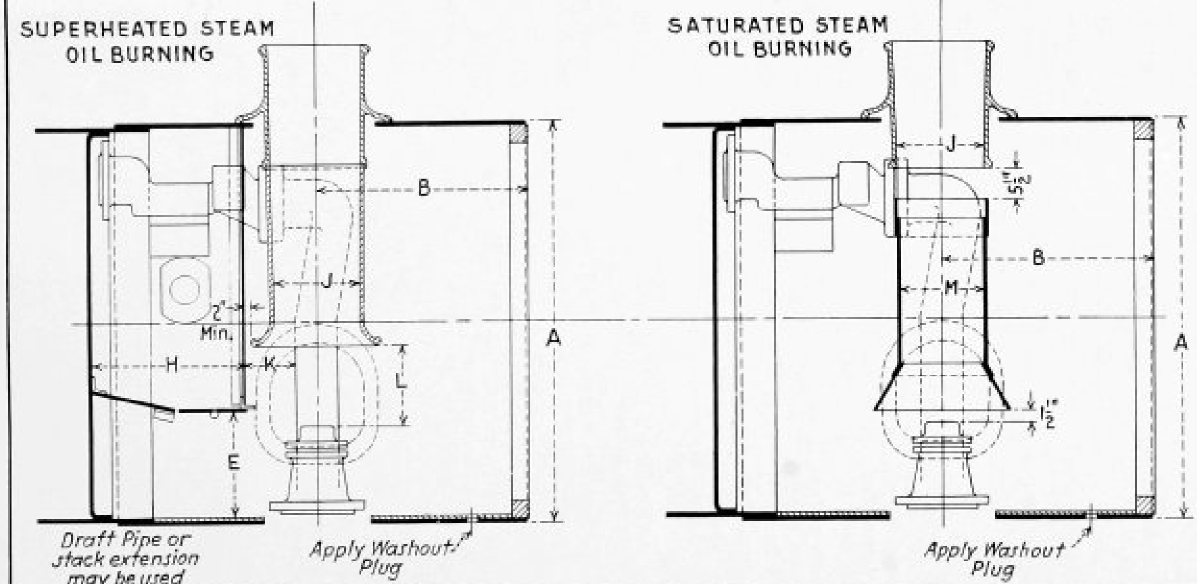
The Air Reduction Sales Company has moved its executive offices from 342 Madison avenue to the Lincoln building, 42nd street opposite the Grand Central Terminal, New York, N. Y.

The Lincoln Electric Company, Cleveland, O., announces the removal of its Baltimore, distributor's office from 432 North Calvert street to 600 North Calvert street, Baltimore, Md.

The Ohio Steel Foundry Company, of Lima and Springfield, O., has purchased the steel foundry department and steel casting business of the Industrial Brownhoist Corporation, Cleveland, O., and Bay City, Mich. The steel foundry itself is located at Bay City. Extensive improvements are planned, among the first of which will be a modern 15-ton open-hearth furnace.

The Prest-O-Lite Company, Inc., 30 East 42nd street, New York, N. Y., announces the opening of a new plant for the manufacture of dissolved acetylene at 1240 Stewart avenue, S. W., Atlanta, Ga. The new plant is designed to take care of the demand occasioned by the increased use of the oxyacetylene process in this industrial area. It is situated on a private siding of the Atlanta and West Point Railroad. With the opening of the new plant, the old plant at 345 Kuhrt street, S. W., Atlanta, will discontinue operations.





Header	No. of Rows deep	H: No. of Rows wide 5 to 7	8 and 9	10 to 12
Improved Through-Bolt	2	19"		
	3	24"	25"	
	4	28"	29"	30"
	5	30"	33"	37"
	6		37"	38"
Tee Bolt	3	16"	16"	16"
	4	18"	18"	18"
	5	21"	21"	21"
	6		24"	24"

M	Standard C.I. Stack Extension L	K	J
9"	13"	11"	11"
10"	13"	12"	12"
11"	14"	12"	13"
12"	14"	13"	14"
13"	15"	13"	15"
14"	15"	14"	16"
15"	16"	14"	17"
16"	16"	15"	18"
17"	17"	15"	19"
18"	17"	16"	20"
	18"	16"	21"
	18"	17"	22"
	19"	17"	23"
	19"	18"	24"

C	B	A
27"	44"	90"
28"	44"	91"
28"	45"	92"
28"	45"	93"
29"	45"	94"
29"	46"	95"
29"	46"	96"
30"	46"	97"
30"	47"	98"
30"	47"	99"
31"	47"	100"
31"	48"	101"
31"	48"	102"
32"	48"	103"
32"	49"	104"
32"	49"	105"

C	B	A
21"	37"	70"
21"	38"	71"
21"	38"	72"
22"	38"	73"
22"	39"	74"
22"	39"	75"
23"	39"	76"
23"	40"	77"
23"	40"	78"
24"	40"	79"
24"	41"	80"
24"	41"	81"
25"	41"	82"
25"	42"	83"
25"	42"	84"
26"	42"	85"
26"	43"	86"
26"	43"	87"
27"	43"	88"
27"	44"	89"

C	B	A
14"	31"	50"
14"	31"	51"
15"	31"	52"
15"	32"	53"
15"	32"	54"
16"	32"	55"
16"	33"	56"
16"	33"	57"
17"	33"	58"
17"	34"	59"
17"	34"	60"
18"	34"	61"
18"	35"	62"
18"	35"	63"
19"	35"	64"
19"	36"	65"
19"	36"	66"
20"	36"	67"
20"	37"	68"
20"	37"	69"

Method of determining the length of smokebox in a locomotive boiler

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Length of Locomotive Boiler Smokebox

Q.—Will you be good enough to tell me the simplest method of determining the length of smokeboxes in locomotive boilers? J. G.

A.—The accompanying plate shows a method of determining the length of the smokebox for locomotive boilers. It also shows lengths of smokeboxes for the various diameters. Dimension *B* is tabulated to give a clear area through netting of 125 percent of the total gas area, using netting having a clear area of 50 percent or more. Increase dimension *B* to give 125 percent when using netting having less than 50 percent clear area. Dimension *C* is tabulated to allow the three strips of netting to have the same width and to allow a proper width of door. The door is to extend the full height for smokeboxes up to a 90-inch diameter; for a 90-inch diameter and over use a door 30 inches high. In determining dimension *E*, it is necessary first, to give 100 percent gas area under the plate for outside steam pipes and 115 percent for inside steam pipes; second, to bring dimension *E* in a figure ending in ½ inch; and third, to bring the table plate not higher than bottom of the lower flues. Dimension *F* is to be 63 percent to 68 percent of the total gas area. Dimension *G* to be 85 percent to 90 percent of the total gas area. Dimension *H* is governed by the type of header. Dimension *K* is the minimum for a cast-iron stack extension with a 2-inch clearance from the deflecting plate. This can be decreased 2 inches by cutting off the back of the extension. The improved through-bolt type of header is preferred and must be provided for on all new designs. Dimension *M* draft pipe may be used in place of stack extension on oil burners. The draft pipe around nozzle aids the draft to sweep the table plate clear of cinders.

Safety Valves for Watertube Boiler

Q.—A watertube boiler has 2000 square feet of heating surface and a superheating surface of 500 square feet. Under the A. S. M. E. code how many and what size safety valves are needed? Please show how this is figured out. W. W.

A.—The A.S.M.E. Boiler Construction Code 1927, Section 1—Power Boilers; requires the following:

P-269. Safety Valve Requirements: Each boiler having more than either 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 as given in Par. A-11 and A-12 of the Appendix.

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 use more than 6 percent above the maximum allowable working pressure, or more than 6 percent above the highest pressure to which any valve is set.

P-271. One or more safety valves on the boiler proper shall be set at or below the maximum allowable working pressure. The remaining valves may be set within a range of 3 percent above the maximum allowable working pressure, but the range of setting all of the valves on a boiler shall not exceed 10 percent of the highest pressure to which any valve is set.

P-274. The minimum aggregate relieving capacity of all of the safety valve or valves required on a boiler shall be that determined on the basis of a 6 pounds of steam per hour per square foot of boiler heating surface for watertube boilers. For all other types of power boilers, the minimum aggregate relieving capacity shall be determined on the basis of 5 pounds of steam per hour per square foot of boiler heating surface for boilers with maximum allowable working pressure above 100 pounds per square inch and on the basis of 3 pounds of steam per hour per square foot of boiler heating surface for boilers with maximum allowable working pressures at or below 100 pounds per square inch. In many cases a greater relieving capacity of safety valves will have to be provided than the minimum specified by this rule and in every case the requirements of Par. P-270 shall hold.

The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose, only the tubes, fireboxes, shells, tube sheets and the projected area of headers need be considered. The minimum number and size of safety valves required shall be determined on the basis of the aggregate relieving capacity and the relieving capacity marked on the valves by the manufacturer. Where the operating conditions are changed or additional heating surface, such as water screens or water walls, is connected to the boiler circulation, the safety valve capacity shall be increased, if necessary, to meet the new conditions and be in accordance with Par. 270.

P-275. If the safety valve capacity cannot be computed or if it is desirable to prove the computations, it may be checked in any one of the following ways, and if found insufficient, additional capacity shall be provided.

(*a*) By making an accummulation test; that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. The safety valve equipment shall be sufficient to prevent an excess pressure beyond that specified in Par. 270.

(*b*) By measuring the maximum amount of fuel that can be burned and computing the corresponding evaporative capacity upon the bases of the heating value of the fuel. (See Appendix, Pars. A-11 to A-17).

(*c*) By determining the maximum evaporative capacity by measuring the feed water. The sum of the safety valve capacities marked on the valves, shall be equal to or greater than the maximum evaporative capacity of the boiler.

In accordance with Par. 274 the boiler in the question would require safety valves with an aggregate relieving capacity of:

2000 x 6 = 12,000 pounds per hour.

Appendix A-11 of the A.S.M.E. Boiler Construction Code of 1927 is as follows:

A-11 Method of Computing Discharge Capacity. The required discharge capacity of a safety valve or valves for a boiler may be based either on the heat units in the fuel consumed or on the amount of steam generated.

The number of heat units in the fuel that each safety valve will handle per hour, for valves of the ordinary types in which the discharge capacity is proportioned to the lift, may be obtained as follows:

$U = 161{,}000 \times P \times D \times L$ for bevel seats of 45 degrees.
$U = 227{,}500 \times P \times D \times L$ for flat seats.
$U = 72{,}500 \times P \times A$ for seats of any angle.

The amount of steam that a valve will discharge in pounds per hour, may be found as follows:

$W = 110 \times P \times D \times L$ for bevel seats at 45 degrees.
$W = 155 \times P \times D \times L$ for flat seats.
$W = 50 \times P \times A$ for seats of any angle.

where,

U = number of heat units in the fuel that a safety valve will handle per hour B.t.u.
W = quantity of steam that a safety valve will handle per hour, pounds.
P = absolute boiler pressure = gage pressure plus 14.7 pounds per square inch.
D = inside diameter of valve seat, in inches.
L = Vertical lift of valve disk, measure with 3 percent excess pressure, inches.
A = Relieving area in square inches = $3.1416 \times D \times L \times$ sine of seat angle.

In order to compute the size of safety valves, it is necessary to know, in addition to the heating surface, the working pressure of the boiler. This was omitted in the question and I have therefore for illustration assumed 150 pounds boiler pressure.

Transposing the formulae $W = 50 \times P \times A$. The required relieving area of the safety valves A would then be,

$$A = \frac{W}{50 \times P}; \quad P = 150 + 14.7 = 164.7$$

$$A = \frac{12000}{50 \times 164.7} = 1.45 \text{ square inches relieving}$$

area required.

The diameter and number of safety valves required to give this required relieving area is dependent upon the lift and the style of seat of the valve used. Assuming a 45-degree beveled seat with a valve lift of a 0.10 inch and then transposing the formulae:

$A = 3.1416 \times D \times L \times$ sine of seat angle,

to find D the diameter we would then have:

$$D = \frac{A}{3.1416 \times L \times \text{sine of seat angle}}$$

$$D = \frac{1.45}{3.1416 \times 0.10 \times .70711}$$

Sine of 45-degree angle = .70711

D = 6.52 inches = two 3½-inch diameter valves required.

In accordance with Par. 269 this boiler would require two safety valves.

The safety valve capacity should be checked by one of the three methods outlined in Par. 275 and if found insufficient additional capacity should be provided.

Heating Surface of Locomotive Boiler

Q.—In the April issue of THE BOILER MAKER in the Questions and Answers Department I notice an interpretation for figuring the heating surface in locomotive-type boilers under the heading of "Staybolt Heads as Heating Surface."

May I call your attention to the following:

1. A locomotive-type boiler unless actually a locomotive boiler is classified as a stationary boiler and comes strictly under the requirements of Section I, of the A. S. M. E. Boiler Construction Code. This is a decision of the A. S. M. E. Boiler Code Committee.

2. Page 57, Paragraph 274 of the 1927 Code specifies that, "The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose only the tubes, fireboxes, shell, tube heads and the projective area of headers may be considered."

Again from the A. S. M. E. Test Code for stationary boilers, "Heating surface which consists of that portion of the surface of the heat-transfer apparatus exposed to both the gases being cooled and the fluid being heated, at the same time, computed on the gas side."

Personally I agree with the interpretation that you have given in the April issue of THE BOILER MAKER, and I would be very pleased if I might use this method. However, in view of the authorities quoted above I do not believe it would be permissible.

Will you kindly advise me of your opinion at your earliest convenience? T. C. E.

A.—The usual rule is to consider as heating surface all the surfaces that are surrounded by water on one side and by flame or heated gases on the other, usually the external instead of the internal diameter of tubes for greater convenience in calculation. External diameters of boiler tubes are usually given in even inches or half inches. This method is standard practice, with practically all locomotive builders.

The answer to the question in the April issue was given for a locomotive-type boiler and the method of computing the heating surface shown is used by locomotive builders. Most locomotive boilers come under the jurisdiction of the Interstate Commerce Commission and therefore do not adhere strictly to the A.S.M.E. Code. The answer is a general method and is not intended as a strict interpretation of the A.S.M.E. Code.

In figuring heating surface to determine the minimum aggregate relieving capacity of all the safety valves required on a boiler, the method called for in Par. 274 of the A.S.M.E. Boiler Construction Code should be used.

Cause of Rivet Heads Pitting When Being Driven

Q.—I would like to ask a few questions on rivets that we are using on boilers. The steel that the rivets were made of stood the tensile test and the bending tests, but in driving the rivets we used an air dolly for holding on. When the rivets cooled off there were pits on the heads. Some show these pits on both ends. We had our chemists analyze them but we are still in the dark. My reason in writing this note is as a boiler inspector I would like to know something about this pitting. We have rolled special sheet but no results. The only way the pitting does not show so much is to use two air hammers. To get to my point—if I send you a few of these defective rivets you may be able to throw some light on it. N. A. McL.

A. The trouble you are experiencing is no doubt due to the use of the air dolly. The air dolly fits tightly and has a constant pressure against the head of the rivet, while the air gun or holding bar will vibrate or jump away from the head of the rivet, when the rivet is being driven. Therefore it can readily be seen that any dirt or scale in the head or die of the air dolly will cut into the head of the hot rivet, pitting same.

Care should be taken when using the air dolly to clean out the die before each rivet is driven, if necessary.

Overheating or burning the head of the rivet will also show pitting, when the rivet is held with an air dolly. This is due to the fact that the air dolly does not work on the head of the rivet, while with the air gun the pitting marks caused by overheating the rivet are smoothed over by the action of the air gun on the head of the rivet.

E. A. Doyle, consulting engineer of The Linde Air Products Company, New York, was elected president of the American Welding Society at the annual meeting of the society held April 25, 1930.

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

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	

Cities

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

Selected Boiler Patents

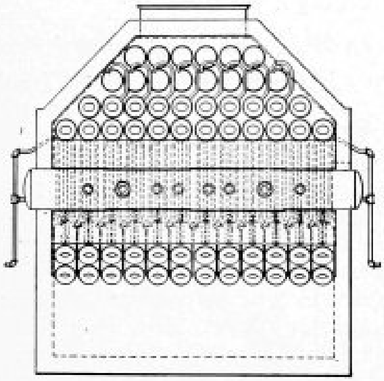
Compiled by
DWIGHT B. GALT, Patent Attorney,

Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,731,957. BOILER CONSTRUCTION. GUSTAVE WELTER, OF NEW HAVEN, CONN., ASSIGNOR TO THE BIGELOW COMPANY, OF NEW HAVEN, CONN., A CORPORATION OF CONNECTICUT.

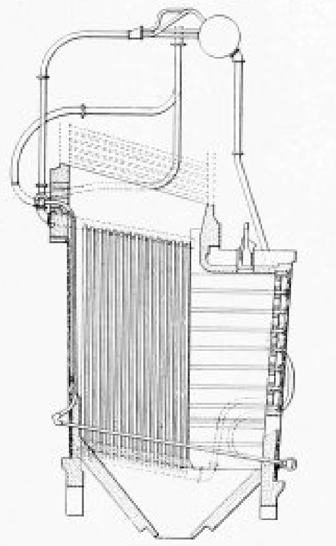
Claim.—In a boiler of the type described, a series of transverse rows of independent watertube units, each unit having upper individual tube unit drums, the units of each row being alined longitudinally with the units of



each other row, a steam drum located above the water level in said drums and connected thereto, and means comprising pipe connections below the normal water level in said drums and between each individual tube unit drum of the units of one row and a plurality of individual tube unit drums of the units in front of said row to maintain a uniform water level in said independent units. Two claims.

1,734,656. BOILER FURNACE. JOHN VAN BRUNT, OF FLUSHING, NEW YORK, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

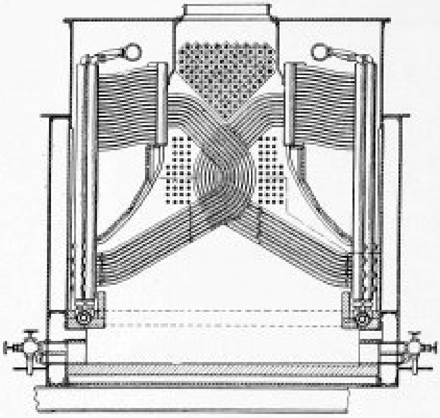
Claim.—In combination, a boiler, a combustion chamber, a plurality of upright tubes defining a portion of the combustion space, a header into which the upper ends of said tubes are connected, a header into which the



lower ends of said tubes are connected, downcomer means connecting said lower header with the boiler, upcomer means connecting said upper header with the boiler, and other tubes outside the combustion chamber directly connecting said headers together, said latter tubes being spaced more closely adjacent the region in which the first mentioned upright tubes are subjected to the greatest heat.

1,735,345. STEAM BOILER. WILLIAM H. WINSLOW, OF CHICAGO, ILLINOIS, ASSIGNOR TO GEORGE W. DULANY, JR., OF CHICAGO, ILLINOIS.

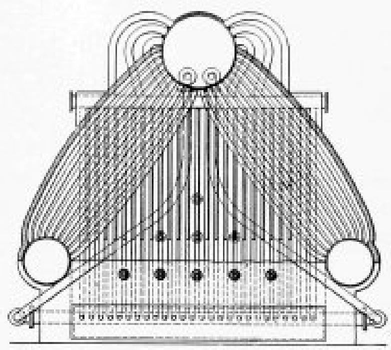
Claim.—A boiler construction of the class indicated, comprising an upright tubular downcomer manifold, generating tubes communicating with said manifold adjacent the lower portion thereof and inclined at an angle thereto, the upper ends of said tubes being bent back upon themselves towards said manifold, and intermediate vertically disposed tubular separat-



ing manifold communicating with the upper ends of said generating tubes, and means providing communication for water and steam from said separating manifold to the upper portion of said downcomer manifold. Six claims.

1,731,577. BOILER. WALTER M. KEENAN, OF NEW YORK, N. Y., ASSIGNOR TO THOMAS E. MURRAY, OF BROOKLYN, N. Y.

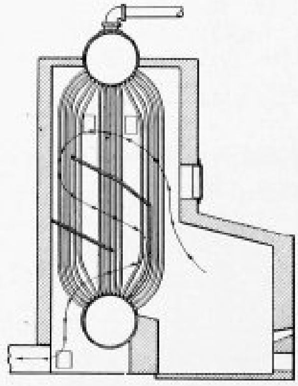
Claim.—A boiler of the marine type having a central steam drum at the top, parallel drums at the sides and tubes extending upward from such side drums to the central steam drum, a lower header extending trans-



versely across the bottom of the front or firing end of the boiler, an upper header extending across the top of the rear end, continuous tubes extending horizontally from the lower header to the rear and thence upward to the upper header, pipes leading from the front end of the steam drum to the lower header and pipes leading from the upper header to the rear end of the steam drum. Two claims.

RE. 17,464. WATERTUBE BOILER. ALFRED C. DANKS, OF CLEVELAND, OHIO, ASSIGNOR OF ONE-HALF TO KINGSLEY L. MARTIN, OF MONTCLAIR, N. J.

Claim.—In combination in a boiler of the vertical type, having a lower drum and an upper drum arranged in substantially vertical alinement one above the other and three sets or banks of watertubes extending upward from the lower drum to the upper drum, a firebox, an outlet flue at the



rear of the boiler at the lower portion thereof, a baffle extending from the lower drum longitudinally of the tubes of the front bank for a portion of their length and then transversely of such tubes and across the middle bank of tubes and across the space between the middle and rear banks of tubes and terminating short of the rear side of the rear banks of tubes, and a second baffle extending inward from the vertical rear wall of the boiler setting across the rear bank of tubes and into the middle bank of tubes and spaced below the transverse portion of the first baffle. Three claims.

The Boiler Maker

Name registered U. S. Patent Office

Volume XXX **July, 1930** **Number 7**

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

Chicago: 105 West Adams St. Cleveland: Terminal Tower
Washington: 17th and H. Sts., N. W.
San Francisco: 215 Market St.

H. H. BROWN, Editor
L. S. BLODGETT, Managing Editor
WARNER LUMBARD, Associate Editor

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

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Efficiency in Shop Operation

Certain very definite principles and qualities of management are evident to the informed and interested visitor in any industrial plant and the boiler shop is no exception. Almost at a glance can the efficiency and morale of a shop be established by a general estimate of the arrangement, facilities and attitude of the men towards their work and also by a sizing up of their supervisors.

In this issue the second article describing the plant and facilities of a modern boiler shop, that of the Illinois Central Railroad, at Paducah, Ky., is published. By studying the features of this shop and its operation, our readers will find every element that goes to make up a productive and contented organization.

The plant is one of the two or three of the most modern boiler shops in this country, which, to all intents and purposes, means in the world. In its arrangement and mechanical facilities there is none better. Something more, however, is required than mere physical equipment to establish a high level of efficiency in any organization, and probably the most important items are understanding supervision of the staff, interest in its welfare, proper lighting, heating and ventilating conditions, interest in safety and accident prevention, training methods and the like, All these are more or less intangible, but where they exist the morale of the organization is excellent and production is established on a high standard.

Certain phases of the application of these policies at the Paducah boiler shop are mentioned in the article this month. Whether a shop is old or new the same principles of management should be in force.

In the purely productive side of shop operation, the scheduling system on the Illinois Central offers many advantages not the least of which is simplicity. The details of this system, as outlined, indicate that even with a large amount of maintenance the work can go through the shop without delay by having the entire staff of general foremen enter into the planning of the master schedule with the master mechanic. Each department is then responsible for its own production and any delays that may occur are checked almost immediately.

Dovetailing with the planning of work at this shop is the stores and material delivery system. This too is reduced to its simplest possible form and delays practically never occur from lack of the necessary parts or material.

Above all at this shop, clean floor spaces, lack of litter and cluttered conditions are outstanding characteristics. In general a clean shop is a safe and a productive one. In the mere process of keeping the shop clean, an actual saving, amounting to over $500 a day, is made by salvaging scrap and materials and parts taken from stripped boilers.

For the safety feature the Paducah boiler shop is outstanding, and this result is gained by a careful study of working conditions by a shop committee supported by the management. Whenever changes can be made that will improve conditions, suggestions made by the committee of department foremen are promptly acted upon, and the necessary machine guards, or scaffolds or safety devices are supplied.

Understanding of shop conditions and willingness to improve them have paid dividends to the Illinois Central in better production. It will do so for any railroad.

Tension Tests of Rivets

Because of the uncertainty which exists regarding the use of rivets in tension and the lack of scientific data regarding either the strength or the reliability of rivets in tension, an investigation has been made at the Engineering Experiment Station of the University of Illinois by Professor Wilbur M. Wilson and William A. Oliver to determine the strength of rivets in tension and also to determine the initial tension in rivets. The results of this investigation are given in Bulletin No. 210 published by the University of Illinois last month.

All rivets used in the investigation were made from rivet steel having an average yield point of 37,184 pounds per square inch and an ultimate strength of 54,618 pounds per square inch. Specimens cut from undriven rivets had about the same properties as the specimens cut from rivet rods. The rivets used had a nominal diameter of ¾ inch. Some rivets were driven with an air hammer, others with a press riveter.

As a result of the tests it was concluded that the strength in tension of hot-driven rivets made of good material and properly driven, having two button heads, was slightly greater than the tensile strength of the rod from which the rivets were made. Rivets having a long grip were not quite as strong as those having a short grip, due presumably to the fact that the long rivets did not fill the holes for their entire length as completely as did the short ones.

The conclusions arrived at with respect to the initial tension in rivets were as follows: All hot-driven rivets having button heads had an initial tension equal to 70 percent or more of the yield-point strength of the rod from which the rivets were made. Cold-driven rivets had a low initial stress. Rivets having a long grip had a somewhat greater initial stress than those having a short grip. Practically all rivets having two button heads and a grip of 3 inches or more had an initial stress equal to 90 percent of the yield-point strength of the rod from which the rivets were made.

The tests indicate that hot-driven rivets in general are subjected to a tensile stress nearly equal to the yield-point strength of the material, but they do not show whether this tension affects the strength of the rivets in shear. The tests apparently justify the general use of rivets in tension if the shear stress is not reversed. A tensile stress due to an external load may, however, be undesirable in the case of rivets subjected to alternating shear; for slip between plates is prevented largely by friction, and if the initial tension is overcome by an external load, the pressure between the plates is relieved and slip will occur, allowing the rivets to become loosened if subjected to many sheer reversals.

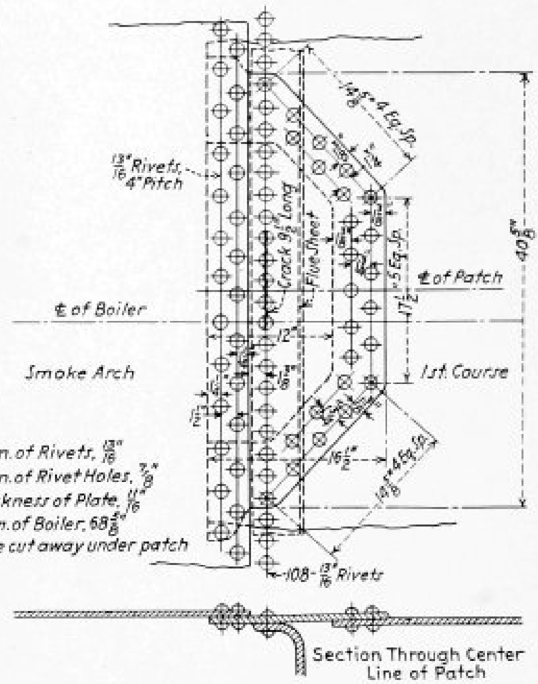
The results of this investigation, which have been indicated briefly above, are a valuable addition to the existing knowledge of riveted joints, and copies of the bulletin, containing the test data, should be carefully studied by users and builders of riveted structures.

Communications

Patch for Front Tube Sheet Seam

TO THE EDITOR:

The enclosed print illustrates the manner of applying a boiler patch when the barrel is cracked through the rivet holes at the front tube sheet circumferential seam.



Method of applying front tube sheet seam patch

In applying a patch of this kind it is essential to cut out the plate under the patch in order to slip the new plate under the smoke arch as shown. The ends of the patch must be scarfed to assure a good fit at those points.

Berkeley, Cal. J. B. BECKER.

Welding Rectangular Steel Tanks

TO THE EDITOR:

A boiler maker, who had contracted to construct a considerable number of rectangular steel tanks of various sizes, found himself "up against" a number of very interesting details. This communication will not concern itself about the making and reinforcing of the specified number of outlets or the manner of welding or riveting the necessary reinforcing pads. Neither will attention be given to the locating and fastening of whatever steel angles might be required for stiffening or supporting the several tanks. Only the manner of forming and welding the tanks will be discussed here.

There were many tanks 3 feet square and high, to be constructed from ¼ inch tank steel, and what the boiler maker discovered in regard to the making and welding of this size of tanks will be related here.

The first tank built was made of six pieces of steel, each 3 feet square, with square edges placed with their inside corners touching and welded in those positions. One tank made in this manner was enough and the boiler maker immediately cast about for ways and means whereby he could lessen the amount of work necessary and also produce a better looking tank without several short crooks in the welded edges. The boiler maker found that there were required the welding of 12 seams, each 3 feet long, or 36 feet of welding for each tank. It was also found that the 90-degree corners did not fill readily with fusion metal and considerable extra time and welding rod material was necessary to build up these 90-degree corners.

The next tank made was put up in three pieces, one piece 3 feet by 12 feet with three right angle bends in it, forming the four sides of a tank and two pieces 3 feet square made the top and bottom. All these three pieces were planed on the inner edges to 75 degrees, 15 degrees being removed from the inside edges in order that the welding crevice would have an opening of 60 degrees instead of 90, as with the first tank.

The boiler maker found that by making three bends in the 12-foot piece of steel, he got rid of welding three sides, thus leaving nine instead of twelve sides to be welded. However, it was found not very easy to make the third bend in the long sheet. It was easy to make two bends, but the third one was a "humdinger" and the boiler maker cut out the 12-foot piece then and there, and, instead of one 3-foot by 12-foot piece and two each 3 feet by 3 feet, he made three pieces each 3 by 6 feet. These three pieces, placed properly together, formed a cube and did away with 9 feet of welding, the same as with the 3-foot by 12-foot side piece. In making these pieces, he found it necessary to increase the size of the pieces slightly; as much, in fact, as was reduced when the edges were planed to 75 degrees instead of 90 degrees. That is, he made this slight increase in the opposite sizes whenever it was found necessary to maintain exactly the inside measurements of the 3-foot tanks.

The boiler maker found another "bug" in using the three-piece layouts of two sides each. It was a mean job to start the welding, owing to the very "ticklish" operations necessary in placing and holding the two-side pieces. So the boiler maker made the next tank of two sheets, each 3 feet by 9 feet and each carrying right-angle bends. These bends were easy to make in the two-piece tank of three sides each, and could be pushed together almost in "any old way" and assume and retain their proper shape.

The boiler maker got into trouble with the 12-foot piece and found that it had "taken-up" during the making of the three bends, thereby causing the tank to be slightly less than 3 feet square. Further tests were made and due allowance added to the three-side pieces with two bends each, and allowance was also carefully calculated for the beveling of the sides and ends to 75 degrees.

In welding the first tank, the boiler maker started at one corner and went right around the tank until all the twelve 3-foot welds had been made; but he found frequent trouble as the sides showed a decided tendency to "haul in" and would slip past each other unless occasionally driven apart. Due to this operation, the several slight bends and crooks in the sides of the tank appeared after the welding was completed.

After considerable experimenting, it was found necessary to so start each weld that its ending would be at a double corner. That is, instead of starting at any corner and welding each side in succession, a start would be made in such a manner that when all sides had been welded but two, these two sides would be at 90 degrees with each other. This means that the welding was not carried around the tank until only a single 3-foot side remained, but was so planned that two 3-foot sides remained, with a corner between them. Then the boiler maker welded a few inches of one of the two remaining sides, then a few more inches on the other side, alternating on each side until both sides had been welded progressively toward the free corner.

It was found necessary to wedge the plates apart ahead of the welding and as the plates were pulled together by cooling of the fusion metal, the boiler maker "eased-up" the wedge which held the sides slightly apart, so they were a little less than 1/32 inch apart at the edge of the fusion metal. This method kept the tank sides straight.

Indianapolis, Ind. James F. Hobart.

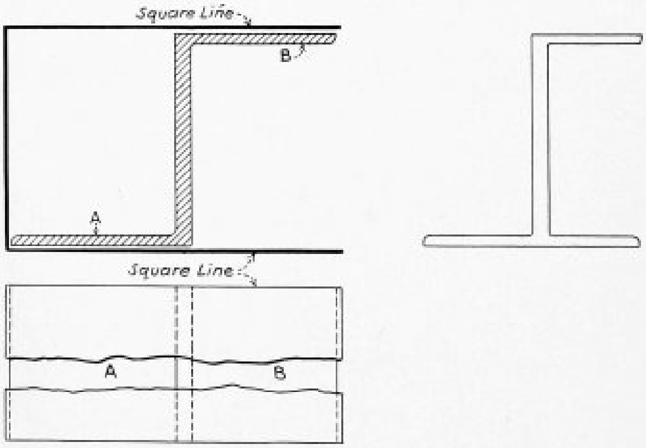
Squaring Zee Irons

To the Editor:

Considerable difficulty often is experienced in keeping the top and bottom flanges of irregular shapes square with one another. This applies to zees, columns, H-beams, I-beams, etc.

For such work a channel square, as sketched, has been found to be effective.

This type of square can be made from any light-



Construction of square for truing flanges of irregular shapes

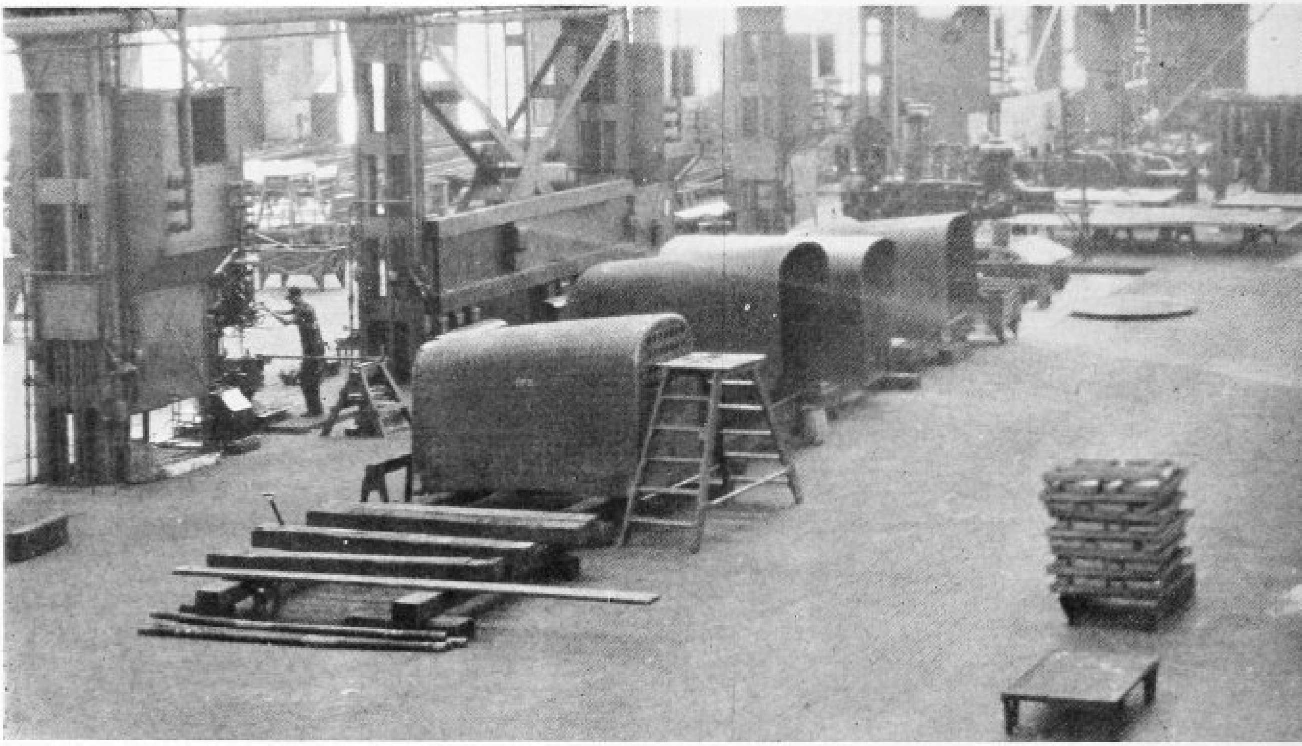
gage sheet metal, carefully squared and bent in the shape of a channel as shown.

Of course, individual squares must be made for the different sizes of stock, but a 6-inch square can be used for all the various shapes of that size.

The time required to make such a square is more than compensated for by increased accuracy and speed of operation.

Alhambra, Cal. C. B. Dean.

Harold F. Kneen, for the past year assistant plant superintendent of the Lincoln Electric Company, Cleveland, O., has been made plant superintendent of that company. He is a graduate of Cornell University, receiving the degree of Mechanical Engineer in 1925.



Scheduling Boiler Repair Work

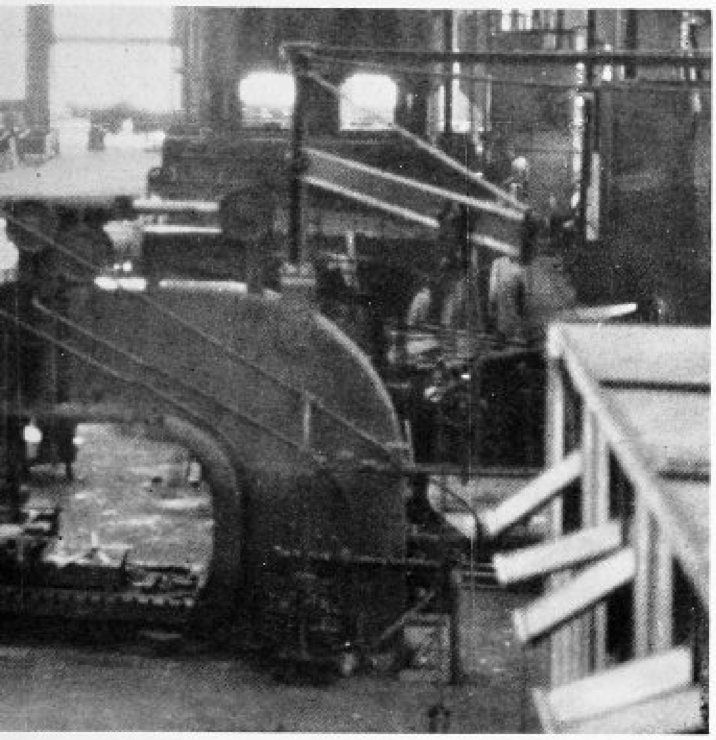
at Illinois Central Paducah Shops

With a general idea of the organization as well as the layout and equipment of the Paducah, Ky., boiler shop of the Illinois Central Railroad in mind, as described in the June issue, the first essential item of the production practice at this shop, which will now be discussed, is the method of scheduling repairs. It will be recalled that an average of 30 Class 2 and Class 3 locomotive repairs a month is handled through the shops, which covers all major boiler repair work for the entire system. To accomplish this amount of heavy work efficiently and promptly requires careful and accurate planning on the part of each department.

Previous shopping dates for classified repairs and mileage records determine approximately the time at which locomotives are to be delivered at the Paducah shops for overhauling. At a staff meeting of all department foremen held in the master mechanic's office once a week, each foreman indicates the dates at which certain work can be handled in his department, and from the discussion which occurs and from his records the master mechanic compiles a weekly shopping list which is issued immediately after the meeting to all those present. From week to week the dates specified on this list are revised. The shopping schedule thus arranged is closely followed by the master mechanic who is responsible for the maintenance of the program and for the dates at which the various class repairs are to be brought to the shop and delivered complete. Briefly, this schedule contains the following information: Engine number; pit to which the engine is assigned; the class engine; the division on which it operates; date shopped; date at which repairs start; boiler work finished; wheel work; side rods and date out with a note covering the principal items to be repaired, which latter designates the class. A similar master schedule is compiled for tank work.

Coming to work in the boiler department, a preliminary inspection report is made by the general local boiler inspector or by the general boiler foreman, if there is any doubt of the class repair needed. This report is filed in the general boiler foreman's office and serves to inform him roughly of the requirements of each locomotive as it comes up for discussion at the staff meeting, when the shopping schedule is being formulated.

Before a locomotive is shopped, however, the general or the assistant general boiler inspector inspects the boiler and makes out a report covering the details, copies of which go to the mechanical officials and to each boiler department foreman. This report serves as a guide in handling the boiler work through the shop. On this report is given



ing; repair manhole cover, and special items.

As a boiler progresses through the boiler shop, the local inspector makes periodic examination of the work and also inspects all material and parts that were not included in the original report. After determining the requirements of the schedule from the master mechanic's report, a schedule is made out for each gang of the boiler shop staff by the general boiler foreman and these department schedules are issued to all gang foremen and lead men to serve as a basis for determining their requirements. For example: A Class 2 repair, which requires the work to be carried out in the boiler shop, is handled by the boiler shop firebox department. The schedule from the foremen of this department includes the following information shown in Table 1.

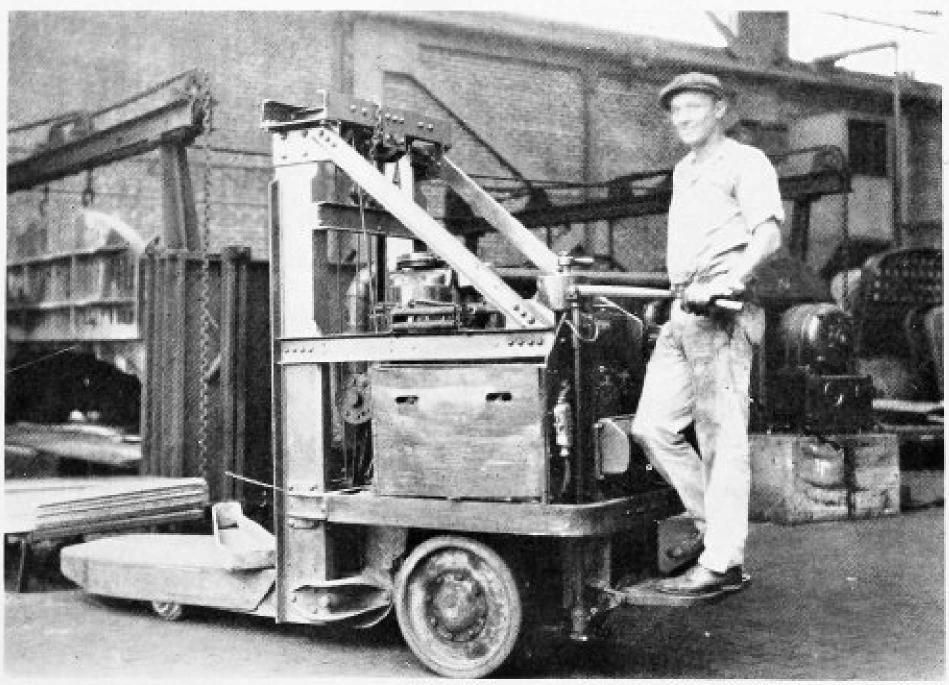
Forms similar in character detail the work of the firebox department, erecting shop, which covers flue work, flue sheets, door sheets, crown sheets, patches, arch tubes, stays, bolts, smokebox repairs, and other items as required by Class 3. As indicated, this work is carried out in the back shop. The foreman of the flue department has itemized in his schedule the small and large flues to be delivered to the department, flues rattled, cut off, ground, welded, swaged, safe ends made and safe ends or new flues delivered to specific engines. A similar form is made out in the tank department detailing the operations to be carried out on each tank brought to the shop.

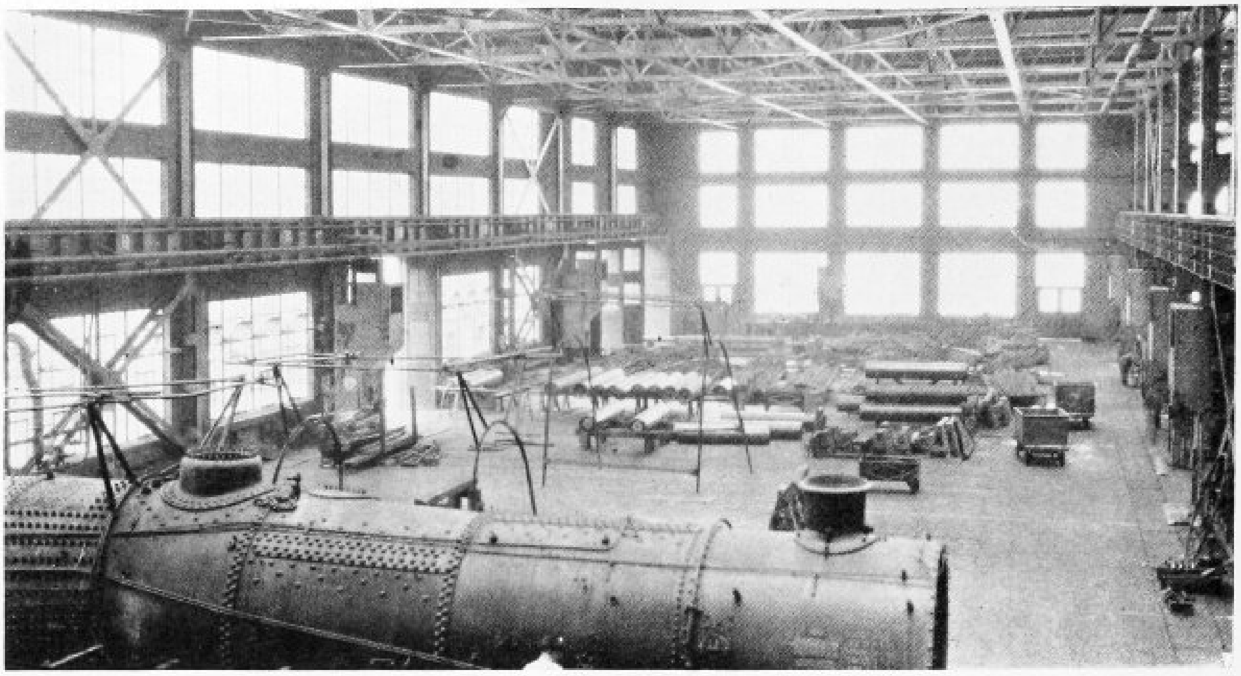
As noted in the previous article, the boiler staff is divided into five departments each having a foreman in charge under the general boiler foreman. In order to maintain a constant check on the progress of work through the boiler shop and the production, the various foremen are required to make out a daily work report on each engine. This report indicates all items repaired and renewed. At the end of each month, these daily work reports are copied on a regular form, which is filed in the shop superintendent's office as a permanent record for him of the production of the shop.

the dates of the previous hydrostatic test, flexible cap inspection, flue inspection, lagging off; which gives a general idea of the history and condition of the locomotive. A typical report issued to the boiler department might include the following items: Examine smokebox; examine throat sheet; examine front head; renew ash pan; repair ash pan rigging; renew firebox; reset small flues; reset superheater flues; repair grates; renew grate rigging; renew stack.

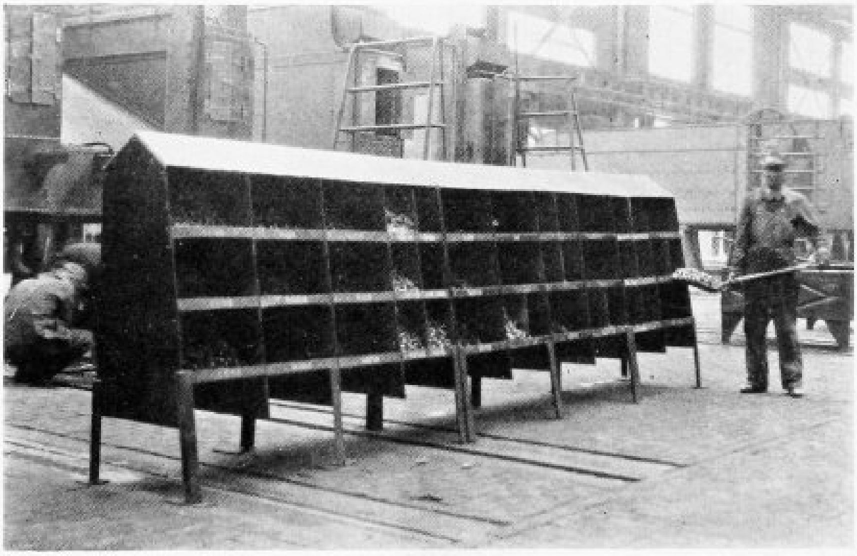
Details of tank work also would be given on this report for a typical case as follows: Examine bottom sheets; renew bad coal pit sheets; renew braces; repair splash plates; renew comb-

(Above) A clean shop is a safe shop. (Right) Lift trucks and skids form an important part of the delivery system





(Above) Special frames are used to mount air tools for ease in drilling, reaming and the like



(Left) Bins for bolts, nuts and small part supplies are placed at convenient locations in each department

In addition to the weekly meeting of the foremen, the master mechanic and staff meet each morning at 8:00 a.m., in the erecting shop, to inspect the work then in progress. The department schedule for each engine is checked for the items completed; the operations that are to be performed during that day, and a notation is made of delayed items, which must be speeded up. This form, which is made out for each engine in the master mechanic's office before that engine is shopped, serves as a running record of the progress of each engine in the various departments. As soon as this tour of inspection is completed, the several department foremen make out reports of the items in which the departments are interested and turn these over to the gang foremen who correct delays and maintain production.

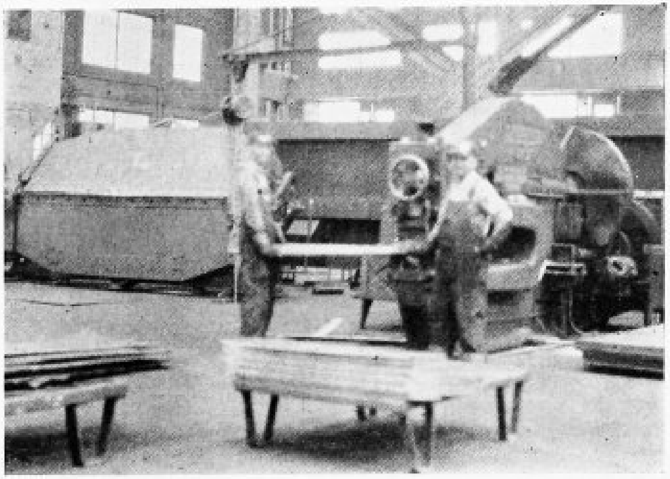
Finally, a meeting is held in the general boiler foreman's office every Monday afternoon, at which all boiler foremen, lead men, and inspectors thoroughly discuss the operations of their various departments and preparations are made for the meeting of the general foreman with the master mechanic which takes place every Tuesday afternoon in the latter's office.

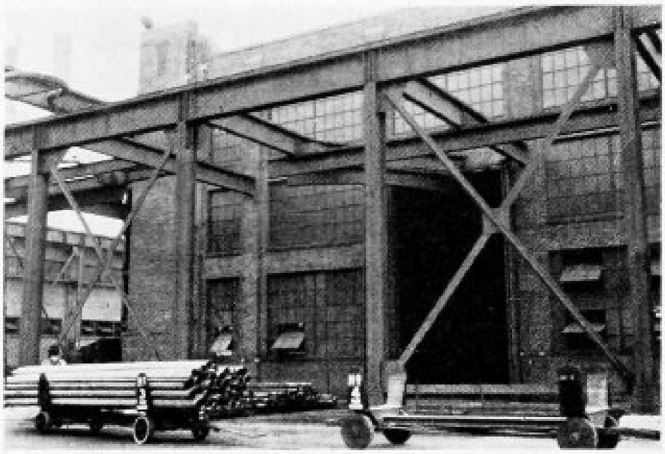
Although the description of the production systems may seem complicated to the average reader, actually the functioning of it is simplicity itself, the details being carried out with a minimum of clerical staff. One clerk only is required in the general boiler foreman's office to handle all reports and records made necessary by the system. Reduced to its simplest details, the schedule is divided into four elements; what may be termed the master schedule, arranged weekly by the master mechanic; the supplementary schedules, issued by department foremen to assistant foremen and gang leaders; the daily work report, checked by the master mechanic and department foremen each morning; and the daily reports of work accomplished by each shop department or gang, which is compiled monthly in the form of a permanent record which is retained in the office of the shop superintendent.

No schedule can be maintained in any shop unless delays are reduced to a minimum. One of the greatest aids for eliminating unnecessary delays is an efficient stores department, and a flexible material-handling system. Just as in the scheduling at Paducah, material-handling methods have been organized so that delays for lack of material practically never occur. The system has been reduced to its simplest form, and the zone men are responsible for the material requirements of their respective departments. At a meeting in the general boiler foreman's office after working hours each afternoon, the gang foremen determine what materials require replenishing and orders are made out and sent to the stores department to be filled. Such orders are filled after 4:00 p.m., the materials being delivered to the proper location in the shop. Stocks of all manner of material and equipment are maintained full at all times.

Throughout the day, any shortage in material that occurs is taken care of on special orders and such orders are delivered from stores to the proper department within an hour's time. If the progress of a job is in any way impaired by delay, a rush order is put through and the materials are delivered within 10 minutes by bicycle messenger, if the parts are light, or by motorcycle and side car or tractors, if heavier.

Tractors, lift trucks, motorcycles, and bicycles are all used in the delivery systems. Tractors are fitted with guards at the front so they may be employed as pushers for shifting flat cars, in addition to hauling trailer trucks. Skid bins, made of corrugated sheets and supported on angle iron legs are located throughout the shop to haul small materials and parts as well





(Top) Shearing plates. (Center) Flues are handled from erecting shop to flue shop in special trailers. (Below) Clear floor space simplifies the fabricating processes

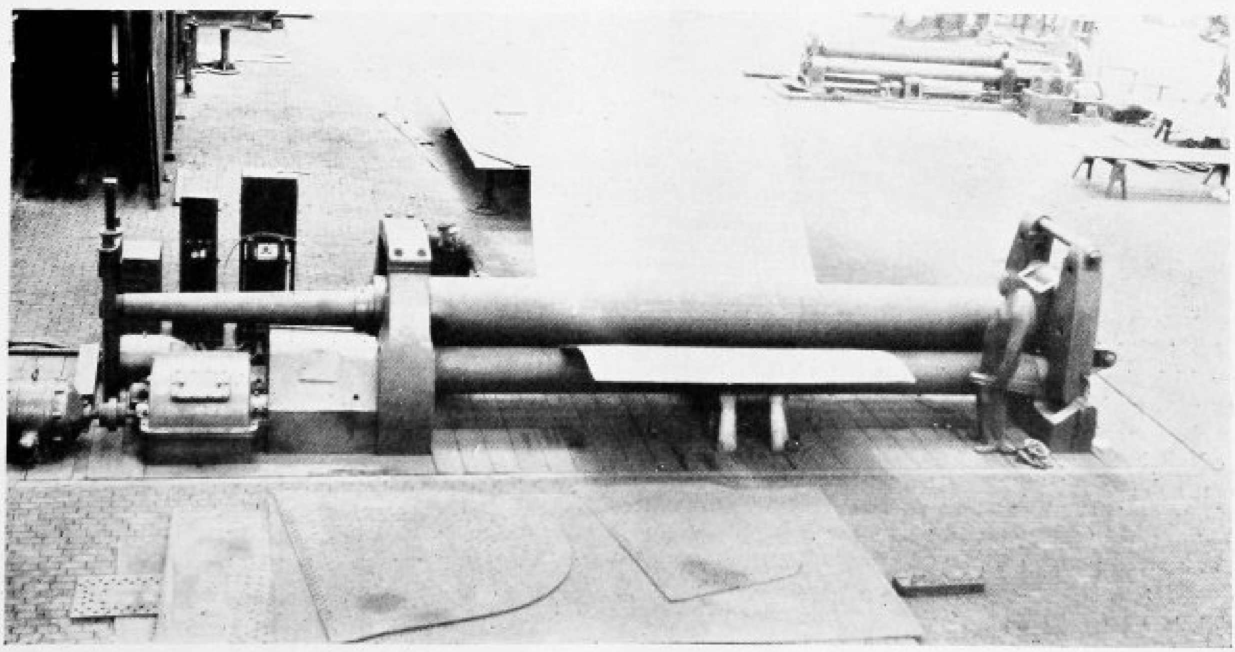


Table I—Schedule Sheet

Boiler Shop Firebox Department

Engine No. ....Pit No..................	Front flue sheet riveted ....
Date in ....Out	Smokebox cut off ....
Boiler delivered	Smokebox made ....
Boiler returned	Smokebox on ....
Hydrostatic test	Smokebox riveted ....
Firebox out	Syphons welded ....
Firebox made	Boiler braces ....
Firebox in	Boiler calked ....
Mudring rivets in	Corner patches ....
Flexible stays in	Flues ....
Flexible caps in	Reinforcing plates ....
Flexible sleeves in	Air drums tested ....
Rigid stays in	Flues out ....
Rigid stays driven	Boiler scaled ....
Front flue sheet in	

New Work

Firebox	Syphons ....
Back end	Flexible sleeves ....
Smokebox	Flexible caps ....
Front flue sheet	

as for serving as scrap bins. Lift trucks shift these skids in the shop and most of the movement of small parts and materials is handled in this way, which relieves the shop cranes from this small service. The bins mentioned also are arranged so that they can be handled by the shop cranes if the materials contained are too heavy for the lift trucks.

One outstanding feature of the shop is its cleanliness and clear aisles and floor spaces. Bins for holding small parts, such as rivets, nuts, bolts, washers, and the like, are located at convenient points in each department so that no time is lost when such items are needed. These bins are maintained with a full supply of all necessary materials at all times. In keeping the shop free of the litter from stripped boilers, ash pans, tanks, and the like, or scrap material, laborers are constantly employed to clean up. Wherever possible, such scrap or stripped materials are salvaged and placed in their proper bin. If they cannot be reclaimed, they are sent to the scrap yard, where they are again inspected carefully for possible use.

The result of this effort is twofold. In the boiler shop alone an average of over $500 worth of usable material is saved every day. An efficiency that hardly can be measured also results from the elimination of congestion in the working spaces of the shops. Aisles are kept clear for the movement of material by the delivery system and for handling boilers and parts between sections of the shop; while the clear floor space for carrying on production makes possible the easier and safer fabrication of boiler work. In the matter of safety alone such care in keeping the shop floor clean pays for itself in the reduction of disagreeable accidents which impair the efficiency and morale of the men as well as in the lessening of loss in man hours.

Complete crane facilities to accommodate the movement of all heavy material in the shop were described in the previous article. Supplementing this important shop feature, individual hand hoists are located at all fabricating machines to eliminate all unnecessary hand labor and to relieve the main shop crane equipment. From the shop cranes to the lift trucks utilized, no material handling element has been overlooked that would serve to improve the efficiency of the production scheme and make the manual labor easier.

Before discussing special equipment and boiler shop methods employed at Paducah, one other important feature of a special character, which requires mention, is the matter of safety. In general, it may be stated that a safe shop is a contented and efficient one and in this respect the Paducah shop is no exception. Here the safety idea is developed to a position of major importance in the minds of the mechanical officials and this feeling has been impressed on every man in the shop. Safety bulletins are posted in prominent places throughout the entire plant and, in each shop, a special safety board is displayed. When an accident occurs, no matter how minor it is in character, the details of it are posted on the safety board as a reminder to the men that carelessness, even for a moment, may cause some one suffering. To make the warning most emphatic, a small figure is displayed on the board to represent a workman. When an accident occurs, this figure is painted in bright colors to indicate which part of his body is injured. The figure remains posted against the department in which the accident took place until the man involved is back on the job.

Immediately after an accident, the foreman of the department fills out an accident report. If it is minor in nature, emergency kits are available to care for the injury. If hospital care is required, the foreman obtains an order to enter the man for treatment and then he remains at the hospital until a full report of the injury is available. Every effort is made by proper care and medical attention to have the injured man fit for work again within three days. After this time has elapsed, if he is not better, the case must be reported to the Bureau of Locomotive Inspection of the Interstate Commerce Commission.

No matter how minor the accident may be, an investigation of the cause is made by a shop committee, composed of three men from different departments, who suggest such changes or precautions to be observed in avoiding future injuries similar in nature.

Another important phase of shop operation is the training of young men for the various trades. In this connection, a move is under way at present to establish a more elaborate apprentice training under the federal vocational system than is at present conducted at the Paducah shop. Shop training for boiler maker apprentices and boiler maker helper apprentices is excellent, but it is felt by the railroad officials at Paducah and especially by E. C. Roddie, shop superintendent, who has fostered the plan, that the additional school training under the Federal vocational system is of great help in developing young men who logically will become the supervisors of the future. It is believed that arrangement with the public schools of Paducah can be made in the near future to provide the necessary instruction to amplify the present apprentice courses given at the shop.

In boiler work, the course for boiler maker apprentices now includes:

- 6 months heating rivets and helping boiler makers
- 6 months tank repair and sheet iron work
- 6 months rolling flues, ash pan work, and front end work
- 6 months staybolt work and setting flues
- 7½ months general boiler work with the firebox gang
- 7½ months general boiler work in the erecting shop
- 3 months fusion welding practice
- 6 months laying out and flanging

The course for boiler maker helper apprentices is similar to the above training, except that the first six months training in heating rivets and helping boiler makers, as given the boiler maker apprentices, is omitted, and 4½ months instead of 7½ months is given to general boiler work with the firebox gang and with the erecting shop boiler crew.

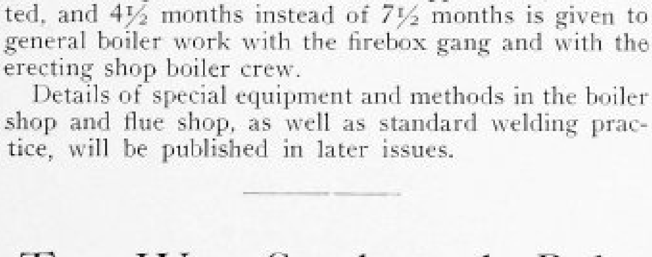
Details of special equipment and methods in the boiler shop and flue shop, as well as standard welding practice, will be published in later issues.

Two-Way Smokestack Rake

By James Wilson

The accompanying elevation shows the bottom course of a donkey boiler smokestack, which had to be offset two ways to clear obstructions. For convenience, let us suppose that the elevation is a pipe 10 inches in diameter, 18 inches high with an overhang of 12 inches one way and 9 inches the other way.

First we are required to get the correct overhang. Proceed this way: Set out a right angled triangle, *B-C-D*, making *B-C* 12 inches long, and *C-D* 9 inches.

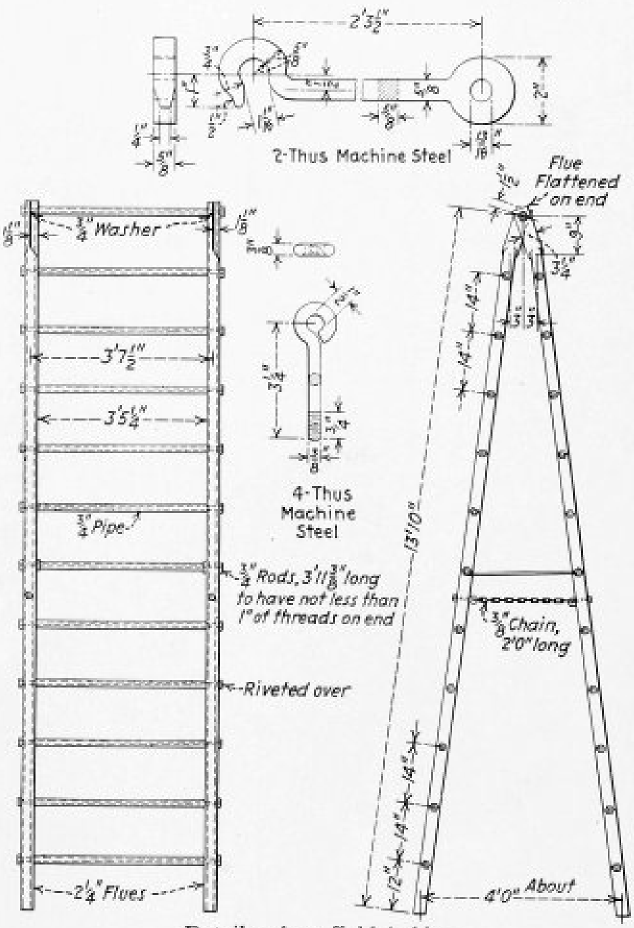


Development of stack with two-way rake

This gives *B-D*, the correct overhang. Make *B-E* equal to *B-D*, as shown, and *A-B* 18 inches long. Describe a circle in the pipe equal to the mean diameter. Now set out a line equal in length to the circumference of the pipe; divide the circle, also the circumference line, into the same number of equal parts; erect perpendiculars at the points found and either project or measure the lines above and below the center line, thereby completing the pattern, by drawing in curved lines through the points found. Any allowance for lap joints is added.

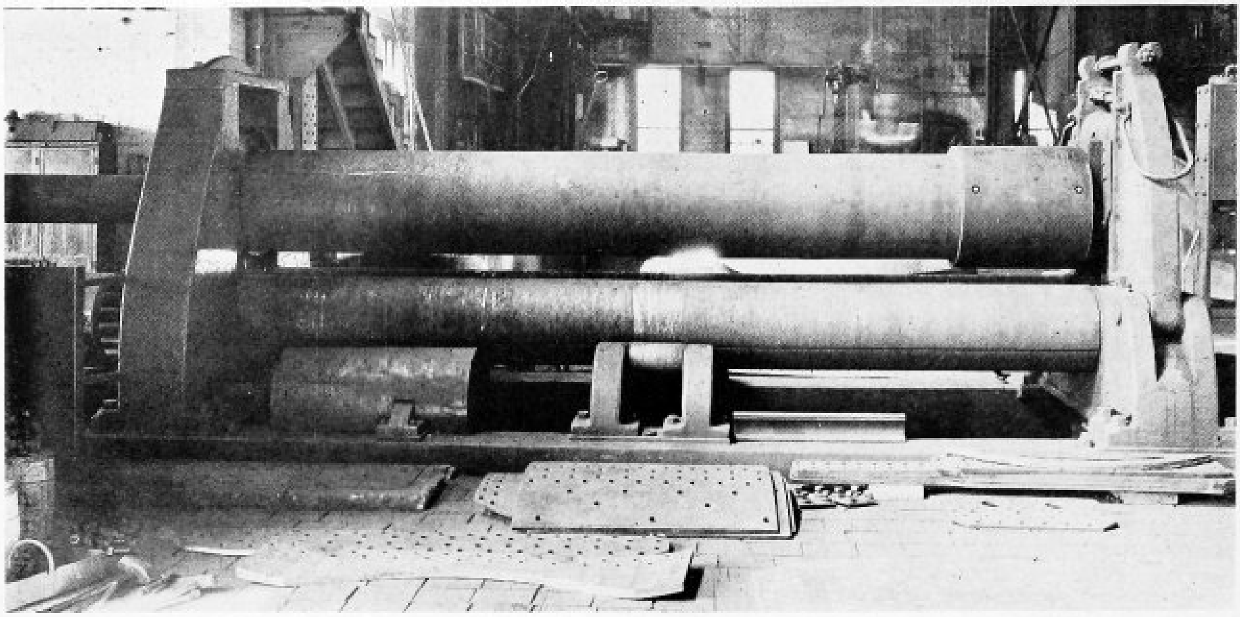
A Scaffold Ladder

An eastern railroad has adopted scaffolding ladders of the design shown in the detailed drawing, as standard equipment and has distributed them for use in tank shops, boiler shops and car shops. The ladder consists of four sections of 2¼-inch flues, flattened and bent at one end in the manner shown and bolted together



Details of scaffold ladder

by means of one of the standard rung bolts. The rungs are made of ¾-inch pipe and are secured between the side rails by long ¾-inch bars of round stock, which pass through the rungs. These bars are threaded at each end, bolted securely in position and riveted at the ends to prevent loosening of the nuts. There are 11 rungs on each section of the ladder, spaced 14 inches apart. The total height of the ladder is 13 feet 10 inches and it has a spread of approximately 4 feet. A ⅜-inch chain, 2 feet long is placed midway up the ladder, to limit the spread of the two sections. A hook latch is bolted to one section and latched to a rung of the other section.

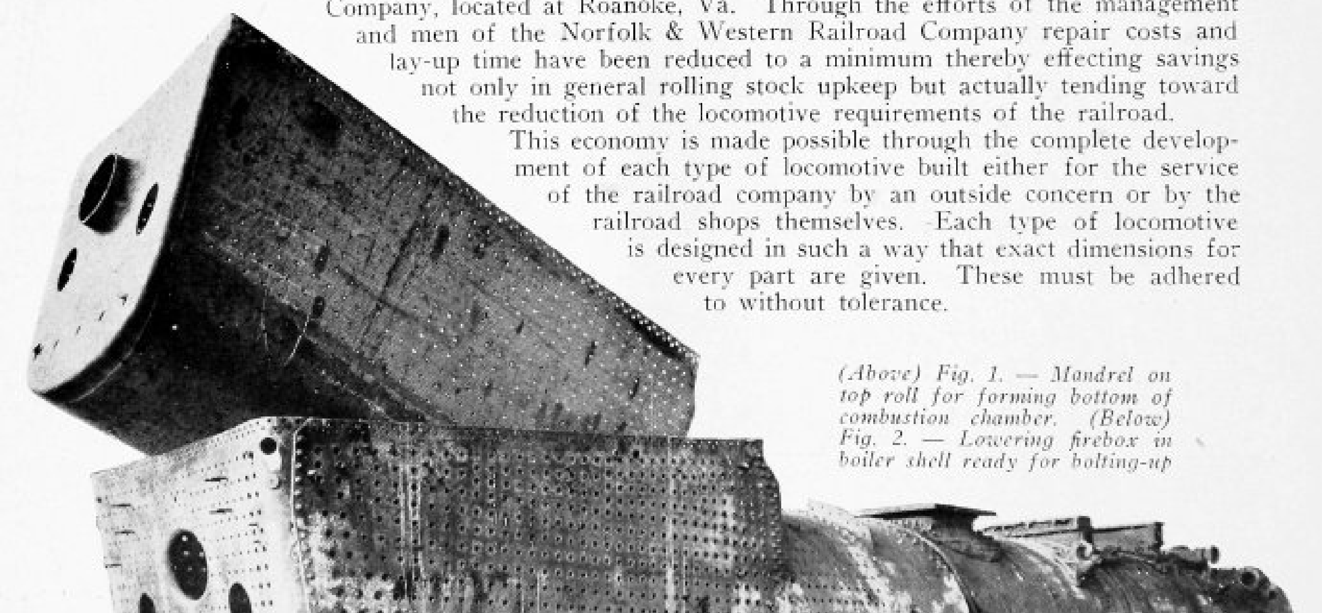


Forming Fireboxes

An interesting example of the economies made possible through the employment of both standardized methods of boiler construction and standardized parts is seen at the Roanoke boiler shop of the Norfolk & Western Railroad Company, located at Roanoke, Va. Through the efforts of the management and men of the Norfolk & Western Railroad Company repair costs and lay-up time have been reduced to a minimum thereby effecting savings not only in general rolling stock upkeep but actually tending toward the reduction of the locomotive requirements of the railroad.

This economy is made possible through the complete development of each type of locomotive built either for the service of the railroad company by an outside concern or by the railroad shops themselves. Each type of locomotive is designed in such a way that exact dimensions for every part are given. These must be adhered to without tolerance.

(Above) Fig. 1. — Mandrel on top roll for forming bottom of combustion chamber. (Below) Fig. 2. — Lowering firebox in boiler shell ready for bolting-up



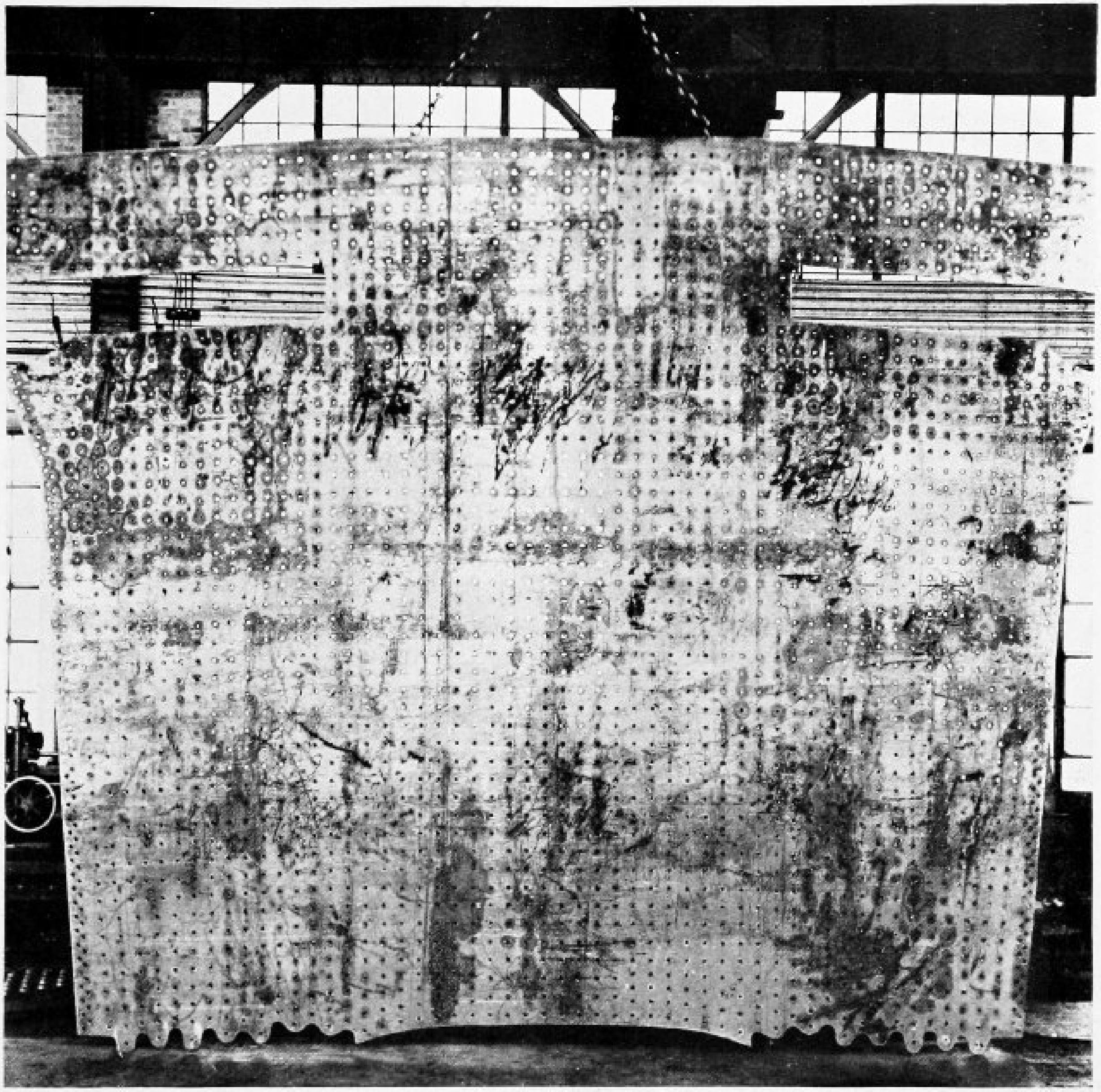


Fig. 3.—Sheet cropped and drilled, ready to roll

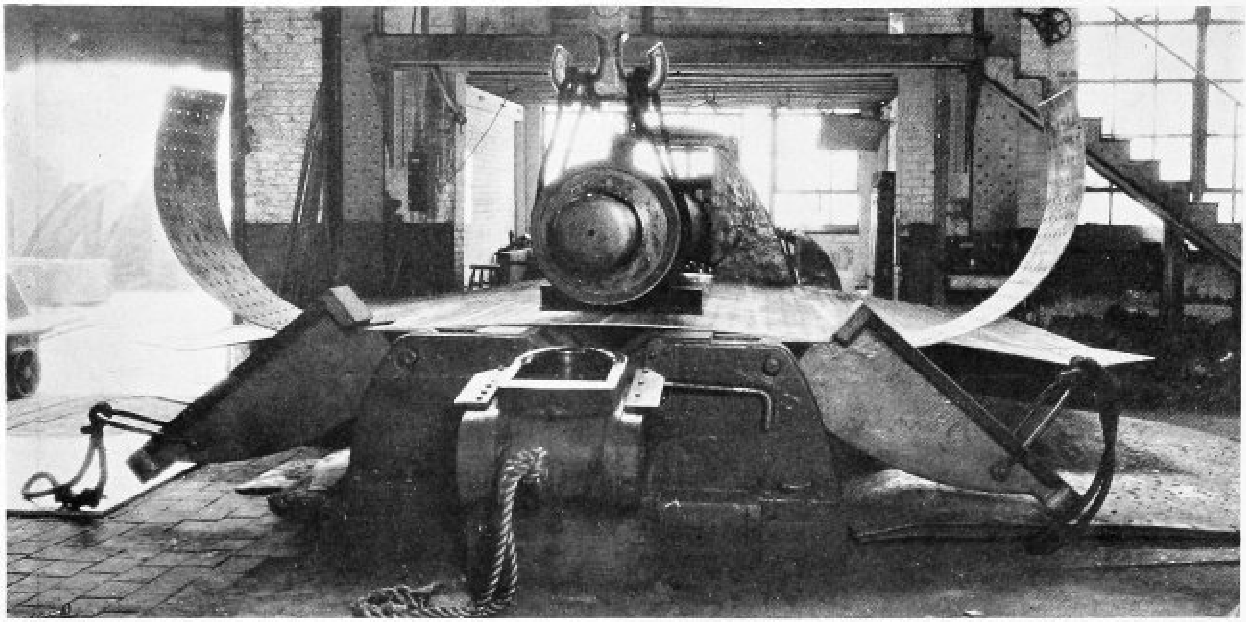
The drawings, prepared by the drafting room, are complete in every detail. The locations of holes are given exact and whether the boiler is manufactured in the shops of the railroad or by an outside locomotive-building company, the same procedure is followed and adherence to all details in layout is required in order to assure the absolute duplication of each part in all of the boilers. It is only through such strict adherence to the development plans as prepared by the drafting room of the Norfolk & Western that full advantage, resulting from complete interchangeability of boiler parts, can be realized.

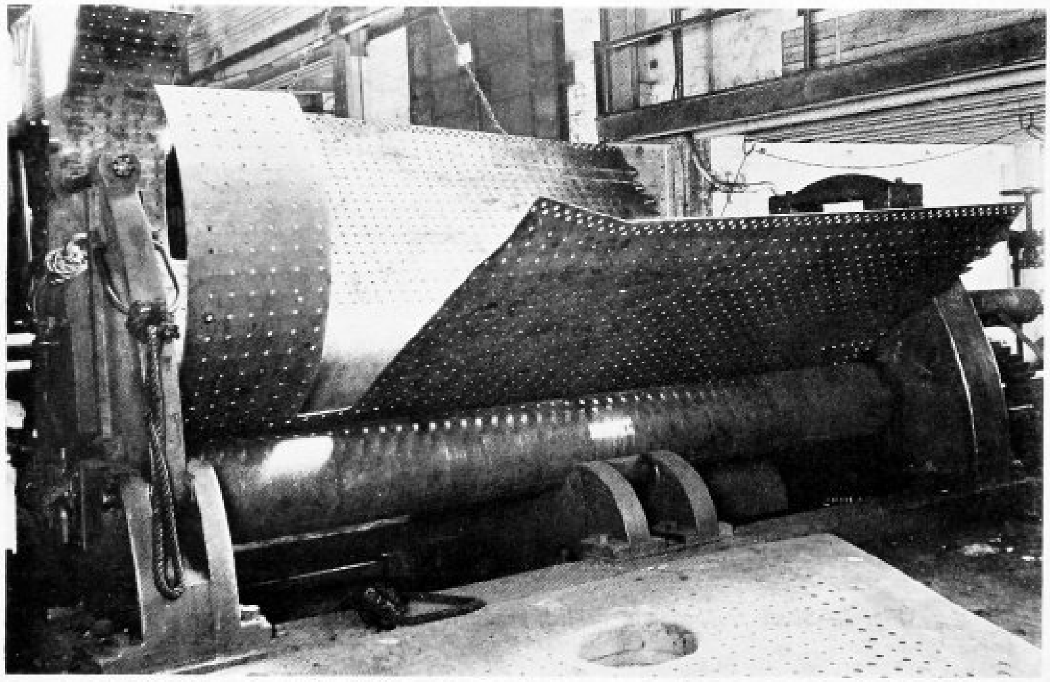
As soon as each drawing is completed the men of the shop lay out one plate for each drawing. This plate becomes a template for the layout of similar plates in other boilers and in the case of a number of locomotives being prepared, this is the last plate of its kind to be used. After the first plate is laid out, it is drilled, cut to size, and completely trimmed. All holes, with the exception of flue holes, are cut under size, the rivet holes being drilled $\frac{1}{16}$ inch smaller in diameter than the required size of holes. Flue holes, however, are drilled full size.

With the first plate completely drilled and trimmed, four sheets, together with the template, are clamped together and placed on the press for drilling. Holes are placed at intervals throughout the plates and into these holes bolts are applied. The clamps are removed and the drilling process is carried to completion.

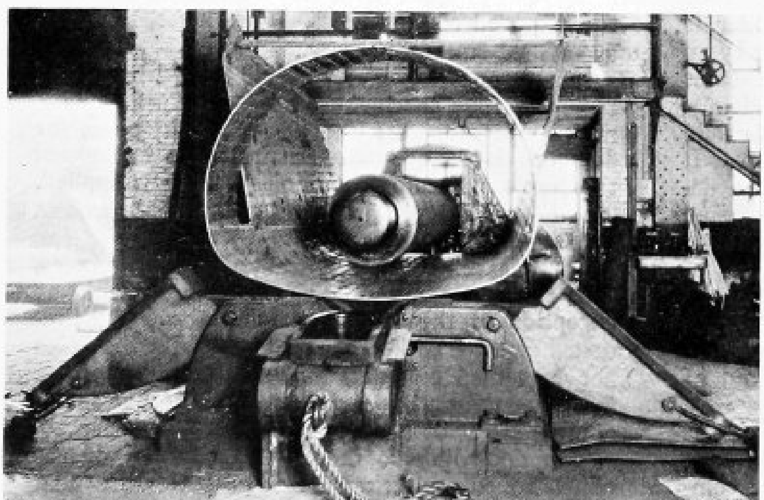
In the case of the back head, all staybolts holes, arch tube holes, and mud ring rivet holes with the exception of the flange rivet holes and the firedoor holes are drilled at this time. With the holes above named cut and the edges of the plate trimmed, the outline is traced on the other sheets and the edges of all back head plates are sheared.

The door hole is then cut, the edges of the plates rolled and trimmed. The plates are next clamped together and drilled, a lead hole only be-





(Above) Fig. 4.—Bottom of combustion chamber formed with housings down to remove mandrel. (Left) Fig. 5.—Forming the crown. (Below) Fig. 6.—Removing fire-box from rolls



ing cut for the arch tube holes. The mud plug hole and arch tube holes are completely drilled after the flanging process has been accomplished.

Large holes in the back head are not drilled to size until the brace casting, which was described in a previous article on the Norfolk & Western locomotives, has been riveted to the back head. At that time all holes are drilled to size.

The inside and outside throat sheets are marked out, cropped, and the flange lines given. No holes, however, are drilled until after the fitting-up process. Hand flanging is employed for shaping the throat sheets, the plates being shaped over a flange former. The flange lines and bend lines, as given on the development drawing, comprise sufficient information for the workmen to completely flange the plates.

Following the flanging operation, the inside sheet is fitted in place, checked in all dimensions, removed, and drilled. The outside sheet is fabricated in a similar manner, all rivet holes being marker punched from the barrel and wrapper sheet. All staybolts holes, arch tube holes, and mud ring holes are laid out and drilled. The steam dome is of the pressed steel type no holes being applied until the time of fitting to the boiler. The holes for riveting are taken by marker punching the location of the rivet line from the boiler course. This procedure is also followed in the case of the layout of the steel auxiliary manhole.

In the case of side sheets, one-half of the sheets, previously laid out and drilled, are beveled with the burr side up. The other half is beveled with the burr side down, in order to provide for the left and right sheets. The back flue sheet is laid out, sheared to proper size without a flange, the edges being chipped to the proper dimension. This type of flue sheet without the use of flange has been adopted by the Norfolk & Western Railroad and is employed in the completely welded firebox. A description of this type of sheet, together with the lugs which have been developed for reinforcing the top of the flue sheet and the crown sheet, was previously described in the article on the 10 Mallet locomotives published in March.

The fourth barrel ring is laid out from the development drawing, together with the weit strips. These are planed on all sides with the exception of the throat sheet opening, which is cut with a torch and chipped, the angle wearing plate, which is hexagonal in shape, is bevel-planed on six sides. The corners, however, are chipped round.

The first, second and third courses are prepared similar to the fourth course with the exception that all four edges of the plates are planed, a bevel, however, being employed in machining the circumferential seams.

This completes the layout of the major plates of the locomotive. The front tube sheet, however, is prepared from the cross section boiler

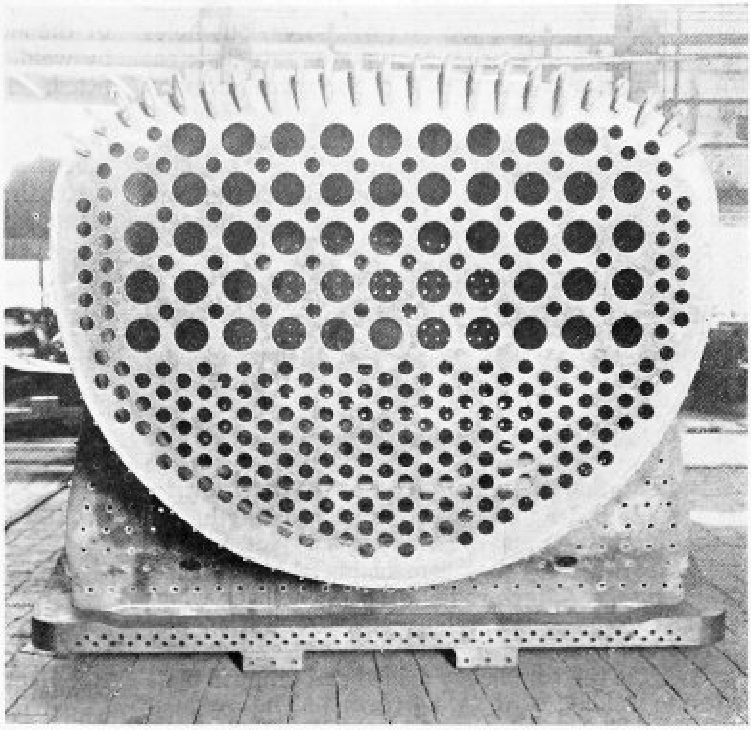
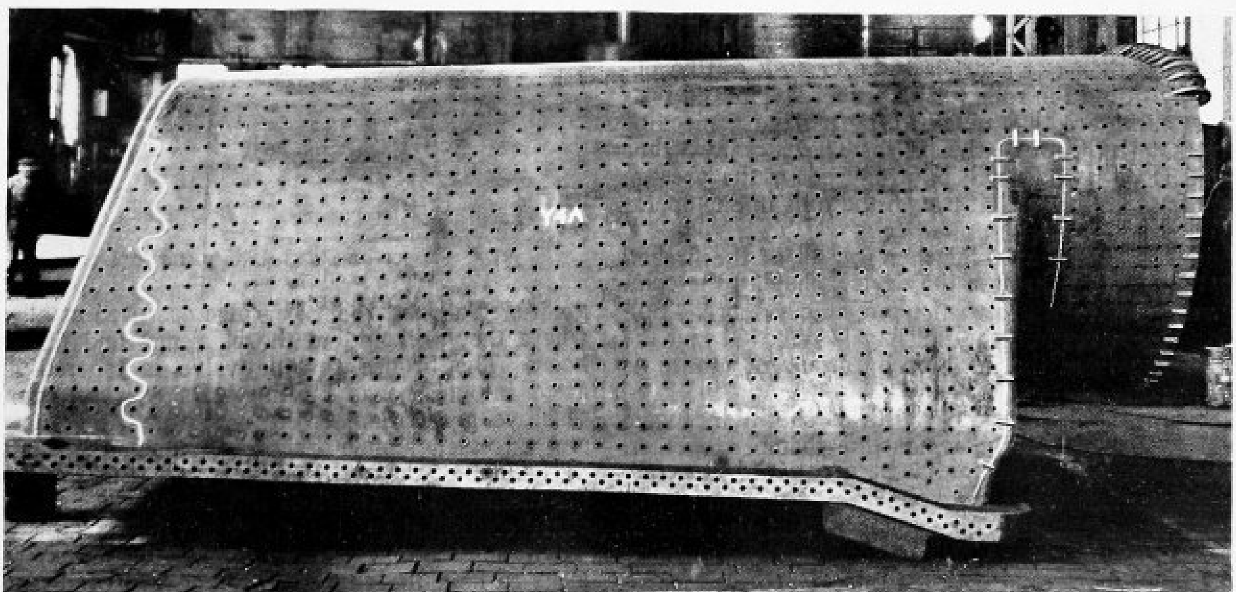


Fig. 7.—Front view showing flue sheet welded in and reinforcing ribs welded on

Fig. 8.—Complete firebox with throat sheet welded in, reinforcing rods welded on at throat sheet and back flue sheet, and extension for back bottom corners welded on



drawings. No development plan is prepared for this particular plate, since the location of the various holes can be taken from the cross section plans with sufficient accuracy to insure proper fitting in the final assembly.

The Norfolk & Western Railroad is noted for the large amount of welding and small amount of flanging used in the fabrication of its new boilers. Welding has been employed with unusual success and the construction of a completely welded firebox is a fine example of the work that is accomplished at these shops. Within the past few years, this company has developed the use of the one-piece crown, sides, and combustion chamber sheet which is considerably larger than the usual type of one-piece sheet. Rather than employing a four-piece sheet with a crown sheet, two side sheets, and the combustion chamber sheet, these pieces being welded together with a longitudinal seam on each side of the firebox, this company orders the largest plate available and welds triangular pieces at the back corners of the sheet in order to obtain the required length.

In the fabrication of the firebox six plates for a one-piece crown, sides and combustion chamber sheet are drilled on the 72-inch radial drills. The back wings of the sheet were cut in a scalloped shape and triangular pieces also cut in this form were prepared and welded.

Fig. 3 shows the completely drilled and cropped plate prior to the welding of the wing corner. The irregular or scallop weld formation, which will be noted at the lower corner of the plate, was used in attaching the wing corners. The wing corners were prepared from the same plate, the material being cut from the scrap which was trimmed from the lower portion of the sides sheet.

Following the drilling of the crown, sides and combustion chamber sheet, the plate is ready for rolling.

In Fig. 1 is shown a plate roll set up ready to form the combustion chamber end of the sheet. It will be noted that a collar, approximately 2 inches larger in radius than the upper plate roll, has been fitted to one end of this roll; the collar is adjusted to the roll and is tightened by means of set screws. The use of this collar permits the rolling of the plate at one end of the machine while preventing the upper roll from coming in contact with the other end of the plate. With this device, the combustion chamber radius may be rolled to curvature without affecting the sides sheet of the firebox.

Prior to the insertion of the firebox sheet, the roll is adjusted to permit the rolling of the plate in one passage. It has been learned that speedy production, when more than one sheet is to be curved, can be obtained by fitting the rolls to the proper height and testing the curvature thus obtained, by passing a piece of scrap material through the rolls. The curvature thus formed is that which will be produced by the passage of the final firebox plate through the rolls in one operation.

With the rolling machine thus set, all of the firebox sheets are passed through the device, shaping the combustion chamber wings to the proper curvature. Following this operation, the housing is removed and the collar taken from the machine by means of cranes as shown in Fig. 4.

The crown sheet is then rolled, as shown in Fig. 5 bringing the wings of the combustion chamber together. When the proper curvature has been obtained, the combustion chamber wings are bolted together with straps, the housing of the machine lowered, and the firebox removed from the rolls. The shape is maintained by fitting pipes as spacers between the sides sheet.

Following the rolling of the firebox sheet, the wings of the sides sheet are welded, the throat sheet inserted by welding, the tube sheet attached, and the door sheet fitted. These plates are completely welded with a V-weld on the fire side of the firebox. The completed firebox, showing the scalloped weld, throat-sheet and tube-sheet reinforcements, are shown in Fig. 8.

Repairs to locomotive boilers are carried out in a manner similar to new construction, the replacement parts being ordered from the storekeeper, who in turn orders the material from the boiler shop. Thus a replacement of any sheet for any type of locomotive built under the Norfolk & Western system of standards may be fitted to the required locomotive perfectly. Time is saved, labor is reduced, and above all, the loss of shopping time suffered for repairs is materially reduced.

Portable Air Hoist

A new-sized Utility portable air hoist of 2000 pounds capacity has been introduced by Ingersoll-Rand Company, 11 Broadway, New York.

This type of hoist employs a radial, four-cylinder, counterbalanced, reciprocating-piston-type air motor, which is reversible. All wearing parts and cylinders are easily renewable, and the cylinders are also interchangeable.

The reduction gears between the motor and drum are spur gears cut from carefully selected materials, and, wherever necessary, they are heat-treated to insure ample strength and wearing qualities. The gears are completely enclosed in a housing which excludes all dust and permits the gears to operate in a bath of semi-fluid

Ingersoll-Rand Utility air hoist

grease. Ball and roller bearings are used at all points where they will add to the efficiency and life of the hoist. The bronze throttle valve is tapered and is fitted into a bronze bushing. Its ease of operation, sensitive graduation, adjustment for taking up wear, and extremely simple design are outstanding features.

A clutch of the positive-jaw type is used to disengage the motor. This clutch is thrown out by an eccentric shaft controlled by the clutch lever which is conveniently located on the top of the hoist and automatically locks to hold the clutch either engaged or disengaged.

What is taking place in

Modern Locomotive Practice*

By W. G. Black†

High boiler pressures and temperatures require rigid maintenance standards to realize operating efficiency

The multitude of details now involved in boiler design and maintenance is such as to require the combined talent of eminent engineers, metallurgists and master boiler makers for their solution, and I use the term master boiler makers with the same degree of importance, for much of the work you are doing, which I may almost define as research in character, aids them in applying their talent to the solution of these most demanding problems.

As you are aware, the great changes in more efficient transportation which have been made in the past few years have not only demanded a higher order of maintenance of existing equipment, but have stimulated a development in mechanical transportation agencies which are unequaled for any similar period in railroad history. While these developments have extended throughout the entire range of modern transportation methods, and some forms of transportation have even been revolutionized, the steam locomotive will be with us for many years to come, as the chief means for the movement of the vast volume of commerce, upon which the welfare and prosperity of the nation depends.

The decreasing cost of general commodity production imposes upon the railroads an obligation to produce their commodity with the maximum economy and efficiency. In other words, the railroads must resort to efficient production in the same manner as other industries, which must be accomplished by close co-operation and by exacting supervision to create a high order of maintenance, all of which tend to reduce the ultimate cost of railroad operation.

I look upon the activities of the Master Boiler Makers' Association in a broad sense not only with respect to boiler maintenance but also in design and construction, and the completeness with which you meet this standard is a measure of the value of your services to yourselves and to your employers, and the better you will be prepared to participate in the advancement of the art which your craft represents.

The increase in production to which reference has been made is being attained largely through an increase in the power developed by locomotives. This has been accomplished through increased steam pressures and substantial increases in firebox volumes. The higher steam pressure and larger firebox have necessitated the use of heavier and higher quality boiler plate; larger staybolts, more closely spaced and the best class of workmanship in construction.

The purposes of these larger boilers, as you are doubtless aware, is to increase the boiler capacity at higher speed, and to provide sufficient steam to meet the heavy demands of all operating conditions. The boiler dimensions are limited by clearance requirements, and those that are now being built probably have reached the maximum diameter consistent with the conventional design of simple locomotives. As compared with past practices, we therefore, have boilers very much larger in diameter, very much heavier, with fireboxes proportionately very much larger, all being forced to capacity by means of mechanical stokers, and all operated at substantially higher speeds than was heretofore possible. This naturally introduces stresses and strains exceeding in magnitude those to which we have been accustomed, and also, without doubt, produces effects unobserved in earlier construction. It is plain that with the increased length of fireboxes and higher steam pressures, not only are the strains due to pressure increased, but the range of temperature to which firebox sheets are subjected is very much greater and these conditions demand efficient workmanship on the part of locomotive boiler makers.

The fact that new conditions have been introduced requires unceasing effort and vigilance on your part, in order that the best results can be obtained and that future construction may be improved as a result of your experience.

The solution of these new problems depends upon the combined experience and judgment of those who are charged with the immediate responsibility of the designs. There should be no hesitancy about consulting with the superintendent of motive power, the mechanical engineer, or the group of inspectors usually assigned to plants where locomotives are under construction. It is now even more important than ever that you should have a thorough knowledge of the specifications and of the railroad's standard engineering and shop practices. These comprise the recorded experience not only of the railroads with which you happen to be connected but of other railroads as well.

In almost every district, the time between locomotive shoppings for general repairs, especially for freight and passenger engines, is controlled to a certain degree by the boiler. Since practically all boiler work requires that the fires be drawn, a very considerable expense results whenever it is necessary to do this. This expense arises not only because of labor and material in the repairs, but because of the value of the modern locomotive as a revenue producer. Do you realize that the items of interest and depreciation on the modern high-power freight locomotives amount to approximately $30 per day, for every day in the year? This fact empha-

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* Address delivered at the twenty-first convention of the Master Boiler Makers Association, held at Pittsburgh, May 20 to 23.

† Mechanical assistant to the president, Chesapeake & Ohio, the Hocking Valley and the Pere Marquette.

sizes the importance of planning work ahead so that when the locomotive is taken out of service for repairs, all preparations have been made and necessary material is on hand so that the repairs can be made in a workmanlike and efficient manner, and the locomotive returned to service with the minimum delay.

Your aim, insofar as boilers are concerned, will be the same as that of your co-worker, the machinist, which is to realize, with a minimum of failures and expense, the maximum term of service for every locomotive which is built or repaired.

One of the present perplexing problems in boiler maintenance is the difficulty which some railroads are having because of cracks which develop in the knuckle of flanged sheets. I venture to suggest two conditions which may contribute to these failures: First, failure properly and thoroughly to anneal the sheets after flanging, and second, the practice of prick punching the sheet, which is sometimes employed to indicate the limits of the radius of the knuckle. It is our opinion that the matter of annealing flanged sheets properly is one of prime importance, and the work should be done only through the application of the most improved metallurgical principles. We believe that the time required to bring the sheet up to the necessary temperature, the time that it is held at this temperature, the degree to which the sheet is heated and the rapidity with which it is cooled, are all vital factors in producing the desired results.

Staybolt trouble is always with us, and this trouble has been magnified because of the increasing boiler pressures, the decreased distance between the staybolts, and the necessarily increased size of the bolts. Part of the staybolt trouble is undoubtedly due to operating the boilers at their maximum capacity. This demands a much higher order of staybolt workmanship. The staybolts must be properly applied in both sheets with sufficient good threads both on the bolts and in the sheets, and in driving the bolts proper care must be used in holding on or in backing them up.

Without doubt, staybolt trouble can be relieved to some extent by giving some attention to water circulation. Some thought is being given to proper water space in waterlegs of these large fireboxes. Some boilers are operating with water space of 5 inches around the firebox while others have 6½ and 7-inch water spaces. This increase is accomplished by increasing the width of the mud ring. With firebox temperatures of approximately 2500 degrees, a liberal water space to increase water circulation should reduce the firebox sheet and staybolt temperatures.

Along with the developments which have occurred in locomotive design, certain appurtenances have come into extended use and they have a decided influence upon maintenance problems. I will mention a few of these:

The thermic syphon has proven a valuable aid to the firebox heating surface in all locomotives originally designed with insufficient boilers. Not the least of the advantages of syphons, however, is in the improved circulation which follows their application and which tends to reduce the side sheet and staybolt trouble.

—cracked flanges
—staybolt trouble
—thermic syphons
—grate openings
—washing boilers
—inspection needs

It has become an established fact that the feed-water heater by introducing water at a high temperature to the boiler will not subject the boiler to sudden temperature changes, which will tend to give better boiler sheet condition.

We are also fortunate, as compared with the past, in being able to protect the flues and side sheets from fluctuation in temperature, due to the admission of large volumes of cold air occasioned by opening the fire door. The automatic stoker has made this opening of the door infrequent, but when it is necessary, the automatic fire door, because of its quick action, has reduced the time of cold air admission.

Considerable development has been made on grates with respect to the air opening through them, and the distribution of air to the fire bed. This problem has a very decided bearing upon the tendency of staybolts to leak, general maintenance of side sheets in the firing zone, and the maintenance of ash pans.

One of the other appurtenances, as to which there is considerable difference of opinion, is the boiler check. This is sometimes located on top of the boiler, but the most universal practice is at the side. It is the opinion of some mechanical men that the top location is preferable because there is less tendency to cool the heated side sheets. If this theory is correct, it would appear that the top location should have a noticeable effect on the life of these sheets. This is a subject well worthy of investigation.

A few words with respect to one of the most troublesome past problems in boiler maintenance may be helpful. You need no advice from me that the quality of the water used for steam purposes is of great importance in boiler operation and maintenance.

The hot-water system of washing out boilers has eliminated considerable trouble from leaky flues, staybolts, crown and side sheets. The use of this system has greatly assisted in decreasing maintenance. It is always the most economical practice to remove as much as possible of the scaling matter, as well as other injurious substances, before the water is delivered to the locomotives. Where conditions are very bad, this practice will pay a substantial return upon the investment. Where it is not practical to treat the water before it is delivered to the boiler, temporary treatment can be applied either at the roadside tank or direct in the boiler or tender tank at the terminal. This will materially relieve scaling and leaking conditions at an expense far less than would be occasioned if the insulating coating produced by scaling were permitted to accumulate on the tubes and sheets. In the light of our present knowledge it might be said that the accumulation of heavy or hard scale in the boilers, with attendant leaking conditions, is entirely unnecessary as the situation can be corrected by proper treatment of the water. A substantial improvement has also been made in the reduction of pitting and corrosion, and it is expected that further economies will result when full advantage is taken of the information and developments already available.

One of the complaints against any form of water conditioning has been the tendency to increase foaming. However, it has been conclusively demonstrated that this can be held under satisfactory control by following a carefully planned blow-off schedule, which is not only a great benefit in reducing the foaming complaints, but also assists in keeping the boilers clean and in good condition. There are several improved types of blow-off cocks and blow-off mufflers that are very beneficial and simplify the blowing off of boilers both on the road and at terminals.

In conclusion, I would like to add a word regarding the inspection of existing boilers and the qualifications of inspectors who make the inspection. The boiler inspector should, of course, be a first-class journeyman, with experience in the business and a first-class knowledge of the standard boiler practices of his own road, and a general knowledge of the prevailing practices of other roads, so that he may always bring to his task the most advanced experience. Armed with these qualifications, the inspector should proceed to a discharge of his duties with the same purpose as he would expect to attain if the work were done by an outside company. In other words, his judgment should be unbiased, and his insistence upon a high grade of workmanship should be unyielding.

Obviously, every inspector should have a thorough and complete knowledge of all boilers under his jurisdiction, and this should be in record form in order that it may be consulted by all who are interested in locomotive efficiency. Such a record, if properly maintained, will also prove an invaluable aid in new design and construction.

I should like to add a few final words in respect of an agency concerned in the maintenance of boilers, which I have no doubt, is often placed in the troublesome class. It not infrequently happens that in requiring a high standard of maintenance the Bureau of Locomotive Inspection under the direction of Mr. Pack, is not only raising the efficiency of locomotive operation as a whole, but by insistence upon timely repairs is aiding in safety first and in reducing the maintenance of equipment expense. The federal boiler inspectors are high-grade experienced mechanics, and their requirements may well be taken as a standard by which to measure the degree of your own efficiency. There is a natural and very human tendency for us to excuse ourselves for deficiencies. This does not raise our civic, moral or craftsmanship standards. Therefore, I would suggest, in the interests of the great numbers of skilled mechanics whom you represent, that you continue to set for yourselves the highest workmanship and standards.

Conference of Canadian Provincial Boiler Inspectors

The triennial Conference of Provincial Boiler Inspectors of Canada was held in Calgary, Alberta, on May 5 to 12, for the purpose of considering revisions, additions and changes to the Canadian Interprovincial Boiler Regulations. The Province of Alberta served as host to the Conference for this meeting, Walter Smitten, Commissioner of Labor of the Province, and F. W. Hobson, Chief Boiler Inspector, officiating. The meetings of the Conference were held in the old provincial court house, now the Land Title office, which was the first masonry structure in Alberta.

Those in attendance at the Conference were as follows:

D. M. Medcalf, chairman, representing Ontario; T. Inglis, secretary, representing Saskatchewan; A. S. Bennett, representing British Columbia; F. W. Hobson, representing Alberta; R. A. Stewart, representing Manitoba; N. S. Walsh, representing Quebec; C. W. Obert, representing A.S.M.E. Boiler Code Committee.

The power boiler, heating boiler and unfired pressure vessel sections of the Canadian Interprovincial Boiler Regulations were reviewed paragraph by paragraph, with a view to correcting and bringing up to date whatever features past experience had shown needed revision. Among the subjects discussed were such items as bracing and staying of flat surfaces, dished head construction, furnace construction, factors of safety, fittings and attachments, including safety valve requirements. One of the most important features of the Conference was the discussion on fittings and attachments in which there had been a lack of uniformity of practice. As a result, many of the features of the rules in which the different Provinces were at variance, were satisfactorily adjusted.

Due consideration was paid to low pressure heating boilers and to unfired pressure vessels, and here also efforts were made to place the rules on a basis where the various Provincial inspectors could agree on uniformity of enforcement. Particularly in connection with applications of welding were such studies of importance and value, in view of the greatly increased use of welded construction. The members of the Conference agreed that the use of welded construction is advancing at a rate that commands their serious attention and thought. For this reason, the developments in both Europe and the United States were carefully studied. The recent revisions in the A.S.M.E. Unfired Pressure Vessel Code and also the proposed A.S.M.E. specifications for welded boiler drums were seriously considered. As a result, a number of important modifications of these two sections of the Interprovincial Boiler Regulations were agreed upon.

It was the consensus of opinion of those present, that the meeting had been highly beneficial in eliminating differences of opinion and establishing uniformity of viewpoint among the various Provinces, upon all matters in which they are mutually interested. It was also a matter of satisfaction to the members of the Conference to know that revisions have been authorized in the Interprovincial Regulations, which will bring their rules up to date and co-ordinate their practice with the best that is known in both Europe and the United States.

At the close of the Conference, adjournment was taken for a period of two years, the next meeting being scheduled to be held at Montreal in the Spring of 1932. D. M. Medcalf was reelected chairman of the Conference, and T. Inglis, secretary.

NEW ELECTRODE.—The Lincoln Electric Company, Cleveland, O., announces a new welding electrode for use on light gage material which will be known as "Lightweld." It can be used on 16, 18, 20 or 22 gage material in making a lap, butt or corner weld. It gives a dense weld free from pin holes. This electrode was designed to be used with a manual carbon arc and with from 30 to 60 amperes direct current and for horizontal, vertical or overhead work.

Applying Locomotive Fireboxes*

Master Boiler Makers discuss how work is done either on or off the frames

Your committee finds the above question on applying fireboxes a difficult but interesting one to discuss, as the conditions, under which some shops labor, are not conducive to best and most economical production results.

In all cases where the shop is equipped with overhead traveling cranes, the general opinion prevails that the cutting out and applying of fireboxes can be done much more economically when boilers are taken off of the frames and sent to the boiler shop. It is generally admitted that for a superior quality of workmanship, it can only be accomplished by giving the men ample room and placing the boiler in a position where men can give and do a first-class exhibition of workmanship. This can only be truly accomplished by taking the boilers off the frames.

It is further admitted, in a great many cases, that it is impossible to remove the boilers because the shop is not equipped with the machinery necessary. As a matter of preference, the boilers should be removed from the frames.

Your committee further finds, in all cases where boilers are removed from the frames and sent to the boiler shop, that there are a great many which show repairs to be necessary on parts other than firebox sections. The work most certainly can be performed in a far more economical and efficient manner with boilers in position where men can do a first-class workmanlike job.

The following are the reports of work as performed by different railroads:

One of our railroads believes it more economical to remove the boiler from the cylinders and frame and to apply the firebox in the boiler shop. Boiler shop costs will average \$70 to \$150 higher where the firebox is applied in the erecting shop, and the boiler is not cut loose from the cylinders or removed from the frames.

A check of seven engines, which had new fireboxes applied on one of the divisions, six of which were applied in the erecting shop without removing the boilers from the frames or cylinders, and one on which the boiler was removed from frames and cylinders, and the firebox applied in the boiler shop, showed that the labor costs in the boiler department averaged \$167.69 more on each of the six fireboxes applied in the erecting shop. In this instance, the increased costs varied from \$63.25 to \$310.94. These costs are governed by work that may have been in addition to the firebox proper; waist sheets, front flue sheets, patches, new application of flexibles, etc., all of which bear their share of the increase.

In the shops of another railroad, work was performed as follows:

At the main shops, where the boiler shop is equipped with crane service, on all locomotives receiving new fireboxes, the boilers are taken off the locomotive frames and sent to the boiler shop for firebox application. The belief on this road is that, in shops equipped with crane service, it is the most economical and certainly the safest way to apply fireboxes.

One of the benefits derived from sending the boiler to the boiler shop is that the mud ring can be removed and necessary repairs made to the frames. Other machinery parts are left in the erecting shop, where they can be worked on without the necessity of sending machinists and other mechanics to the boiler shop.

With the use of cranes, it is found that the boiler can be easily handled, turned, and the application of the firebox can be made more economically and quickly. Further, where firebox applications are made with boilers left on the frames at the erecting shop, this system makes for more or less confusion by tying up crane service in the erecting shop, causing considerable waiting of mechanics of both crafts to use the crane at the same time.

At small shops, where efficient crane service is not available, fireboxes are applied in most cases with the locomotive boiler left on the frames. It is usually due to necessity and not from choice.

There is another feature to applying fireboxes to locomotive boilers when the boilers are left on the frames that should be considered, and that is the question of safety. The belief is common that it is much safer to apply fireboxes when the boilers are taken from the frames. When boilers are left on the frames, it is, of course, necessary to scaffold much higher, and in the application of radial stays, men are at a considerable distance from the ground, and certainly working at a disadvantage. They also unquestionably stop working for a brief time when the crane is passing overhead.

It is general opinion, that the most economical and certainly the safest way is to remove the boiler from the frame to apply fireboxes, where crane service is provided for the purpose.

The following is an approximate man hour performance of fireboxes passing through one of their largest shops:

1. Flues are removed .... 32 man hours
2. Mud ring is cut out. The rivets are cut with a rivet buster and the corner plugs are burned out with an acetylene torch. The inside corners of the firebox are cut out and a special wedge is driven between door sheet and mud ring, or flue sheet and mud ring with a rivet buster, and as the wedge is driven in, the mud ring moves down and is removed .... $33\frac{1}{2}$ man hours
3. Firebox is cut out on the inside in about 18-inch squares. By doing this the firebox is later driven out in pieces, by inserting a backing-out punch into various staybolt holes and knocking out these pieces with a rivet buster .... 3 man hours
4. Drill out staybolts and take out firebox .... 63 man hours
5. Radial stays are burned out from the outside. The crown sheet is removed in one piece 23 man hours

* Committee report presented at the twenty-first convention of the Master Boiler Makers' Association, held at Pittsburgh, May 20 to 23.

6. All burrs are chipped ....15½ man hours
7. Firebox is laid out in what is known as a one-piece firebox wrapper sheet ....24 man hours
8. All holes are then drilled in the firebox sheet with the exception of mud-ring holes, which are punched in ....15 man hours
9. Wrapper sheet is rolled into shape and the door and back flue sheets are applied, which are later buli riveted onto the wrapper sheet. All door and flue sheets are flanged in a McCabe flanger and later annealed ....75½ man hours
10. Firebox is set on 4-inch by 6-inch wood blocks, which are on the floor. The crane is then hooked to the boiler and the boiler is lifted and set over the firebox ....1¼ man hours
11. Mud ring is applied with screw jacks and air rammer ....6 man hours
12. Sheets are riveted to the mud ring from the outside with a cone-headed die, and rivets are held on with a double-action hammer on the inside. 41 man hours
13. Staybolt holes are tapped and staybolts are applied and cut off with an acetylene torch to their proper lengths ....147 man hours
14. Boiler is turned on its side and staybolts are driven with a double-action hammer. While the boiler is on its side, the radial holes are tapped and radial stays are applied. The boiler is then turned on its back for driving of radial stays, which are driven on the inside of the firebox. The boiler is then turned to its proper position and radials are driven from the outside and at the same time the staybolts on the back head and throat sheet are being driven ....274 man hours
15. Telltale holes in staybolts are drilled ..16 man hours
16. Door hole is acetylene welded to the back head .. ..3 man hours
17. Boiler is now set on its frame and sent to the erecting shop for finishing ....2½ man hours
18. Flues are applied and machinists apply studs and get boiler ready for test ....72 man hours
19. Boiler is tested and is now ready for service ....13 man hours

Total ....860¼ man hours

On another railroad repairs are performed as follows:

The standard practice is to remove the boiler from the frame and send it to the boiler shop; however, a few boxes have recently been applied with the boilers on the frames.

For a railroad as large as this one, which requires the renewal of 600 fireboxes per year, it has been found more economical to remove the boilers from the frames and at the same time get a better job of workmanship on account of being able to use the hydraulic riveters to drive up the rivets. It also enables them to turn the boilers on rollers in a position that permits a better job of crown bolts and at the same time permits of driving all side bolts down handed.

Templates have been provided for all modern wide fireboxes, and the fireboxes are assembled and riveted up ready to place in the shell, as soon as the old box is removed. This enables the staff to return the boiler to the erecting shop in eight days.

All of the old fireboxes are removed with the acetylene torch.

It requires approximately 1200 man hours to renew a firebox in one of the modern locomotives on this road.

Still another railroad reports as follows:

Fireboxes are applied with the boiler removed from the frame. This may be handled in two ways:

1. Boiler removed and sent to boiler shop, the frame being stored outside until the boiler work is done.
2. Boiler removed and sent to boiler shop, the frame being left on the pit, and as much of the frame repairs completed as possible, while firebox is being applied.

This whole question is decided by the equipment and facilities that boiler shops have for making a quick return of the boiler. Where shops have an up-to-date boiler shop, the frames remain on the pit. On this railroad, boilers are returned to the erecting shop from the boiler shop in 5 to 10 working days.

When the firebox is applied with the boiler on the frame, it takes about 25 percent longer to do the boiler work, and very little or no work can be done by the machinist as the boiler makers are in their way.

The man hours are practically 25 percent less with the boiler removed from the frame, taking into account the cost of cutting off and applying the boiler to frame cylinders.

It is the experience of this railroad that better workmanship is assured with the boiler off the frame. The firebox can be assembled, the sheets laid up and fitted in better when done on the floor. If riveted together, seams can be calked on the water side.

If welded, the seams can be properly reinforced on the water side.

Assuredly, safety of workmen should be considered. With boiler on the floor, the boiler can be turned to any position most convenient for the workmen; thus eliminating all overhead reaming, tapping and driving of bolts or rivets. This not only assures that work can be done in the most comfortable and convenient position, but also eliminates the danger of tools or material being dropped on fellow workmen. Another angle to be considered is, with the boiler removed from the frame, a proper inspection can be made of the bottom of the smokebox, and new sheets applied when necessary.

Still another railroad reports as follows:

First method.—When the boiler requires a firebox only, the boiler is left on the frame. The old firebox is removed on the stripping track, the engine taken to the sand-blast track, and the boiler sand blasted. While this is being done, a new firebox is gotten out with wrapper sheet in one piece.

Edges of wrapper, flue and door sheets, are beveled on the floor for welding and calking. The engine is shopped at night and the next morning at 7 A. M. the application of the firebox begins.

The flue sheet is applied first, then the engine is raised up by two cranes, while the wrapper sheet is placed in position over the frames. Next the engine is set down in place, and the wrapper sheet is pulled up in position by means of a cable through the roof sheet.

The door sheet is then applied. The firebox is clamped in shape and tack welded about every 12 inches. The firebox is set in proper position by dividing the water space and lining up the stay and crown bolt holes.

The mud-ring holes are reamed and rivets driven. The firebox is now ready for welding and staybolt tapping. This method allows the reinforcing of the weld within approximately 24 inches at the flue sheet, and 40 inches at the door sheet, from the mud ring.

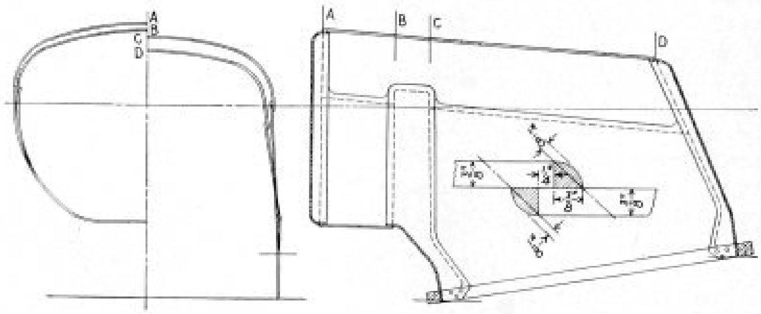
By this method, the boiler can be completed and tested in four working days. During this time the necessary repairs have been made to the cylinders, frames, frame braces, etc. An actual time study of this firebox taken on a Mikado-type boiler having a complete installation of flexible staybolts is as follows: 312 expansion radials; 158 straight radials; 1308 staybolts; 1778 flexible caps; 200 2¼-inch flues; 40 5½-inch flues.

The above totals 770 man hours, and the labor cost, $562.70.

Second method.—The same type boiler was studied as in the first method.

When the boiler requires additional repairs, such as bottom or whole shell course, back head, throat sheet, outside wrapper sheet, or cylinders renewed, the boiler is removed from the frame.

The frames remain in the shop and are inspected for defects, and repairs or renewals made to the frames, frame braces, cylinders and bushings, waist sheet, deck castings, tail braces, driver brake fulcrums, motion work, shoes and wedges laid off, etc.



Electrically welded lap seams at locations indicated

The operations are as follows:

The old firebox is removed as in the first method, the waist sheets and cylinder bolts, steam pipes and liners, bumper braces, and the smokestack are removed, and the boiler is sand blasted.

While this is being done, the new fire firebox is gotten out, all welding and calking edges are beveled, the firebox is fitted up, welded and reinforced on the floor ready for application. When the boiler is shopped, it is turned up on its back and the firebox is applied, lined up, and made ready for staybolts and rivets.

An actual time study of this firebox complete, along with the cost of removing and applying the boiler on the frame is as follows:

Labor cost of the firebox	$499.96	682 man hours
Labor and material cost of removing and applying boiler on frame	58.13	53½ man hours
Total	$558.09	735½ man hours

Taking the boiler off the frame is the best and most economical method, as the best workmanship is performed and assures more safety to workmen by eliminating overhead work.

These figures show a difference of 88 man hours, less than the application of the firebox with the boiler on the frames, which covers over and above, man hours of removing and applying the boiler on the frames.

Still another railroad reports as follows:

Fireboxes are applied to boilers off the frames. The fireboxes are of the combustion chamber type and are for heavy power. The boxes are made in four pieces, consisting of wrapper sheet, door sheet, flue sheet and throat sheet. All seams are lapped and electrically welded on both sides, as shown in the illustration.

Item	Labor	Cost
Cost of removing boiler from frames	16 man hours	$ 10.88
Cost of applying boiler to frames	72 man hours	50.08
Manufacturing firebox (Welding and fitting-up)	146 man hours	118.78
Application of firebox to boiler	732 man hours	469.49
Total	966 man hours	$649.23

Your committee feels that this topic should be of very keen interest to members of this association and therefore has gone to considerable trouble to secure information from railroad shops in different sections of the United States, in order to show a fair comparison in cost with work done under various conditions, where equipment and means for doing the work is not in all cases the same. The committee feels that in both methods there are many factors which would contribute to economy in production cost, other than those which were brought out in this report. Such points have been left for discussion by members at this convention. No doubt, many of the members will be able to profit by the practical information that will be brought forth by discussion of the facts as set forth by this report.

The committee takes this opportunity of thanking the different members of this association who contributed largely to the success of this report by supplying valuable data on the methods used on their roads. We trust that the suggestions made as to the best practice in applying fireboxes as well as the discussion will prove of value to them and to the companies they represent.

The report was prepared by a committee composed of Leonard C. Ruber, chairman, Albert F. Stiglmeier, and John P. McGowen.

Discussion

John Harthill (New York Central): I think we will eliminate many questions and get more out of this subject if, when we get up to discuss this subject, we will mention what kind of a shop we have, whether it is modern and up-to-date, or partly modern; and also give a short description, which can be done in a few words, of the size of the boiler, the number of radial bolts and staybolts and so on. If one man says he installs a firebox in 500 man-hours, and another tells that he puts it in in 900, there is some reason for that difference in man hours. We have fireboxes with 100 bolts, and some as high as 2600. We cannot put in one firebox in the same time as the other.

We apply most all of our fireboxes on the erecting floor on account of floor-space conditions. We have a shop that is only partly modern; about twenty-three or twenty-four years old. Our floor space is such that we cannot take our boilers off the frames and bring them to the boiler shop. Therefore, we apply our boilers on the frame. I maintain, and I think many members will bear me out in this, that if your supervisors are on their toes you can do just as good a class of work on the frames as you can on the floor.

A. F. Stiglmeier (New York Central): As a member of this committee, I would like to speak on this subject. I have applied many fireboxes, both on the road that I am now with and on the road I was previously connected with. I have applied them in both ways, and I believe I am in a position to tell you something about applying fireboxes both ways. Mr. Harthill states that if the supervision is on its toes you can not have anything put over on you. Perhaps if you held the motor yourself you wouldn't get anything put over on you, but do not let anybody tell you that a man, in putting fireboxes in on the frame, can not put anything over on you. Take for instance a motor running over 300 revolutions for tapping out. You can get a variation of 0.008 inch over the staybolt sizes. A motor running at 300 revolutions will give about 0.0065 oversize. A motor running 260 revolutions for cutting holes for staybolts will give 0.005 inch oversize holes. If the man holding the motor does not take his weight off it, you will get a variation of staybolt holes and will have to cut your bolt to fit every hole.

When I was with the Baltimore & Ohio, we put in an average of 35 fireboxes a month. We put them in both ways and I am going to tell you that I am in favor of putting in fireboxes off the frame. When you are working on a cylinder, how are you going to inspect between the cylinder and the smokebox?

On the road I am now with, we are taking all boilers off the frame at the present time. We are removing half or full smokeboxes on over 90 percent of the engines getting fireboxes. Suppose we put a firebox in on the frame and find the backhead cracked. You all know what it is to put in a backhead on the frame, and you know how hard it is to put in gusset stays.

We have taken data on three different classes of power; not only the boiler with 2600 staybolts but one with the 1600 and one with 1800. Our shop operates on piece work and there is nothing lax on the part of the men. The larger box with the engine on the frame took thirty-seven calendar days in the shop to install. The one we took off the frame we ran out in twenty-two calendar days.

Now what is the result? I am giving you facts of a piece-working shop, where there is no possible chance of the men lying down on the foreman. We can put in a firebox in the boiler shop and a mechanic will average \$1 to \$1.25 per hour. We can put that boiler in on the frame and he will make from 85 cents to 95 cents per hour. Now these are the facts, and if there is that much difference in cost there must be a difference of about 25 percent in time.

In putting in a firebox with a combustion chamber, you cannot get in between the shell and the combustion chamber bottom to lay up the throat sheet. You have to draw it up. The same way with flue sheets. You cannot lay them up; you might wedge them but this takes time. In putting in fireboxes, due to certain conditions, we use half side sheets. They may not be exactly half side sheets, but we make the crown sheet and part way down the side. If we put that side sheet in on the frame, we cannot get into the water space to reinforce it. You can weld on one side, whereas if you put your firebox in on the floor you can weld on the fire side too. You can take off the old metal on the outside and reinforce it and you will have a very good job, a better job than welding on one side.

You have heard men recommend that we weld on both sides with reinforcement, so surely putting in a firebox with the boiler off the frame is far superor to putting it in on the frame, from the standpoint of man hours, workmanship, and cost.

A. E. BROWN (Louisville & Nashville): The L. & N. railroad has a modern shop where I am located at South Louisville. We have hydraulic flanging machines, crane power, and all the necessary facilities. I cannot see where there should be any comparison or consideration between the application of a firebox on the frame versus the application of a firebox in the boiler department, where you can handle the boiler. There are many disadvantages to applying a firebox on the frame. We all know that boiler makers cannot work to advantage on a large firebox renewal job under these conditions.

When an engine comes into the shop for this class of repairs, my practice is to immediately proceed with the fabrication of the firebox on the engine before anything is done on it. I get the firebox out ready to apply. We can apply a firebox to the Pacific type in seven days. I heartily approve of the application of fireboxes in the boiler shop.

IRA J. POOL (Baltimore & Ohio): I understood Mr. Stiglmeier to say you cannot reinforce firebox sheets on the water side. Now we apply about 90 percent of our fireboxes on the frames, and we have a system whereby we reinforce practically all the seams on the water side. We do that by tacking the firebox in place, and after we get it tacked in place we raise it and lower it so as to get at all of the seams, and we shove it over against the wrapper sheet, permitting twice the width of the water space. Practically all the seams in the application of new fireboxes are thus reinforced.

L. M. STEWART (Atlantic Coast Line): Common sense will tell you that, if you have the facilities, the best thing to do is to remove the boiler from the frame. If you have not the facilities to do so, do the best you can. If you have the most modern equipment it will lower your cost. We all know that, and certainly it has been proven beyond a doubt that the best method, where you have the facilities, is to remove the boiler from the frame.

A. F. STIGLMEIER: What he says is very interesting. I spoke of welding side sheets in the combustion chamber of the firebox. I would like to ask Mr. Pool how he can drop a combustion chamber firebox to weld a side sheet. He said practically all the welding; he did not say all the welding. That is the point I am raising. You can do some of it but you cannot do it all. I wish he would give us that information; how it is possible to drop a combustion chamber firebox for welding?

IRA J. POOL: I said we are welding practically all the seams because in some cases we are not doing it all, but it is possible in a great many cases to do it all. In some of our big Mallet power, we do not weld or reinforce the welding around the bottom of the combustion chamber at the throat sheet because it is too expensive. After the box is completely assembled in the boiler, we drop the back end down for some distance and that permits the combustion chamber to project upward at the front of the boiler, and allows space enough for a man to get down underneath to reinforce that. In regard to side sheets, we are reinforcing our side sheets where they are fastened to the crown sheet, and we are reinforcing the vertical sheets at the back end.

Repairing Cracked Mud Rings or Corners, without Removing the Rings*

1. The foundation or mud ring of any boiler, especially the locomotive, is of vital importance, therefore the care in maintenance and repairing of this most

* Committee report presented at the twenty-first convention of the Master Boiler Makers' Association, held at Pittsburgh, May 20 to 23.

essential part of the boiler should receive the utmost consideration, in order to get full return of service from it. Worn and cracked out spots should be promptly and permanently repaired.

2. In our opinion the most economical method of repairing cracked mud rings or mud-ring corners, without removing the ring, is to remove a sufficient number of rivets from the mud ring, on either side of the defective part, at the same time removing or burning out a portion of the firebox sheet or corner, depending on where the defect is. Vee out the cracked portion of the mud ring, starting from the water side, making a wide portion of the vee in the top of the mud ring; then weld by the autogenous welding process.

3. Preparation for the weld on the mud ring is equally as important as any other part of the firebox where pressure is maintained to a high degree and the service is severe, as the mud ring is subject to very severe strains and also to the ashes and corrosion from leakage to the adjacent parts. Where rivet holes are cracked out or oversize, the complete welding up of holes and cracks is desirable and re-drilling new holes to correct size. When a hole is not more than 3/32 inch over the rivet size, welding up and reinforcing the part 20 percent makes a first class job.

A piece of ½ inch boiler plate should be placed on the bottom of the mud ring. This plate should be about 5 inches long and ¾ inch less than the width of the mud ring to allow ⅜ inch space on each side for welding. Weld the plate all around to the bottom of the mud ring.

If the mud-ring corners are weak and giving trouble all the time, they should be removed and new reinforced mud-ring corners installed, extending at least 12 inches around the corners with the corners reinforced.

In case either the inner or outer sheet can be removed to make repairs, this should be done with whichever sheet is most convenient for the man doing the work. In case the men do the work from the outside, the portion of the sheet removed can be saved and welded back in place again, providing it is not defective. If the sheet is removed on the inside of the firebox, a new sheet should be installed on account of the inside sheets being subject to direct heat from the fire, which wastes them out much sooner than the outside sheets.

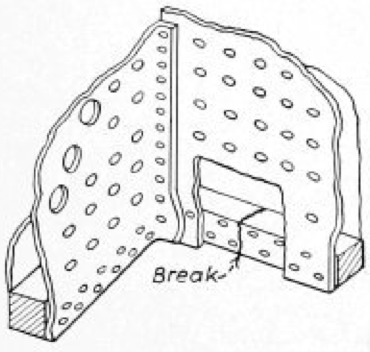


Fig. 1- Showing Part of Side Sheet Removed and Break in Mudring

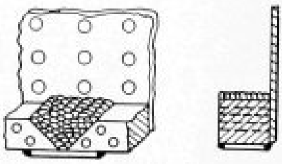


Fig. 2- Showing the Break Veed out and Welded

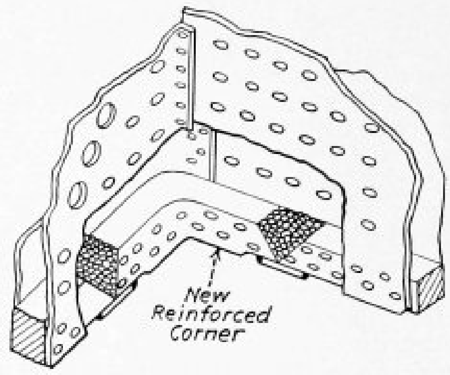


Fig. 3- Showing Part of Side and Tube Sheet Removed and New Mudring corner Welded in Place

Method of Welding Broken Mud Ring

1—Cut opening in side sheet and remove rivets as shown. 2—Vee out the break with cutting torch then clean the welding surface to a bright metal. 3—Put a ½ inch steel plate on bottom of mudring. The plate should be 5 inches long; the width ¾ inch less than the width of the mudring. This is to allow ⅜ inch space on each side of the plate for welding to mud ring as shown in Fig. 2. 4—Weld the mudring, making a weld to the plate in the bottom of the "V" and finish with reinforcement on top as shown in Fig. 2. 5—Drill rivet holes and apply standard side sheet patch, welding in place.

Method of Welding Broken Mud Ring

6—Where mudring corners are weak or broken they should be replaced with new reinforced corners extending about 12 inches around the corner. Welding as in Fig. 2.

4. Sanding of the part welded is essential to efficient welding, as there is no method known that really cleans as does a good job of sanding. Where a roughing tool is used the rust and corrosion are worked into the metal making a dirty weld, which is extremely inefficient. The attached illustration shows the method of repairing broken mud rings.

5. A method of keeping corners tight has always been some job for the boiler division. The preparation of corners, laying up properly, filling oversize rivet holes from both sides of the ring, correct lap allowance, calking with correctly designed tools, sanding and welding of calking edge for about 12 inches around the corners and up above the grate frame are all essential in keeping corners tight. Welding should be roughfullered.

After the engine is in service, the corners should be carefully watched for small leaks and promptly repaired to eliminate wasting of the sheet and ring.

No discussion from the floor followed this report.

This report was prepared by a committee composed of W. N. Moore, chairman, E. J. Reardon, John Clas.

Scientific Water Correction

The Dearborn Chemical Company, Chicago, Ill., has recently published a 95-page book on the subject of "Scientific Water Correction." This volume, written in a non-technical manner, is divided into 19 chapters which deal with the methods for obtaining efficient feedwater treatment as a necessity for economical steam production. Such subjects as water analysis and its interpretation are treated in sufficient detail to stress its importance. Other chapters deal with scale formation: its mechanism, treatment for control of and its removal. Corrosion, foaming, priming and embrittlement are covered in five chapters while one section of the volume is devoted to the effect of oil in boiler water. The remaining chapters of the book deal with the protection of boilers out of service, the preparation of boilers for service, and the various Dearborn facilities devoted to the treatment of boiler feed water.

The Prest-O-Lite Company, Inc., 30 East 42nd street, New York, has placed in operation a new plant for the manufacture and distribution of dissolved acetylene at Casper, Wyo.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Washing Locomotive Boilers

Q.—Should the blow-off cock be left open where a boiler (locomotive boiler especially) is being washed out? H. S. L.

A.—It is not necessary that the blow-off cock be left open when washing out a locomotive boiler.

Complete instructions for washing out locomotive boilers can be found in the American Railway Association's Manual of Standard and Recommended Practice, issue of 1930, section F, page 83.

Heating Surface of Locomotive Boiler

A.—Referring to the question in the June issue on "Heating Surfaces of Locomotive Boilers" by T. C. E., I would further state that in computing the heating surface of a locomotive-type boiler in accordance with Par. 274 of the A.S.M.E. 1927 Boiler Construction Code, Section I, it is satisfactory and general practice to take as heating surface, the inside surface of the firebox that is exposed to the products of combustion, without deducting the area of the staybolt heads.

Efficiency of Triple-Riveted Joint

Q.—Will you kindly furnish me the formula for solving the following problem: What is the efficiency of a triple-riveted joint with 1 3/16-inch steel rivets; pitch, 8 inches; boiler plate with the tensile strength of 80,000 pounds?

I recently underwent an examination for the position of U. S. inspector of locomotives, and the above question was the only one that proved perplexing.

Anxiously awaiting to hear from you relative to the formula for solving that problem, I remain. C. B. K.

A.—The question does not include sufficient information for determining the efficiency of a triple-riveted joint.

Location of Safety Plugs

Q.—Please tell me in what place and at what height the safety plugs are located in vertical tube boilers. J. G.

A.—The height and location of the safety plugs in vertical tube boilers is as follows:—

Vertical Firetube Boilers: In an outside tube, not less than one-third the length of the tube above the lower tube sheet.

Vertical Firetube Boilers, Corliss Type: In a tube, not less than one-third the length of the tube above the lower tube sheet.

Vertical Submerged-Tube Boilers: In the upper tube sheet, and projecting through the sheet not less than one inch.

Vertical Boilers, Climax or Hazelton Type: In a tube or center drum not less than one-half the height of the shell, measured from the lowest circumferential seam.

Cahall Vertical Watertube Boilers: In the inner sheet of the top drum, not less than 6 inches above the upper tube sheet, and projecting through the sheet not less than one inch.

Wickes Vertical Watertube Boilers: In the shell of the top drum and not less than 6 inches above the upper tube sheet, and projecting through the sheet not less than one inch, so located as to be at the front of the boiler and exposed to the first pass of the products of combustion.

For other types and new designs, fusible plugs shall be placed at the lowest permissible water level, subject to the direct radiant heat of the fire or in the direct path of the products of combustion, as near the primary combustion chamber as possible.

Calculation of Vacuum Tanks

Q.—The May issue had a problem on the "Calculation of Vacuum Tanks." In this article the author has computed the values for $t^{2.25}$ which do not agree with my computations.

For example, ½-inch plate,

$$0.5^2 = .25$$
$$0.5^3 = .125$$

Then $0.5^{2.25}$ should be less than 0.25 and more than 0.125, or figuring it by the use of logarithms:

Log. of 0.5 = 9.69897 — 10

Log. of 0.5 × 2.25 = 21.82268250 — 22.50

= 9.32268 — 10

or .2102

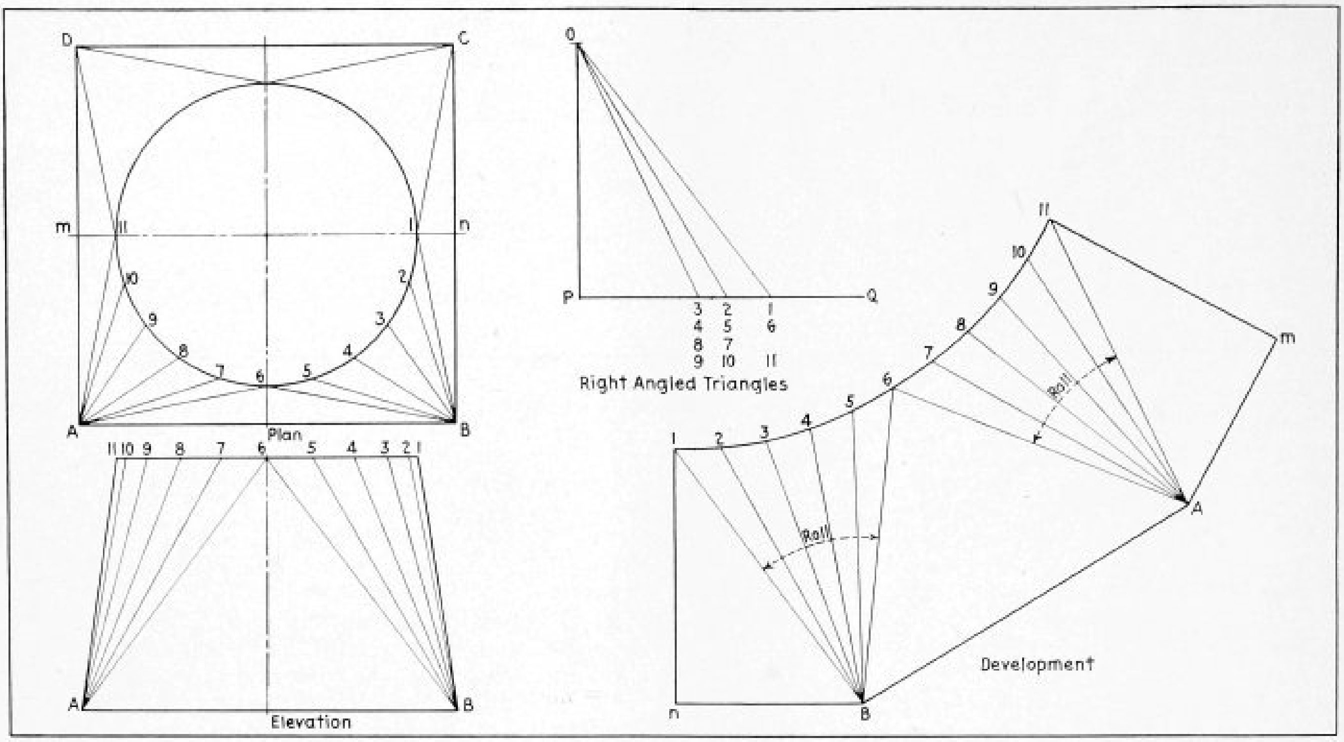
Then $5^{2.25}$ = .2102.

Will you please advise me if my calculations are correct? J. S. A.

A.—The calculations submitted in the question are correct and Table I in the question on "Calculation of Vacuum Tanks" in the May Issue is corrected as follows:

Table I

Thickness of Shell Plate—Inches: Fraction	Decimal Equivalent	Corresponding Values of $t^{2.25}$
1/4	.25	.0442
9/32	.28125	.05761
5/16	.3125	.07301
11/32	.34375	.09048
3/8	.375	.11004
13/32	.40625	.13173
7/16	.4375	.15566
15/32	.46875	.1818
1/2	.5	.2103
17/32	.53125	.2409
9/16	.5625	.2740
19/32	.59375	.3094
5/8	.625	.3473
21/32	.65625	.3876
11/16	.6875	.4303
23/32	.71875	.4756
3/4	.75	.5234



Development of square to round transition piece

Layout of a Square to Round

Q.—What is the most simple layout of a square to round? H. S. L.

A.—To develop a transition piece having a square base and a round top, as shown in the illustration, it is first necessary to draw the elevation and plan view.

Draw the horizontal line *m-n* through the plan view, thus dividing the object into two symmetrical halves. It will now be seen that if a development is made of the lower portion, as shown in the plan, a duplicate of the resultant figure will be a complete development.

Divide the top into any number of equal parts, 20 being used on this layout; the greater the number of equal parts taken, the greater the accuracy of the final development. Number the divisions taken in the lower portion of the plan view from *1* to *11* as shown, connect points *1* to *6* with *B* and points *6* to *11* with *A*. Number and connect the corresponding points in the elevation in the same manner. These lines represent the surface lines of the object and the next step is to obtain the true lengths of these lines. The construction of a series of right-angle triangles is necessary in order to find the true lengths of these lines.

To construct the right-angle triangles draw the horizontal line *P-Q* and erect the perpendicular *P-O* at *P*, *P-O* being taken equal to the vertical distance between the base and the top in the elevation, this distance being the common altitude for all of the triangles taken from the points *A* and *B* in the elevation. With *P* as a center and with the dividers set equal to the distance *B-1* of the plan view, scribe an arc cutting the line *P-Q* at *1*. Connect *1* with *O* completing the right-angle triangle *O-P-1*, *O-1* being the hypotenuse and the true length of the line *1-B* of the plan or elevation. Repeat this procedure, taking *P-2* equal to *B-2*, and *P-3* equal to *B-3*, etc., until the true length of all the surface lines have been determined.

The next step is to develop the pattern. Draw the horizontal line *n-B* equal to *n-B* of the plan view and at *n* erect a perpendicular. With *n* as a center and with the dividers set equal to *B-1* of the elevation, scribe an arc cutting the perpendicular just drawn, locating the point *1*. Connect *1-B*.

With *1* as a center and with the dividers set equal to *1-2* of the plan view, scribe an arc; then, with *B* as a center and with the dividers set equal to the true length of the line *2-B*, scribe an arc cutting the arc just drawn, locating the point *2*. Then with *2* as a center and with the dividers set equal to the distance *2-3* of the plan view, scribe an arc; then, with *B* as a center and with the dividers set equal to the true length of the surface line *B-3* scribe an arc cutting the arc just drawn locating point *3*, proceed in the same manner, taking *3-4*, *4-5*, *5-6*, equal to *3-4*, *4-5*, *5-6* of the plan view and with the corresponding true length surface line, until the line *6-B* is drawn, then with the point *B* as a center and with the dividers set equal to the distance *A-B* of the plan, scribe an arc, then, with *6* as a center and the dividers set equal to the length of the surface line *A-6* scribe an arc cutting the arc just drawn locating the point *A*, proceed as before completing the half development.

Breakage of Mud Ring Weld

Q.—I should like to have the reaction of experienced boiler men on a question, but before asking it, will have to make a slight explanation. We have been building a locomotive-type boiler with forged steel mud ring. We purchase long bars for this purpose and forge the rings to meet the requirements. The forging operation having been completed, the major weld in the ring where the two ends are joined together is electrically welded. This weld is located midway between the front head and the throat sheet. The weld is thoroughly inspected and when the ring is completed, it is given an 18-hour anneal. There is also built up on this weld a large scab on the upper and lower side as additional reinforcement.

Now in firing up one of these boilers slowly we have found in six cases out of over three hundred boilers manufactured of this type that the master weld has cracked, causing a bad leak and repair job. What is the cause of this breakage? J. V. K.

A.—The information furnished in the question, while not explanatory of the exact method of preparing the weld and the method of welding the firebox ring, would indicate to me that the method used in welding was satisfactory. Considering that only two percent of the total welds were defective, would lead me to believe that the trouble experienced was some defect in the individual weld and not in the method used, also that the cause of the breaks was not due to the location of the weld in the firebox ring. Unless there is something unusual in the design of the boiler at the throat, the stresses set up due to firing up the boiler should not effect the weld in the firebox ring, if the weld was properly made before applying the ring to the boiler.

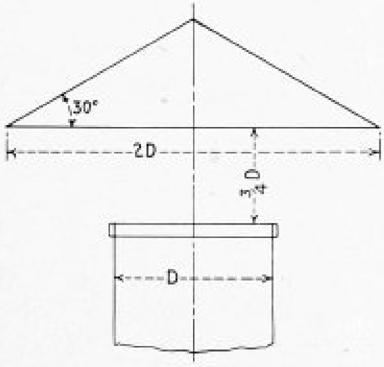
Defective welds are generally due to the use of poor welding wire, or the improper preparation of the weld. The work should be properly beveled and the edges thoroughly cleaned from dirt, rust and grease by chipping, sandblasting or grinding. The weld must be executed on clean metal.

Theory of Smokestack Hood

Q.—What is the theory of a hood or umbrella at the top of a smokestack, and what are the relative sizes of a well designed hood? F. X. D.

A.—Umbrellas or conical hoods for smokestacks are used to keep out the rain and for the prevention of down drafts.

I do not know of any set rules for the proportioning of these hoods; however, the principal thing is to keep



Height of hood above smokestack

the hood high enough above the top of the stack so as to allow a free passage of the smoke.

A good rule to follow is to raise the hood to a height equal to at least three-quarters the diameter of the stack as shown in the illustration.

Obtaining Watertight Riveting

Q.—Kindly inform me if it is possible to get an absolutely watertight job around the rivets by means of pneumatic hammering without caulking them? If it is possible, please inform me what kind of heating gives the least amount of scale (gas, coal or electric). B. M. S.

A.—It is possible under the right conditions to obtain a watertight rivet by pneumatic hammering. The best way to secure this result is to use either an air dolly or pneumatic hammer for holding on; however, there is no assurance that every rivet driven in this manner will be watertight.

Rivets heated in an electric furnace will not scale as readily as those heated in a combustion furnace, for the reason that in combustion furnaces the heating begins at the outer surface and penetrates the rivet until it reaches the core. As a consequence, most rivet heaters insist that the rivet should have an appearance approximating white heat before it is sufficiently heated to be driven. An analysis of such a rivet will show that deterioration of the metal has begun.

Uniform heating is obtained with the electric heater. The current passes equally through all portions of the rivet and as the atmosphere keeps the outer surfaces cool, the core becomes hot first and the heat radiates from the core to the outer surface.

Efficiency of Riveted Joints

Q.—I would be glad to see the following problems figured in THE BOILER MAKER.

(1) The efficiency of a single shear, riveted seam with any given size rivets, spacing of rivets and thickness of steel.

(2) The efficiency of a butt strap joint with any given size of rivets, spacing of rivets and thickness of steel.

(3) Also the efficiency of a seam in single shear with a double row of rivets. I do not understand how to figure the strength of bridges between rivet holes in, say a sheet 11/16-inch thickness with a tensile strength of 66,000 pounds per square inch and holes drilled 1 1/16 inch in the riveted seams. I. A. M.

A.—(1) The efficiency of a single shear, riveted seam with any given size rivets, spacing of rivets and thickness of steel is determined as follows:

Let TS = tensile strength stamped on plate, pounds per square inch

t = thickness of plate, inches

P = Pitch of rivets, in outer row, inches

d = diameter of rivet after driving, inch diameter of 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 rivet in single shear, pounds per square inch

n = number of rivets in single shear in unit length of seam.

Assuming $TS = 55{,}000$,

$t = 1/4$ inch

$P = 1\,5/8$ inch

$d = 11/16$ inch

$a = .3712$ square inch

$s = 44{,}000$ pounds (A.S.M.E. Code)

$c = 95{,}000$ pounds (A.S.M.E. Code).

To determine the efficiency of single shear, riveted seam commonly called a lap joint, as shown in Fig. 1:

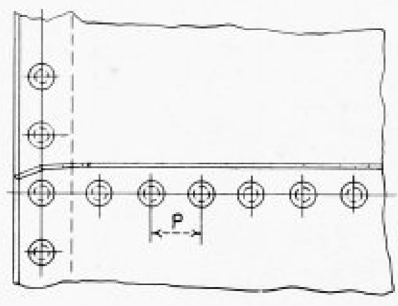


Fig. 1

Let 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 one rivet in single shear = $n \times s \times a$

D = crushing strength of plate in front of one rivet = $d \times t \times c$.

Divide B, C or D (whichever is the least) by A and the quotient will be the efficiency of a single-riveted lap joint.

$A = 1.625 \times 1.25 \times 55.000 = 22.343$

$B = (1.625 - 0.6875)\ 0.25 \times 55{,}000 = 12{,}890$

$C = 1 \times 44{,}000 \times 0.3712 = 16.332$

$D = 0.6875 \times 0.25 \times 95{,}000 = 16{,}328$

$$\frac{12{,}890\ (B)}{22{,}343\ (A)} = .0576 = \text{efficiency of joint.}$$

(2) The efficiency of a butt strap joint with any given size of rivets, spacing of rivets and thickness of steel is determined as follows:

In addition to the symbols shown in Paragraph (1), let

S = shearing strength of rivet in double shear, pounds per square inch

b = thickness of butt strap, inches

N = number of rivets in double shear in a unit length of joint.

Assuming TS = 55,000,
t = 3/8 inch
b = 5/16 inch
P = 4 7/8 inches
d = 7/8 inch
a = .6013 square inch
s = 44,000 pounds (A.S.M.E. Code)
S = 88,000 pounds (A.S.M.E. Code)
c = 95,000 pounds (A.S.M.E. Code).

To determine the efficiency of a butt strap joint, this example being a triple-riveted butt and double strap joint, as shown in Fig. 2.

Let A = strength of solid plate $= P \times t \times TS$

B = strength of plate between rivet holes in the outer row $= (P - d)\ t \times TS$

C = shearing strength of four rivets in double shear, plus the shearing strength of one rivet in single shear, $= N \times s \times a + n \times s \times a$

D = strength of plate between rivet holes in the second row, plus the shearing strength of one rivet in

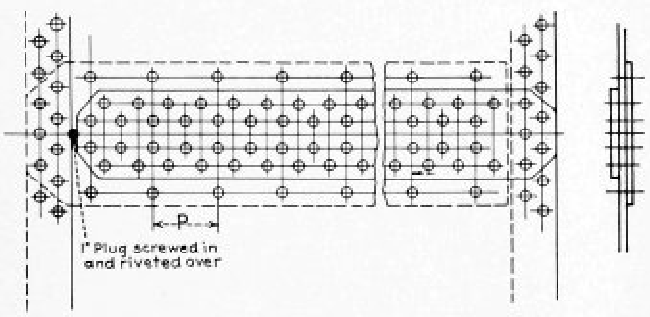


Fig. 2

single shear in the outer row $= (P - 2a)\ t \times TS + n \times s \times a$

E = strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of one rivet in the outer row $= (P - 2a) t \times TS + d \times b \times c$

F = crushing strength of plate in front of four rivets, plus the crushing strength of butt strap in front of one rivet $= N \times d \times t \times c + n \times d \times b \times c$

G = crushing strength of plate in front of four rivets, plus the shearing strength of one rivet in single shear $= N \times d \times t \times c + n \times s \times a$

Divide B, C, D, E, F, or G (whichever is the least) by A and the quotient will be the efficiency of a butt and double strap joint, triple riveted.

$A = 6.5 \times 0.375 \times 5000 = 134{,}062$

$B = (6.5 - 0.8125)\ 0.375 \times 55{,}000 = 117{,}304$

$C = 4 \times 88{,}000 \times 0.5185 + 1 \times 44{,}000 \times 0.5185 = 205{,}326$

$D = (6.5 - 2 \times 0.8125)\ 0.375 \times 55{,}000 + 1 \times 44{,}000 \times 0.5185 = 123{,}360$

$E = (6.5 - 2 \times 0.8125)\ 0.375 \times 55{,}000 + 0.8125 \times 0.3125 \times 95{,}000 = 124{,}667$

$F = 4 \times 0.8125 \times 0.375 \times 95{,}000 + 1 \times 0.8125 \times 0.3175 \times 95{,}000 = 139{,}902$

$G = 4 \times 0.8125 \times 0.375 \times 95{,}000 + 1 \times 44{,}000 \times 0.5185 = 138{,}505$

$$\frac{117{,}304\ (B)}{134{,}062\ (A)} = 0.875 = \text{efficiency of joint.}$$

(3) The efficiency of a seam in single shear with a double row of rivets is determined as follows:

I am assuming that this is intended to be a lap joint double riveted as shown in Fig. 3.

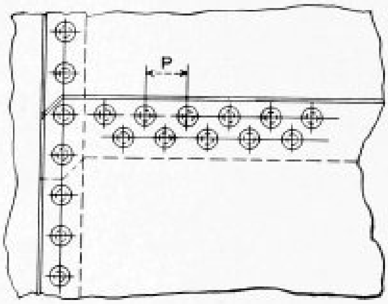


Fig. 3

Assuming TS = 55,000,
t = 5/16 inch
P = 2 7/8 inches
d = 3/4 inch
a = .4418 square inch
s = 44,000 pounds (A.S.M.E. Code)
c = 95,000 pounds (A.S.M.E. Code)

Let 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.

$A = 2.875 \times 0.3125 \times 55{,}000 = 49{,}414$

$B = (2.875 - 0.75) 0.3125 \times 55{,}000 = 36{,}523$

$C = 2 \times 44{,}000 \times 0.4418 = 38{,}878$

$D = 2 \times 0.75 \times 0.3125 \times 95{,}000 = 44{,}531$

$$\frac{36{,}523\ (B)}{49{,}414\ (A)} = 0.739 = \text{efficiency of joint.}$$

The strength of the bridge between two rivet holes in a sheet would be the ratio that the strength of the plate between the rivet holes would have to the strength of the corresponding solid plate, or,

$$\frac{P - d}{P} \times TS,$$

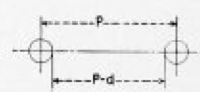


Fig. 4

where,
P = pitch of rivets, inches
d = diameter of rivet hole, inches
TS = tensile strength stamped on plate, pounds per square inch.

Associations

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

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	

Cities

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

Selected Boiler Patents

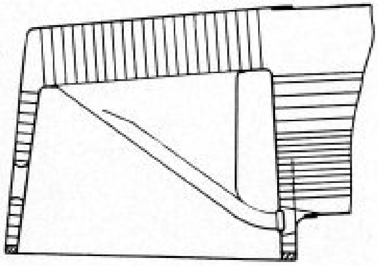
Compiled by
DWIGHT B. GALT, Patent Attorney,

Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,717,028. TUBE CONNECTION. CHARLES GILBERT HAWLEY, OF CHICAGO, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, A CORPORATION OF DELAWARE.

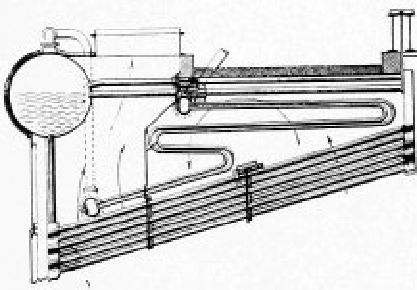
Claim.—In combination with a steel firebox sheet having an opening therein, a copper tubular member having an end extending through said



opening, and a steel ring lodged upon the end of said tubular member and autogenously welded to that portion of the steel firebox sheet defining said opening, the end of said tubular member being left free to slip within said steel ring.

1,700,237. SUPERHEATER. ARTHUR D. PRATT, OF SHORT HILLS, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

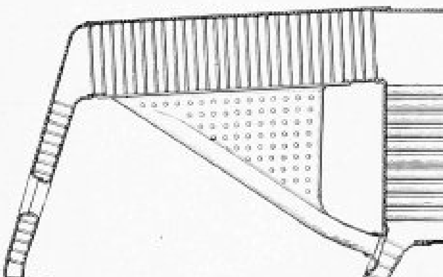
Claim.—In combination, a steam boiler and a superheater having parallel inlet and outlet headers and tubes of a general **U** shape connecting the headers and contacted by the hot gases of the boiler, the legs of the **U**



being of substantially unequal length with the longer leg connected to the inlet header and the shorter leg connected to the outlet header, the relative lengths of the legs being such that the longitudinal extension due to the heat of the steam in each leg and of the gases in contact therewith is substantially the same in each leg. Eight claims.

1,700,140. LOCOMOTIVE-BOILER FIREBOX. CECIL M. ROGERS, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX CO., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

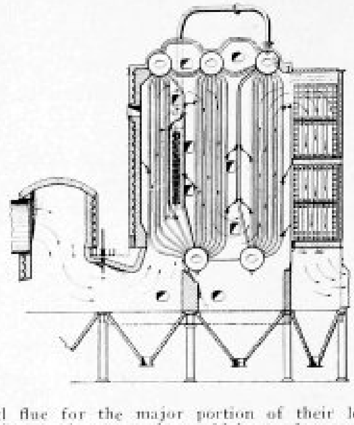
Claim.—A locomotive boiler firebox, in combination with a substantially rigid water circulating element disposed in said firebox and having ends



which open through the sheets thereof at different elevations, one of said sheets having an annularly corrugated flexible portion with its flexing fulcrum disposed eccentric with respect to corrugation thereof the groove of the corrugation increasing in width and in depth from the top to the bottom on either side, and one end of said element being fixed in said corrugated portion adjacent said fulcrum.

1,734,983. STEAM BOILER. HERMAN B. SMITH, OF PLAINFIELD, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

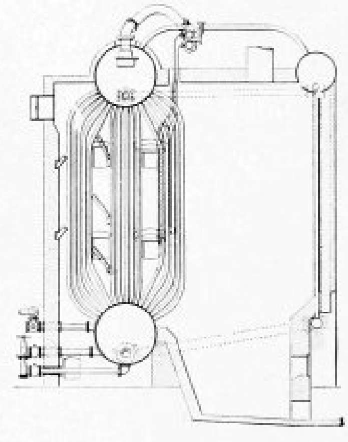
Claim.—A steam boiler having a vertical flue, a steam and water drum at the top of said flue, a water drum at the bottom of said flue and at one side thereof, a bank of tubes connected to the upper drum and extending



vertically in said flue for the major portion of their length and having their lower ends bent and connected to said lower drum, an external source of hot gases, and a gas inlet connecting said source to the bottom of said flue, and means to direct the hot gases from the inlet into the bank from beneath the bent portions of the tubes. Eight claims.

1,731,427. BOILER FURNACE. GEORGE T. LADD, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO LADD WATER TUBE BOILER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

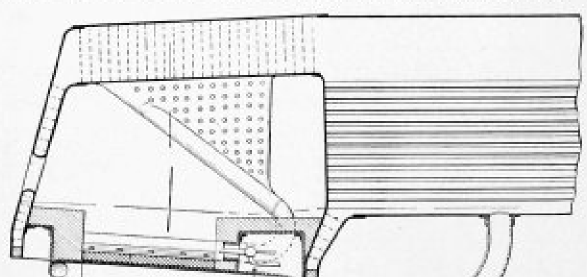
Claim.—In combination, a combustion chamber having a bridge wall at the rear, a boiler over said bridge wall having an upper and lower drum, a row of upright tubes subject to heat within the chamber extending over



said bridge wall and connected at their upper ends to said lower drum, a tubular water screen in the lower portion of the combustion chamber, and common downcomer means from the boiler directly connected to the lower end of said upright tubes and to one end of the tubes of the water screen and an upcomer connection for the water screen. Five claims.

1,732,769. LOCOMOTIVE BOILER. ARTHUR W. NELSON, OF PARK RIDGE, ILL., ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILL., A CORPORATION OF DELAWARE.

Claim.—A locomotive boiler construction embodying therein a barrel and a firebox, a pair of relatively flat hollow water-heating and circulating elements disposed therein and extending downwardly and inwardly from



the side water legs of the firebox, means for delivering water from the boiler barrel from a point forwardly of the front water leg thereof, into one end of each of said elements and a thermic syphon, one for each element and each opening at one end through the crown sheet and each connected at its other end to the other end of an associated element. Four claims.

The Boiler Maker

Name registered U. S. Patent Office

Volume XXX | August, 1930 | Number 8

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

Chicago: 105 West Adams St. Cleveland: Terminal Tower
Washington: 17th and H. Sts., N. W.
San Francisco: 215 Market St.

H. H. BROWN, Editor
L. S. BLODGETT, Managing Editor
WARNER LUMBARD, Associate Editor

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

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Boiler Inspection

On page 214 appears a communication from one of our readers discussing the boiler inspection situation, as applying particularly to locomotive boilers. It is apparent that his contacts and experience over a long career of boiler making have been in shops where inspection evils have been allowed to exist. There are many such shops, but by no manner of means are they in a majority nor do they constitute a large minority.

In both the railroad field and in the power field, there are official boiler inspection organizations, staffed with highly-trained and experienced men. Under A. G. Pack the Bureau of Locomotive Inspection of the Interstate Commerce Commission has been developed to a high state of efficiency, and it is only necessary to examine the records of this governmental department to obtain a picture of the condition of locomotives in the railroad field during the last decade. If poor inspections on the part of railroad inspectors were as widespread as our correspondent's criticism would lead us to believe, no such improvement as has actually taken place in the condition of locomotives over the country as a whole would have been possible. From time to time the records of the Bureau of Locomotive Inspection are published in these pages and, in the most recent report, may be noted a decrease of 18 percent in the number of boiler failures as compared with 1928; a decrease of 35 percent in the number of persons killed and a decrease of 15 percent in the number of persons injured. As compared with 1923, the records show a decrease of 68 percent in the number of accidents due to boiler failures; 68 percent fewer persons were killed and 74 percent fewer persons were injured. With these figures in mind, there can be no doubt as to the adequate maintenance of locomotive boilers.

In the power field, the National Board of Boiler and Pressure Vessel Inspectors, the report of whose eighth annual meeting is published in this issue, is the organization responsible for the safety of all boilers built to the requirements of the A. S. M. E. Boiler Code. The preamble to the by-laws of this board constitutes a declaration of policy under which every member of the board conducts his work. This preamble is as follows:

"The National Board of Boiler and Pressure Vessel Inspectors is 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 to secure interchangeability between political subdivisions of the United States."

Inspectors to be considered competent and permitted to use the National Board stamp must meet extremely rigid examination requirements covering every phase of boiler construction, repair and inspection. The result is that a certificate of competency in the National Board is considered the best possible proof of an inspector's fitness. The work of the board ever since its inception has been above criticism.

Statistics for the past fiscal year, as reported at the annual meeting, show that 20,164 power boilers of all sizes and types were registered with the board; that a total of 290,205 boilers were examined by insurance company inspectors and of these 250,957 boilers were also reported by 20 chief inspectors of the National Board, which indicates that they were built under the A. S. M. E. Boiler Code. The remaining 39,248 boilers were therefore non-code boilers. The report of the statistician also indicates that a total of 1004 power boiler accidents occurred in which 22 persons were killed and 20 injured, the property loss amounting to $312,488.59. Of the total number, only 106 accidents were to code-built boilers, with 5 killed, 2 injured and a property loss of $91,320. Non-code boilers, which means improperly-built and poorly-inspected boilers, caused 898 accidents with 17 killed and 20 injured and a property loss of $221,168.59. These figures give a clear picture of the relative safety of boilers and pressure vessels built to high standards under competent inspection as compared with those which conform to no standard and where careless workmanship gets by.

We do know that such boilers are built and, when they fail, carelessness and poor inspection are contributory causes, but, as pointed out in the beginning, they constitute a small part of the boiler field either for the locomotive or the power plant. It follows, therefore, that there must be a great many more competent and careful boiler makers and inspectors than there are incompetents. The object of all authorities interested in the construction and operation of boilers, of whatever type they may be, is to eliminate poor workmanship and faulty inspection entirely, and in this respect our correspondent's criticism is fully justified. Such conditions must not be allowed to exist!

Laying Out Problems

One phase of boiler work that is always of interest to our readers is the solution of unusual laying out problems. From the apprentice to the oldest man in the shop there is a fascination in watching a competent layerout at work. There is a very definite reason for this. Beyond the mere fact that the layerout is engaged in an entirely different kind of work than any other department in the shop, it is the transition point at which the theory of the designing department is changed into the practical form familiar to everyone.

The thought suggests itself that, so many of our readers are engaged in this important branch of the art of boiler making, they must necessarily have solved practically every kind of layout problem it is possible to imagine. In order to put on record for the benefit of the trade at large some of the unusual layout methods developed by readers, it is our intention in coming issues to publish worthwhile layout problems.

An invitation is therefore extended to all layerouts, who read THE BOILER MAKER, to submit for publication problems which they have solved that may have some out-of-the ordinary feature—whether simple triangulation layouts or those of a more complicated character. The important point to remember in describing the methods used is to be sure that the drawings demonstrating each layout are clearly and accurately made. Thus when the explanation of the various steps is given, it will be possible for any reader familiar with the fundamentals of laying out to follow the work with understanding. All articles published will be paid for at our regular rates.

Communications

Better Inspection Needed

TO THE EDITOR:

I recently have read with much interest several articles in THE BOILER MAKER written by some of our highest railway officials, and I wish to say that one subject, which they discussed certainly appealed to me; that is, inspection. From their statements they all consider proper and competent inspection absolutely necessary to keep the modern locomotive boiler in a high state of efficiency. Their ideals are high and I often wonder why they do not make a more consistent effort to make them a reality.

I have worked at the trade for over 32 years, doing all classes of work, and have successfully held all positions in the boiler shop from the bottom to the top. I have never lost the interest in the trade that I had when I first started out as an apprentice.

I have always regarded rigid inspection as a vital necessity to the business from all points of view. It is also so regarded by the majority of our boiler manufacturers that I can not say that the same high regard for proper inspection is generally felt by the minor officials and supervisors of our railroads. As a rule they merely aim to keep within the law. The result of this is that we will find in most of our railway shops that the system is bad, while in some of the larger ones it is absolutely terrible.

Several things contribute to this condition, one of which is the speed mania that has spread over the country since the war. Everything is being done by schedule. The schedule is generally made up before the engine enters the shop. Of course the schedule force has the road inspection report to work on, but they lose sight of the fact that shop inspection is of more importance, and as a result give it very little consideration. This makes the shop inspection a catch-as-catch-can affair. Defects are discovered after the time they should be cared for on the schedule and as a result of this they are handled in any way whatever to get by with them. Sometimes I fear they are passed up altogether. The inspector gets called for not being earlier in his inspection and the foreman gets the same for being off schedule. The schedule must be maintained regardless of anything else. Naturally where all attention is centered on one thing others go by the board. The inspector becomes careless, the journeymen also; careless and indifferent workmanship; the engine gets out with all its parts, but how.

Speeding up is also a contributing factor to poor terminal or roundhouse inspection. The roundhouse foreman in his efforts to cut terminal delay hardly wants to give the inspector time to walk around the engine, let alone make the proper inspection; he is expected to rap the bolts and look over the flues, fire appliances and arch tubes while the boiler washer is doing his work. By the time he has done this, the boiler washer has replaced half of his plugs, so if the inspector wants to make any plug hole inspection he has to step out to do it before the others are replaced. It is the same way with everything else. The inspector is generally regarded as a nuisance and every one seems to take pleasure in retarding him in his work. They know that he can not help himself, that his complaints never get very far, so you see that the engine merely gets the "once over," not an inspection.

To show you what this will lead to I will give you an experience I had in 1920. Of course this was some time ago, but things have not changed much in this period. I was sent out of one of the large shops on a western road to a large terminal in the wheat belt to take charge of the boiler work on this division. While I was instructed to pay special attention to fire appliances, it did not take me very long to find out that other things needed attention. Nearly every engine that passed through the three roundhouses in that territory showed signs of past leakage coming from under the jacket. On looking over past staybolt records I could find nothing about staybolt renewals, so I asked the inspectors how come. They informed me that it was probably tell-tale hole leakage, but as it had stopped and the bolts sounded all right the roundhouse foreman would not permit the jacket removal. I asked the foreman to have some of this jacket removed but he never had time, so I just waited patiently until the time rolled round for a monthly inspection, then I told him he would either remove the jacket or he would work the engine without Form No. 1. The matter was finally placed before the division foreman who decided in my favor but it brought tears to his eyes to do it. Under the first jacket we found just 26 staybolts that had either been plugged or the telltale hole stopped up by mud collecting in them.

After that the jacket was removed on every engine that showed any indications of past leakage. On the engines that we raised the jacket, we never found one clean. The number of defective or leaky bolts ran from 3 to 29, and I want to tell you that we never stopped until we had cleaned up the division.

Of course I was a popular fellow around there after I had caused this blowup, so popular that I left there just four months to a day after I set off the fireworks. One thing I know, however, is that I made things good for my successor for I have met him several times and he says *they all* try to please the boss boiler maker there now.

The method of selecting men for inspectors is also bad, as fitness seems to be the qualification last and least considered. In some shops senior employees are given the preference, while in others the popular fellow gets the job or may be some young man whom the foreman has a preference for and wants to advance. The small differential rate that is paid does not make the place attractive to men who could properly qualify and who would take the proper interest in the work in all its phases, men who know the work from the start to the finish and who would insist on very part of it being up to standard.

One road seemingly goes to the extreme in their exaction of qualifications for the position of inspector. I will give you a verbatim copy of one of their bulletins for this job.

"Position is now open in roundhouse for a boiler inspector. Rate 85 cents per hour, 8 hours per day or more if necessary, 7 days per week."

A man to qualify for this position must be a competent oxy-acetylene burner and welder; an electric cutter and welder; a flanger and layerout. He must also be able to accomplish any other work that carries this rate.

Among my large acquaintance working at the trade there are some awful liars but I have not met one yet that would say that he could qualify for this job. Yet they get men to take these jobs. Would you really call them inspectors. They may be, but they are not all the other things specified in the bulletin and that fact alone destroys their possible value as an inspector for it makes it possible for the foreman to handle the inspector as he sees fit. Of course it will be said that the foreman would not do this, yet it has been done before. Any system that makes an inspector subservient to a supervisor or foreman is a poor one. The time will come when the foreman will become careless in handling his reports; carelessness in the foreman begets carelessness in the inspector and soon the inspection becomes merely a farce.

I will cite an inspection I witnessed in this shop where the inspector has to be an all round man. A boiler maker and helper who had been working the job filled the boiler and connected the pump. Under house pressure the boiler maker calked several small leaks, although I do not know how he found them, for old fittings and studs belonging to the machinists were leaking so badly you could not tell where the water was coming from. The boss came along and told them to pump her. They did, to the required pressure, when he told the helper to go over on another job and get a fellow welding there. He came over and the boss told him to get a hammer and rap the bolts, also look the flues over, as they had to get this engine tested by night. This was done by this welder and the water let out. This welder signed the form for the inspection the next night. Of course I suppose another welder made an internal examination the next morning, but I know the one that signed up did not.

In this shop there are about 40 men getting a differential rate and, whenever the service of an inspector is required, it is customary to grab the nearest differential man regardless of his title. Some system, eh? Yet the officials will probably tell you of their perfect inspection.

Another method of selecting inspectors, that produces poor work, is in picking a man whose qualifications are not balanced. By this I mean a man with plenty of theoretical but no practical knowledge or *vice-versa.* An example of this was noted just a few days ago. A shop was building a submerged-flue upright boiler for a wrecking crane. I did not learn whom the inspector was representing, whether the State or the insurance people, but any way it was all left up to him. This fellow sure was heavy on sheet numbers, steel tests and rivet holes but there he stopped. He actually wore the rivet holes slick with his fingers feeling for burrs and when the holes were finally filled up he concluded his job well done for there his inspection stopped although he stayed right with the job until completed. I wish readers of The Boiler Maker could have seen the brace job; twenty-two braces supporting the top head, no two of them carrying the same load. These braces are made in one piece and riveted to the head and shell at an angle of about 20 degrees. The boiler maker applying them never made any effort to set them to their proper position before marking off his holes. He marked them off and drilled them and if the brace happened to be long he took a maul and bent it until his holes came fair; if short, he fastened the foot to the head and pinned it until he either pulled the foot off the brace or the head. As the inspector was on the job the foreman of course never said a word. It reminded me of the old-time wagon blacksmith fitting braces to a wagon body. He would bore all of his holes and bend the brace to suit.

Now Mr. Editor, as I have stated before, I have always had an interest in the trade and want to see it at its best. I have always worked towards securing a rigid, and, if possible, a universal system of inspection. I can say that I materially assisted in the passage of inspection laws in two of our states as well as the present Interstate Commerce Commission law. I am telling you this because I do not want you to think this is the whine of a disappointed punk who thinks he ought to be an inspector. I am writing this because I firmly believe that some of our prominent railroad men are either not sincere in their inspection talk or that they are kidding themselves to believe that they have an efficient inspection service on their roads.

You I believe can help the matter along by a few well chosen and directed questions whenever you have the opportunity to be present when one of these inspection talks is being made. Well directed questions sometimes start misguided people on the right track for they sometimes start investigations that show these people where they have been wrong before.

Now if you have read this far I thank you for I hope that there may be something in this letter that will contribute to the betterment of the cause. If at any time you see anything that I can do to help the matter along please communicate with me.

Huntington, W. Va. R. T. Boster.

High Pressure Work

To the Editor:

As is fairly well known at the present time, the progress which has been made in steam power installations has resulted in higher pressures than was ever dreamed of a few years ago. In fact had anyone even spoken of pressures of over 1000 pounds as a commercial proposition, say 20 years ago, he would have been considered as an impractical visionary to put it mildly.

The writer recalls when boilers of the four-furnace, double-ended marine type, built for 210 pounds working pressure were considered the last word in high pressures. Even now the pressures in the firetube type of boiler do not range much above that pressure, due to the difficulties encountered by the boiler designer in the adequate staying of the flat surfaces necessary in this type of boiler, and also because firetube boilers do not lend themselves very readily to high pressure design.

However, in the watertube type, the pressures have mounted rapidly, especially in the last five or six years, until now there is more than one installation operating at 1800 pounds per square inch. The old-time ideas and methods of boiler construction must be discarded, and, in order to insure satisfactory results, a machine shop precision of workmanship is of paramount importance. No longer can the layerout find the length of plate necessary to form a drum by the simple and old established rule-of-thumb methods of adding to the circumference of the head three times the plate thickness; nor even if he uses the theoretically correct 3.1416 times the thickness will he be safe unless he takes into account such disturbing variables as allowances for machining the shell and heads, stretch of plate when bent in hydraulic presses, hot rolling, and also allowances for press and shrink fits. Dependent upon the individual shop practice, these factors must be taken into account and summarized in order to make this primary calculation.

In this article we are dealing with pressures which are considered at the present day to be moderately high: that is, pressures up to about 500 pounds per square inch, which is about the limit for riveted construction of practical size drums. The reason for this limit is of course that as the pressure rises the plate thickness must be increased proportionately and is also in direct ratio to the diameter of the drum.

Although the steel mills can supply billets of almost any thickness, the maximum thickness of a boiler plate is determined by the size of billet from which it is rolled. The maximum size billet is determined by the mechanical limitations of the steel mill. Physical limitations set up by the A. S. M. E. Boiler Code also increase the difficulties of producing exceptionally thick boiler plates because these specifications call for bending and tensile tests, and these are harder to obtain as the plate thickness is increased. The maximum thickness for riveted work may be considered as about 2½ inches. If a thicker plate is required it will be at the expense of length or breadth, possibly both.

When designing large boilers, naturally the drums are made as large as possible to obtain a maximum number of tubes, and consequently a maximum heating surface. This maximum size of course is related to the plate thickness. That 2½ inches is quite thick enough for the boiler manufacturer to fabricate is readily seen when we consider the problems he is faced with, in bending and riveting such material.

Taking the bending into consideration first, he has to transform a flat slab into a perfect cylinder or partial cylinder. He cannot, of course, roll it cold as it is beyond the capacity of any rolls yet devised. He can, if he so desires, roll it hot which means he must put in a huge plate furnace and special equipment for handling plate to the rolls, and, in addition, a powerful hydraulic press for the initial operation of bending the plate edges.

Alternatively he may elect to bend it cold by small increments, a method which although it is more wasteful of time than hot rolling, will produce longer drums than is possible with the latter method. If he does, he may not need the furnace but he has to put in a giant press. Anyone familiar with the principles of bending moments of beams, can easily figure up the enormous pressures required to overcome the elastic limits of a plate over 40 feet in length and 2½ inches thick between former blocks. Due to the particular nature of this work, the beams for such presses are, as a rule, designed by the boiler manufacturer, and the utmost ingenuity must be exercised to get a beam which will close the cylinder, the majority of firms having to be satisfied with a beam which will close it to within 120 degrees of the circle, thus making two seams instead of one, adding cost to the construction and unnecessary weight to the drum.

It has been found that due probably to stresses set up in heavy plates in the rolling mills, it is not at all rare for them to crack open in the bending process if there happens to be a cold spell; in spite of the fact that the usual test coupons cut from the plate will conform to the A. S. M. E. Code bending and tensile tests. To overcome this risk the plate must be warmed in cold weather to remove the chill, so some sort of furnace or heating medium must be provided.

Turning now to the subject of riveting, the ideal proportion, of course, is a question open to discussion but supposing we decide to use 2-inch or even 1¾-inch rivets for our 2½-inch plates; with a pressure of 80 or 100 tons to the square inch, we are faced with the problem of designing a riveting machine capable of exerting a pressure of from two or three hundred tons at the end of a cantilever beam which must not be less than 18 feet in length. That the designers of such machines have been able to supply the demand speaks volumes for their efforts, but, as might be expected, they have had to turn to alloy steels in order to obtain such results.

With holes reamed out to a minimum of tolerance, and about 6 or 7 inches long, the rivets need to be practically perfect both for size and shape. It takes very little to prevent a rivet entering a hole the full length, and if it should get stuck in the hole, a collar will be formed.

To sum up, we may say that the progress made in boiler design has been accompanied by a similar progress in methods of manufacture, but that we cannot afford to sit back now in smug satisfaction and think we are doing the best possible. We must remain ever alert to new ideas in order to keep pace with the more exacting specifications which may be expected in the course of time when more information is available as to the action of high temperatures and high pressures in combination, and of the cumulative effect of repeated cycles of zero to maximum pressure on boiler drums.

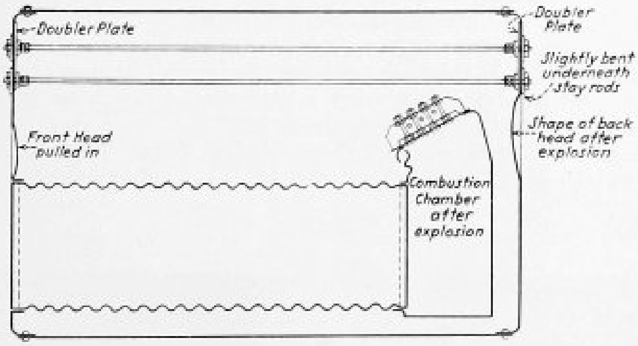
New Brunswick, N. J. J. Winthrope.

Scotch Marine Boiler Repairs in the Everglades

To the Editor:

The Everglades of Florida is a flat country with practically no drainage other than that provided by the dredging of canals. Most of the dredge boats used in this work are steam dredges equipped with Scotch marine boilers of the wet back type.

Some time ago one of these boilers used on a dredge boat exploded, blowing down the crown sheet of the combustion chamber, and tearing away the flue sheet through the top row of flues for a distance of approximately 4 feet. The flue sheet was badly buckled. The back head was also pulled inwardly about 4 inches in the shape of a gradual dish, beginning at a point just below the doubler plate and stay rods. The front head was also pulled in approximately 1¼ inches between the flue holes near the knuckle on the left side.



Damage to Scotch boiler as result of explosion

The combustion chamber was badly damaged, a number of staybolts being pulled through the sheets. The corrugated furnace, otherwise than being slightly flattened where connected to combustion chamber, was not damaged. The shell plates showed no evidence of being strained or damaged.

After inspection was made of the boiler it was found necessary to renew the entire combustion chamber, which was furnished by the original builder of the boiler and had no holes other than the flue holes and opening flanged to receive the corrugated furnace.

In order to make the necessary repairs, the boiler, which was 10 feet in diameter, with ¾ inch shell plates quadruple riveted butt joint and carried 125 pounds pressure, was taken off the dredge boat and set on the canal bank. The job was given out on contract.

The flues were first cut out; then the combustion chamber was cut out in small strips with the aid of the acetylene torch after which the stay rods were taken out and the back head cut out and laid on blocks. With the aid of suitable strongbacks the head was then straightened and bolts put through staybolt holes and annealed. The front head was not cut out being pulled straight with the aid of blow torch and strongbacks. The furnace was then reshaped, there being no irregularity beyond the first corrugation.

The combustion chamber was then pulled in place, the back head put in place and water space evenly divided. After marking off the staybolt holes and rivet holes the work was all withdrawn and the holes properly lined up and drilled. The work was then put in place again and fitted up tight. The rivet holes were given a slight countersink; all riveting was done by hand, the boiler being rolled to best suit the work.

The crown bar bolt holes in the crown sheet were tapped in the crown sheet and the bolts were screwed in from the top, projecting through the sheet far enough to take a full nut. The nuts were countersunk and packed with lamp wick; crown bars were fitted up before the chamber was applied in the boiler and flanged plate washers were fitted over the crown bars to receive the crown bolts with a ¼-inch thick steel separator or thimble between the bar and the crown sheet.

The conventional doubler plate reinforcement was riveted on the inside of the back heads and the stay-rods were upset on each end and secured in place with 3-inch nuts, standard thread, with a jam nut on the inside of the head and packed with a gasket and heavy plate washer.

After the application of the flues and staybolts was completed, a hydrostatic pressure of 185 pounds was applied and the job showed up well with only the customary pin holes.

Jacksonville, Fla. Chris. S. Handlee.

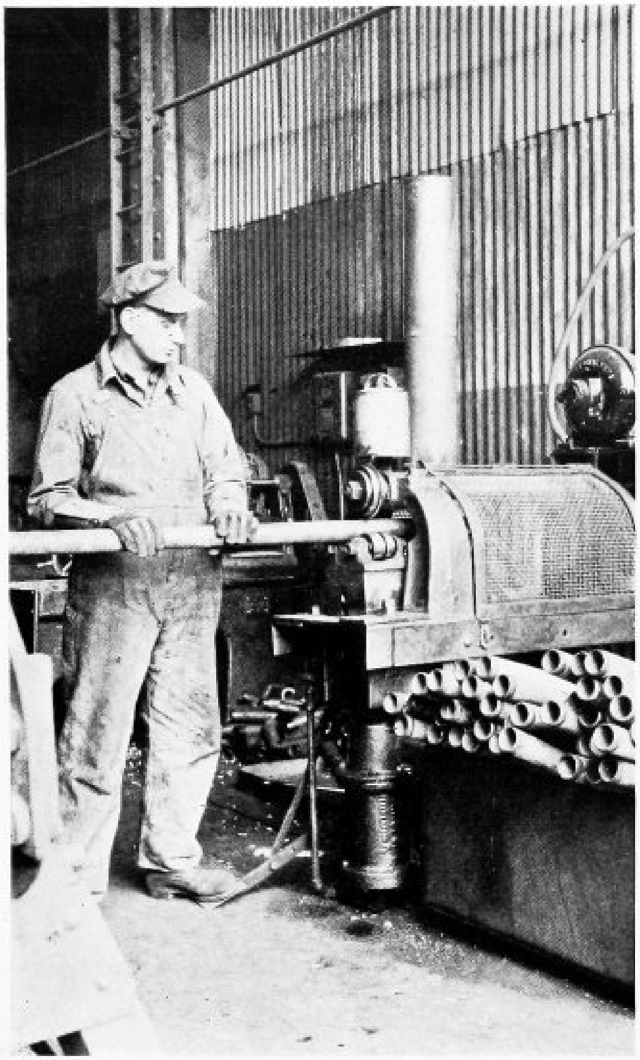
Welding Cracks in Boilers

To the Editor:

The writer has recently had occasion to answer the following question: Will it be safe to weld, if the State Inspector consents, a crack that extends through six rivets at a joint, the crack being in the front head of the drum on a watertube boiler? This question, in the writer's opinion, would be answered as follows:

It is not practical to weld cracks on watertube boilers which extend over two inches. The best method would be to cut out the defective parts and weld in a patch of oblong shape, place the rivets back at the joint and weld the patch on the head. This is the safe and the most practical way. The oblong patch should be set in and a butt weld made. Then the holes should be drilled in the bottom of the patch where the rivets were and the rivets replaced. Cracks develop on account of the material becoming fatigued and to attempt to weld instead of patch this would be to have the same trouble occur again in the next few days. By placing in a new piece of boiler plate after cutting out the fatigued material will make a permanent job and one which the State inspector would approve of.

San Antonio, Tex. R. H. Parrish.

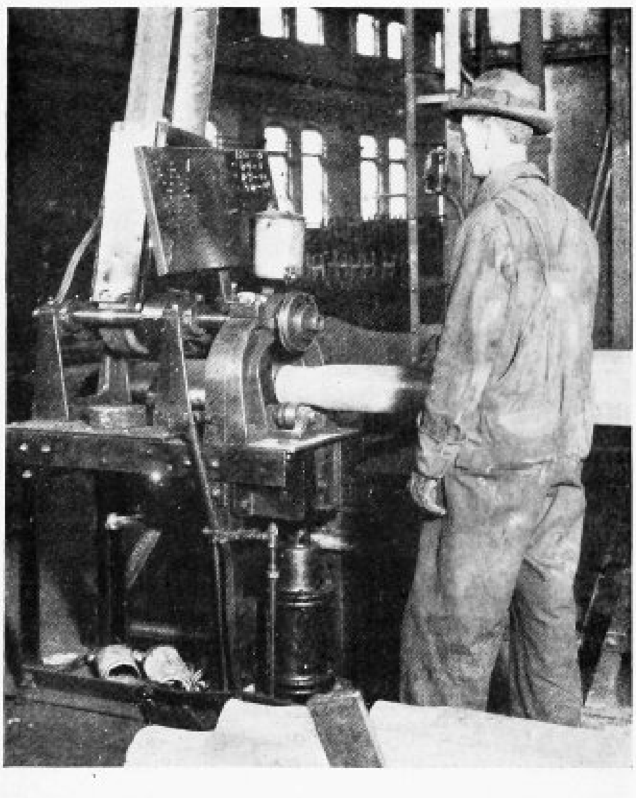


Safe Ending *at the* N. & W. Shops

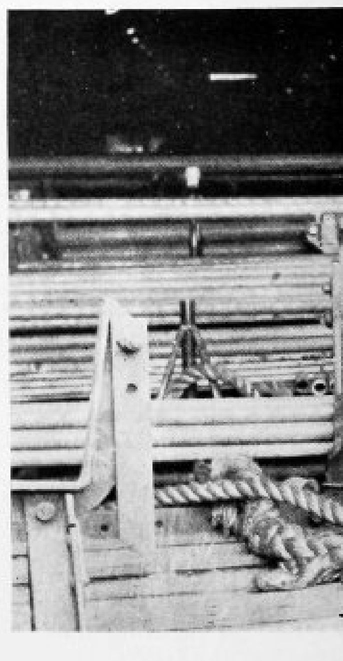
With a normal output of approximately 500 safe-ended flues in an eight-hour day, the safe-end department of the Norfolk & Western Railroad, Roanoke, Va., has attracted wide attention. Not only because the department can turn out reclaimed flues at a rate of one per minute, but because this is done with a minimum of effort and a total lack of confusion is this shop of interest.

Located in an obscure corner of the large erecting shop at Roanoke, this flue department occupies a space approximately 80 feet long and 40 feet wide. Considering the machinery employed in this space, the area is extremely small. This small space, rather than tending towards cramped working conditions and conflicting operations, actually works out to the advantage of the plant by reducing transportation requirements. The department is laid out for straight-line operation, starting outside the plant with the stripping of the flues and superheaters from the locomotive. The work moves in one line towards the sphere of operations in the erecting shop where the safe-ended flues are refitted in the boiler.

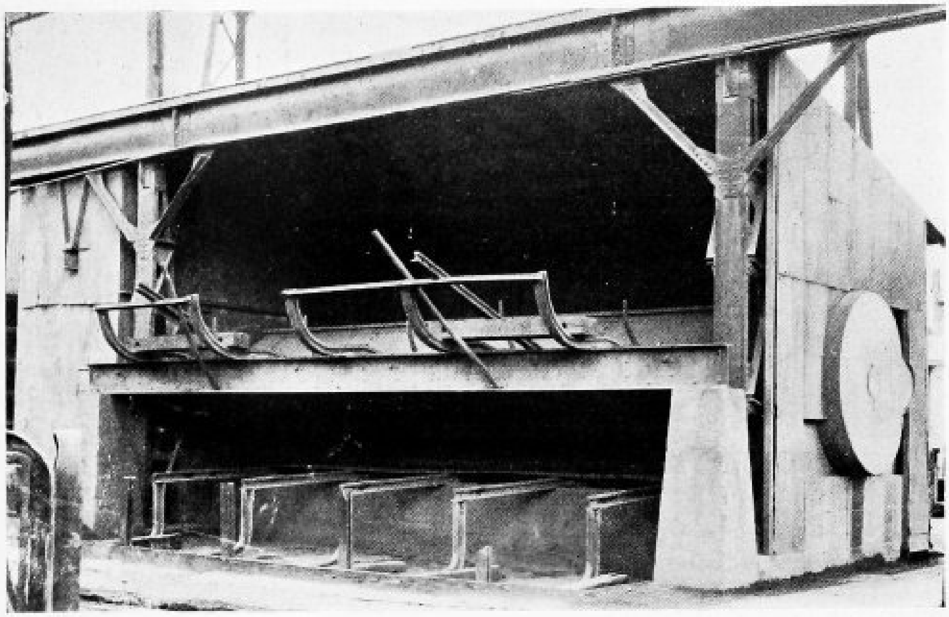
At a distance of about 50 feet from the erecting shop is located the rattler which cleans all the flues



(Above)—Cutting flues in a motor-driven machine employing circular disk cutters. (Left)—Machine for cutting superheater tubes. (Right)—The safe ending machinery layout reduces transportation



The rattler at the Roanoke shops can clean 285 locomotive flues at one loading



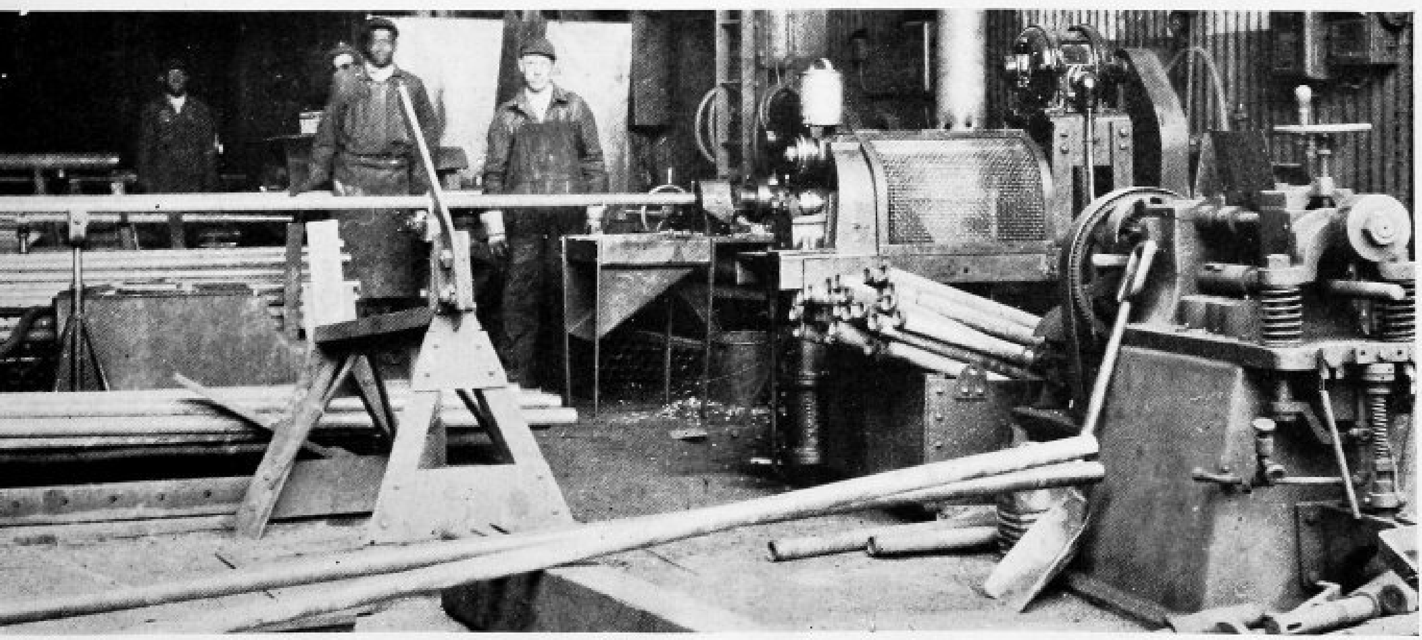
of a locomotive boiler at one loading. This machine, designed and constructed by the Norfolk and Western Railroad, has been in service 15 years. It is operated by a 100-horsepower, alternating-current motor. The normal capacity of the rattler is 285 standard flues of 2¼ inches diameter at one loading. These are cleaned in an hour to an hour and a half, depending on the condition of the flues which may have lengths up to 24½ feet. Fifty-eight superheater tubes may be cleaned by the machine at one loading.

It is the practice at the Roanoke shops to keep all of the flues of one boiler together and all of the superheater tubes together while they are being put through the safe-ending process. Flues and superheaters, however, are never cleaned in the rattler at the same time.

On completion of the cleaning process, the flues are taken to the safe-ending department by means of an overhead traveling crane which places the flues just inside the large doors before the first machine. Adjacent to each machine is located a frame of angle and plate steel construction, into which the flues are placed in order to keep the material off the floor.

The first machine through which the flues pass is a flue cutter designed and built by the Norfolk and Western Railroad. This machine, which is motor driven, employs a circular disk cutter. Two idler rollers below the cutter disk hold the work and exert an upward pressure on the work to speed the cutting process. Pressure on the idler rollers is controlled by a compressed-air cylinder beneath the rollers. A foot-actuated valve regulates the air cylinder.

The flues are held at the proper height in the machines by two or more roller-topped jacks located along the length of the flue.



On completion of the cutting process the flue is dropped into the next frame, where it is ready for the next operation. The location of frames between the machines merely necessitates the raising of the flue from the frame on the left, placing it on the lining-up rollers, and, after the operation, dropping the flue into the right frame.

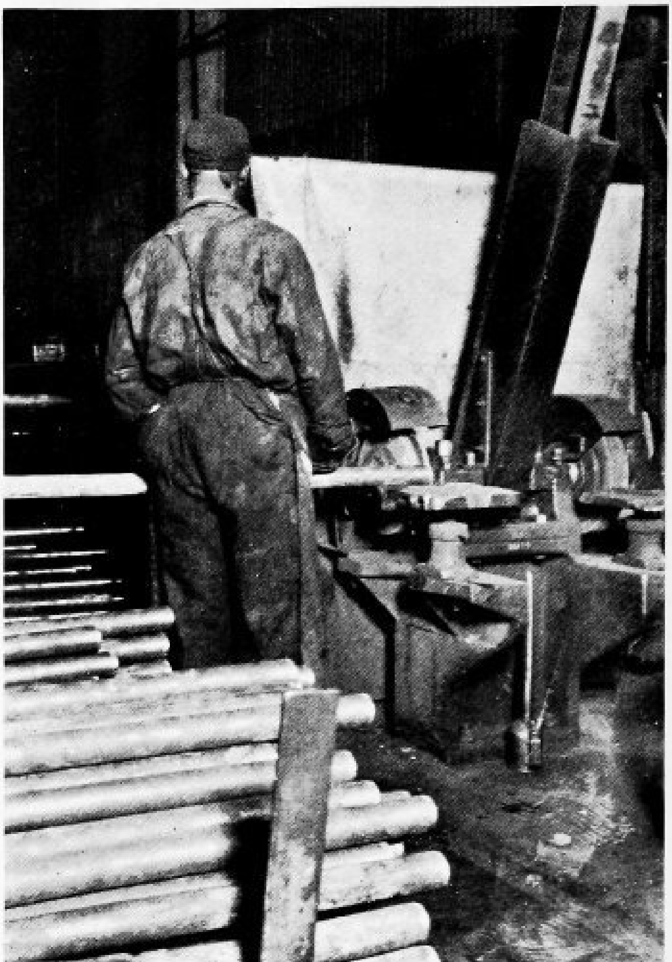
The next machine scarfs the cut flue end prior to welding the safe end. This machine is a redesigned bolt cutter made by the Norfolk and Western Railroad. The work is held in the machine by means of a vise arrangement with jaws shaped to take the flue. The machine is motor driven.

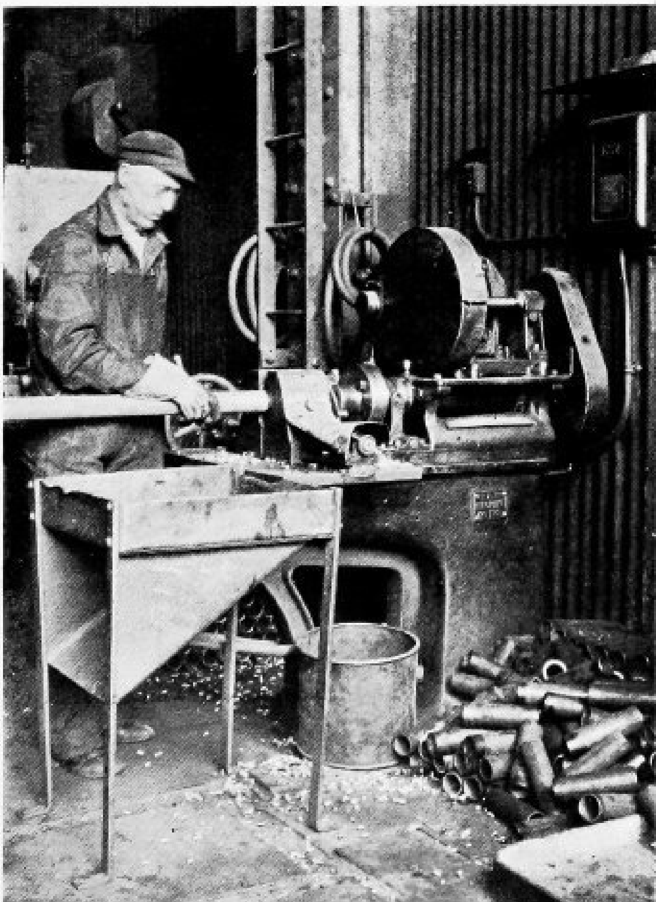
Following this operation, the tube passes to a double emery wheel where the end of the flue is ground to produce a satisfactory welding surface. This machine is also a Norfolk and Western product and prepares the flue for the welding of the safe end.

The welding of safe ends at Roanoke is accomplished by use of an electric resistance machine. This system has been in use at this shop since 1912 when the first resistance safe-end welder was installed in a railroad shop. The first machine is now in use at the Portsmouth, O., shops of the railroad.

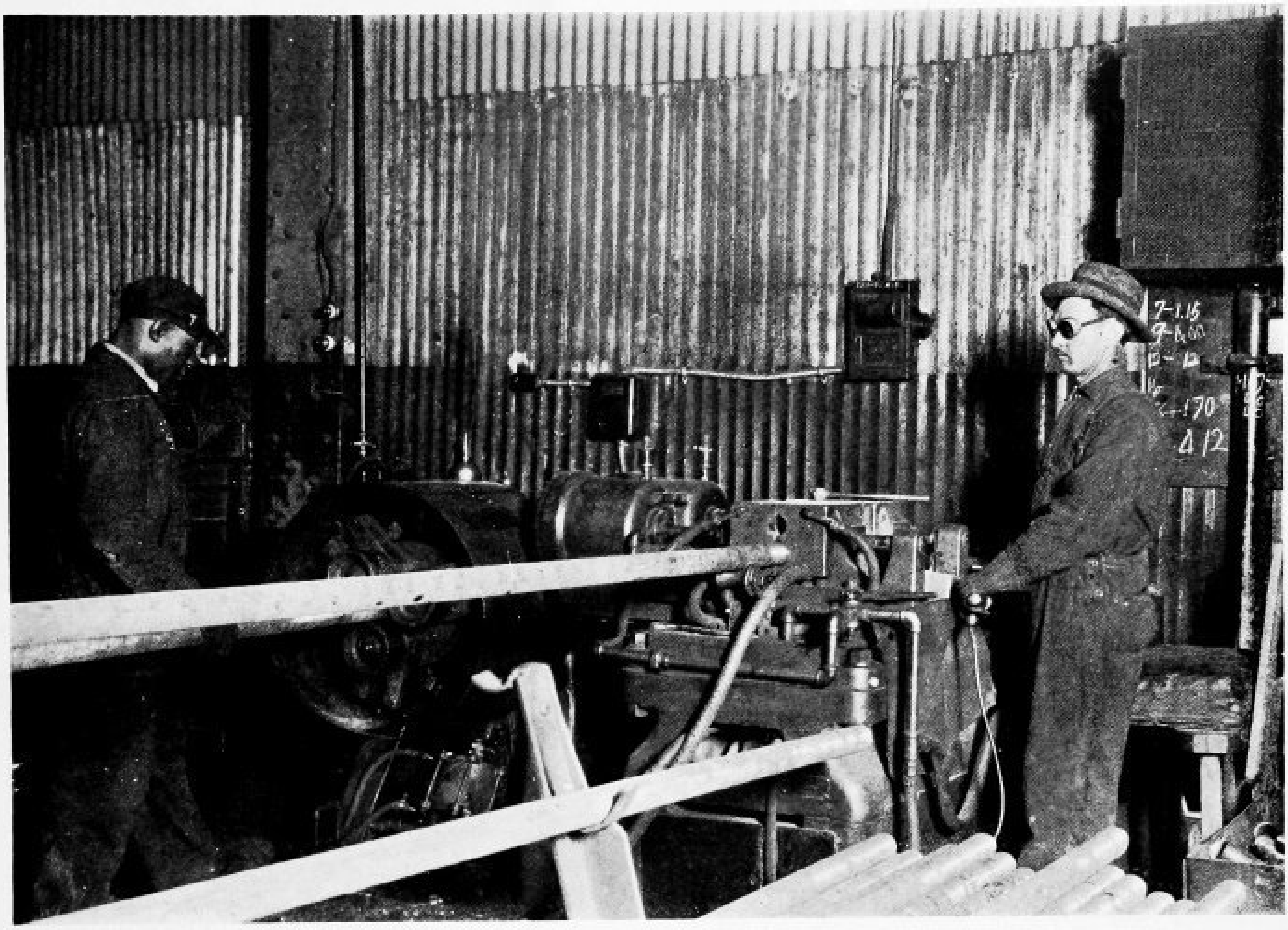
The resistance welder now in use is equipped with pneumatically-operated clamps having interchangeable copper dies for flues from 2 inches to 6 inches diameter. The pressure necessary to push up and consummate the weld is secured by means of a double-acting hydraulic cylinder mounted directly on the welder. The voltage and current regulator for various sizes of flues is obtained by a five-point regulator switch mounted on the right hand end of the welder frame. All copper dies are thoroughly water cooled as are also the secondary lead connections. With a 2¼-inch flue, the welding time is about 13 seconds resulting in a production of between 60 and 70 flues per hour. With superheaters, however, the welding time is about 30 seconds resulting in a production of approximately 8 per hour.

With the flue still hot from the welding operation, it is passed to a flue roller which rolls down the weld of the tube and safe end. This machine has a cast-iron frame supporting a large hollow cylinder rotated by a 5-horsepower motor. The front of the rotating cylinder carries three idler rollers, being adjustable in and out from the center by means of a separate screw and slide arrangement. The slide, supporting the rollers, is linked with three toggle levers which receive movement while in rotation by means of a foot-operated air-cylinder mechanism. A stationary mandrel supports the tube in the center of the rotating cylinder and carries a welding former, for each size of tube to be welded, at the center of the welding rollers.





(Right)—Grinding the flue end prior to the safe-end welding operation. (Below)—Redesigned bolt cutter used for scarfing the flues for welding



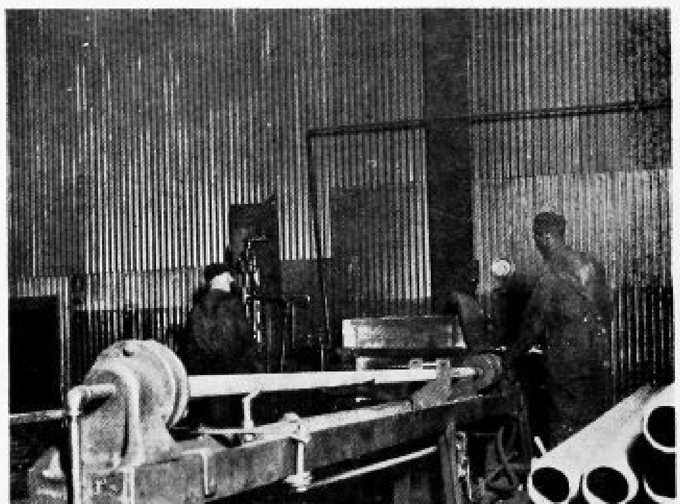
In operation the tube with its safe end is pushed over the welding former so that the weld is directly under the rollers. These are brought down on the heated weld by means of the foot valve operating the air cylinder, and the rotation of the head revolves the rollers around the weld smoothing it down outside and inside.

Following the safe-ending process, the flues are tested in a hydraulic testing machine to determine the soundness of the weld. The flues are then stacked at the inside end of the department from which point they are moved by crane to the flue-fitting floor.

The safe-ending department is served by a 10-ton overhead crane.

In the course of this article the process of safe ending superheater tubes has not been dealt with in detail. However, this process, with the exception of the cutting operation, follows the straight-line method similar to that employed for flues. A special superheater tube cutter is located at the opposite side of the department. The flue welding machine may be employed for superheater flues as well.

This department, composed of 10 men, handles the entire safe-ending requirements of the Roanoke shop. Speed is not a vital factor in the operation of the department since the production schedule of the shop is not so great that speed is demanded. But the department is well laid out, compact, and so arranged that handling of materials is reduced to a minimum.



(Above)—Electric resistance safe-end welding machine with flue roller at the left capable of safe ending more than sixty flues in an hour's time. (Below)—Hydraulically testing flues

Method of calculating the

Efficiency of Boiler Patches

By Howard P. Gordy

Much has been said in the past concerning the use of patches in boiler repair work but little has been mentioned in regard to methods for calculating the efficiency of boiler patches. In this respect the following method used by the Baltimore and Ohio Railroad Company, Baltimore, Md., for calculating patches may be of interest. These rules, applicable to means for reinforcing longitudinal cracks from 1 inch to 12 inches in length, employ the following functions:

l = length of crack in inches.
t = Thickness of shell in inches to which patch is to be applied.
TS = Tensile strength of course to which patch is to be applied.
S = Shearing value of one rivet in single shear.
N = Number of rivets in single shear.
p = Shortest pitch of rivets.
d = Diameter of rivet holes.
E = Efficiency.
F = Factor for angularity.
P = Working pressure of 210 pounds per square inch.
r = Radius of shell, 38¼ inches.

As an example, assume the patch shown herewith is to be applied to the first course of a locomotive boiler to reinforce an 8 inch crack. The thickness of the shell course to be patched is ¾ inch, and the course has a diameter of 76½ inches. The thickness of the patch should be equal to the thickness of the shell, or ¾ inch. The tensile strength of the shell course is 55,000 pounds per square inch.

To find the exact length of crack, drill a small hole at each end and consider the distance from the extreme edge of one hole to extreme edge of the other hole as the length of the crack. The actual value of the metal lost by the crack can then be determined.

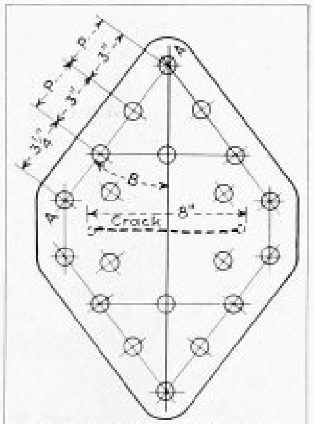
Actual value of metal lost equals:
$l \times t \times TS$, or 8 inches $\times$ ¾ inch $\times$ 55,000 = 330,000 pounds

After finding the value of the metal lost by the crack, it is necessary to determine the number of rivets in shear needed on each side of the patch. To do this use the following formula: (assuming 1-inch diameter rivets, $1\frac{1}{16}$-inch diameter holes will be necessary to insure good caulking with ¾-inch plate).

Number of rivets needed in shear,

$$N = \frac{l \times t \times TS}{S} = \frac{8 \times \frac{3}{4} \times 55{,}000}{39{,}010} = 8.4$$

The above calculation shows that it is necessary to have at least 8.4 or approximately 9 rivets in single shear on each side of the patch to make the shearing value of the rivets at least equal to the value of the metal lost by the crack. The patch selected has 10 rivets in shear on each side of the crack so it can be seen the number of rivets is sufficient.



Patch for 8-inch crack

Knowing the patch has sufficient rivets, and that they are placed to give a good caulking space, the efficiency along the line *A-A* must be determined. The patch must have an efficiency at least equal to the efficiency of the longitudinal seam.

To find this efficiency the line of rivets *A-A* must first be figured as a longitudinal line not considering the angularity the line *A-A* has with a vertical center line of the shell.

Efficiency (without considering angularity),

$$E = \frac{p - d}{p}, \text{ or } \frac{3 - 1\,1/16}{3} = 64.5 \text{ percent}$$

Providing the line of rivets *A-A* were in a horizontal line, the efficiency would be 64.5 percent. This, however, is not the case, and the number of degrees in the angle *B* must be found. This can be determined by trigonometry or the use of a protractor.

After finding the number of degrees in angle *B* which is 36½ degrees or approximately 37 degrees a factor can be determined which allows additional strength due to the angularity of the line of rivets *A-A*.

The following formula gives the factor allowed due to angularity of the line of rivets *A-A*:

$$F = \frac{2}{\sqrt{3 \times \text{sine } B^2 + 1}} \text{ or}$$

$$\frac{2}{\sqrt{3 \times .6018^2 + 1}} = 1.385$$

By multiplying the efficiency obtained without considering the angularity, by the factor allowed due to the angularity the actual efficiency along the line of rivets *A-A* is as follows:

$E \times F$ or $64.5 \times 1.385 = 89$ percent

In summing up, the entire formula for the efficiency along the line of rivets *A-A*, can be expressed as follows:

Angular efficiency =

$$\frac{2\,(p - d)}{p\sqrt{3 \times \text{sine } B^2 + 1}} \text{ or}$$

$$\frac{2\,(3 - 1\frac{1}{16})}{3\sqrt{3 \times .6018^2 + 1}} = 89 \text{ percent}$$

Having determined the efficiency of the patch, the bursting pressure of the shell to which the patch is applied can be obtained.

$$\text{Bursting pressure} = \frac{TS \times t \times E}{r} \text{ or}$$

$$\frac{55{,}000 \times .75 \times .89}{38.25} = 959 \text{ pounds per square inch}$$

Dividing the bursting pressure by the working pressure gives the factor of safety.

$$\text{Factor of safety} = \frac{\text{bursting pressure}}{\text{working pressure}} \text{ or } \frac{959}{210} = 4.56$$

Drill Test Holes in Shells of Unfired Pressure Vessels

By George H. Stickney*

Prevention of accidents through detecting weakened structures and observing unsafe operating practices is the underlying purpose of inspections by insurance companies. However, the owner and insurance company both are anxious to maintain equipment in good shape so, naturally, it does not matter by whom or through what agency the discovery of unsafe conditions is made so long as an accident is prevented.

The purpose of this article is to explain a type of drill test hole which will act as an eternally vigilant watchdog to give warning when the shell metal of pressure vessels (boilers excepted) becomes so thin that it is no longer safe for the pressure carried. This is to be in addition to regular inspections and not in any way to take the place of them. It detects merely the dangerous thinning of shell plate, whereas inspections reveal many and varied unsafe conditions.

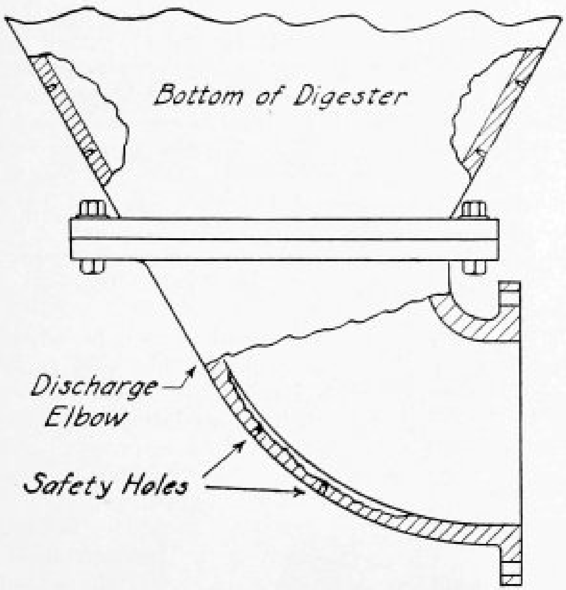


Fig. 1.—Elbow at bottom of digester, where metal is eroded

Definite knowledge that plate thickness is within safe limits is one of the most important features in explosion prevention, and it is one of the most difficult to determine by the usual inspection methods.

Unfired pressure vessels differ from boilers in that they are used to a great extent to cook or prepare stock of all kinds in process of manufacture. In stationary vessels the stock moves about and circulates under steam pressures and temperatures and, by scouring action, wears away the shell metal.

In rotating vessels wear is very positive and has been found, in many cases, to reduce plate thickness uniformly throughout the entire inner surface of the vessel.

Many localized areas in these vessels need special precautions against dangerous thinning. As an example we can mention a discharge elbow at the bottom of a digester, rendering tank or any other vessel with a fitting or part through which stock is blown when the cooking process is finished. Erosion is concentrated and severe at the turn of the elbow, Fig. 1. Frequently the metal wears completely through at this point, resulting in loss of material and possible danger to persons.

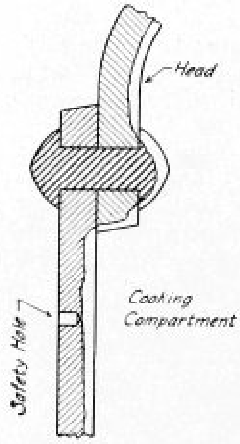


Fig. 2.—Erosion in single shell vessel

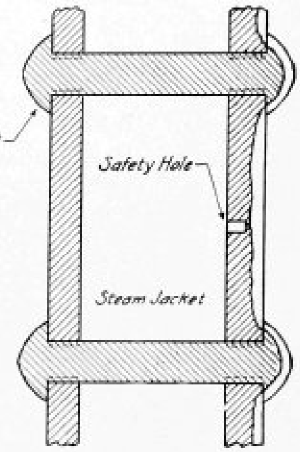


Fig. 3.—Erosion in double-shell vessel

Drill testing by merely drilling through the metal and then measuring the thickness, sealing or plugging the hole afterward, has been about the only method for accurately determining thickness. This method has many disadvantages and inspectors have generally encountered substantial resistance, for some very good reasons, on the part of owners and users when the *through* drill testing has been proposed.

All that we are interested in regarding thickness is to know for a certainty when metal under pressure and subject to wasting has been reduced in thickness to such an extent that the remaining metal is not sufficient to withstand with safety the pressure carried. For this purpose we recommend what may be termed *predetermined minimum safe thickness test holes*, which are of ¼-inch diameter and drilled from the outside (in a single-shell vessel) to a depth equal to the minimum safe shell thickness, Fig. 2.

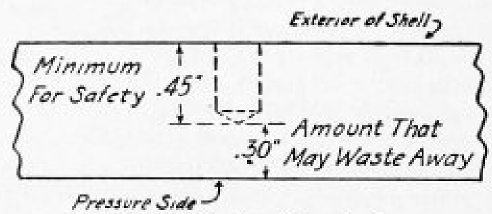


Fig. 4—Depth of test hole

The designed maximum safe working pressue of an unfired pressure vessel should be based on a factor of safety of at least five, and it is believed that manufacturers generally meet this standard. The depth of the test holes at the point of the drill should be suffi-

* Superintendent boiler department, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn. Reprinted through the courtesy of *The Locomotive*.

cient to equal a shell thickness that will give a factor of safety of at least three.

Following are the formulae for computing the safe working pressure of single-shell vessels and the minimum safe shell thickness:

$$(1)\ SWP = \frac{t \times TS \times \%}{R \times FS} \qquad (2)\ t = \frac{P \times FS \times R}{TS \times \%}$$

where SWP = safe working pressure; t = plate thickness; $\%$ = efficiency of longitudinal joint; FS = factor of safety; TS = tensile strength of shell material; R = radius of shell.

As an example we may consider a shell 72 inches in diameter, ¾-inch thick, and with a longitudinal joint of 80 percent efficiency. The safe working pressure of this vessel would be:

$$SWP = \frac{0.75 \times 55{,}000 \times 0.80}{36 \times 5} = 183 \text{ pounds per}$$

square inch.

Using this value in Formula 2, and substituting 3 as the value of FS,

$$t = \frac{183 \times 3 \times 36}{55{,}000 \times 0.80} = 0.45 \text{ inch is the minimum}$$

safe thickness

and the depth to which test holes should be drilled, Fig. 4.

The pitch or distance between centers of holes is more or less arbitrary, but in general it should be in proportion to the size of the vessel and in consideration of whether the anticipated wasting is general and uniform over the entire surface, or localized within a restricted area. For very large vessels, say over 72 inches in diameter and subject to uniform wasting, a pitch of from 36 inches to 48 inches is suggested. For vessels between 36 inches and 72 inches in diameter a pitch of about 24 inches to 36 inches will generally give adequate protection, while for smaller vessels the pitch can be reduced to about 12 inches, except where intense wasting away is anticipated within a restricted area. In that event it may be advisable to drill a few holes at carefully selected points over a smaller area.

When metal on the interior or pressure side of the shell wastes away sufficiently to communicate with the bottom of a hole, steam or any other pressure will blow out into the room and give warning by being heard or seen.

In double-shell vessels such as jacketed tanks and hemispherical kettles, the inner shell is the one subjected to reduction of thickness and is therefore the one that must be protected by drill test holes. The holes should, of course, be drilled in the inner shell from the pressure or jacket side, Fig. 3.

There should be frequent visual inspections of jacketed vessels with pressure in the jacket and the stock-containing chamber empty and open. For very large vessels it will be necessary to use an electric light connected to a long extension cord. Swinging this light around will enable the operator to detect any steam that may be blowing into the vessel.

These test holes in jacketed vessels must, by necessity, be drilled at the time of manufacture. Single-shell vessels can be drilled after installation, but it is better to do the drilling during construction in the shop, particularly for vessels that are to be lagged with insulating material on the outside. When lagging is contemplated small pipes, can be secured to the shell directly over the holes.

Sometimes the question arises as to whether these test holes weaken a structure. We can assure anyone that they do not. In fact, the plate itself can be weakened and still remain stronger than the longitudinal seam, which is scarcely ever 95 percent as strong as the solid plate. So unless the holes weaken the plate below the strength of the longitudinal seam, the strength of the structure is not changed. Quarter-inch holes, spaced as close as 12 inches apart and drilled entirely through a plate, will reduce the net strength of the plate only one percent, as may be seen by the following calculation: $(12 - 0.125) \div 12 = 0.99$. From this it is evident that such test holes are too small and too widely spaced to affect the vessel's strength.

Although this method is not new, it has not been generally practiced by manufacturers and certainly has not been used to the extent its merits warrant.

Manufacturers are urged to provide minimum safe thickness test holes as regular practice for all vessels that are used in any service where the metal is subject to wasting away from any cause. If the holes are drilled when the plates are on the laying-out table it will take very little time and the cost will be small.

Portable Horses

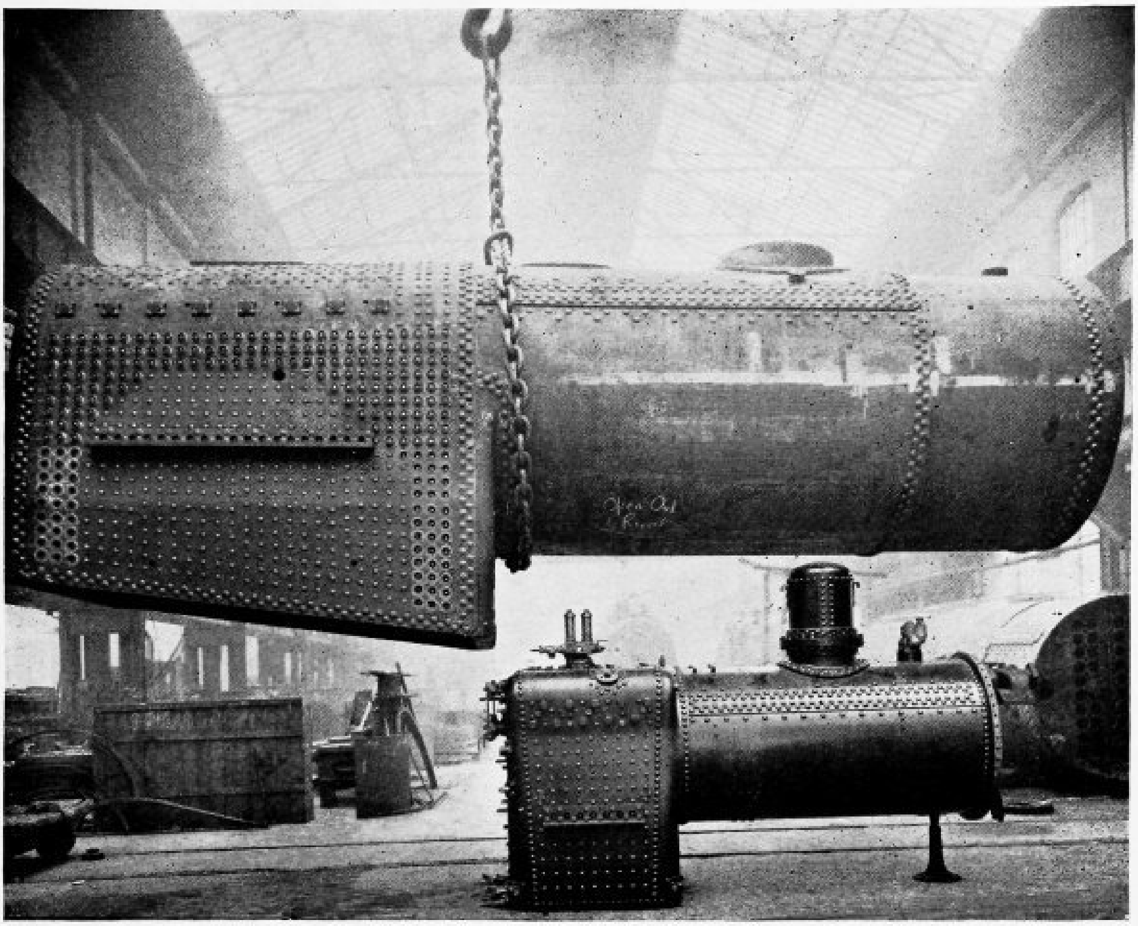
A folding steel horse, utilizing standard sized lumber as a rail, has been introduced by the Toledo Pressed Steel Company, Toledo, O., for use in mills, boiler shops, machine shops and other plants associated with the metal-working industry. This horse, shown in the illustration, has a cross member constructed as a toggle and when this is clamped down, the jaws of the horse grip the wooden rail tightly. The jaws bite down as well as in, binding the rail firmly on three sides, preventing splitting and side-sway—no other bracing is required.

There are no springs to break or set, no adjustable parts to manipulate, yet ordinary thickness variations for any standard sized lumber are readily accommodated. The legs are made from heavy gage steel in the shape of 3-inch ribbed channel sections.

Folding steel horse

Taken down, the horse folds compactly, making transportation and storage simple. They are supplied in eight heights 18 to 60 inches, and different models take 1-inch or 2-inch wood rails on edge or 2 by 8-inch flat. Some idea of their weight may be obtained from the fact that a pair of 25-inch horses weigh 24 pounds.

There are many uses in the shop and in the field to which these horses may be put.



An interesting contrast of two new Beyer-Garratt locomotive boilers recently completed at Gorton Foundry, Manchester

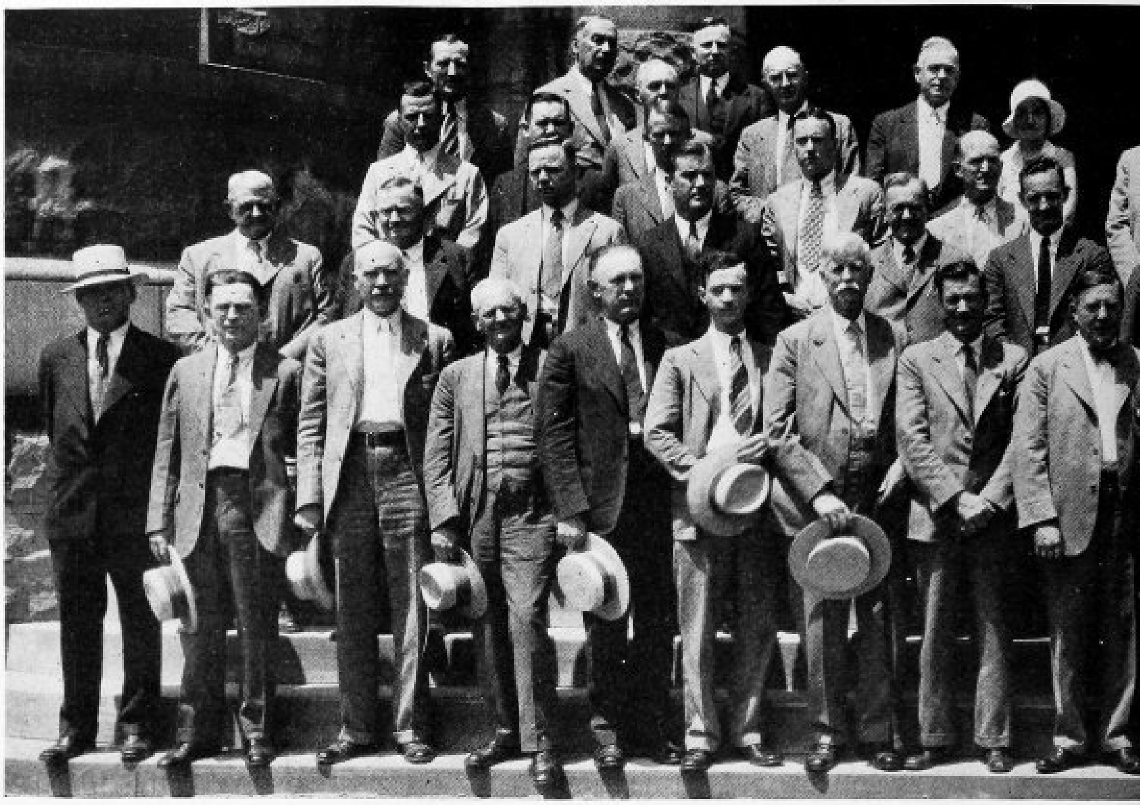
A contrast in British Boiler Types

By G. P. Blackall

Two notable locomotive boilers have recently been completed at Gorton Foundry, Manchester, England. The smaller is for a Beyer-Garratt locomotive built for the Ceylon Government Railways 2-foot 6-inch gage. The larger is destined for one of six big Beyer-Garratt locomotives for South Africa.

The smaller boiler has a diameter of 3 feet 10 inches, and is 7 feet in length, with a firebox 4 feet by 4 feet 10⅜ inches outside dimensions. There are 105 tubes in the boiler barrel, and the total heating surface of the boiler and firebox is 574 square feet, with a grate area of 14.9 square feet. Its weight is over seven tons. The big boiler is 7 feet 3⅜ inches in diameter by 14 feet long, and the outside dimensions of the firebox are 10 feet 9 inches by 8 feet 5 inches. There are 313 tubes in the boiler barrel, and the total heating surface of the boiler and firebox is 4185 square feet, with a grate area of 74.5 square feet. The weight of this boiler is 40 tons, which is virtually the same as the total weight of the complete locomotive going to Ceylon.

The view shown of the two boilers in the builder's plant indicates very graphically the scope of work covered at the Gorton Foundry.



Members of the National Board of Boiler and Pressure

National Board Discuss

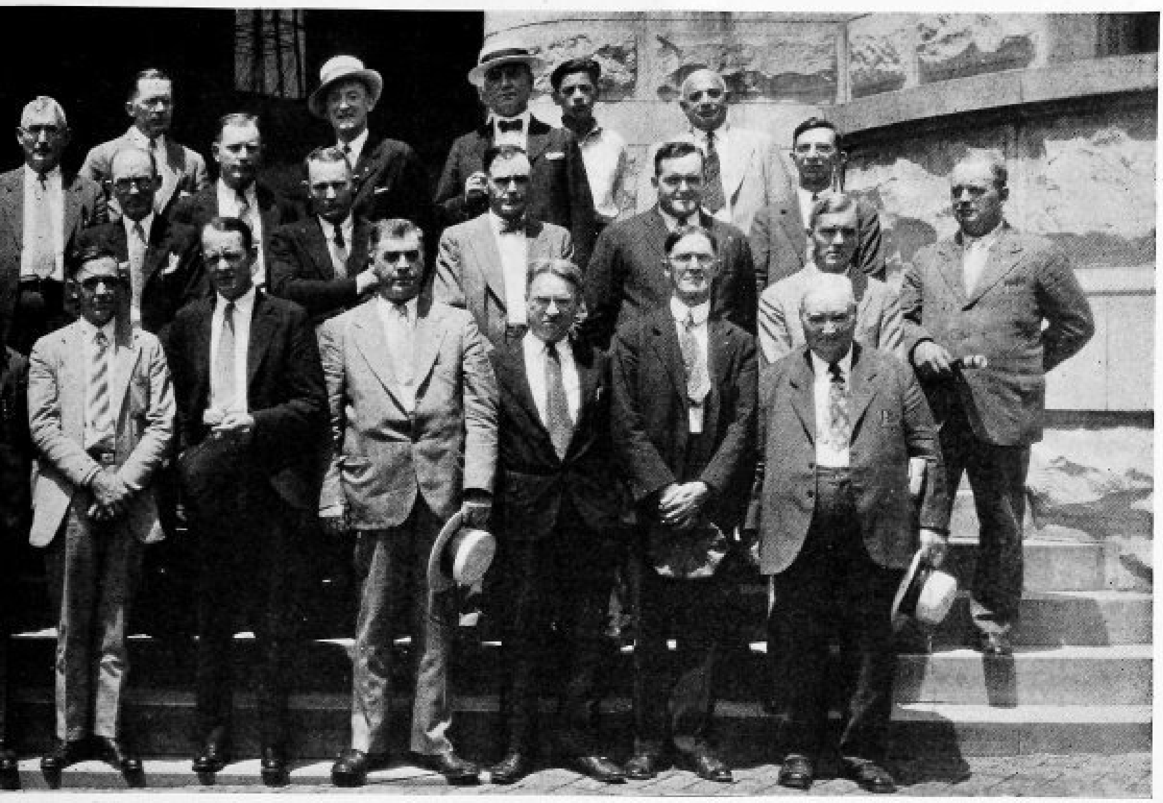
Question box features eighth ann vessel inspectors' organizatio were registered with National Boar

On June 17, C. D. Thomas, chairman of the National Board of Boiler and Pressure Vessel Inspectors, opened the eighth annual meeting of that organization at the Hotel Patten, Chattanooga, Tenn. About seventy-five state, city and insurance company inspectors, all members of the board, and their guests, from the boiler manufacturing and supply companies were in attendance. Chairman Thomas, who is chief boiler inspector in the State of Oregon, presided throughout the entire three days' duration of the meeting. After the formalities of welcoming the inspectors to Chattanooga by representatives of the city government and the manufacturers' organization, Chairman Thomas presented his annual address, an abstract of which follows:

Function of the National Board

The Boiler Code Committee, as you know, formulated a set of rules and regulations for the manufacture, installation and operation of steam boilers and other pressure vessels. After these rules were formulated, some manner of uniform enforcement was necessary if they were to prove of any value to the various interests involved. The Boiler Code Committee realized that it was impossible for its members to have anything to do with matters of a political or commercial nature. It therefore could not place or enforce these regulations in the different states and cities; hence, the Uniform Boiler Law Society was organized. The activities of this organization resulted in the adoption of the boiler code in many states and cities now operating under the code. However, the adoption of a uniform standard did not necessarily mean a uniform application of the code for the reason that the various chief inspectors of these subdivisions had ideas of their own which, at times, varied considerably from each other. Therefore, the Boiler Code Committee invited the chief inspectors of these political subdivisions to become an advisory committee to the Boiler Code Committee. Thus, the Boiler Code Committee was kept in close touch with the actual working conditions of the code, and was able to assist, by interpreting the various paragraphs of the code, in a more uniform application of its rules. This procedure did result in greater harmony in the application of the rules, yet, it did not bring the states and cities into complete agreement.

In order to have this agreement complete, or as nearly so as possible, the National Board of Boiler and Pressure Vessel Inspectors was organized. This organization consists of the chief inspectors of the various political subdivisions operating under the code of rules formulated by the Boiler Code Committee. By holding meetings annually, we are able to exchange opinions and settle differences that may exist, and work in complete harmony with the Boiler Code Committee.



ctors and their guests assembled for eighth annual meeting

Boiler Code Enforcement

eeting of the boiler and pressure uring past fiscal year 250,957 boilers cidents due to boiler failures increase

We believe that the existence of this Board has resulted in a better understanding regarding the object of the Boiler Code Committee than could have been obtained by any other method. We are not only able to advise the Boiler Code Committee on the practical application of its rules, but we are also able to relieve them of many duties which otherwise would necessarily be brought up for their consideration. As time goes on, this organization will be able to take over still more duties in the way of designs and tests that would otherwise be incumbent on the Boiler Code Committee.

The manufacturers of boilers have also, we believe, received some benefits from the organization of this body. It is needless to call your attention to the chaos that existed in the manufacturing industry prior to the adoption of the code. Competition was so keen that the manufacturer desiring to make a good safe product could not compete with the irresponsible maker of boilers. The public at large could not distinguish the difference between a boiler made of good material with first-class workmanship and one of inferior metal and poor workmanship, for the reason, that in outward appearance they looked about the same and the result was that the cheaper boiler generally got the preference.

The National Board, through its control of all inspectors, is in a position to render valuable service to the manufacturer. If an inspector permits some manufacturer to disregard a certain provision of the code or to cheapen his product by inferior workmanship, it will soon be noticed when that boiler is placed in service and a revocation of his commission to inspect boilers will follow. This is not only a protection to the legitimate manufacturer but it also is a protection to the user as well as the public.

It is not the purpose of the boiler inspector to unnecessarily find fault with a boiler being manufactured in a shop. He is there to assist the manufacturer in the full compliance with the code, and when errors do occur, to point them out and insist on a correction being made. It is his duty to see that the proper materials are being used; to note the manner in which the boiler is being fabricated; to check on designs and see that they conform to the code. When there is any doubt in his mind as to the design or manner of construction, he should immediately consult his superior before accepting such a design or permitting practice in which there is some doubt, and obtain a decision before such progress has been made, which can not be readily rectified. Boiler manufacturers not only accept such an inspection but they desire it. It has been our experience that they are ever ready and anxious to comply with all reasonable demands, especially when such demands are backed by the boiler code itself.

What has been said of the boiler manufacturers applies equally as well to the manufacturers of unfired pressure vessels. The Code for Unfired Pressure Vessels is now being revised so that it will be more practical in its application. Strict shop inspection is required for all such vessels. Should the manufacturer of unfired pressure vessels desire that his product be acceptable in all states and cities which have code regulations, he should immediately register with the secretary of the National Board and demand that his product be inspected only by such inspectors as hold commissions in the National Board. His product can then be stamped National Board and this will guarantee to him that it can be used in any state or city that has code regulations. Unless the manufacturers of unfired pressure vessels wake up and realize the necessity of standard methods of manufacture and inspection of their products, they will have difficulties of all kinds in having their product approved by the various states and cities operating under the code.

I wonder if you fully realize that more property is destroyed by the explosion of unfired pressure vessels than is destroyed by the explosion of steam boilers. There is a reason for this. The boiler manufacturers have adopted standard and safe methods. Why manufacturers of unfired pressure vessels will persist in making both code and non-code vessels is rather hard to understand. Yet, they do this very thing and for no other reason, as I see it, than to grab a few dollars, unmindful of the possible destruction of life and property.

We hope to see the day, and not in the far distant future, when manufacturers of all vessels will adopt safe and sane methods of manufacture; when they will say to the prospective purchaser that wants a cheap unreliable product, "We will not build such a vessel for you. It is unsafe and will not give the service required, but we will build you a vessel that is safe and we will back it with our guarantee, that if properly used, it will render good service for years to come." Do away with all cheap methods which have caused so much destruction in the past. Manufacture all your vessels according to the rules of the Boiler Code Committee. Then if the vessel is properly supervised after being installed, you can sleep in peace knowing that you have done all in your power for the public good.

I am unable to understand just why the manufacturers of unfired pressure vessels hesitate to furnish data reports with their product. This has been the practice of the boiler manufacturers ever since the code became effective. Are not unfired pressure vessels equally as dangerous as fired? Can they not realize that a vessel containing air or explosive gases is equally as dangerous to the public as boilers? Why is it that manufacturers of unfired pressure vessels desire to make vessels of a thinner metal than is required for boilers for the same pressure? Is there any reason why special dispensation should be given to the manufacturers of unfired pressure vessels? We believe not, and so far as Oregon is concerned I issue this warning, that we will not accept a vessel for installation unless the same complies with the code in every respect and a manufacturer's data report attested by a certified inspector is filed with our department for each and every vessel used in our state.

To avoid any misunderstanding regarding this we would advise all manufacturers to register with the National Board of Boiler and Pressure Vessel Inspectors and send data reports in duplicate to our secretary-treasurer. This will guarantee to you that your product may be used in any state or city operating under the code.

I have perhaps stressed the necessity of manufacturers registering with the National Board in rather strong language, but I want to impress upon your minds that unless you do so register you run the risk of your product being acceptable only by such states or cities as will accept any product whether inspected by a qualified inspector or not. What I mean by a qualified inspector is this; those who have proved by their experience and knowledge that they are qualified and have passed the examination required by the National Board and hold commissions from that board to inspect boilers and other pressure vessels.

The public, of course, is not in a position to grasp all the benefits to be derived from a uniform administration of laws relative to boilers and pressure vessels. But when we can tell them that it makes for safety of life and property; that the manufacturer, knowing his product is acceptable in all places where the code is effective, is able to produce boilers and pressure vessels at a smaller cost than when each state or city has a special law requiring special construction; that all vessels manufactured under those rules are safe in so far as it is within human power to make them safe; that he is buying a boiler or pressure vessel that is dependable and if given reasonable care will render service much longer than could be expected under the old practice; that he is receiving more value for his money than could be possible under the old method; when we can tell him that the symbol, stamped on the vessel with a National Board number is a guarantee to him that the material used and the manner of construction is of the highest standard, he can then feel assured that he is at least receiving a square deal. When an inspector visits his plant and points out defective valves, dirty water glasses, unprotected blow-off piping, minor leaks here and there, or where the boiler is dirty, setting defective and many other defects incident to the operation of his plant, it is not for the purpose of criticizing his plant but to have these defects remedied before they become dangerous and to help him to keep his plant in a condition that will produce one hundred percent in operation.

If the inspector will only remember the fact that the operator is in business to make money if possible and that he is not willing to incur needless expense, but when you can show him that by making this or that improvement he is assured of a greater output or that by repairing his machinery at once or replacing defective or unreliable part, he will be assured of continuous operation and thereby save a dollar, he is not only willing to listen but will not delay in making the needed change.

When the National Board was first organized, I am sure that the chief inspectors of the various states and cities represented had different ideas as to the proper method of enforcement. Evidence of this was shown at our first meeting in Detroit in 1921. If those of you who have copies of the proceedings of this meeting will scan its pages, you will readily grasp the different ideas there expressed, but I wish to call your attention to this fact, that although each had a different opinion regarding the manner of enforcement, yet all were in a receptive mood and showed by their spirit of cooperation that they were willing to exchange their ideas with the hope that by doing so some uniform method of procedure would develop whereby all could be brought together. I am glad to state that it was the seed sown at this meeting which grew and developed into what we are today.

I am of the opinion that every state and city affiliated with this organization is receiving a wholesome benefit from its influence. I know that my state has, for the reason that manufacturers who were opposed to the safety orders when first put into effect, now not only admit they have been beneficial, but are enthusiastic regarding the results obtained. I want to impress the fact upon your minds that uniform action and uniform results can only be obtained by and through this organization. The same may be said of the ones who receive the most benefits of all, the user.

While the Code Committee, the boiler manufacturer and the user are in full accord, are we, the National Board members, doing our part? You will note on the program the purpose for which we were organized which is as follows:

"The National Board of Boiler and Pressure Vessel Inspectors is 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"

This declaration of principles must be adhered to if we expect beneficial results, and in so far as it relates to boilers, I believe we have the situation well in hand, but we are not so well organized in the unfired pressure vessel field. The reason for this, of course, is that the code itself is not yet complete. Yet, there is sufficient information in this code to establish a standard. In a recent communication from the Chairman of the American Uniform Boiler Law Society, I find that seven states have adopted this code; two others have adopted the code with restrictions and several states and cities have the code under consideraion at this time, and there is no doubt in my mind that as soon as the present proposed revisions are embodied in the code, many of these states and cities will accept it as their standard.

It therefore behooves the members of this organization to stand as a unit in the support of the Boiler Code Committee, making one standard for all, the same as is done with the boilers, and not compel the manufacturers to stamp their product with a state standard or drive them to the necessity of inquiring of the officials of each state or city whether their product can be used or not.

There are cases on record where local manufacturers have refused to manufacture vessels after a decision of the Boiler Code Committee to the effect that the vessel would not meet the code requirements, other manufacturers outside of this state did manufacture such vessels in violation of this provision and attempted to install them in that state.

As soon as the present proposed changes in the unfired pressure vessel code are adopted, I hope that all states and cities now operating under the code will adopt these rules as their standard and do away with any special regulations that may conflict with it. This code, if revised as proposed, will meet all conditions that exist in the operating field today. Let us therefore put the full force of this organization behind it and make it the standard for every state in the union.

Progress can only come through the patient and individual efforts of the various interests involved, and the code committee can aid only by wise and helpful interpretations. There is no cure-all for our troubles, no magic remedy, no wizard law which can produce these results. They can only be produced by our own individual efforts. The constructive work of our amalgamated interests is assisting the people of the entire United States in the saving of life and property and in this great movement I wish every representative to feel that he is an important part.

There are, of course, certain conditions in each individual state and city in which you are particularly interested and by your attendance at these meetings we, as a whole, may be able to help you solve your problems. It is only by our united efforts that we will be able to accomplish that which will eventually harmonize our laws so that there will be one code and one rule for enforcement. With this great object in view, let us forget our own selfish interests and work in harmony for the best interest of all concerned.

Secretary Myers' Report

It is with deep regret that I call to your attention the sudden death of Wm. P. Eales, Chairman of the Pennsylvania Board of Boiler Rules and representing that state on the National Board. Mr. Eales was deeply interested in the affairs of the National Board, and his counsel and advice have been constantly sought and freely given in the developing of this board to bring about uniformity in boiler construction, inspection and installation in the political sub-divisions of the United States that have boiler inspection regulations.

The A. S. M. E. Unfired Pressure Vessel Code is becoming more popular each year, and the necessity for such a code is becoming more pronounced. At the present time we have several states and cities that have adopted this code, and within the next few years there will be a great many more states and cities enforcing unfired pressure vessel regulations.

The inspection of unfired pressure vessels is so closely allied with boiler inspection that the inspection regulations for boilers apply in all cases, particularly in shop inspection and stamping. All of you will recall the condition which existed in the interchangeability of boilers between political sub-divisions in the United States prior to the organization of the National Board, and I feel quite safe in saying that not one member of this board has the desire to go back to the old way that existed before we became organized. However, the authorities charged with the enforcement of unfired pressure vessel regulations have the same responsibilities in the protection of life and property in the enforcement of these regulations that they have in the enforcement of boiler regulations. The same provisions that you have set up to safeguard your positions in the shop inspection of boilers by having such inspections made by persons who are qualified to properly interpret and apply the Code, should be put into effect for unfired pressure vessels; that is, all states and cities which now have unfired pressure vessel regulations, and those that adopt such regulations in the future, should provide that all unfired pressure vessels shall be stamped upon completion with either their State or City Standard and serial number and the National Board serial number. When vessels are stamped in this manner there can be no question but they were inspected during construction by a person whose qualifications were tested by a written examination in one of the states or cities which are members of the National Board, and we strongly recommend that such provisions be put into your State and City Codes.

The boiler registration fees were increased effective July 1, 1929. This increase will net approximately $1800 more per year than the old rate and will take care of current operating expenses at the present time, including the expense of an annual meeting. After the expenses of our last convention were paid there was an actual balance of $104.72 on hand.

Following is the total number of boilers registered for the past four years:

	1926	1927	1928	1929
1 to 5 horsepower	13,272	11,903	12,398	13,163
6 to 50 horsepower	4,299	3,334	2,860	3,038
51 to 200 horsepower	2,007	2,031	1,943	2,979
201 to 500 horsepower	668	428	469	545
501 horsepower up	499	364	383	439
	20,745	18,060	18,053	20,164

It will be noted that the number of boilers registered last year compares favorably with the number registered in 1926. In 1927 and 1928 it fell off about 2000 for the year.

At the conclusion of this report, L. C. Peal, city boiler inspector, Nashville, Tenn., presented the statistical report for the year. This report, in part, follows:

Boiler Statistics for Fiscal Year

Since 1927 we have tried in several different ways, to secure with some degree of accuracy, the total number of boilers that were in operation in the United States. This obviously, is no small undertaking. Less than one-half of the various states have boiler inspection departments, and the non-code states of course have no record of boilers within the state.

There are a few of the code states that have failed to give us the data which we requested in our questionnaire. However, taken as a whole, the cooperation we have received from various channels during the last year has been very gratifying, and we want to express our appreciation at this time for this assistance.

In our report last year, we had 251,793 boilers reported by twenty-five chief inspectors. Insured boilers last year were reported as 276,830, leaving 25,037 boilers for the non-code territory.

This year, we have twenty chief inspectors reporting 250,957, and insured boilers amount to 290,205. This means, this year we have 39,248 boilers that were placed in non-code territory.

Accidents and Failures

Accidents and failures of all kinds reported this year were a great deal higher than last. We have a total of 1004 accidents reported, with a fatality list of 22, with 20 injured and a property loss of $312,488.59.

Code and Non-Code Accidents

We had 106 boiler accidents, five killed, two injured and $91,320.00 property loss.

Non-Code accidents 898, with seventeen killed, twenty injured and property loss of $221,168.59. Comment here is needless.

Types of Boilers Involved

Cast-iron sectional	515
Low-pressure steel	31
Horizontal return tubular	219
Watertube	130
Firebox	79
Vertical tubular	30

Only one failure to unfired pressure vessels was reported and that was a home-made acetylene tank. A man lost both eyes as result of this accident.

Deaths and injuries are still being reported from tube and blow-off failures. If safety latches were used on all firing and clean out doors, these accidents could have been prevented.

We could comment here for a long time on the different accidents, but time will not permit. We want to mention a few, however.

We had two explosions of lap-seam boilers, due to lap-seam cracks. In these accidents three were killed, eight injured and $30,000 loss.

We wish to mention also, several reports of accidents to three-pass, low-pressure steel heating boilers. Several cases are reported of burned boilers, due to low water, the lower tubes only being burned, leaving the upper tubes and the fusible plug intact. We mention this without comment here, as we feel that matter will be discussed later on in the meeting.

In conclusion we wish to thank the insurance companies for their co-operation and also the others who have given us their aid.

Following the statistical report, secretary C. O. Myers made several announcements, after which Charles Duni, chairman of the board of mechanical engineers of Los Angeles was introduced to address the meeting. In his remarks Mr. Duni stressed the need of cooperation between members of the board in promoting safety in boiler and unfired pressure vessel operation and maintenance. Others of the California delegation were introduced and make a few remarks.

An innovation in the program in the form of a question box was next in the order of business, and the discussion aroused by the questions follows:

The Question Box Discussion

Secretary C. O. Myers: The first question is this: "Every one knows that it is practically impossible for a manufacturer not to make minor mistakes occasionally. Is it not proper for an inspector to use his judgment in passing work that contains small violations of the code and which do not appreciably affect the safety of the boiler or pressure vessel?" That is a very good question. We have some inspectors who apply the code literally, word for word, and I think that I would like to hear from some of the members on how they feel about the matter.

E. W. Farmer: The inspector who has the shop inspection should at least make a memorandum and call it to the attention of the authorities so that hey will not be placed in an embarrassing position of having it called to their attention by other sources, and let the authorities decide whether they want to approve it or not.

A. C. Weigel, (Combustion Engineering Corp.): That question, of course, is very interesting to us. We do know that we are human, we make some little mistakes once in a while and we do feel that, as suggested by Mr. Farmer, the proper way to handle it is for the inspector to report it so that we do not get the comeback from the field. We do not believe, however, that there ought to be too much leeway in these allowances made by the inspector; they all have different opinions. I might say that Mr. Morrison submitted sometime ago a list of tolerances that he was talking about for his own insurance company. I think Mr. Morrison went too far; I think he will ease off before he gets done with his tolerances, but some such rules as that may be good.

Chairman Thomas: Mr. Morrison, would you like to say something on this?

J. P. Morrison, (Hartford Steam Boiler Insp. & Ins. Co.): I do not believe I want to discuss the matter of tolerances. It seems I am committed to something of that kind and I have an idea that ultimately it will be adopted, but to return to the question. The shop inspector has no choice but to insist that the boiler or pressure vessel comply with the code literally where the code is clear, and the use of the term "small errors" is quite deceptive; I might think a crack 6 inches long is a small crack; some one else might think a crack 1/16 inch long was a small crack. That represents my idea as to the need and purpose of the code of tolerances. Now, if the shop inspector detects a slight error, something that does not have, to his mind, any influence on the safety of the boiler, that shop inspector should take the matter up with his superior. We will presume he is working for an insurance company; the matter ought to be referred to the chief inspector to whom this shop inspector reports, and that chief inspector should take it up with the state authorities under whose jurisdiction the boiler is to be operated and who really have the final say as to whether they will accept that boiler or not. Now, if that state chief inspector agrees that it is something that is of no importance, and frequently those little errors are of no importance, I see no reason why the boiler should not be passed, but the shop inspector has not the authority to do it, and if he takes that authority, sooner or later he is going to run into grief.

Now those of us who have had shop experience know that it is mighty difficult to keep down all the little errors. At the same time we used to see holes reamed $\frac{1}{16}$ inch, where they ought to be reamed $\frac{1}{4}$ inch; the shop inspector has no authority to say "I am satisfied to have this hole reamed $\frac{1}{16}$ inch when the code says $\frac{1}{4}$ inch. So, to refer again to the matter of tolerances, when we use comparative terms like little and small, the human equation enters into it quite strongly, and for the benefit of the strictly shop man, I would repeat something I have said probably many times, that the shop inspector and the shop superintendent, who form a habit of thinking and saying, "That is good enough," soon get on the toboggan and go down hill.

D. L. Royer, (Ocean Accident & Guarantee Corp.): Those of you who know me know that whenever I can get a chance, I will cut open an old boiler. It takes me back quite a few years when Mr. Edgar and I were hammering around up in Wisconsin; Sunday morning I inspected a boiler, and I had some words to say to the man who built it, who happened to have been called in to put in a set of tubes. The cover plate did not line up, you could see that the rivets were out of line, and I just told him that I thought that a good shop ought to be able to put out a better job than that, and he said, "The trouble with you fellows is that you don't know anything." He said, "I admit that a punched rivet hole is better than a reamed rivet hole, and you go around here howling about a code and the enforcement of a code, and it won't do any good; that boiler will last as long as any of these glorified products you propose to make us build, and when we build them it will cost twice as much." I saw there was no use in arguing with that old gentleman; furthermore, I was convinced that the type of workmanship in that particular boiler frequently was the cause of serious accidents.

I had to think of it here the other day when I got hold of a drum that was not built in accordance with any code. It was lap joint; the drum had been subjected to extreme service; the pressures carried gave a factor of safety of a little less than four and a half. The boiler was finally discontinued from service because they did not have any more use for it and it laid there and rusted for several years before we cut it up. When we opened up the seams, everything was wrong; the seam was over calked; it was badly upset; the plates did not line up at all; the holes apparently were punched, and every hole I examined was out of line. Under the microscope, you could see definite strain lines. I will say, however, that it was a beautiful job of riveting, those rivets were well driven and we could not find one place in that drum where the metal had started to crack, nor where there was any sign at all of the diseases of boiler plate that we look for.

I do not cite that, gentlemen, as an instance to prove that we should let down on the workmanship; I believe that a job should be done just as well as we know how to do it. I believe that the adoption of the code has been the most wonderful thing for the boiler industry, and all industries involved, in this country, but I do believe that our experience in the war with tolerances should be brought up and considered at this time. I ask you, what is the use of a very narrow tolerance on one operation and a broad tolerance on another operation, when both enter into the safety of the structure the same way?

I doubt very much whether it will improve riveted designs to draw those tolerances in so narrow that inspectors and shop men will go after them with a micrometer. Furthermore, I am convinced that some of the serious diseases of boilers do not attach to so-called poor workmanship which has been the subject of a lot of discussion recently. Take the drum that I just mentioned; the fundamental design of that drum throws it out of line five-eighths of an inch; it is a lap joint. That design alone is worse than anything you could do to the thing in workmanship.

Finally I say this, with my friend Mr. Morrison, you cannot give shop men discretion, but when there is an error that has been made in the shop, they should be required to refer it to their superior who can communicate with the manufacturers and between them determine whether this error affects the safety of the structure. We do not want to lean back so far that we get a situation in boiler making that is analagous to our present prohibition law and, at the same time, we do not want to have a broad code that will let you put in any kind of workmanship. When you visit the shops in this town, if you will recall the shops as they were five years ago, you will have something to think about. Boiler making in the town of Chattanooga, in my experience, is no longer boiler making, it is machine shop practice. I do not think that it would be wise to call in tolerances of the kind of boilers you will see under construction here, even as narrow as they are at the present time.

Secretary Myers: The next question is: "The A. S. M. E. code is mandatory and imposes limitations on materials that may be used, for certain forms of construction and stresses. If progress is to be made, new materials must be experimented with on a practical scale. Should there not be provisions to permit such experimentation and should not the various inspection departments be willing to permit departures from the code for specific experimental purposes?" That question, I believe, was put up to the code committee, and at the last meeting I think there was something brought up along that line, and I believe Mr. Obert could tell you how the code committee feels on that subject.

C. W. Obert, (Honorary Secretary, Boiler Code Committee): Before starting on that, Mr. Myers, I want to call the attention of the gentleman who raised that question to paragraph P-1 of the Power Boiler section of the code, which reads as follows:

"Specifications are given in Section 2 of the code for the important materials used in the construction of boilers, and where given, the material shall conform thereto. If in the development of the art of boiler construction, other materials than those herein described become available, specifications may be submitted for consideration."

Now, a good many people have asked that same question, temporarily ignoring that provision in the code. The code committee has, on a great many occasions, taken advantage of that particular provision. It is the usual requirement of the code committee that, when a manufacturer is submitting or asking permission to use a different material, he will submit a complete specification of the material in question and give something on which the code committee can work in order to go to the A. S. T. M., our sister body that does the specification writing on materials, and get an idea of what the material is good for.

The reason I speak of that in particular is the long history we have had of this so-called semi-steel. It is a little better than cast iron, supposed to be made by the admixture of a certain amount of steel scrap in the foundry cupola, and it is claimed to be a little better than cast iron, and all kinds of requests have been brought to the code committee in years gone by, "Why can't we use semi-steel?" This so-called glorified cast iron was to be used in places where the plain cast iron is prohibited, particularly for nozzles, and the Code Committee has always sat back and said, "Submit a specification."

Now, taking other classes of materials, you will notice that while the Power Boiler Code has not recognized anything to speak of beyond the limits of steel, the Unfired Pressure Vessel Code has gone so far as to recognize copper plate, copper tube, copper staybolts and brass pipe, and now we have reached out into the realm of alloy steels for certain things. In a number of cases where alloy materials have been put up to the code committee, you will find specifications in section 2 of the code pertaining to them. Now the thing that Mr. Myers referred to, which is the latest thing that has come before the code committee, has been specifications in regard to nickel steel. With all these alloys coming up for consideration, the manufacturers have begun to reach out for something that will give an equivalent strength, a little lighter weight, and one particular steel that has been given consideration along that line has been nickel steel.

One boiler manufacturer recently inquired about the acceptability of nickel steel, and upon submitting a specification there was a definite arrangement made for the use of that material. We are having specifications come up covering these other alloys, manganese steel and chrome nickel steel. I think it is safe to say that the code committee is in a receptive state of mind, that when a specification is submitted, if the boiler manufacturer thinks he can gain something by using such a steel, and will submit a specification and that specification is sufficiently standardized so that the American Society for Testing Materials has recognized it, the code committee will be willing to go along and express an opinion as to what it thinks of the value of that material.

It is very certain that the Boiler Code Committee does not desire to create any situation that is going to hamper progress. It has always been the desire of the Boiler Code Committee to make such a standard in regard to any construction of any material as will aid in developing the art rather than hampering it.

The discussion of questions continued throughout the remainder of the first day's meeting and will be completed in the September issue.

G. D. Spackman has been elected president of Lukenweld, Inc., a subsidiary of the Lukens Steel Company, Coatesville, Pa., supplying welded steel construction to machinery and equipment manufacturers.

Registration at National Board of Inspectors' Meeting

The following members and guests of the National Board of Boiler and Pressure Vessel Inspectors were in attendance at the eighth annual meeting:

G. K. Anderson, official stenographer, 5716 Cedar Ave., Philadelphia, Pa.
Thomas R. Archer, chief boiler inspector, Public Bldg., Wilmington, Del.
J. S. Arnold, secretary industrial board, Department of Labor and Industry, Harrisburg, Pa.
L. M. Barringer, chief boiler insp., 505 County-City Bldg., Seattle, Wash.
J. L. Baxter, Chattanooga, Tenn.
H. T. Bettz, Peabody College, Nashville, Tenn.
Robert S. Black, 740 25th St., Detroit, Mich., The Detroit Edison Co.
Blaine M. Book, chief boiler insp., Department of Labor and Industry, Harrisburg, Pa.
Jas. A. Cash, city commissioner, Chattanooga, Tenn.
Paul Cassidy, 312 Walnut St., Chattanooga, Tenn., The Hartford Steam Boiler Insp. & Ins. Co.
J. F. Davis, manager, Titusville Iron Works, 20 N. Wacker Drive, Chicago, Ill.
D. D. Dove, inspector, London Guarantee & Accident Corp., 225 Collinsville Ave., E. St. Louis, Ill.
Louis A. Dani, Rm. 26, City Hall, Los Angeles, Cal.
M. A. Edgar, chief boiler insp., Industrial Commission, State Capitol, Madison, Wis.
L. V. Edwards, Plibrico Jointless Fire Brick Co., Chattanooga, Tenn.
T. C. Ervin, Lucey Manufacturing Corp., Chattanooga, Tenn.
E. W. Farmer, chief boiler insp., Rm. 20, State House, Providence, R. I.
Wm. Ferguson, asst. supt., Travelers Insurance Co., Hartford, Conn.
E. R. Fish, chief engr., Boiler Division, Hartford Steam Boiler Insp. & Ins. Co., Hartford, Conn.
Chas. E. Fisher, The Titusville Iron Works, 507 N. Perry St., Titusville, Pa.
Wm. H. Furman, chief boiler inspector, Department of Labor, State House, Albany, N. Y.
W. A. Geen, Union Indemnity Co. & New York Indemnity Co., New Orleans, La.
Harry W. Gould, Board of Water Commission, Water Works Park, Detroit, Mich.
A. C. Grist, The Lookout Boiler & Mfg. Co., Chattanooga, Tenn.
T. A. Heringer, chief boiler insp., Industrial Commission, State Capitol, Salt Lake City, Utah.
Chas. D. Holzshu, The Bartlett-Hayward Co., 3409 Greenway, Baltimore, Md.
H. Hunter, 2223 Leslie Ave., Nashville, Tenn.
Harry C. Jacobs, boiler insp., City of St. Louis, 4327 S. 37th St., St. Louis, Mo.
T. McLean Jasper, The A. O. Smith Corporation, Milwaukee, Wis.
A. F. Jensen, The Hanna Engineering Works, 1765 Elston Ave., Chicago, Ill.
Otey Johnson, 2100 Hayes St., Nashville, Tenn.
Thos. D. Knowles, The Union Oil Company of California, Los Angeles, Cal.
F. B. Leary, Travelers Ins. Co., 1906 Broad St., Nashville, Tenn.
John C. Lewis, Hartford Steam Boiler Insp. & Ins. Co., Chattanooga, Tenn.
John M. Lukens, city boiler insp., 424 City Hall Annex, Philadelphia, Pa.
C. E. McGinnis, city boiler insp., Board of Mechanical Engrs., City Hall, Los Angeles, Cal.
C. D. Malone, Texas Company, Knoxville, Tenn.
Chas. J. Manney, Ohio Boiler Insp. Dept., 706 Yuster Bldg., Columbus, Ohio.
J. H. Moran, The Texas Company, Nashville, Tenn.
Halstead H. Mills, city boiler insp., City Service Bldg., Detroit, Mich.
H. H. Morrison, The Permutit Company, 1013 Provident Bldg., Chattanooga, Tenn.
J. P. Morrison, supt. of insp., Hartford Steam Boiler Insp. & Ins. Co., Hartford, Conn.
A. J. Moses, Hedges-Walsh Weidner Co., Chattanooga, Tenn.
D. V. Musgrove, The Fidelity and Casualty Co., 315 Hamilton Bank, Chattanooga, Tenn.
W. C. Murphy, Ocean Accident & Guarantee Corp., 409 Provident Bldg., Chattanooga, Tenn.
Wm. P. Murphy, Hartford Steam Boiler Insp. & Ins. Co., Chattanooga, Tenn.
C. O. Myers, Secretary Treasurer, National Board of Boiler & P. V. Insp., 1105 Brunson Bldg., Columbus, Ohio.
J. D. Newcomb, Jr., chief boiler insp., Rm. 328, Capitol Bldg., Little Rock, Ark.
F. W. Norris, Marion Steam Shovel Co., 407 Oak St., Marion, Ohio.
C. W. Obert, The Union Carbide & Carbon Research Laboratories, Inc., Thompson Ave. and Manley St., Long Island City, N. Y.
O. B. Olmstead, Ontario Iron Works, Pulaski, N. Y.
F. A. Page, chief boiler insp., Industrial Accident Commission of California, State Bldg., Civic Center, San Francisco, Cal.
L. C. Peal, city boiler insp., City Hall, Nashville, Tenn.
H. H. Peek, Lookout Boiler & Mfg Co., Chattanooga, Tenn.
John W. Price, State of New Jersey Board of Examiners & Boiler Ins., 65 N. Delancy Place, Atlantic City, N. J.
Dan L. Royer, chief engr., Ocean Accident & Guarantee Corp., 1 Park Ave., New York, N. Y.
W. A. Sadd, 1st National Bank, Chattanooga, Tenn.
M. C. Schwab, The Schwab Boiler & Machine Co., 16th and Canal St., Milwaukee, Wisc.
Joseph F. Scott, Chairman, Engrs. License & Steam Boiler Insp. Bureaus, State House, Trenton, N. J.
E. L. Shuff, Combustion Engineering Corp., Atlanta, Ga.
R. A. Snively, The Columbia Casualty Co., 1 Park Ave., New York, N. Y.
C. D. Thomas, chief boiler insp., Bureau of Labor, State House, Salem, Oregon.
C. Thompson, 458 N. W. 4th St., Miami, Fla.
Frank Steffanides, 320 Wayne Ave., Lansdowne, Pa.
A. B. Summers, Ocean Accident & Guarantee Corp., 409 Provident Bldg., Chattanooga, Tenn.
Wm. Svatos, Ocean Accident & Guarantee Corp., 409 Provident Bldg. Chattanooga, Tenn.

W. T. Thrasher, Chattanooga, Tenn.
J. E. Trainer, The Babcock & Wilcox Company, Barberton, Ohio.
Wm. B. Tulloch, city boiler insp., City Hall, Evanston, Ill.
E. J. Walsh, Chattanooga Boiler & Tank Co., Chattanooga, Tenn.
A. C. Weigel, mgr. boiler dept., Combustion Engr. Corp., 200 Madison Ave., New York, N. Y.
Carl Weigel, The Hedges-Walsh Weidner Co., Chattanooga, Tenn.
John G. Wheatley, chief engr., Royal Indemnity Co., 150 William St., New York, N. Y.
J. B. White, Andrew Jackson Hotel, Nashville, Tenn.
Geo. Wilcox, chief boiler insp., Rm. 612, Bremer Arcade Bldg., St. Paul, Minn.
J. M. Wood, chief boiler insp., 404 State House, Indianapolis, Ind.

Flexible Backhead Braces

By C. E. Lester

In an earlier issue of The Boiler Maker the writer described a ball-type joint brace for supporting locomotive backheads, designed to make inspection and replacement easy.

The brace described in that article, while well designed and which, according to calculations, was well within the safety limits, nevertheless, had an appearance of weakness in that the bottom of the jaw or claw was open and the thought suggested itself that the claw might spread under tension. This chance for failure was very remote; still the appearance of the open jaw suggested weakness. The drawings illustrated herewith present two types of brace which have no such appearance of weakness as just described.

It will be observed that the first bolt illustrated is simply a ball-headed bolt flattened about one-fourth its diameter at the head in order to permit its insertion in the vertical part of the slot in the lug. When this is done, a quarter turn of the brace allows it to drop in the socket and the brace is then ready for adjustment by use of the nut at the back end.

The alternative bolt and lug are but little different. The bolt head is not flattened and the lug openings are made to suit this particular type. The bolt is simply inserted through the top section of the lug and shoved forward about one inch. This allows the reduced section of the bolt to slip through the narrow section of the lug and drop into place and may then be pulled back into place and seated.

These braces were designed to simplify renewal and inspection of backhead braces in locomotive boilers. It is a well known fact that the renewal of a backhead brace entails a large amount of labor and time due to the necessity of removing many other parts in order to get through to the backhead to remove the brace pins.

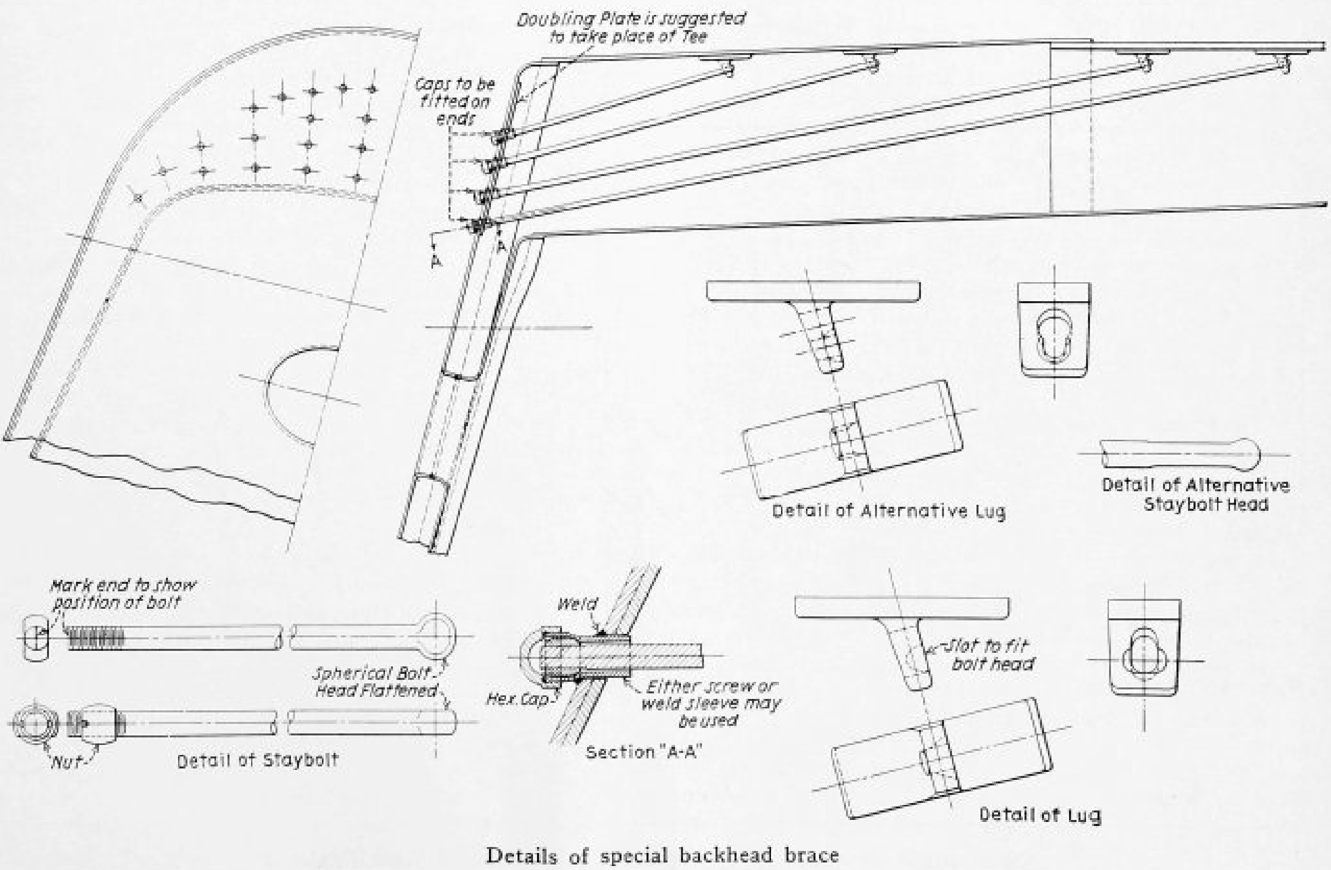
While the proposed type of brace is flexible, having a ball joint at both ends and the liability of breakage is quite remote, in the event of breakage, all that is necessary for renewal is to remove the flexible cap, withdraw the bolt, insert another one and adjust it.

Should the bolt be a long one it may be necessary to remove one or two radial stays in order to insert a small hook in one of the holes to pull the brace up into position.

The necessity of entering the boiler to inspect the old type of brace is eliminated with this type as all that is required is to remove the cap at the backhead.

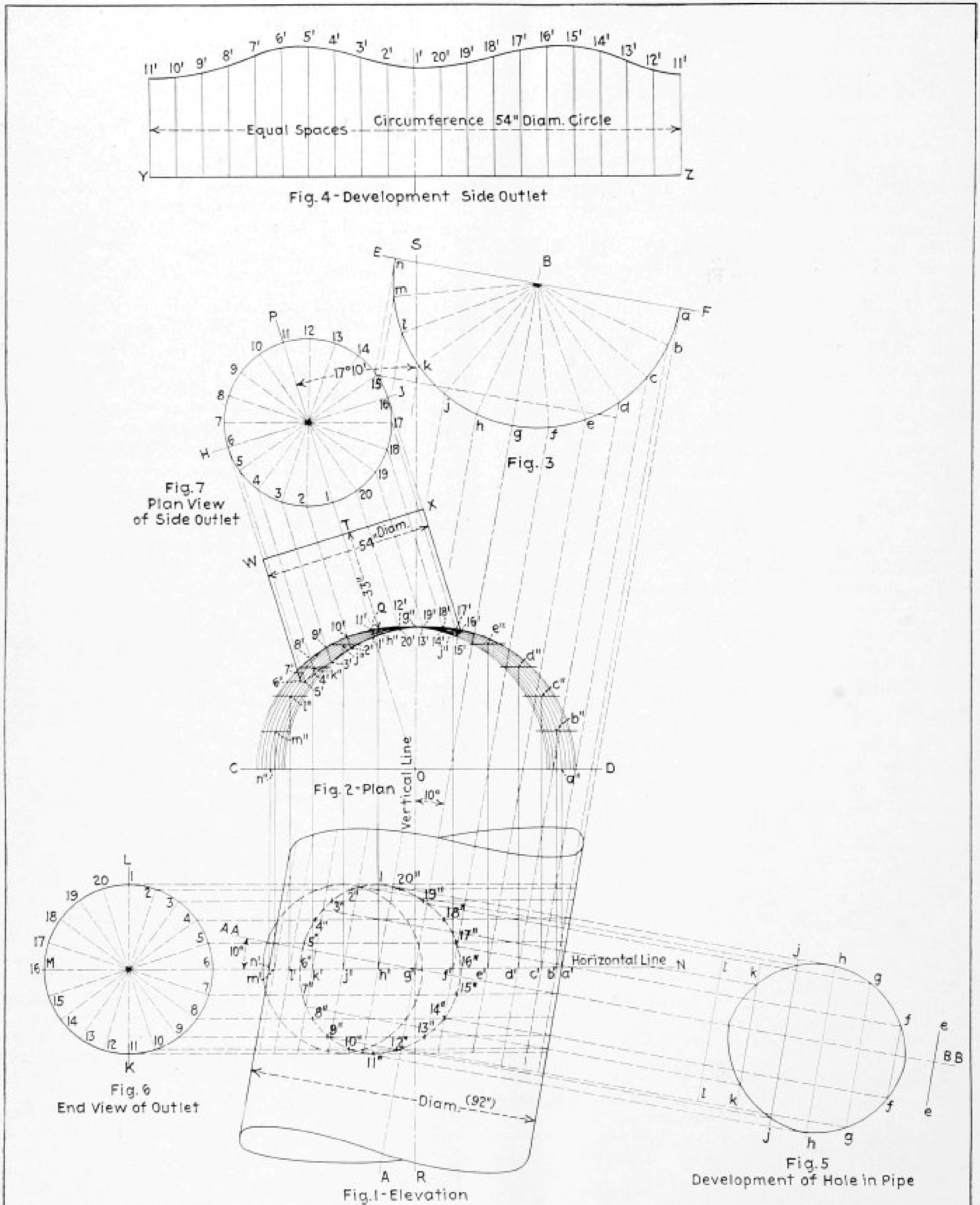
The proposed type brace eliminates the use of tee irons, jaw braces, and brace pins in the badly congested area just in front of the backhead where free circulation is imperative. The area in front of the water level openings is freed from impedimenta.

Boring Bars.—Scully adjustable boring and turning bars for lathes are described in a booklet recently issued by the Scully Steel & Iron Company, 2364 South Ashland Avenue, Chicago. These bars can be used for turning and threading as well as for boring.



Details of special backhead brace

Projection Method of Laying Ou



Development of outlet on a pipe when both elements have angularity

...an Angular Pipe Outlet

By George M. Davies

The problem of laying out a side outlet on a pipe by projection is a simple one. What makes the problem seem complex is the fact that the pipe is inclined at an angle of ten degrees and the center line of the outlet is 17 degrees, 10 minutes off the center line of the pipe.

The first step is to lay out the elevation and plan view.

Draw the horizontal line *M-N*. Cut this line with the vertical line *R-S* as shown in Fig. 1. Through the intersection of these lines draw the line *A-B*, 10 degrees from the vertical center line. Set off one-half the diameter of the pipe on each side of the center line *A-B*, forming the pipe in the elevation.

Then construct Fig. 3, which is the plan view of the pipe, on the center line *A-B*. Divide half the plan as shown into any number of equal parts, 12 being taken in this case. The greater the number of equal spaces taken the greater the accuracy of the development. Number these divisions *a, b, c, d*, to *n*. Parallel to line *A-B* draw lines through the points *a, b, c, d*, to *n*, cutting the horizontal line *M-N* at *a', b', c', d', to n'*.

At *a', b', c', d'* to *n'* erect perpendiculars to the horizontal line *M-N* cutting the line *C-D* of the plan Fig. 2. *C-D* having been drawn parallel to the line *M-N*, extend the perpendicular line drawn through *a', b', c', d'*, to *n'* above *C-D*.

Then, set the dividers equal to the vertical distance from the line *E-F* to the point *b* in Fig. 3. Step off this distance above *C-D* on the vertical line drawn from the point *b'* in the elevation, locating the point *b"* of the plan view, Fig. 2. In the same manner locate the points *c", d", e", f"*, to *m"* and connect these points with a line. This line would then represent a section through the pipe on the line *M-N*.

Then draw the line *O-P* at an angle 17 degrees 10 minutes to the center line *R-S*.

The next step is to draw the end view of the side outlet as shown in Fig. 6, also the plan view of the side outlet as shown in Fig. 7. Divide the circles into any number of equal parts, 20 being taken in this case. Number the points of division in each view from 1 to 20, as shown.

Perpendicular to the line *K-L* and *H-J*, draw lines passing through the points *1* to *20*, extending the lines into the elevation and plan respectively as shown.

It will now be seen that the points *6* and *16*, Fig. 6, are located on the horizontal line *M-N*. In the plan view, Fig. 2, we have shown a section through the pipe through the line *M-N*. Therefore, where the lines *6-16* drawn vertical to the line *H-J* of the plan view, Fig. 7, cut the plan or section in Fig. 2, just drawn, same will locate the points *6'* and *16'* of the plan view, Fig 2.

In the same manner by taking a series of sections through the pipe in the plan view, Fig. 2, these sections being taken where the vertical lines to the line *K-L* drawn through the points *1* and *20* in the end view, Fig. 6, cut the pipe in the elevation, same being constructed as already outlined for the section through *M-N*. In the same manner as the points *6'* and *16'* of the plan view, Fig. 2, were located, the points *1'* to *20'* can be located, thus locating all points of the intersection between the side outlet and the pipe.

The point *Q* is located where *O-P* cuts the section of the pipe through *M-N* in the plan. From *Q* lay off the distance *Q-T* equal to the length of the outlet on its center line as given in the sketch. Draw the line *W-X* equal to the diameter of the pipe and at a right angle to *O-P*.

The distances from the line *W-X* to the points *1'* to *20'* in the plan, Fig 2, will be the true lengths of these lines in the development.

The development of the pattern of the side outlet is shown in Fig. 4.

Draw the line *Y-Z* equal in length to the circumference of the side outlet. Divide this line into the same number of equal parts as taken in Figs. 6 and 7. Erect perpendiculars at these divisions. To locate *1'*, Fig. 4, set the dividers equal to the vertical distance between the line *W-X* and the point *1'* of the plan view, Fig. 2. Set off this distance above the line *Y-Z* locating the point *1'* as shown. By taking the vertical distance from the line *W-X* of the plan to the points *2', 3', 4', 5', 6'*, etc. and stepping these distances off above the line *Y-Z* of Fig. 4 being sure to keep the corresponding relation of figures between Fig. 2 and Fig. 4, the points *1'* to *20'*, Fig. 4, are located. Connect these points and the pattern of the side outlet is completed.

The next step is to lay out the development of the hole in the pipe. This is done by projecting the points *1'* to *20'* of the plan down to the elevation locating the points *1"* to *20"* in the elevation. These points are located by drawing lines parallel to *R-S* through the points *1'* to *20'* of the plan, projecting these lines down to the elevation. Where the line dawn from *1'* in the plan cuts the line drawn perpendicular to *K-L*, Fig. 6, from the point *1*, Fig. 6, locates the point *1"* in the elevation. In the same manner the points *2", 3", 4", 5"* to *20"* are located.

We are now ready to lay out the development of the hole, Fig. 5.

Draw the line *AA-BB* through *g'*, Fig. 1, perpendicular to *A-B*. Step off a series of spaces equal to one of the spaces dividing the plan view, Fig. 3. Draw lines through these points vertical to *AA-BB* and number these lines *e-e, f-f, g-g, h-h, j-j, k-k, l-l*, as shown.

At the points where the line drawn parallel to *A-B* passing through the point *h*, Fig. 3, cuts the line showing the intersection of the side outlet to the pipe in the elevation top and bottom, draw lines through these parallel to the line *AA-BB* cutting the line *h-h*, Fig. 5, locating the points *h* and *h*. In the same manner locate the points *j* and *j*, Fig. 5, by projecting down from the point *j* in Fig. 3, and in like manner *k* and *k*, *g* and *g*, *f* and *f*. Connect these points and the development is completed.

Relief For The Patent Office

By Dwight B. Galt*

With the exception of those having had experience in patent matters, there are very few who realize the vast amount and intricate character of work carried on in the United States Patent Office with its present personnel of 1400 employees. Approximately one-half of this force is known as the examining corps, whose work is in passing upon the novelty and practicability of applications for patents, and determining the breadth and scope of patents to be issued thereon. These examiners are trained in the sciences and in the law of patents, and collectively they are experts in every art and industry known to man.

In spite of industrial conditions, the fiscal year ending June 30, 1930, was the biggest ever known in the patent office. More work was received and more work disposed of than in any previous year, while the total number of all applications, including trade marks, etc., amounted to nearly 118,000. The number of patents granted reached almost 50,000, which is nearly 6000 more than the previous year. The year just closed must have been a profitable one for inventors, since they filed for record in the patent office over 57,000 assignments, licenses, etc., exceeding by 5000 the record of the previous year.

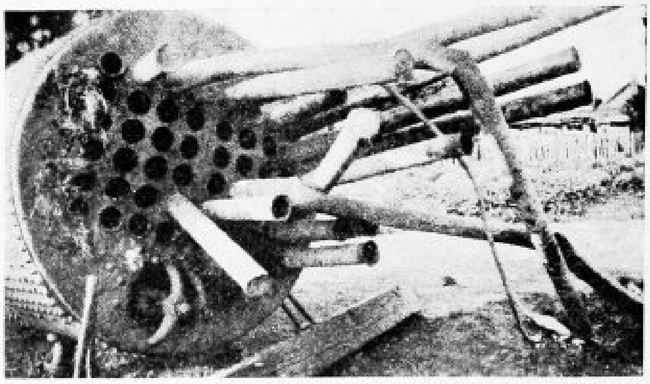
The unfortunate part of patent office work is shown in the amount of arrears. Many of the examiners are months behind in their work; however, Congress has responded to the acute needs of the patent office by passing appropriations for its relief. In addition to ten officials required for this reorganization, the personnel of the patent office is to be increased by 110 technical and 30 clerical employees. This enlargement of the patent office technical force will greatly facilitate the work of the office and is expected to materially expedite applications without too hasty or superficial action.

With this new life in the patent office, inventors can look forward to having their applications examined with reasonable promptness, since it is expected that, in the very near future, work in the patent office will be in such condition that the average time an applicant has to wait for an official action will be sixty days or less, rather than seven months as at present.

Explosion Blows Tubes Out of Boiler

Unusual, in some respects, was a recent accident at an Alabama planing mill where several tubes of a horizontal tubular boiler lost their grip in the front tube sheet and were blown entirely out of the boiler. It was said that some of the tubes had not been beaded and that on others the work had been done improperly. Two men were killed, the boiler house wrecked, and part of the mill damaged.

The accident occurred in the morning before the mill machinery was started up. There was little doubt that considerable over-pressure was present, even though the explosion ruptured neither the shell nor the tube sheets. When the front sheet bulged, after pulling away from three through stays and breaking another, the tubes pulled out and allowed steam and hot water to escape through the tube holes with terrific force. The two victims were caught in the path of this scalding flood and their bodies hurled 200 feet. Reaction shot the boiler backward about a hundred yards.



Tube sheet of boiler after unusual explosion

One tube traveled a quarter-mile to lance its way through the roof of a store, while another went 500 feet from the starting point. Parts of the cast iron boiler front were found a quarter-mile away.

Feed water in use at this plant was stored in a hole dug beside the boiler house and as a consequence considerable mud was carried into the boiler. Thus it was thought that some overheating and softening of the tube sheet may have contributed, along with the improperly beaded tubes, toward causing the accident.—*The Locomotive.*

Bench-Type Pedestal Grinder

Ingersoll-Rand Company, 11 Broadway, New York, announces a bench-type pedestal grinder, known as the Type 9, which can be bolted to a bench or a portable air compressor.

The flow of air to the motor is controlled by a hand-operated globe valve. The machine has a free speed of 3000 revolutions per minute and is designed to take a vitrified grinding wheel 6 to 8 inches in diameter with a ½-inch face. At the end of the grinder spindle, a bit chuck is fastened to take a drill or reamer with a ½-inch straight shank.

The motor, which is of rugged design, has three interchangeable cylinders, spaced about the center line of the spindle, all delivering power to one crank pin. The motor operates in a bath of lubricant, so that all moving parts are continuously immersed.

Type 9 air-powered grinder

*Member of the Washington, D. C. and Indiana Bar Association and patent editor of The Boiler Maker.

The exhaust is directed through the base of the machine, preventing the grindings from being blown into the face of the operator. A steady-rest in front of the wheel aids the operator in holding the work.

Standard equipment includes one 8-inch by 1-inch No. 24 grade Q vitrified wheel for iron and steel grinding, and one bit chuck for ½-inch straight shank or reamers. The necessary wrench is also included.

Dies for Pressed Steel Shapes

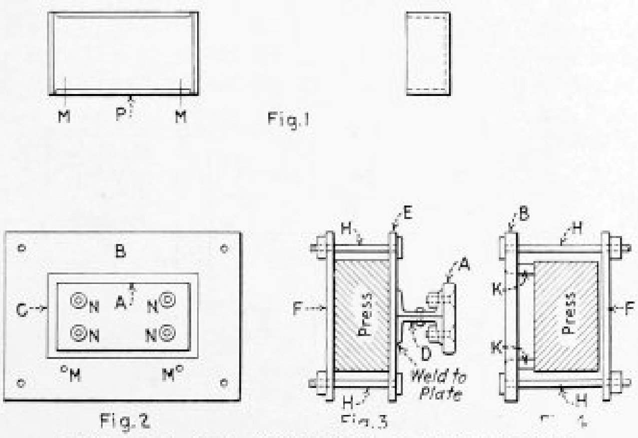
By C. B. Dean

For the production of ordinary pressed steel shapes a good pair of dies can be made at small expense from heavy boiler plate. For pressing material up to ⅜ inch in thickness, 1-inch boiler plate for the dies is found sufficient.

Fig. 1 shows a flanged steel center sill spreader to be pressed.

Fig. 2 shows the development of the dies. On the heavy plate *B*, the outline of the desired piece is drawn as shown at *C*. This also will be the outline of the female die. Inside the line *C* and at a distance equal to 1⅓ the thickness of the metal to be pressed, is drawn the outline of the male die *A*. The plate is cut between the lines *C* and *A* and the dies are machined or otherwise smoothed back to the center of the lines *C* and *A*. The edges at *C* are beveled to one quarter the thickness of the die to facilitate the pressing.

The male die *A* is mounted and secured to the top member of the press as shown in Fig. 3. *D* represents two channel irons back to back, welded to a plate *E*, and clamped to the top member of the press by the bolts *H* and the bars *F*. *A* is secured to this mounting by countersunk bolts through the holes *N*.



Dies made from boiler plate at small expense

The female die is mounted and secured to the bottom member of the press by the blocks *K*, the bolts *H*, and the bars *F*.

In the female die *B*, two rounded pins are set in the holes *M*, as guides, and are lined up with similarly spaced holes in the flange of the spreader as shown at *M* in Fig. 1. Usually the holes are punched before pressing. The hot metal to be pressed is placed in position on the die, with the holes *M* engaging the pins *M*. The press is lowered, flanging the piece in one operation.

To make right and left hand shapes, it is only necessary to loosen the bolts and reverse the dies *A* and *B*. Then the holes *N* must be countersunk on both sides.

Personal

C. B. Woodworth, who has been manager of the western division of Vanadium Corporation of America at Chicago, has been appointed manager of the railroad division of the Corporation. His headquarters will continue in the Straus Building, Chicago. Walter Smith, formerly with the Pyle-National Company, has been appointed assistant manager of the railroad division.

John F. Raps, has been appointed central manager of the Okadee Company and the Viloco Railway Equipment Company, with headquarters at Chicago. He entered railroad service as a special apprentice in June, 1900, with the Burlington, Cedar Rapids & Northern (now a part of the Chicago, Rock Island & Pacific). In July, 1904, he resigned to accept a position with the Toledo, St. Louis & Western at Frankfort, Ind., and in April, 1905, he entered the employ of the Illinois Central at Waterloo, Iowa. In April, 1909, he was promoted to general locomotive inspector, with headquarters at Chicago, which position he has held until he resigned to become central manager of the Okadee Company and the Viloco Railway Equipment Company.

John F. Raps

Everett Chapman has been appointed director of development and research of Lukenweld, Inc., a division of Lukens Steel Company, Coatesville, Pa. In this capacity he will have general direction of laboratory and investigation work in connection with redesigning machinery parts for the welded steel type of construction. Mr. Chapman received his Master of Science degree from the University of Michigan in 1924. After a year at Purdue he became director of research for the Lincoln Electric Company, Cleveland, O.

Obituary

John M. Callen, for a number of years vice-president and director of the Reading Iron Company and the Thomas Iron Company of Reading, Pa., died on July 2 at the age of 73.

William Heaward Wood, inventor of the corrugated locomotive firebox and builder of special hydraulic machinery, died on July 12 at his home in Media, Pa. Mr. Wood was born at Stockport, England and was educated in that country. He later became an American citizen and located at 176 Broadway, New York, where he invented refrigerating and ice-making machinery. For the past 40 years he has resided in Media.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Qualifications for Stationary Boiler Fireman

Q.—Kindly send me all particulars in reference to the position of fireman, first-class, and the qualifications necessary for an examination. I am a fireman, first-class, honorably discharged from the U. S. Navy. At present I am employed by the Brooklyn Edison Company and it is impossible for me to take a day off to obtain this information. J. B. T.

A.—Law 1901, Chapter 733, provides for the licensing of fireman operating stationary steam boilers within the City of New York as follows:

It shall be unlawful for any fireman or firemen to operate steam stationary boiler or boilers in the City of New York, unless the fireman or firemen so operating such boile: or boilers are duly licensed as hereinafter provided. Such fireman or firemen to be under the supervision and direction of a duly licensed engineer or engineers.

Should any boiler or boilers be found at any time operated by any person who is not a duly licensed fireman or engineer as provided by this act, the owner or lessor thereof shall be notified and if after one week from such notification the same boiler or boilers is again found to be operated by a person or persons not duly licensed under this act, it shall be deemed evidence of violation of this act.

Any person desiring to act as a fireman shall make application for a license to so act to the steam boiler bureau of the police department as now exists for the licensing of engineers, who shall furnish each applicant blank forms of application, which application when filled out shall be signed by a licensed engineer engaged in working as an engineer in the City of New York, who shall therein certify that the applicant is of good character and has been employed as oiler, coal passer or general assistant under the instructions of a licensed engineer in a building or buildings in the City of New York or on any steamboat, steamship or locomotive for a period of not less than two years. The applicant shall be given a practical examination by the board of examiners detailed as such by the police commissioner and if found competent as to his ability to operate a steam boiler or boilers as specified in section one of this act, shall receive within six days after such examination a license as provided by this act. Such license may be revoked or suspended at any time by the police commissioner upon the proof of deficiency. Every license issued under this act shall be in force for one year from the date of issue unless sooner revoked as above provided. Every license issued under this act, unless revoked as herein provided, shall at the end of one year from the date of issue thereof be renewed by the board of examiners upon application and without further examination.

Every application for renewal of license must be made within thirty days of the expiration of such license. With every license granted under this act, there shall be issued to every person obtaining such license a certificate, certified by the officers in charge of the boiler inspection bureau, such certificate shall be placed in the boiler room of the plant operated by the holder of such license so as to be easily read.

No person shall be eligible to procure a license under this act, unless said person be a citizen of the United States.

All persons operating boilers in use upon locomotives or in government buildings and those used for heating purposes carrying a pressure not exceeding ten pounds per square inch shall be exempt from the provisions of this act.

Such license will not permit any person other than a duly licensed engineer to take charge of any boiler or boilers in the City of New York.

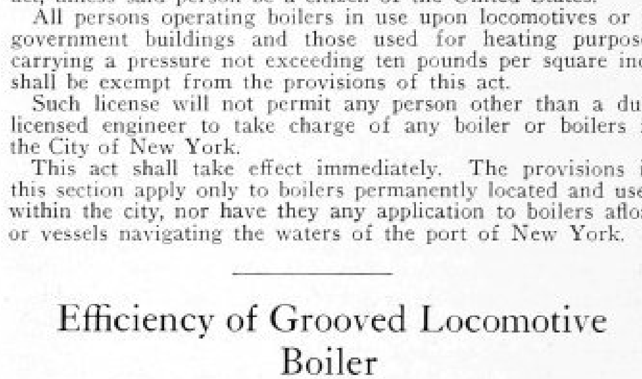
This act shall take effect immediately. The provisions in this section apply only to boilers permanently located and used within the city, nor have they any application to boilers afloat or vessels navigating the waters of the port of New York.

Efficiency of Grooved Locomotive Boiler

Q.—Kindly show how the efficiency and factor of safety is calculated for a locomotive boiler which is grooved as shown on the accompanying sketch.

Is there a danger of the boiler shell cracking at the groove due to vibration or shock? A. B.

A.—A groove as illustrated in the question should be calculated circumferentially to determine the efficiency through the groove with respect to the efficiency of the circumferential seam adjacent to it, as a groove of this type would have little effect on the efficiency or factor of safety of the boiler if same was considered longitudinally.



Section of locomotive boiler showing location of groove

The efficiency of the shell circumferentially through the groove should be calculated for the length of the groove as follows:

Length of groove = 18 inches
Depth of groove = 3/8 inch
Thickness of plate = 1 inch

Original cross-sectional area of plate

$1 \text{ inch} \times 18 \text{ inches} = 18$ square inches

Sectional area of plate through groove

$5/8 \text{ inch} \times 18 \text{ inches} = 11.25$ square inches

$$\frac{11.25}{18} = .625 = 62.5$$ percent circumferential efficiency through groove.

Should this efficiency fall below the efficiency of the circumferential seam adjacent to the groove, the strength of the boiler would be impaired and the groove should be reinforced.

Double-riveted circumferential seams of standard construction for one-inch thickness of plate have an efficiency of from 50 to 60 percent so that in this case the efficiency of the shell through the groove would still be greater than the efficiency of the circumferential seam.

However, all grooves of this type should be immediately reinforced on the outside to stop the grooving from progressing and to strengthen the plate in case the groove does progress before the next inspection.

Vibration or shock applied to the boiler in such manner as to place unusual stresses on the grooved portion of the boiler would cause the boiler to crack at the groove.

Cracks in Scotch Boiler Head

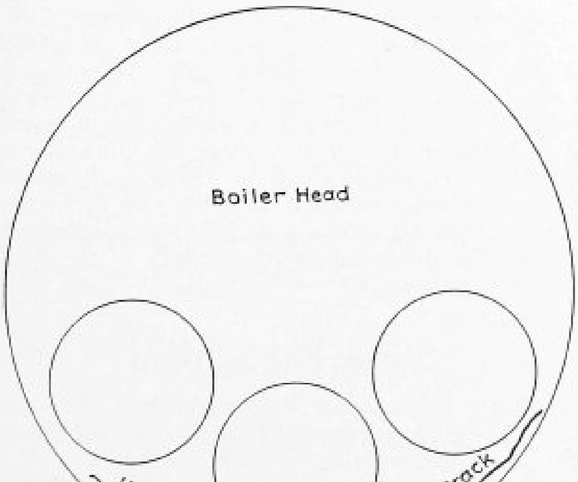
Q.—I am a subscriber to your magazine, The Boiler Maker, and find your Questions and Answers Department very interesting. I would like to get your opinion as to the following boiler repair:

The boiler in question is a Scotch marine boiler built in 1905, carrying a safe pressure of 140 pounds. The boiler is 12 feet in length; 168 inches in diameter; plating has a tensile strength of 66,000 pounds per square inch, and a thickness of 1.125 inches.

There are cracks in the front head; one has a length of 50 inches, one of 12 inches, and there is a groove 15 inches. The crack of 50 inches was formerly welded. There has been some speculation as to cutting out the lower part of the head and patching. The boiler maker that is to do the work claims he can do better work by welding. His opinion is that the center furnace will have to be removed in order to patch the bottom of the head.

Inclosed is sketch of the head. What is your opinion as to the cause of this cracking of head? The owner claims that the boiler was suddenly cooled for washing out. W. G.

A.—The cause of the cracking and grooving is due to the expansion and contraction of the boiler; this condition is exaggerated on the lower part of the front head on a Scotch marine boiler due to the rigidity of the construction around the fireboxes.



Locations of cracks and groove

The sudden cooling of the boiler for washing out might possibly have caused this condition, but the fact that the boiler had previously been welded, also that the boiler showed signs of grooving in this area, would indicate that the action had taken place over a period of time and not one instance of cooling as indicated in the question. A slight movement of the head, due to expansion of the boiler would bring about the damage indicated on the sketch.

The head could no doubt be repaired quicker and cheaper by welding, although if the facilities of a boiler shop were at hand, the renewing of the lower half of the head would be the best solution.

Any welding done must be in accordance with Par. 186 as shown in the Addenda to the A. S. M. E. Boiler Code—Power Boiler Section, which is as follows:

P-186—Welded Joints. The ultimate strength of a joint which has been properly welded by the forging process, shall be taken as 35,000 pounds per square inch with steel plates having a range in tensile strength of 45,000 to 55,000 pounds per square inch. Autogenous welding may be used in boilers in cases where the stress or load is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld. Joints between the doorhole flanges of furnace and exterior sheets may be butt or lap-welded by the fusion process, provided these sheets are stayed or otherwise supported around the doorhole opening and provided the distance from the flange to the surrounding row of stays or other supports does not exceed the permissible staybolt pitch as per Par. P-199. If such joints are lap welded the exterior sheet flange should preferably be placed on the outside or next to the door opening and the firebox sheet flange on the interior next to the water. Autogenous welded construction may be used in lieu of riveted joints in the fireboxes of internally-fired boilers, provided the welds are within two rows of staybolts, or in the case of flat surfaces the weld is not less than one half of a staybolt pitch from the corner.

From this paragraph, welding is permitted where the safety of the structure is not dependent upon the strength of the weld and for this reason it would be necessary to support the plate between the two furnaces, where the 50-inch crack is located. Through stays or gusset braces of ample capacity to support the load upon the head in this area should be provided before welding up the crack.

Netting Area of Master-Mechanic Front End

Q.—Please advise how to calculate the proper netting area in a master-mechanic front end of a locomotive. What is the rule based on grate area, cylinder area or flue area? W. M. W.

A.—The original master-mechanic front end did not provide a front end netting which is common to most locomotives of today, being so located as to extend from the table plate at an angle of about 40 degrees to the forward part of the smokebox. The location of the netting for the interception of the exhaust gases makes the accessibility of the front end rather difficult and many designers have expended their efforts in developing a different arrangement of the netting or spark arrester.

General practice is to give a clear area through the netting of 125 percent of the total gas area of the tubes and flues using netting having a clear area of 50 percent or more.

In 1920 the committee on front ends reported as follows:

Your committee has given some consideration to the matter of front end appliances as affecting fuel economy and locomotive repair costs, but is unable to present a design applicable to all types of locomotives in different classes of service. In fact a suitable general standard would not meet the practical requirements, because of the variables introduced through differences of dimensions vitally affecting the problem. The best arrangement should be determined for each class of locomotive and normal service conditions and using regular fuel supply.

There is, however, opportunity for increased facility in maintenance and reduced cost of repairs through the use of the so-called "unit" front-end netting arrangement. It is obvious that a design permitting the complete removal of the assembled netting will be more easily maintained, will reduce locomotive shop hours and effect a reduction in both cost of labor and material. For these reasons, it is the opinion of the committee that the use of some form of a unit front end should be extended.

A suitable standard having been determined, the front end details should be permanently fastened to prevent further adjustments. The only variable in the front end should be the exhaust nozzle and this should never be altered to cure a steam complaint, until the cause of the complaint has been determined.

Layout of True Ellipse

Q.—What is the approved method of laying out a true ellipse? A. B. D.

A.—Two methods of laying out an ellipse are as follows:

To lay out the ellipse shown in Fig. 1, draw *A-B*, which is the long diameter, and *C-D* the short diameter, at right angles to each other and intersecting at *E*, as the lines in the figure indicate.

With *E* as a center and the radius *E-C*, describe a circle. With the same center and *E-A* as the radius,

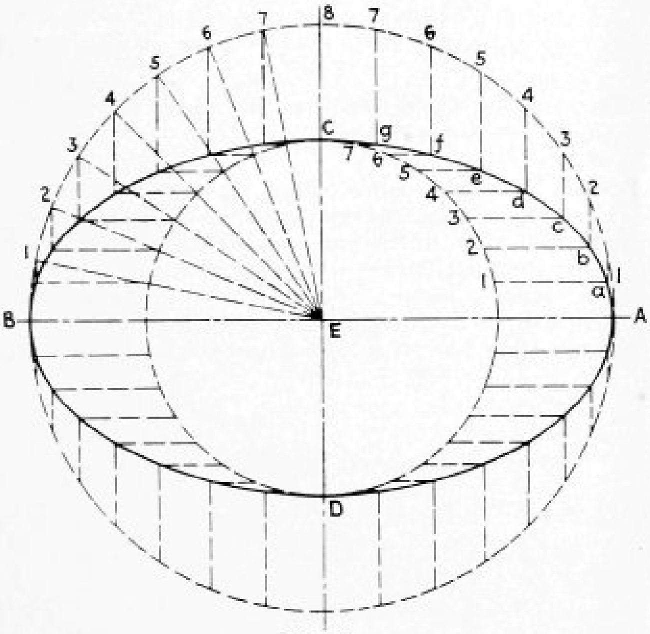


Fig. 1

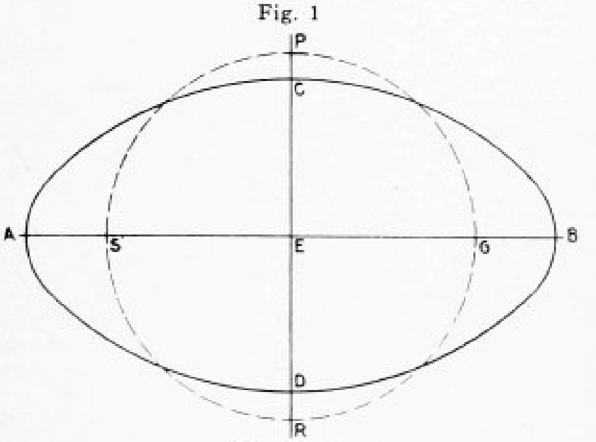


Fig. 2

describe another circle. Divide both circles into the same number of equal parts. The easiest way to do this is to divide the larger circle into the required number of parts and, beginning at the center line *C-D*, draw radial lines through the points of division on this circle to the center *E* of the circles, as shown in the upper left-hand quarter of the figure. The radial lines will divide the smaller circle into the same number of parts that the larger one has been divided into.

Through the points of division on the smaller circle, draw horizontal lines, and through the points of division on the larger circle draw vertical lines. The points of the intersection of these lines will be points on the ellipse.

Thus the vertical line *l-a* and the horizontal line *l-a* intersect at *a* and give the point *a* on the ellipse, Fig. 1.

To lay out the ellipse shown in Fig. 2, draw *A-B*, the long diameter and *C-D*, the short diameter, at right angles to each other, intersecting at *E*, as the lines in the figure.

Next set the dividers to the difference between the long and short diameter less one-eighth (that is to say, if the ellipse were 2 feet by 1 foot, the dividers would be set at 10½ inches. With this as a radius and *E* as the center, draw the circle *PGRS*.

With *R* as a center and the radius equal to the line *R-C*, describe the curve *C*. With the same radius and *P* as a center describe the curve *D*. Then with the radius *G-B*, and from *G* as a center, describe the curve *B*. In a similar manner, with *S* as a center, describe the curve *A*, completing the ellipse. This method does not give a true ellipse but is often employed where speed is more desirable than accuracy.

Business Notes

Tube-Turns, Inc., Louisville, Ky., has added to its plant and equipment to increase the production of tube-turns by 60 percent. Expansion of facilities was made necessary by increased sales which for the first five months of 1930 were 271 percent more than the corresponding period of last year. The new plant was ready for operation on August 1.

The Independent Pneumatic Tool Company, Chicago, opened a branch sales office on August 1, at 6200 East Slauson Avenues, Los Angeles, Cal. A complete line of Thor electric and pneumatic tools as well as spare parts will be carried in stock, insuring prompt service in the Los Angeles district. Vernon Job, formerly manager of the San Francisco office, will be in charge of the Los Angeles office, and will be assisted by B. J. Herron.

C. T. Connelly, formerly in the Detroit office of the company, has been appointed manager of the Buffalo, N. Y., office.

Trade Publications

WELDING WIRE.—The Fusion Welding Corporation, 10257 Torrence Avenue, Chicago, has published an eight-page engineering bulletin, entitled "Weldite Yellow Jacket Electrodes," describing unbeveled plate welding and giving complete detailed instruction. The elimination of the mechanical beveling process and handling, the savings in electrode material and the advantages offered in field erection and accompanying savings in freight-handling charges make this type of welding desirable.

WELDING.—"Automatic Arc Welding by the Electronic Tornado Process" is the title of a very complete and attractive 40-page booklet, publication of which has recently been announced by The Lincoln Electric Company, Cleveland, O. This new booklet contains a host of valuable information on automatic welding with the carbon arc, and describes in detail, the advantages of this process over any other welding process. Results of tests of strength and ductility are tabulated and fully described, as well as other tests which have been made by The Lincoln Electric Company.

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.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—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, Oregon.

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—William Atkinson, 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—John J. Dowd, 142 Pearsall Ave., Jersey City, N. J.; M. A. Maher, 2001 20th St., Portsmouth, O.; R. C. McCutchan, 226 Lipton St., Winnipeg, Man., Canada; H. J. Norton, Alcazar Hotel, San Francisco, Cal.; C. A. McDonald, Box B93 Route 2, Independence, Mo.; J. N. Davis, 1211 Gallatin St., N. W. Washington, D. C.; M. F. Glenn, 1434 E. 93rd St., Cleveland, O.; W. J. Coyle, 424 Third Ave., Verdun, Montreal, Canada; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; J. F. Schmitt, 25 Crestview Rd., Columbus, O.

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, North Carolina.

Fifth Vice-President—William N. Moore, general boiler foreman, Pere Marquette Railroad, Grand Rapids, Mich.

Secretary—Albert F. Stiglmeier, general foreman boiler maker, New York Central Railroad, Albany, New York.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, O.

Executive Board—Charles J. Longacre, chairman, foreman boiler maker, Meadow Shops, Pennsylvania Railroad, Elizabeth, N. J.

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 Ave., Chicago, Ill.

American Boiler Manufacturers' Association

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Vice-President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.

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

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	

Cities

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

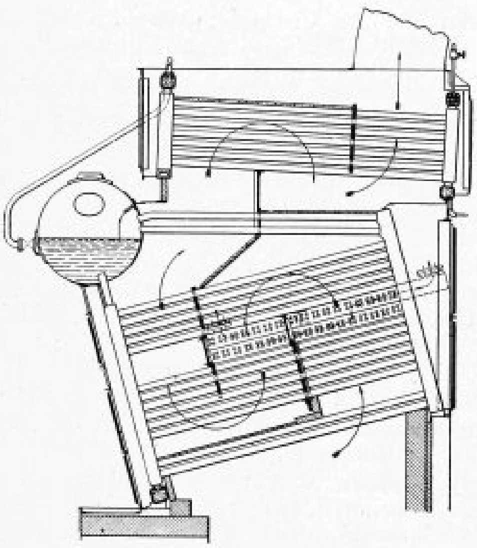
Selected Boiler Patents

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,696,306. FLUID HEATER. WILLIAM INNES, OF NORTHUMBERLAND, ENGLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

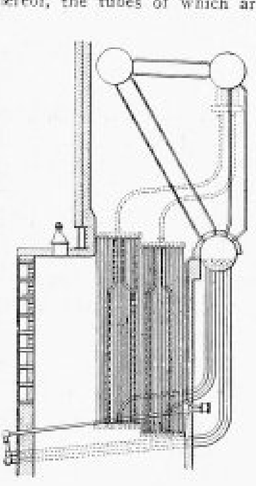
Claim.—The combination with a steam boiler, of an economizer heated by the gases leaving the boiler, said economizer having vertically extending headers at both ends thereof connected by horizontally disposed tubes,



an inlet connection for feeding all of the water supplied to the boiler into the upper ends of all the inlet headers, an outlet connection for feeding to the boiler the water from the same ends of the outlet headers as it enters the inlet headers, said inlet and outlet headers being unconnected except through said tubes, an economizer setting for receiving the gases from the boiler and directing them over said economizer tubes and in a general direction from the outlet of the economizer towards the inlet thereof. Three claims.

1,698,565. BOILER FURNACE. ARNOLD RUHR, OF BERLIN, GERMANY, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, A CORPORATION OF DELAWARE.

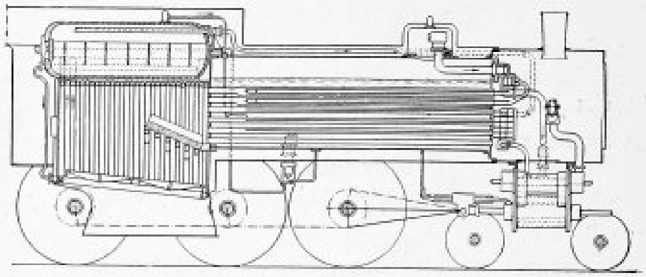
Claim.—In combination, a boiler having upper drums and a lower mud drum and interconnecting tubes, a combustion chamber, a tubular screen for an upright wall thereof, the tubes of which are divided into groups,



upper and lower headers for each group, a downcomer from the mud drum to the lower header of each group, an upcomer from the upper header of each group, and a downcomer from each upper to each lower header, a header common to the downcomers, a plurality of small tubes connecting said header to the mud drum, a header common to the upcomers, and a plurality of small tubes connecting said header to an upper drum. Four claims.

1,700,480. HIGH-PRESSURE STEAM-BOILER PLANT FOR PORTABLE ENGINES. OTTO H. HARTMANN, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT M. B. H., OF CASSEL-WILHELMSHOHE, GERMANY, A CORPORATION OF GERMANY.

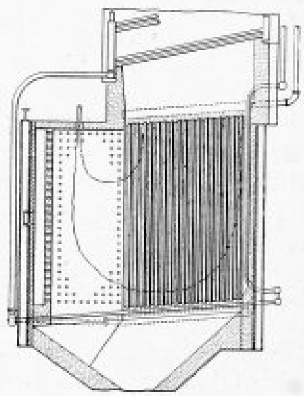
Claim.—In a locomotive a steam engine having a plurality of stages operating at different pressures, a watertube firebox boiler constructed to produce steam of a pressure of at least thirty atmospheres, a horizontal smoke tube boiler heated by the hot gases of the firebox, said smoke tube



boiler being constructed to generate steam of a lower pressure, a connection for conveying steam from the watertube firebox boiler to the high pressure stage of said engine, another connection for leading steam from the smoke tube boiler to the low pressure stage of said engine, a further connection for leading the exhaust steam of said high pressure stage to said low pressure stage, and separate devices for superheating the steam produced in the respective boilers, at least one of said devices being located in the smoke tubes of the smoke tube boiler. Seven claims.

1,698,552. FINELY-DIVIDED-FUEL-BURNING BOILER FURNACE. EDWIN LUNDGREN, OF FREDERICK, MARYLAND, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, A CORPORATION OF DELAWARE.

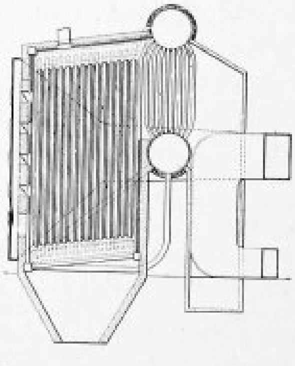
Claim.—In a furnace and boiler setting for burning finely divided fuel in suspension, a combustion chamber having an outlet in an upper part thereof; evaporating surfaces defining a substantial part of the combustion space thereof; refractories defining the combustion space adjacent to that



defined by the evaporating surfaces, including spaced refractory walls dividing such space into a plurality of vertical compartments communicating with the adjacent space; means for admitting the fuel downwardly into said compartments whereby the fuel and flame streams pass downwardly through and laterally out of the compartments into the space defined by the evaporating surfaces and thence upwardly to the outlet. Three claims.

1,731,446. BOILER FURNACE. JOHN VAN BRUNT, OF FLUSHING, NEW YORK, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim.—The combination with a finely divided fuel burning furnace, of a boiler including two rows of substantially upright tubes defining combustion space, header means at the lower end of the tubes of each row, a



row of tubes extending across the lower portion of the furnace and connecting the header means of an upright row with the header means of the other upright row, economizer means including connected upper and lower drums, the upper ends of the upright rows of tubes being connected to said upper drum and downcomer means connecting said lower drum to one of the said headers, and the lower drum being at a level above the lower headers. Two claims.

The Boiler Maker

Name registered U. S. Patent Office

Volume XXX | September, 1930 | No. 9

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

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THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

Request for change of address should reach us on or before the first day 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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The C. & O. Shops

Mechanical officials of the principal railroad systems in this country are rapidly coming to a realization of the importance of modernizing their plants, equipment and methods for carrying out locomotive maintenance work. One of the best examples of the possibilities in this direction is now being demonstrated at the new Huntington, W. Va., shops of the Chesapeake & Ohio Railway Company, where, as described in this issue, the entire locomotive repair plant is under one roof.

In developing plans for the new plant, the various departments were so arranged that the most efficient material handling methods might be employed, and the movement of parts from one department to another could be carried out with the greatest ease. Within departments, modern production methods have been applied and straight-line movement of parts undergoing repair or fabrication forms the basis on which the modern machine equipment of the plant has been arranged. This efficiency of physical layout and methods, combined with a highly trained personnel throughout the plant, has made the Huntington works one of the foremost of its kind in the world.

Boiler Shop Efficiency

In nearly every locomotive repair plant, there are certain opportunities to improve production efficiency, even when it is not possible to modernize the plant and equipment completely. Referring to the boiler department as a specific example of the possibilities to be obtained; a careful study of the necessary stages through which a boiler undergoing repair must pass will indicate a logical arrangement of machine equipment to facilitate the work. All material and parts should flow from one department to another, through the various fabrication operations, and eventually arrive at the assembly point without retracing their movements and with a minimum of handling. Older types of machines that are still useful can be located most advantageously to accomplish this result and, when new machines are to be added to the equipment, they should be carefully selected on merit and fitted into the production scheme at points where they will best serve to speed operations. Simple and effective scheduling methods are essential, as well as efficient material delivery and handling systems.

These are the essential features in the physical arrangement of mechanical facilities of a plant but, without the benefit of a properly trained and organized personnel, they cannot be effective. The shop staff, from the foremen down to the helpers, is the moving force behind production, and, if the men making up the personnel are progressive, equipment will be utilized to the best advantage and methods will be developed to meet the requirements of the mechanical department.

Communications

Better Inspection Needed?

To the Editor:

I have read in your August issue the remarks made by R. T. Boster regarding his opinion of boiler inspecting on most of our railroads, in which he mentions where roundhouse foremen hardly give inspectors time to walk around an engine let alone making proper inspection; also their refusal to remove the jacket when requested. I have been a boiler inspector on the Erie Railroad in Buffalo for the past five years and, although at times I have made things rather hard for the supervision by my desire to strip the jacket from an engine, I have never met with refusal or opposition in that respect nor have I ever been told how much time to take in my inspection, but, on the contrary have always been instructed to take my time and make the best of inspection. I have never heard of any inspector at this point being criticized for the things he did find, but severely so for those he didn't.

The type of man Mr. Boster mentions all through his letter lacks the qualifications essential towards making a good inspector, when he allows any supervisor to tell him what he can have removed to help in his inspection. If these men were familiar with their job and the law and had the guts that God gave a goose, they would insist on the removal of anything they thought necessary for thorough inspection and would tolerate no interference from anyone, as they alone are responsible for what happens and should expect no help when things go wrong from the type of foremen that advocates such inspection as you mention.

Although I haven't had the experience that Mr. Boster has had along this line, I am very glad to be in a position to say that at least there is one railroad in Buffalo that doesn't advocate inspection such as he mentions.

Buffalo, N. Y. Edward H. Thomas.

To the Editor:

As one reads Mr. R. T. Boster's remarks in the August issue of The Boiler Maker in reference to the manner in which the inspection laws are carried out, one is apt to wonder how, under such conditions, can such results be obtained as are shown by the annual report of the I.C.C. inspection department.

Considering Mr. Boster's years of experience and his opportunities for observation, conditions as outlined are dangerous.

Happily such conditions do not obtain in such shops that come under the writer's observation, as outlined by the rules which govern the selection of shop boiler inspectors.

The applicant must have a sound practical knowledge of the trade, he must also pass an oral examination in general boiler work and I. C. C. inspection rules. He must also pass an annual test as regards eyesight and hearing. No one can fill the position of boiler inspector, not even temporarily, unless he has passed these examinations. The results of such rules, emphasized by the fact that they are rigidly enforced, are shown by the record of Federal Inspection reports on all divisions, these being of such a character as to call for a letter of commendation from the superintendent of motive power to all supervisors and inspectors, and I believe a good many will agree with me that to receive a pat on the back from such a source is no mean feat and surely has to be deserved.

This is not written with any idea of disputing Mr. Boster's remarks, but simply to state that conditions can be different, and those cases would be different if officials and supervisors would comply not only with the letter of the law but also with the spirit of it, and if there is a boiler inspector in their employ who has the moral courage to obey the I. C. C. laws, let them, at least, be fair enough, men enough, to back him up.

Joseph Smith,
Lorain, Ohio. Baltimore & Ohio Railroad.

To the Editor:

The editorial in the August issue by Mr. R. T. Boster, has not shown us anything new or explained anything but what the average journeyman boiler maker who has worked in railroad shops knew already. There can be no question concerning the veracity of his statements for the practice has been carried on for some time and I personally believe still continues.

In the shops where I learned the trade they were not at all particular as to just who they made the boiler inspector and even went so far as to take clerks out of the office and place them in charge of boiler inspections. This step was evidently taken so as to hold the qualified mechanics doing the boiler repair work, as real mechanics were scarce and hard to hold. I do not say that all the inspectors were poor but I do say that the ones who were created inspectors from the office were entirely incompetent and unfit for the duties to which they had been assigned.

There can be no doubt that better inspection is needed and right now, for certainly the practice carried on in some shops should be discontinued. Recently I witnessed a reinforcing plate applied to the drums of a boiler wherein, instead of drilling the holes in the shell plates, the so-called boiler maker (railroad class) burned the same with an acetylene burner, and for 1-inch rivets had holes that were fully over ¼-inch too large and very irregular in shape. The rivets were not up nor did the heads on the same conform to standard practice. In calking, the shell plates were very badly scored and the reinforcing plate was porous. This job was done on a stationary plant, but if the boiler makers had been made to do first class in locomotives, they would not have tried to pull off such a poor class of workmanship.

I do not say that there are not good inspectors or boiler makers in the railroad shops, but I dare say that the balance is towards inferiority instead of superiority. To make a good inspector, I believe that one should be well fitted for the position, that he should have served an apprenticeship and also taken up studies along the construction and maintenance of boilers. In some cases helpers have developed into good inspectors but it requires considerable experience before one should be placed in so important a position as boiler inspector.

To prove as to just how competent a body of inspectors he had under his supervision, I saw a boiler shop foreman take all the inspectors in the shop and the roundhouse and send each one individually into a firebox to rap the staybolts and when they were done to make a chart denoting any broken bolts they might find. It was strange to note that out of about eight charts not a one had the same broken or cracked staybolts marked. To cap the climax the supervising boiler inspector had some marked as broken, which upon being cut out were found to be sound.

Coming now to the hurry up as evidenced in the shops, I will say that I saw a broken brace in a boiler that was in the shop for heavy repairs, but the crack was not noted until after the hydrostatic test. As the boiler had to be ready on a certain date, the brace was never repaired, when it should have been renewed. Also when staybolts showed leakage in the tell-tale holes, nails were driven into the same and the boiler allowed to continue. A boiler blew up some time ago in Pennsylvania wherein it was found that several staybolts in a row were broken and cracked, but that the leakage had been stopped by filling the tell-tale holes with nails. These broken and cracked staybolts were the main cause of the explosion.

I do not believe that proper inspections will ever be seen in railroad shops as long as the government permits the railroad company to do their own inspection. If an inspector values his own job, he dare not bring to light all the defects that should receive attention, for as soon as he gets really down to business, he is either demoted or else released. If we are to reduce explosions and other defects in locomotive boilers, it will be necessary to place government inspectors in the shops and to supervise each individual locomotive inspection. I would say that these inspectors would have to be boiler makers who thoroughly understand boiler construction and repairs and not merely men appointed to the position because they were at one time a foreman over the boiler washer gang or an engineman.

The author's description of the leakage under the jacket of engines presents a case that can be evidenced about every day, for the indications on many engines show that there are cracked staybolts or plates, or else leaking calking-edges. When this is discovered, the engine should be shopped and the source of leakage ascertained so that proper repairs can be made before it is too late.

I would like to see the statistics as to just how many locomotive inspectors in government service are from the rank and file of boiler makers. I imagine it might prove a rather small percentage. Do you think that anyone who had not worked on boilers in repairing and construction is in a position to state the cause of a boiler explosion and to condemn the engineer and fireman after they have been killed as allowing low water? Or would you rather accept the opinion of a real old-fashioned boiler maker and inspector who thoroughly understands his stuff, so to speak?

I think that the consensus of opinion outside of officials of the railroads would lead us to believe that there is yet considerable room for expansion in better inspectors and enforcement of the present rules and limitations.

Binghamton, N. Y. C. W. Carter, Jr.

Two Killed by Boiler Explosion

To the Editor:

The most disastrous accident that ever happened on the Ulster and Delaware Railroad took place on August 23, the details of which may be of interest to the readers of The Boiler Maker.

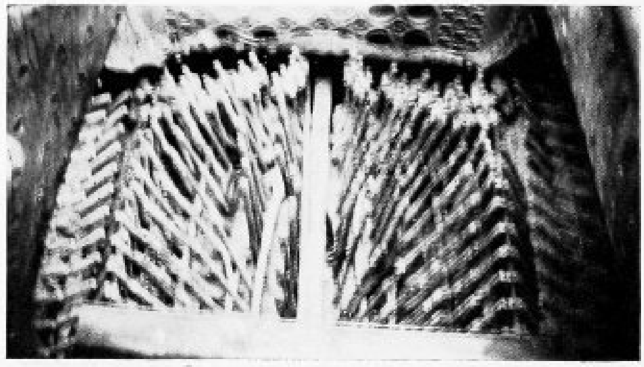
Engine No. 24 left Kingston on a run to Oneonta. The engine was built in 1902 but last year it was made into a superheater. The train consisted of five cars, three baggage and two passenger coaches.

At 8:10 A. M. there was a terrific explosion caused by a crown sheet failure which was due to low water.

The engine was hurled upside down into a gully

At the time of the explosion the train was going about 40 miles per hour. The engine was hurled upside down into a gully, leaving the tender in the same position in the middle of the right of way. The tender's trucks were blown off. On the engine the crown sheet tore at the seam of the back tube sheet and folded back, tearing along the side sheet seams against the door sheets.

The engineer and fireman were killed but none of the passengers was injured. The body of the fireman was



View in firebox showing crown sheet pulled away from staybolts and folded against the door sheet

pulled from under one of the baggage cars. Two of the baggage cars had been thrown off of the track and the trucks damaged but the injuries were not serious.

Kingston, N. Y. W. Gaffken.

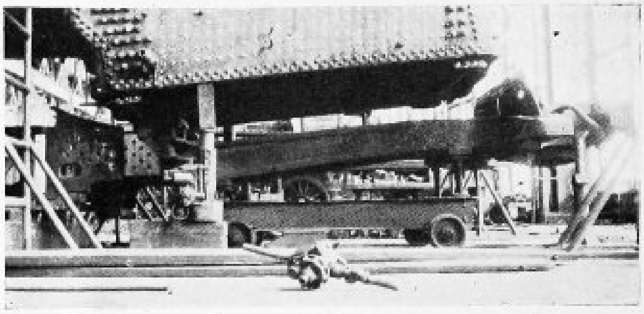
Renewing Fireboxes in M. K. & T. Waco Shops

To the Editor:

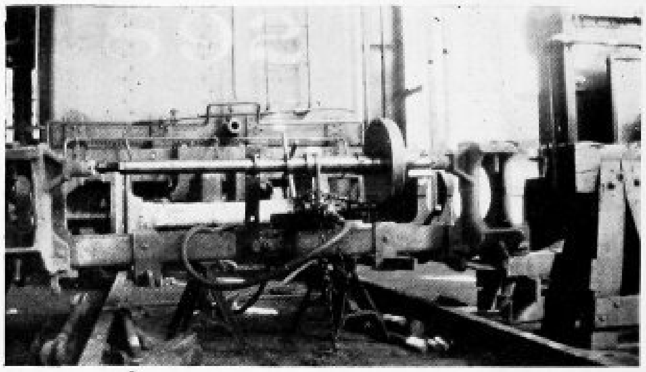
On the first day in the shop, the engine is stripped of the cab and lagging. It is then picked up by an overhead crane and carried to some pit in the shop. The layout man and the apprentice boy mark out the flue sheet and the door sheet in one hour. The punch and shear operator shears and punches the door sheets using a ¾-inch punch. It is then given to the flanger, who, with one helper, flanges the door sheet in one hour. While he is flanging the door sheet, another man punches the flue sheet using a 1¼-inch punch for the flue holes and a ¾-inch punch for staybolt holes. The flue sheet is taken charge of by the flanger. One hour is required to flange the flue sheet. All flanging work is done on the McCabe flanger. While this work is being done the layerout and apprentice mark out the wrapper sheet and give it to the operator of the drill press. It takes one man sixteen hours to drill this. We use patterns for all fireboxes made of $\frac{1}{16}$-inch steel with ¼-inch hole punched in the pattern.

In the morning of the second day the flanger and two helpers and one apprentice boy punch the door hole and flange legs of the flue sheet. In the afternoon they anneal the door sheet. We put a drilling jack on each side of the firebox, one on the back head, and drill ¾-inch holes in all staybolts about 1 inch deep, using telltale holes for the centers. This work takes two men eight hours. We have two men with cutting torches on the inside of the firebox cutting out all flexible staybolts and cutting each side sheet in six pieces and also the crown sheet in six pieces. This takes the two men six hours. One man in the front end cuts all small flues using the Faessler flue cutter, which takes four hours. We burn the superheater flues in two in the front end which takes one man one hour. When we remove the superheater flues there is one man in the firebox, one man in the front end and one man on the floor. We take the flues out of the firebox door and let them fall into a basket.

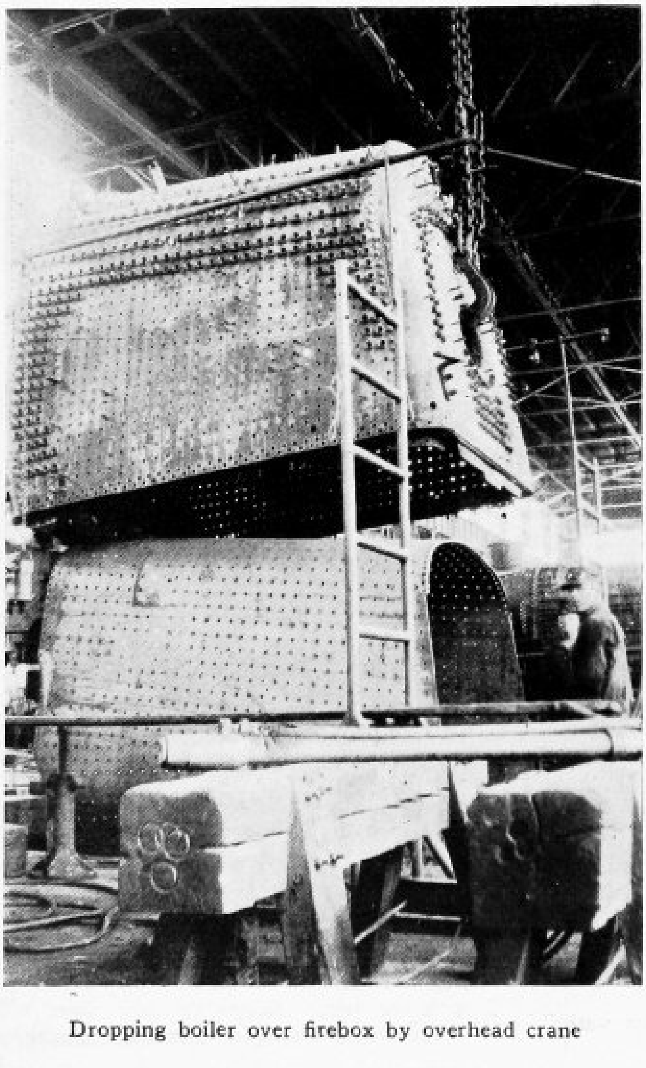
Starting the third day in the shop, three men take a Red Devil rivet buster and knock the heads off the



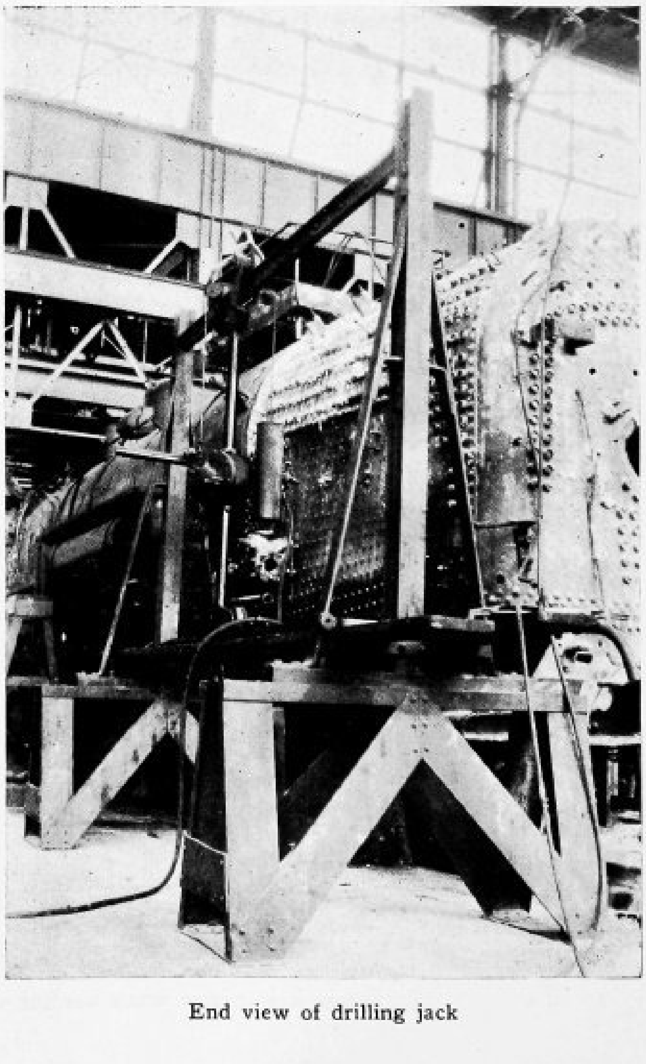
Truck for applying Deta cradle frame under firebox



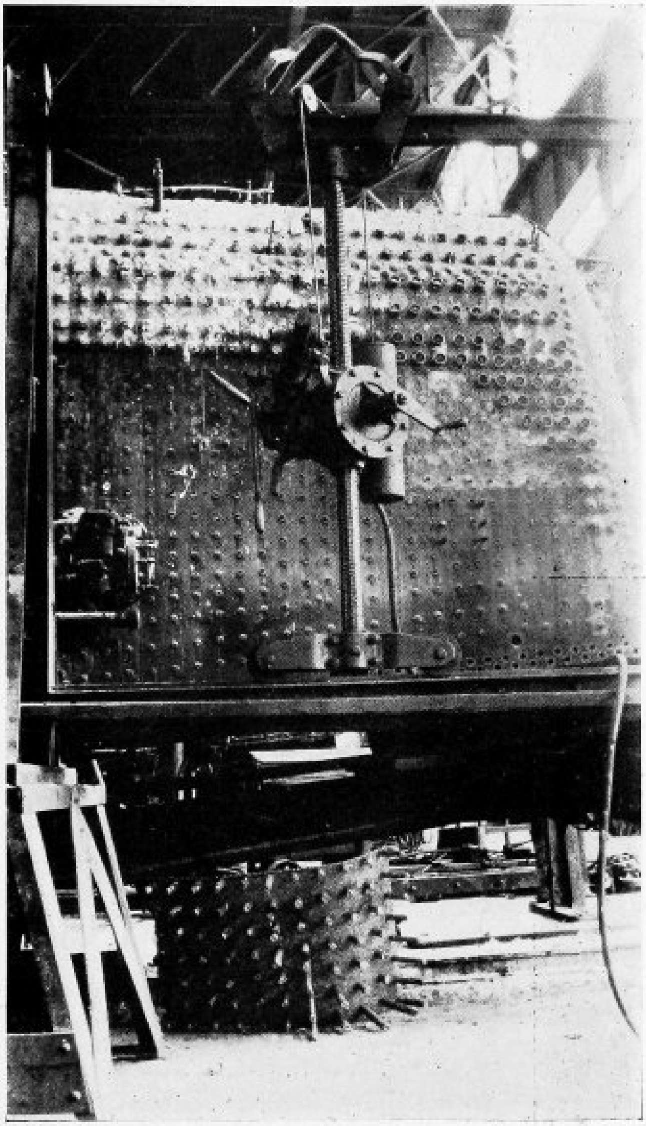
Shop-made jig for turning brake post on tender trucks



Dropping boiler over firebox by overhead crane



End view of drilling jack



Side view of jack for drilling staybolts

rivets in the mud ring and back out all rivets, knocking down the side sheet and door sheet. This takes the three men six hours. Then we start pulling the radial stays, one man burning them on the outside of the wrapper, and one man on the inside with a piece of pipe about 4 feet long pulling them. This work takes the two men four hours. The flanger then anneals the flue sheet. In the afternoon he fits in the flue sheet and door sheet. The boiler is sealed the third night, one man using a portable shop-made sand blast, which takes eight hours.

In the morning of the fourth day we finish pulling the radial stays. We inspect the boiler and all back head braces. The drill press operator drills all flue holes. This takes one man five hours. In the afternoon we put in the firebox. Then we use the crane to pick up the boiler and roll the firebox under the boiler on old flues, letting the boiler down on the firebox. Then we rivet the door sheet in the firebox; all this taking one boiler maker and two helpers three hours.

On the fifth day we pull up the firebox and bolt it to the mud ring, put in and drive the flue sheets, ream all mud ring holes and drive all mud ring rivets.

On the sixth and seventh days we start tapping the staybolt holes with one boiler maker on each side and back head; one boiler maker and helper on the throat sheet; and one helper on the inside, passing taps. We tap out the staybolt holes and drive the staybolts about 4 feet back of the flue sheet, so the flue men can get in and work the flues. We take the length of the flues on the sixth day. Now we have the flues cut and ready to go in. One boiler maker and helper tap out all radial stays inside and out in sixteen hours.

On the eighth morning we start flues in the boiler, with two men in the firebox, and two men in the front end.

We work all the flues and finish tapping and driving the staybolts on the ninth and tenth days and are ready to test the boiler on the tenth evening.

Waco, Texas O. L. Chamberlin.

Eliminating Boiler Scale

To the Editor:

Recently the Dutch steamer *Hontestroom* arrived in England with what is known as the N. O. C. process fitted to her two Babcock & Wilcox boilers, one of which was opened for the inspection of consulting and superintendent engineers interested in the new process. A number of land boilers have been thus installed, but this was the first marine job. After several months steaming with Amsterdam "fresh" water the internal parts of the main steam drum and the large tubes next the fire were found to be in excellent condition, there being only a thin deposit in some of the smaller tubes which was quite soft and easily removable by the fingers. It was stated that by a slight adjustment of the apparatus even this small residue could be eliminated.

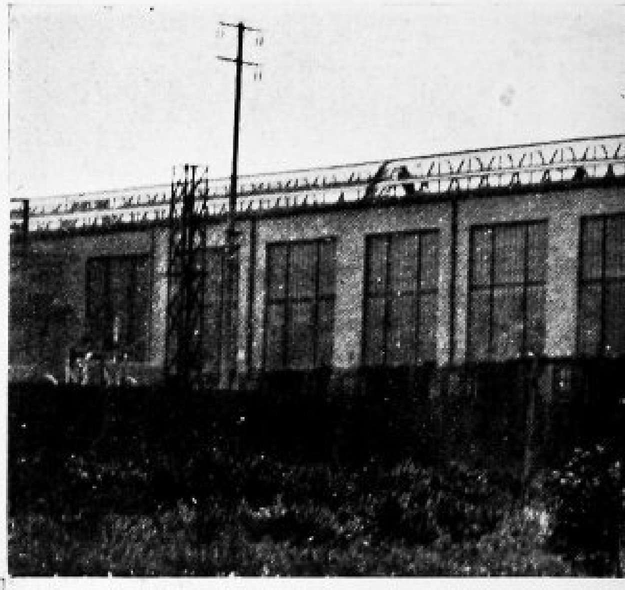
The process is electrical, but there is no "electrolysis," as the minute current, costing about two cents per day per boiler, does not pass through the water at all. The boiler structure itself is alone in circuit, the terminals being attached to the hottest and coldest parts of the shell respectively, between which there is naturally a small difference of potential. Various liquids, as well as metals, are electro-positive in relation to each other, and boiler water is no exception. Moreover, things of unequal potential attract, while those of equal potential repel one another. Working on these well-known principles, the inventors arranged to pass just sufficient current through the boiler shell as would bring it to the same potential as the feed water. There is thus a repulsion between the metallic surface of the boiler and the contained water, so that when the solids separate under the action of heat and try to settle on and adhere to the boiler plate, the attempt is frustrated. The deposit, having no foothold, simply gravitates in the form of loose sludge and is blown out periodically.

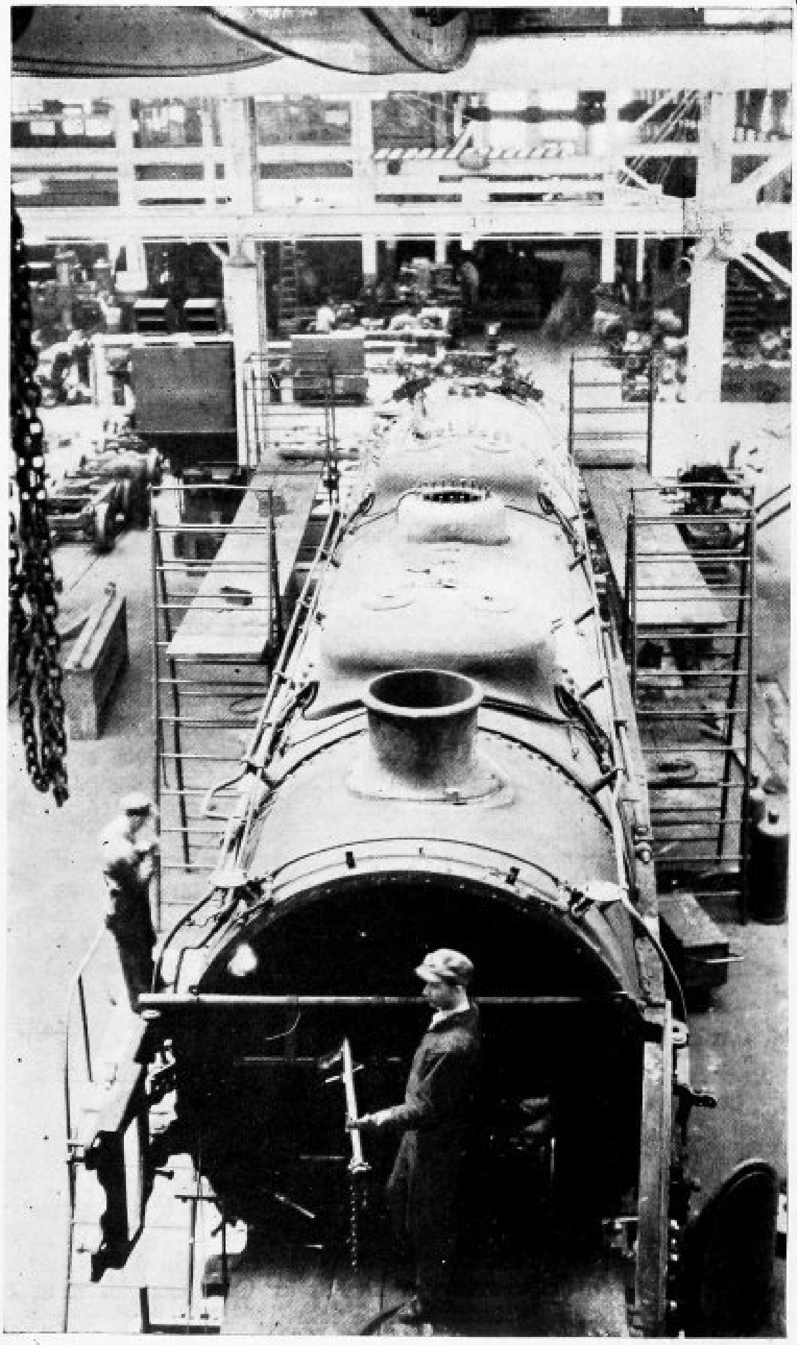
Prevention is, of course, better than cure; but where the deposit has already occurred before applying the apparatus the effect is to loosen and detach the scale so that it is easily removed without chipping being necessary. One such piece in a Lancashire boiler was more than one-half inch thick and so large in area that it had to be broken up before it could be passed through the manhole.

London, Eng. G. P. Blackall.

Additions to the boiler code.—An announcement has been sent out by the Boiler Code Committee of the American Society of Mechanical Engineers that the final addenda sheets to the 1927 Code have been prepared and are available. Those interested in changes that have been made in the code should obtain copies from the secretary of the Boiler Code Committee at 29 West 39th street, New York.

C. & O. Shops
now in operation
at Huntington





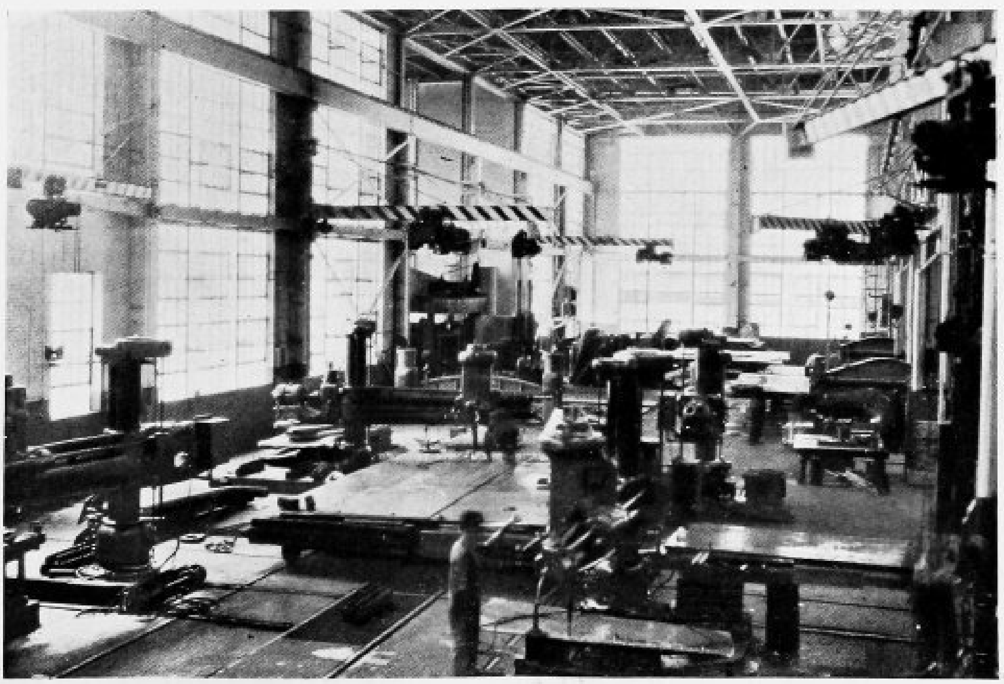
In 1926 the Chesapeake & Ohio Railway placed in operation a modern boiler shop which was to form the nucleus of an entirely new locomotive repair plant. Complete details of the shop and its facilities were published in the June, 1927, issue of THE BOILER MAKER and a floor arrangement plan of machinery is shown on page 252 of this issue. Since that time the plans for expansion have been completely executed and only a short while before the Hocking Valley Railroad and Père Marquette were merged with the Chesapeake & Ohio, during the last few months, the new plant was in full operation. Today the locomotive repair shops at Huntington, all the major units of which are under one roof, constitute what is the equal of any plant of the kind in the entire world.

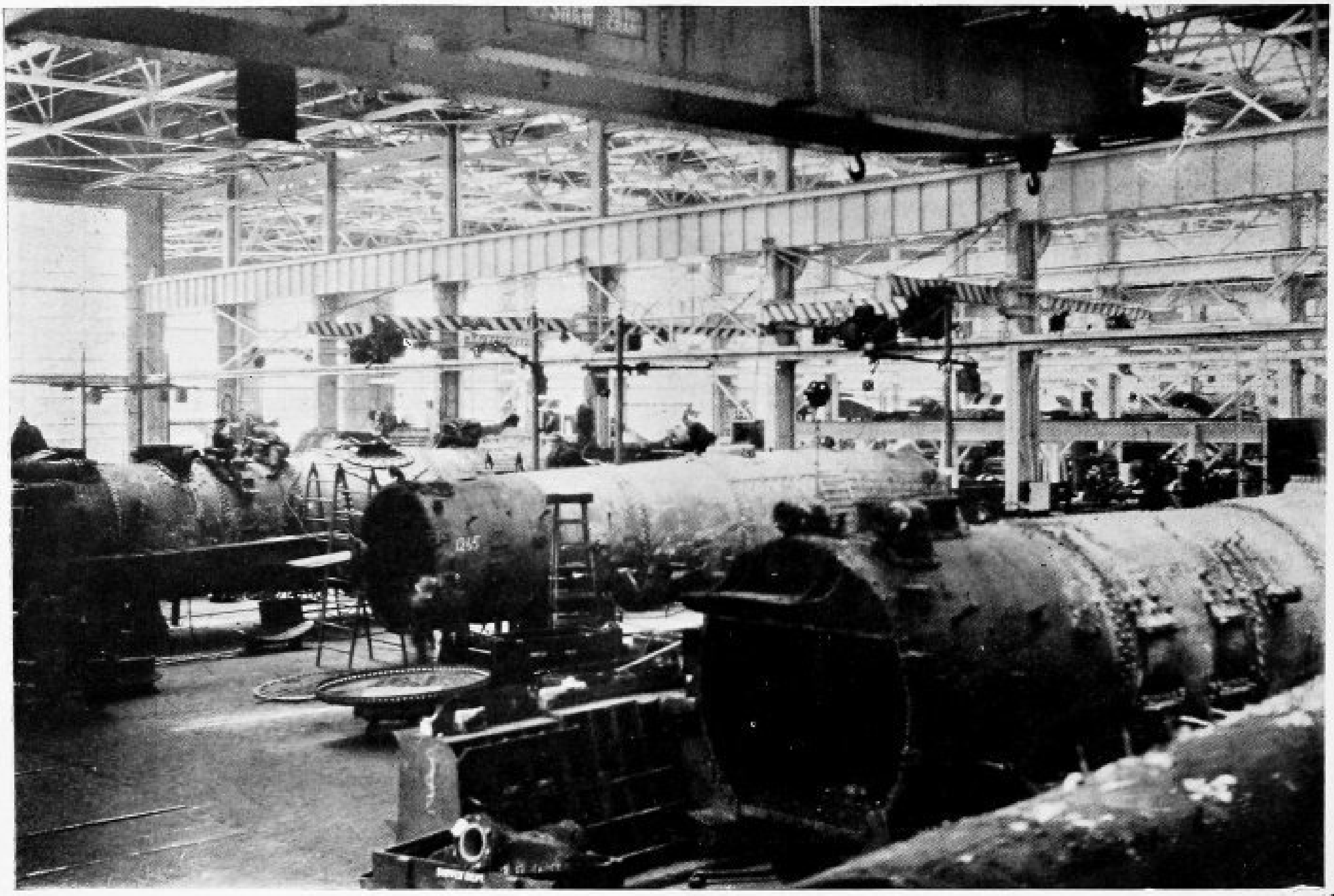
The new shop has been designed to provide the maximum capacity for locomotives sent in to receive heavy classified repairs with the least possible detention from service and at a minimum expenditure of labor. In accomplishing this, full advantage has been taken of the principles of mass production methods and short straight-line movement of materials, following in general the methods employed by the more progressive automobile manufacturers, wherever they have been applicable to locomotive work. Complete detailed time studies were first made to determine the number of machine operations necessary to repair a given number of locomotives a month, which automatically determine the number, size and capacity of the several hundred machine tools which had to be installed to produce balanced shop operation for all of the several departments comprising the locomotive works. The result of this time study was to locate machinery in groups for each separate kind of work, and in the proper sequence of operations in order to avoid all unnecessary handling of parts, which reduces labor cost.

Careful analysis of this time study indicated the desirability of having competent machine tool builders design certain special high-production machines which heretofore have not been available. These are mainly found in the new machine erecting and wheel shop, the boiler shop having been changed very little from the arrangement and equipment previously described.

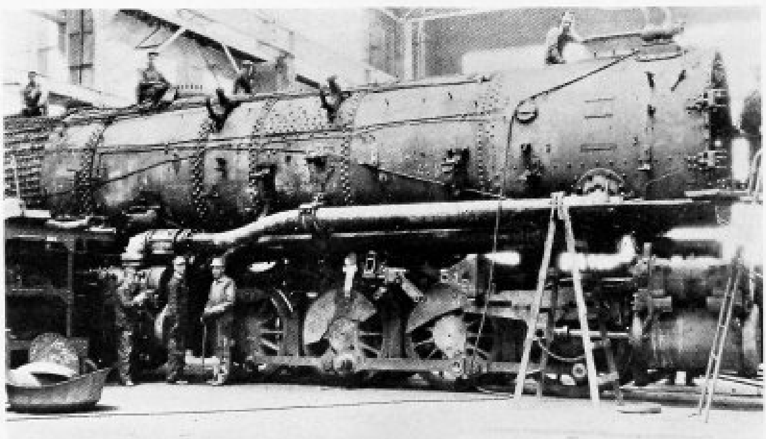
Before attempting the actual detail design of this shop, a committee of engineers was sent to visit a great many of the major railroad repair shops built during the last twenty years, to study their operation, accertain their defects and endeavor to design this shop with a view not only of meeting the present requirements but those of the next 25 or 30 years. In this way the plant as finally developed can be kept abreast of the constantly changing industrial conditions at a minimum expenditure.

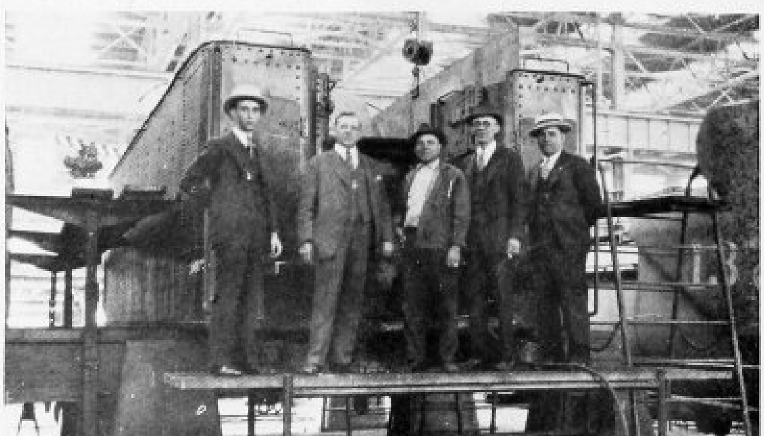
The Chesapeake & Ohio controls the condition of its locomotives by means of records of actual work performed by different classes of locomotives, expressed in terms of the miles run. Classification of repairs is thus determined largely by the service actually rendered by each class of locomotive. The new shop will accommodate 37 locomotives undergoing repairs at one time. By using all of the space available continuously for twenty-five 8-hour working days per month gives an actual capacity for the shop of 925 pit days which is the maximum capacity. The maximum number of individual locomotives that can be given general repairs per month depends upon the number of working days each

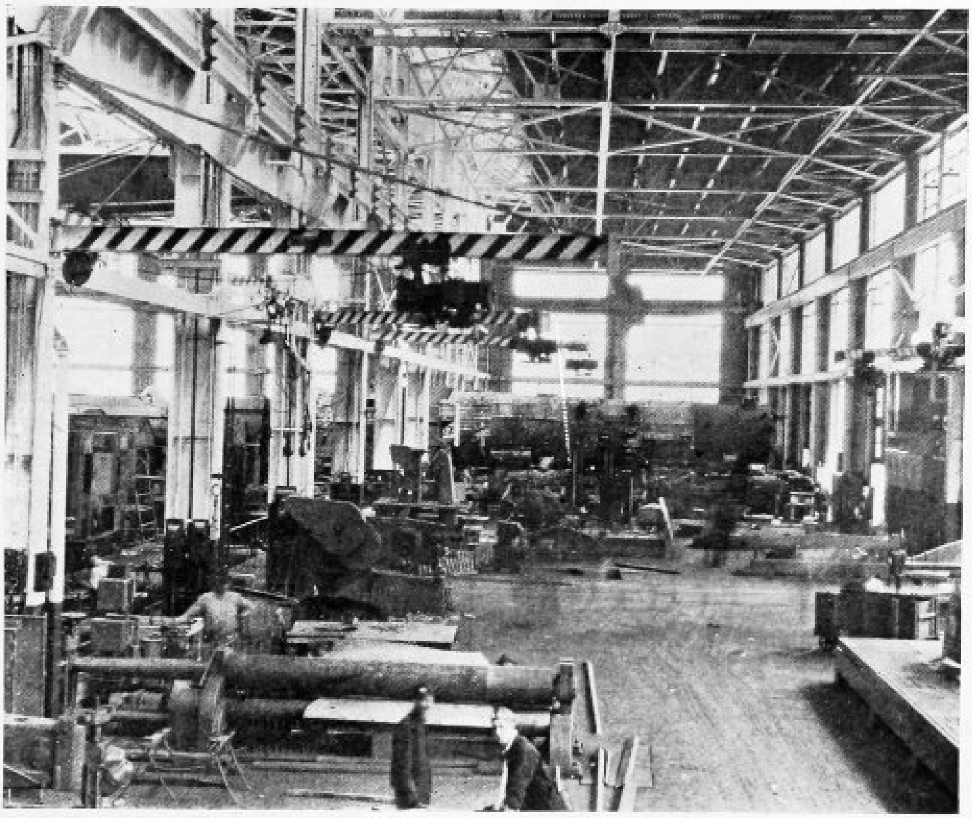




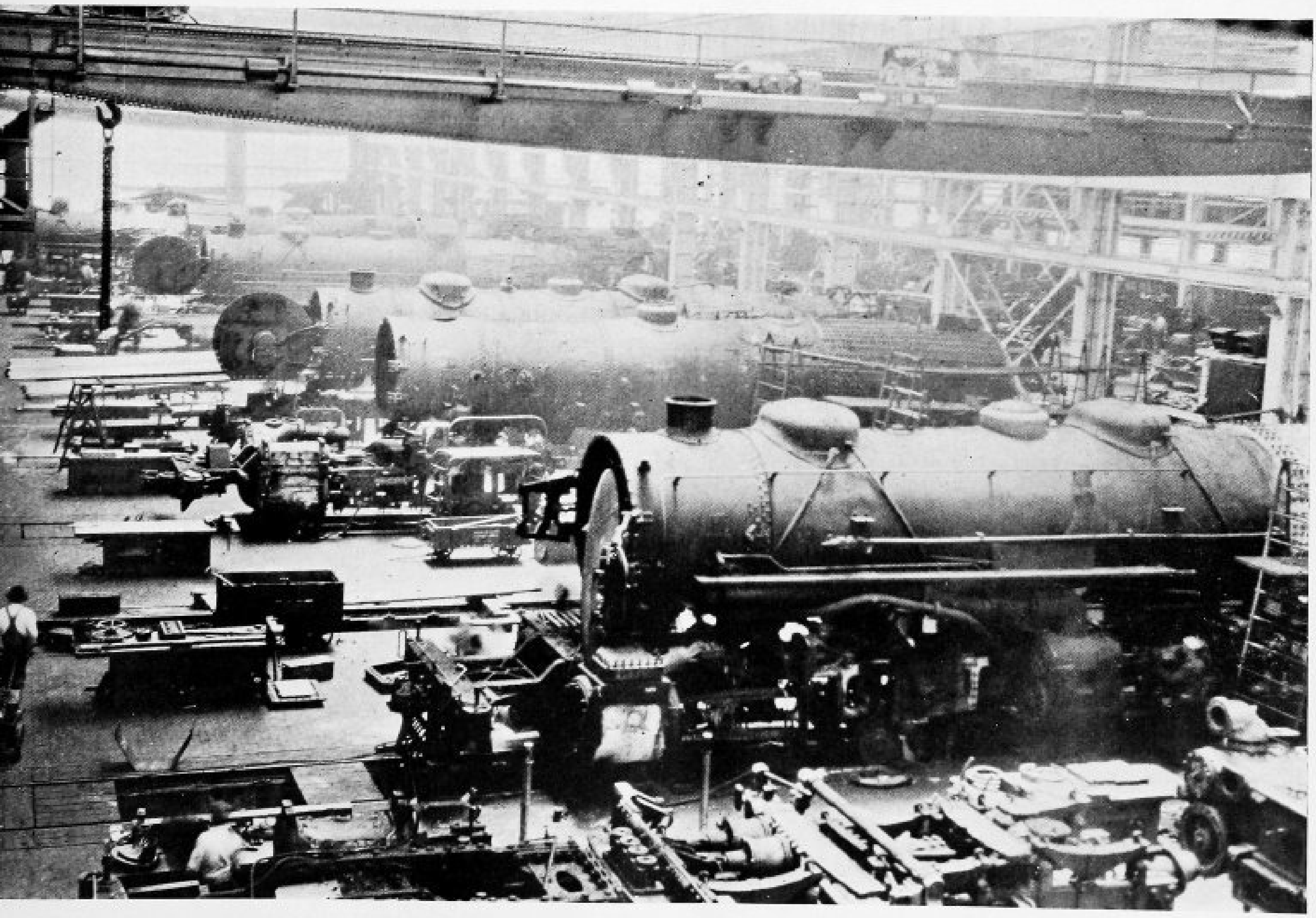
Above is the assembly bay in the boiler shop. At the right a C. & O. Mallet is shown in the erecting shop. Below the chief boiler supervisor and the master boiler maker are shown with their assistants







At the left is shown the fabricating shop while below is a general view of the new erecting shop which was completed early this year to round out the Huntington plant construction program



locomotive requires. Based upon a conservative schedule of 18.5 working days for different classes of Chesapeake & Ohio locomotives, nearly 30 percent of which are large Mallet articulated type, the maximum capacity of the shop would be 50 general repairs per month of the following classes:

Mallet locomotives:

3 to receive Class 2 repairs (new firebox and general machinery)

14 to receive Class 3 (general repairs); making a total of 17.

Other than Mallet locomotives:

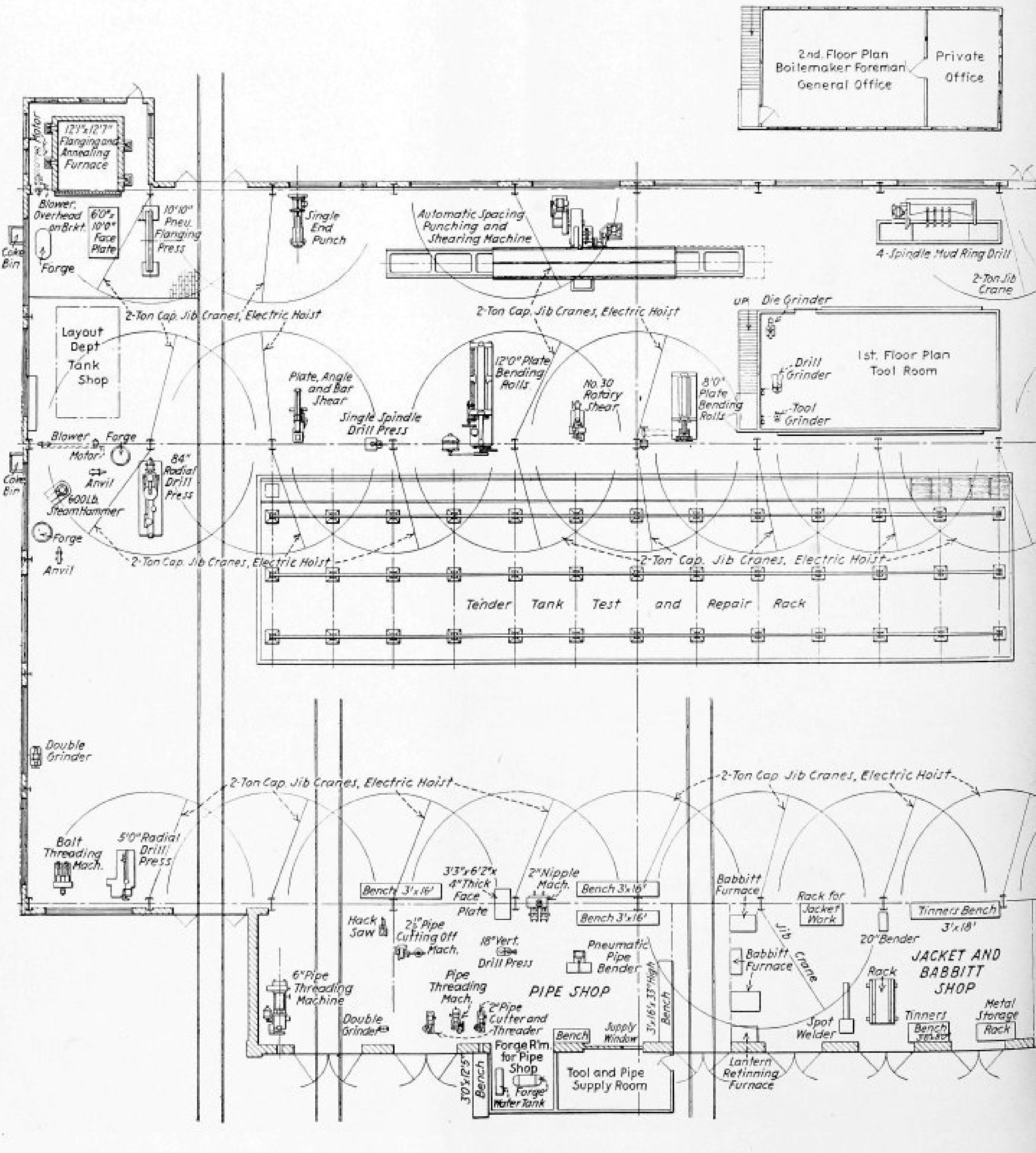
6 to receive Class 2 repairs

27 to receive Class 3 repairs; making a total of 33.

The combined total on this basis will therefore be 50 Class 2 or 3 repairs per month.

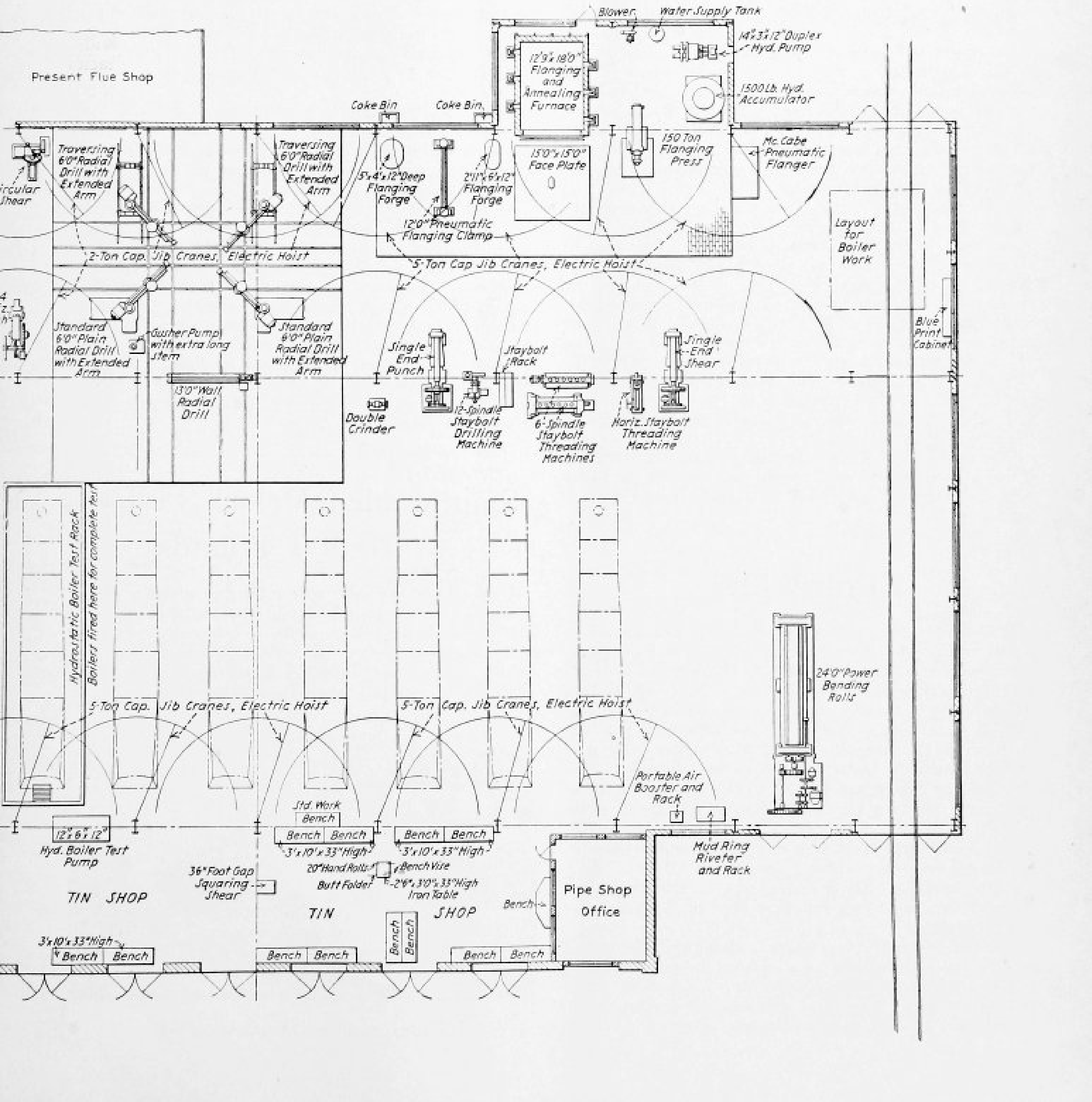
Ninety days before locomotives are scheduled to be shopped for general repairs they are inspected. Accompanying the formal request of the chief mechanical officer for authority to shop each locomotive is a statement of any unusual item of materials required, which information is extended to the shop superintendent, who in turn confers with the general storekeeper, periodically arranging for such materials to be obtained before the locomotive is shopped.

Since a scheduling system is necessary for the successful operation of a repair plant of this kind, a brief description of that now employed at Huntington is of



interest. The purpose of a scheduling system is primarily to hasten the work toward the final out-shopping of an engine sooner than it would have been had it been brought into the shop and allowed to drift along from one job to another until the repairs were completed. At Huntington a new shopping program is made every month, which is in a large measure a revision of the previous month's list, with the engines omitted that have been out-shopped during that period, and those which are still in the shop on which the out-shopping date has been changed are corrected. This naturally changes the expected shopping date of the engines which are to follow them into the shop. New engines are added as their assigned mileage approaches completion.

When an engine is taken off the pit to be out-shopped, another is ready to take its place. By means of inspectors' reports, furnished by the master mechanic as well as by shop inspectors who examine the engine as soon as it arrives it is possible to determine just how many days the engine is to be allowed for repairs. For instance, a large Mallet requiring heavy boiler work and general repairs but not a complete firebox is shopped. Ordinarily the work would require about 14 days. This engine is posted on a large master schedule sheet which is divided by 131 vertical lines which leaves a column at either end for dates and 129 vertical columns, each of which represents a particular type of work on the engine to be scheduled. Each item is given a number for the convenience of the scheduling staff. Thus, Item No. 1 indicates "engine in the shop"; Item No. 23, "boiler tested"; Item No. 129, "engine outshopped." The series of numbers, 1 to 38, includes the first section of the board, covering the erecting shop; then Items No. 38 to No. 55 are shown boiler shop items, etc. In this way, each department is as-



signed a section of the master sheet, even to the stores department, which is assigned one vertical column in which engine numbers are placed, requiring delivery to the shop of large orders of material. In addition, an item is arranged in which the shop must indicate a date for ordering material, usually three or four days after the engine is scheduled. The dates are placed in spaces at the ends of the board, which is divided into 27 horizontal spaces crossing the vertical item columns, with the top space devoted to the date of the first working day, then each succeeding day down the board in chronological order, Sundays and holidays being omitted.

Three boards are required by the scheduling department, one for the month completed, which is used for working up reports; one for the current month for actual working purposes, and one for the following month from which a new schedule is planned as far as 30 days in advance, which is the longest regular schedule. If an engine were scheduled in on the first day of the month, Item No. 1, the date of entry, would appear in the extreme upper left hand corner square of the board, and would be indicated by marking the engine number there in pencil. Each succeeding item is put down in like manner except that it is in different horizontal or day spaces. The day that each job is due is determined by a sheet which has the item numbers and the days they are due figured out and shown for use in scheduling all engines of that type and class repairs.

Each foreman is supplied with a sheet similar to the master sheet with the engines noted for which he is responsible. When such items come due, if his work is completed, he crosses of the engine number. The scheduling office takes up all the sheets each day to check them and determine which jobs are completed and to add other engines as they are scheduled. When a job is not finished on time, the engine number is copied from day to day in red ink until it is finished, after which the foreman checks it out. The master board is correctly posted by aid of these foremen's checking sheets as well as by the scheduling supervisor's personal knowledge of the progress of the work.

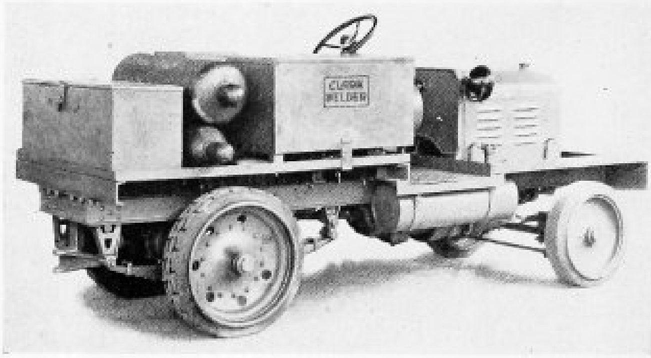
The application of the scheduling system to the new erecting shop and its relation with the work in the boiler shop as now organized will be discussed in the next issue.

Trucwelder

A new portable welding unit which has solved many repair and production problems has been introduced by the Clark Tructractor Company, Battle Creek, Mich. The Trucwelder, as it is called, is a complete, mobile, self-contained, gas-powered, electric arc-welding unit, capable of 24 hours' continuous operation and especially useful in places and on work where there is no convenient source of electric power. The trucwelder takes the welding equipment to the work. A high level of working capacity per unit and output per day is maintained; costs per weld are low.

The unit is equipped with self-starter and headlights, carries all necessary welding accessories (General Electric standard), has ample room for acetylene tanks (for cutting), seating room for crew and ample power for towing trailers.

Arc welding current, ranging from 60 to 250 amperes, at 25 volts, is developed by a self-excited General Electric arc-welding generator with control, driven by a special heavy-duty, 4-cylinder gas engine developing 20 horsepower at 1480 revolutions per minute. Currents



Clark Trucwelder having ample storage room for gas tanks and cutting equipment

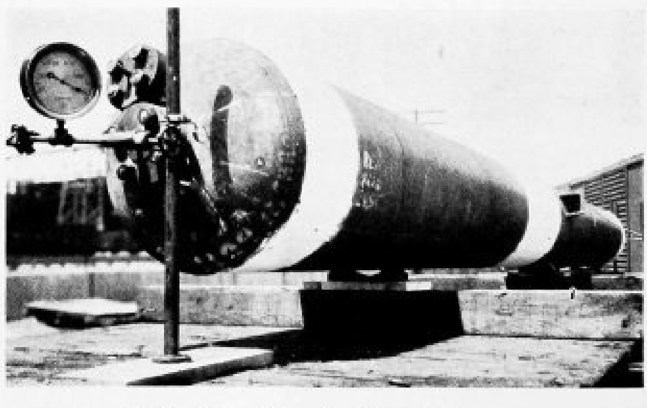
between 25 and 60 amperes may also be obtained by inserting in the circuit a current-reducing resistor provided for the purpose. The current available is ample for use with all commercial sizes of metallic electrodes from $\frac{1}{16}$ inch to $\frac{3}{16}$ inch, also for light carbon welding or cutting.

Engine and generator are connected by a 3-inch wide endless special composition belt. Generator is thrown in and released by a hand-controlled belt tightener—a ball bearing idler mounted on sliding ways, located on the driver's platform to the right of the driver.

Automatic stabilizing of the welding arc is provided by a self-adjusting arc stabilizing reactor. The reactor makes it easy for the operator to maintain a steady arc on low as well as on high currents under all welding conditions. For striking the arc a high open-circuit voltage of 65 volts is available, after which the voltage is automatically reduced to that required to maintain the arc. Adjustments in the range of welding current from 60 to 250 amperes, are made by shifting the generator brushes by means of an external handle. Further adjustment down to 25 amperes is made by an easy shift of electrode leads.

Smithwelded Vessel Tested to 10,000 Pounds

A number of the most severe tests to which a welded vessel has ever been subjected, reaching a pressure of 10,000 pounds per square inch, were recently completed at the plant of the A. O. Smith Corporation in Milwaukee. The vessel tested is a reaction chamber built of chrome-vanadium steel by Smithwelding for 5000



Welded reaction chambers under test

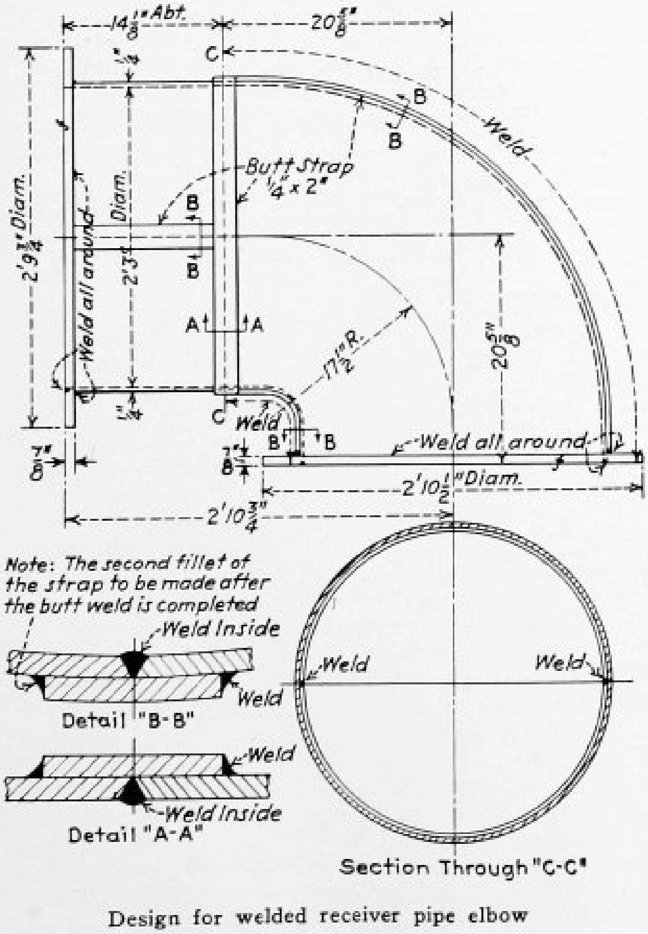
pounds per square inch working pressure in a chemical process. Walls are 3½ inches thick. The vessel is 33 feet long with an inside diameter of 26 inches.

Following the routine repeated stress and hammer tests at 8000 pounds per square inch, the pressure in the vessel was raised to 10,000 pounds per square inch and the entire vessel was carefully examined. As shown in the accompanying illustration there was no scaling of the lime wash. Careful measurement and liquid volume readings showed that the vessel took no set or permanent distortion from the extremely high test pressures. The vessel was shipped for installation on the same night that the tests were concluded.

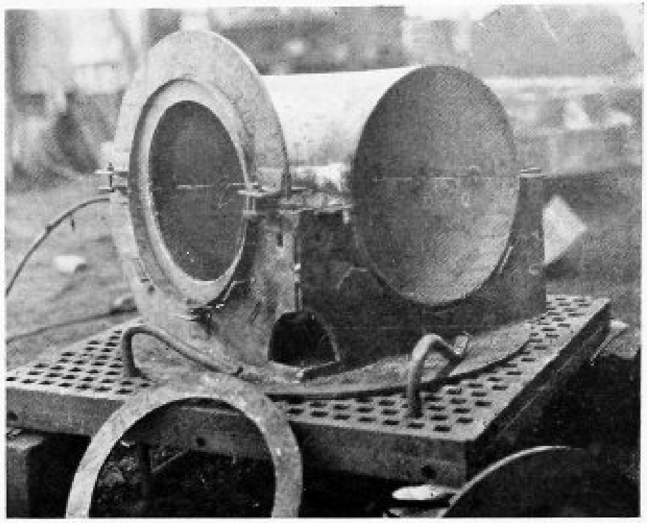
Assembling Receiver Pipe Elbows

By C. E. Lester

The building of the 10,000-ton cruisers for our Government brought to the builders many intricate problems and many difficulties to overcome in the fabrication of the hulls, machinery and accessories. The insistence of the inspection service for all parts to be exactly to specification or drawing, without deviation, irrespective of the necessity for it, added many a burden for unessential exactitude. This paper is not, however, any dissertation on the whims of inspectors but merely a description of the assembly of receiver pipe elbows that entailed some difficulties in securing the accuracy required but hardly necessary.



Design for welded receiver pipe elbow



Set of rings in position on tack-welded elbow

The two pieces of the elbows were received from the flangers in the rough, and, before assembly, were required to be set on a face plate and laid off to the exact size necessary for welding the segments together. They were then cut to the finished length and size. The ends of the elbows were to be inserted in solid angle iron rings which met other angle rings on the receiver pipes, which formed, in effect, a flange union.

These angle iron rings were first formed at the fire and welded together and the interior and faces turned to finished size. The inspection requirements were that the welded elbow should be exact within $\frac{1}{16}$ inch on the diameter. This is close work on a large welded job.

On an analysis of the job preparatory to welding, the necessity for jigs for holding the work was manifestly apparent and the illustration shows the method used.

Two pieces of ⅝-inch plate were placed on a boring mill and circular holes were cut in each of them to the exact outside diameter of the required elbow. Each of these plates was then cut through the center of the hole. The two bottom halves were then welded in the form of a right triangle to a bottom plate.

Angle iron brackets were then welded to each section, both top and bottom, with which to couple the two segments and dog the elbows in place.

Additional rings to fit each interior end were made on a boring mill and turned the exact required size of the inside diameter of the elbow.

The assembly preparatory to welding proceeded by placing a bottom half of an elbow in the jig, applying the inner ring, setting the upper half of the elbow in place, and, with the top half of the outer ring, pulling and dogging the elbow into exact shape.

The segments were then tack-welded before the complete welding operation was carried out.

The illustration shows an elbow in position and tack-welded with a set of rings in position. The other rings are shown removed to permit a better view of the interior.

Locomotives.—August shipments of locomotives, based on reports received by the Department of Commerce, totaled 77 as compared with 56 in July, 129 in August, 1929, and 34 in August, 1928. Shipments for the year to date amounted to 552, as compared to 517 for the same period of 1929.

Washing Locomotive Boilers*

Most efficient method used in washing and cleaning all types of boilers

In preparing this report, your committee has endeavored to cover the subject in a general way, rather than by a study of the methods of handling this class of work on any particular design of locomotive or stationary boiler, in order that the practices recommended herein may be applied to nearly all conventional types of locomotive or stationary boilers used in railroad service.

To wash and clean efficiently boilers operating in most localities, the feed water used should be treated by an approved method developed to meet local conditions, so that scaling matter in the water may be reduced to a minimum. Usually, treated water supplies will produce cleaner boilers without any subsequent leakage. An important element in most processes of treating that should receive careful attention, if advantage is to be taken of the maximum period between boiler washouts allowed by law, is reducing the concentration in the boiler water by means of frequent blowing through a suitable blow-off cock arrangement.

There are several boiler blowing-down arrangements on the market for taking care of these conditions. As a rule however, they are bulky and somewhat expensive. Some railroads have developed road blowing devices in their own shops, which give an easy discharge of water and steam underneath the tender, the force of the steam being broken in a box provided with deflecting devices.

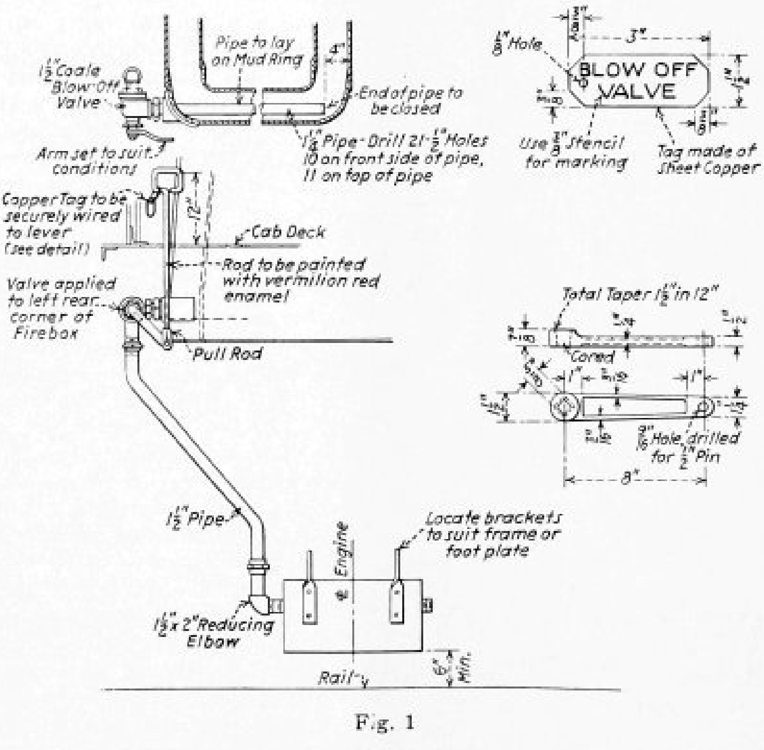


Fig. 1

Figs. 1, 2 and 3 show details of road blowing devices, all of which are excellent, used by at least three Eastern railroads. Any of these arrangements can be operated at will by the engineman in the cab, permitting frequent boiler blowing on the line of the road and at terminals. Experiments made on several railroads have proven that the best results can be obtained by blowing approximately a full glass of water out of boilers on arrival and departure at terminals and blowing on the line of the road about every 25 miles for a period of about seven seconds.

The boiler blow-out arrangement should be connected to one or both of the back corners of the boiler firebox just above the mud-ring or bottom water bar. A perforated pipe attached to the blow-off cock, extending across the door sheet water space, will assist materially in removing sludge from the boiler. Due to circulating conditions, the average boiler collects more sludge and sediment at the back end than at any other point, which condition requires frequent blowing for removal. The size and number of perforations in the pipe attached to the blow-off cock should be governed by the outlet area of the blow-off cock so that sludge may be drawn into the pipe along its entire length.

The application of the above-mentioned equipment and practices has permitted many railroads materially to increase the length of the boiler washout periods on both locomotive and stationary boiler units.

A good organization in large locomotive terminals is essential, efficiently and properly to handle locomotive boiler washing. The following is a brief outline of what may be considered a good organization plan for this work:

(a)—The master mechanic and general foreman should confer with the boiler maker foreman and assist in making assignments of responsibility for the proper keeping of records and also for the proper washing of boilers, the condition of plugs, the condition of threads in sheets, the cleaning of arch tubes, etc., so the particular individual responsible for each operation will be definitely understood by all concerned.

(b)—Upon the foreman boiler maker in charge, and those authorized by the master mechanic and general foreman, devolves the responsibility of having the boilers washed as often as necessary.

(c)—An assigned person shall, each morning, make a list showing by number the locomotives due and overdue for boiler wash. This list should be furnished the hostler foreman, roundhouse foreman, and should be posted in an established conspicuous place for information of employees engaged in this work. It should be the duty of the hostler foreman or others authorized by the master mechanic or general foreman to check

* Committee report presented at the twenty-first annual convention of the Master Boiler Makers' Association, held at Pittsburgh, May 20 to 23.

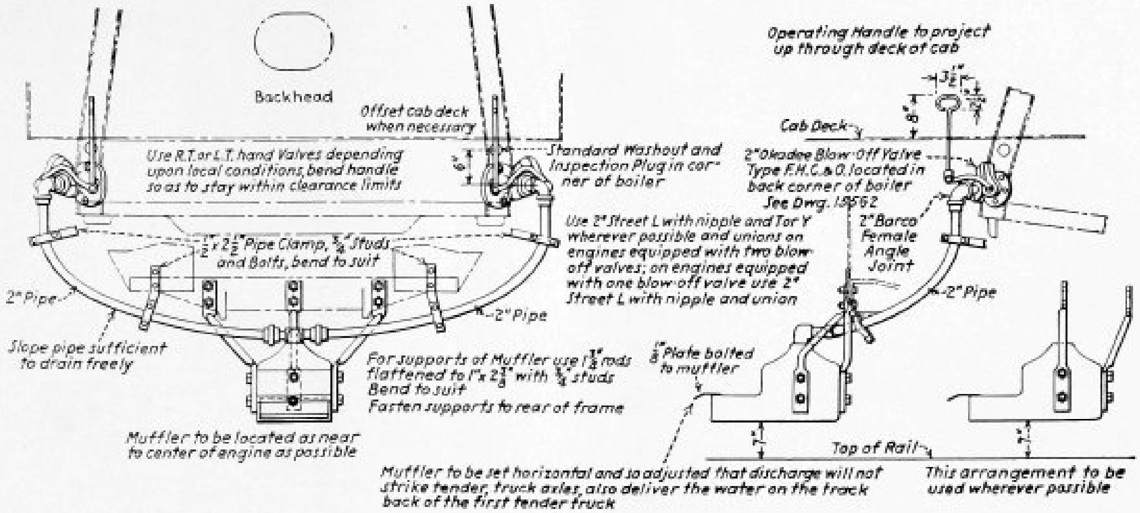


Fig. 2

each engine on arrival at the terminal to determine if it is due or overdue for boiler wash, and to have fires drawn from locomotives which require boiler-washing attention.

Frequency of Boiler Washing.—The maximum period between boiler washings on both locomotive and stationary boilers should be fixed by the master mechanic and boiler maker foreman, subject to the approval of higher mechanical officers, after fully considering the type of boilers, the service in which they are used and conditions of water used in the boilers. In no case should the period be extended beyond the 30-day period required by law. It is good practice to wash boilers that have received heavy repairs in not less than seven days after being put in service.

Blowing Off and Cooling Boilers.—At terminals where hot water boiler-washing plants are installed and where hot water is available for washing and filling boilers, the boilers should be blown off through the blow-back system.

At stations using cold water for washing boilers, the boilers should be thoroughly cooled before water is drained. When boilers are cooled in the natural way without the use of water, the steam should be blown off, but the water must be retained above the top of the crown sheet and the boiler allowed to stand until the temperature of the firebox sheets is reduced to about 90 degrees F., or so that it feels cool to the hand. Then the water is drawn off and boiler washed. When the boiler cannot be spared from service for a sufficient time to be cooled in this manner before washing, proceed as follows:

Use the Injector to Cool Boiler.—When there is sufficient steam pressure, start the injector and fill the boiler with water until the steam pressure will no longer work the injector. Then connect the water-pressure hose to the feed pipe between the engine and tender and fill the boiler full, allowing the remaining steam to blow through the test valve on top of the boiler. Open the blow-off cock and allow the water to escape, but not faster than it is forced in through the check, so as to keep the boiler completely filled until the temperature is reduced to about 90 degrees F.; then shut off the water and allow the boiler to empty itself.

Boiler-Wash Nozzles.—Boiler-wash nozzles are quite similar on most railroads. The connections, of course, vary in length to suit conditions and systems used. Fig. 4 shows wash-out nozzles that are similar in type and are used by many railroads for washing boilers.

Location of Washout Holes.—Fig. 5 shows a wash-out hole plan.

Washing Boiler.—Remove all washout plugs. Begin washing through holes in the side of the boiler opposite the front end of the crown sheet. Wash crown sheet at the front end using nozzle No. 1 or No. 2; then use nozzles No. 3 and No. 4 to wash between the rows of crown stays, directing the stream toward the back end of the crown sheet. After washing is completed through the holes near the front end of the crown sheet, use the washout holes in their respective order toward the back of the crown sheet.

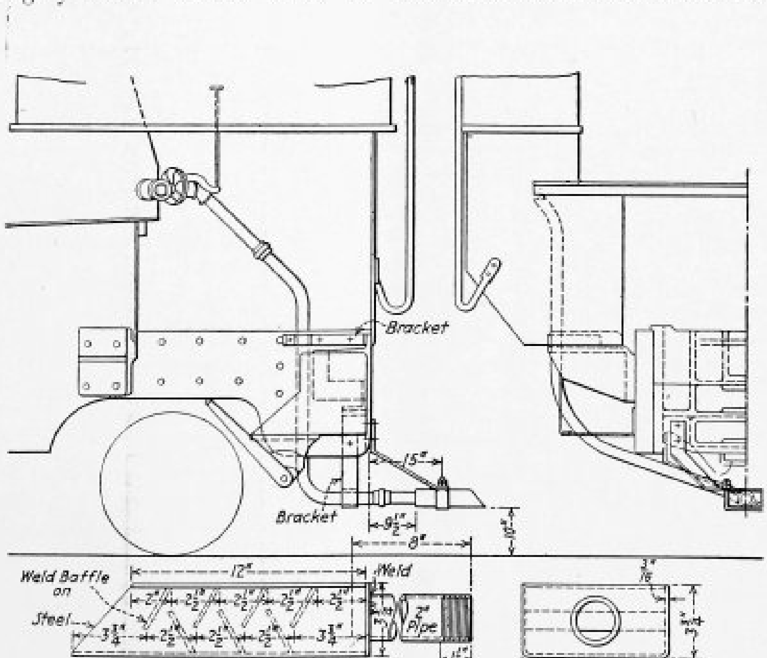


Fig. 3

The object of this method is to work the mud and scale from the crown sheet toward the side and back legs of the boiler and prevent depositing it on

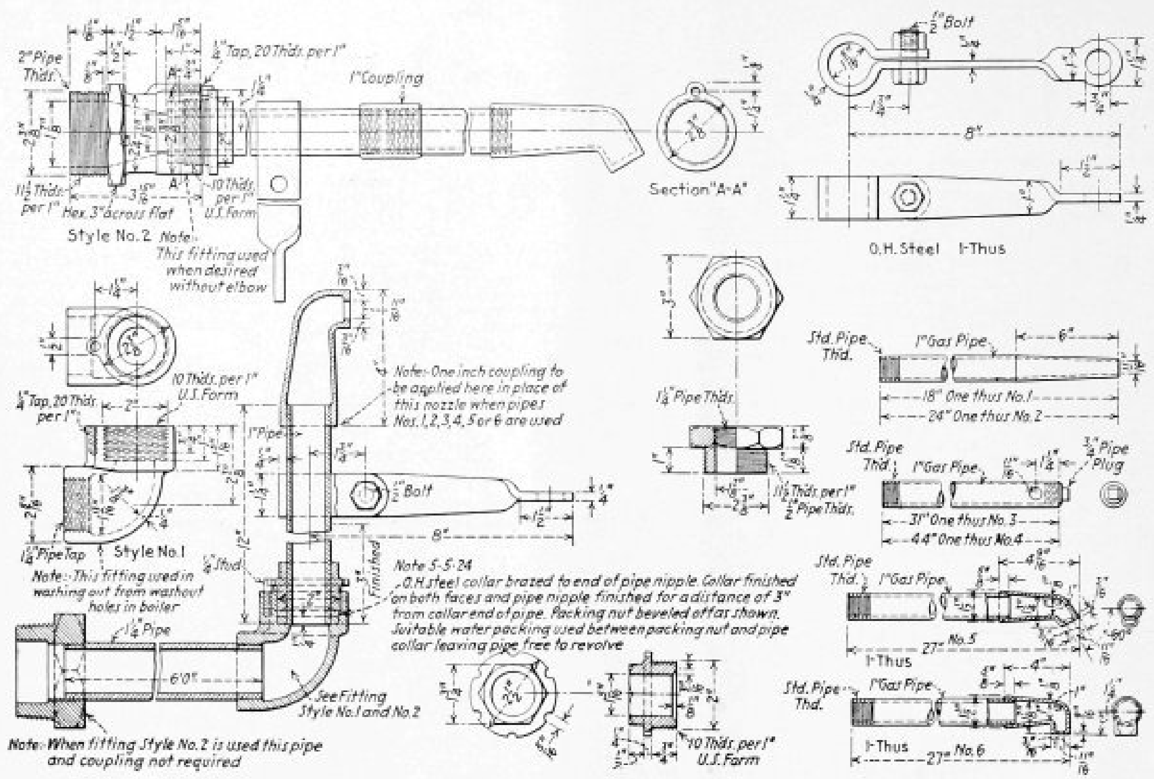


Fig. 4.—Boiler wash-out nozzles

the back ends of the flues. Wash the back end of the flues through the holes provided for that purpose and located near the back flue sheet, using nozzles Nos. 1, 5 and 6, and revolve them by using a swivel connection when the curved nozzles are used. The same nozzles are to be used and the same system followed when washing any part of the flues.

Now return to the holes in the sides of the boiler, opposite the crown sheet, using nozzles Nos. 5 and 6 and revolve them so as to thoroughly wash down the side sheets and staybolts, ascertaining that all spaces on the sides of the firebox are clear of mud and scale. Wash through holes in the side of the barrel of the boiler over the check valves, using nozzles Nos. 1 and 5, or 6 with the swivel connection. Then wash through the hole in the bottom of the barrel near the front end

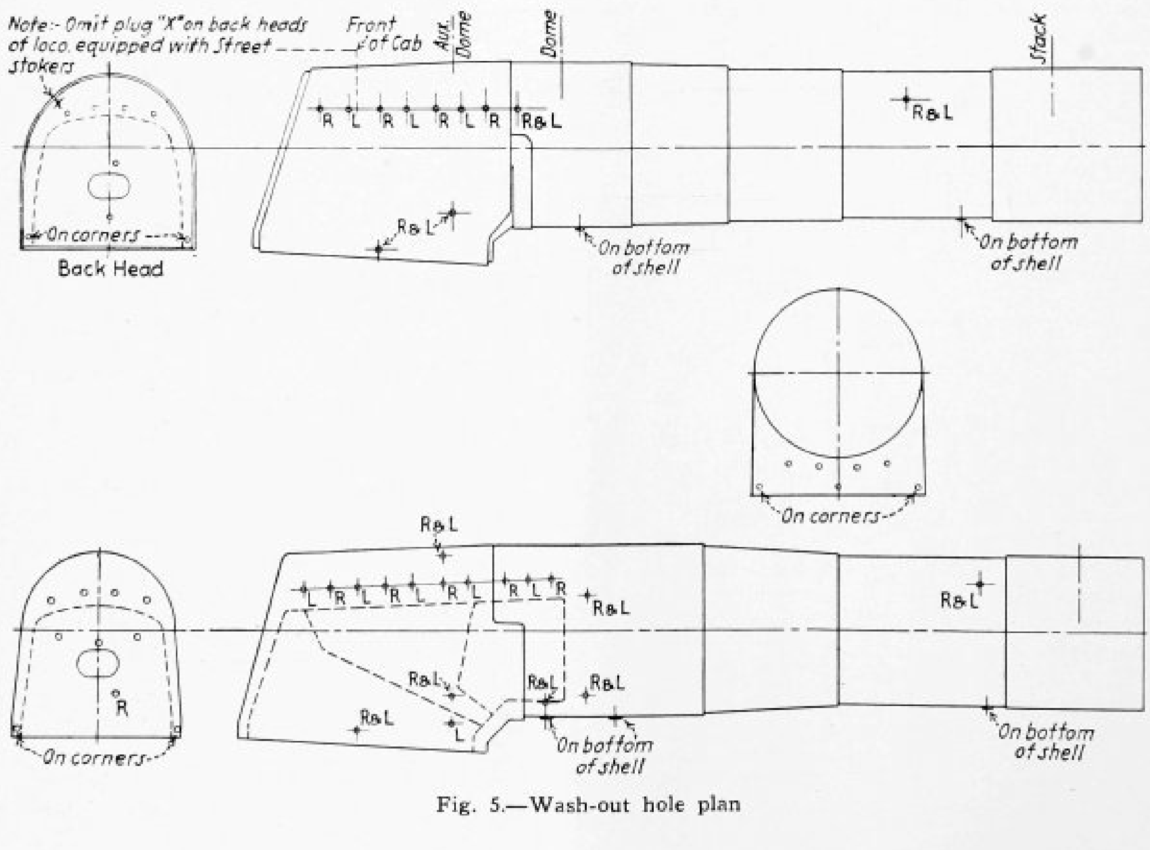


Fig. 5.—Wash-out hole plan

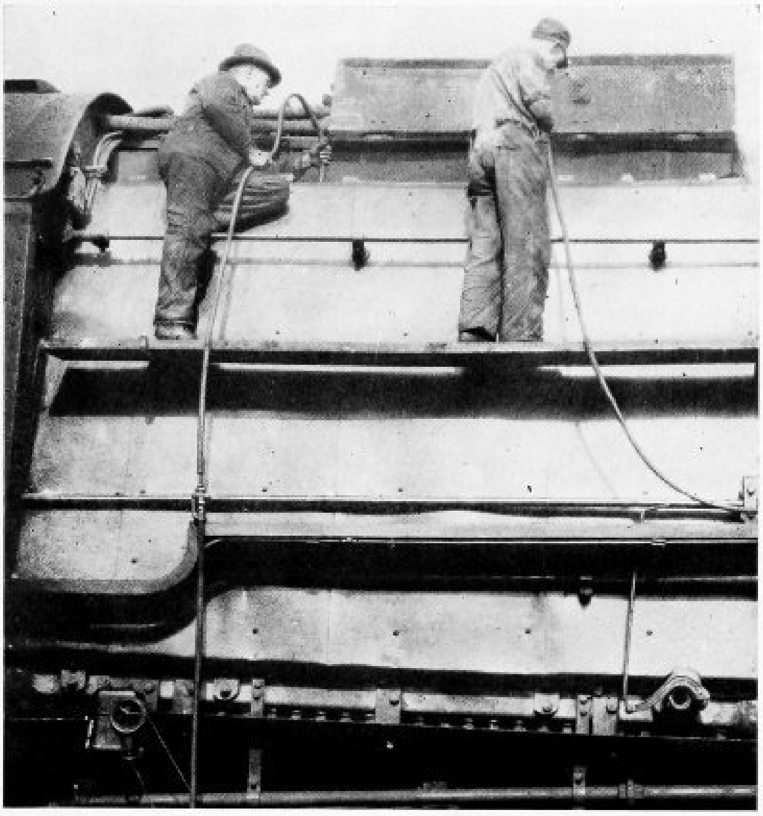


Fig. 6.—Washing vertical watertub·s from outside the boiler

and wash toward the throat sheet with nozzles Nos. 5 or 6. Then use the straight nozzle directly against the flues, reaching as large a space as possible in all directions. Then use the bent nozzle through the rear hole in the bottom of the boiler and then the straight nozzle in the same manner as above, until certain that the flues and spaces between the flues are as clean as it is possible to make them. Next wash the crown sheet from the boiler head using nozzles Nos. 1 and 3 or 6.

When nozzles Nos. 3 or 6 are used the swivel connection with the hole should be used and the nozzle should be inserted to the front end of the crown and slowly drawn back, revolving it at the same time, so as to wash the top of the boiler and all stays or bolts as well as the crown sheet. Wash the water space between the back head and fire-box door sheet through the holes in the back head with nozzle No. 6, being careful to remove all scale and mud above and below the fire-door hole.

Arch tubes must be washed and thoroughly cleaned with a pneumatic cleaner each time the boiler is washed. If scale is allowed to form in the arch tubes, the metal becomes overheated and bulges are formed, or the tubes warp out of line with the sheet, strains are set up, and the tube becomes dangerous. In this condition it may burst or pull out of the sheet. Therefore, it is very important to see that arch tubes are as clean as it is possible to make them, and all concerned should be instructed to comply strictly with this rule in order to insure maximum conditions of safety.

Then nozzles Nos. 5 and 6 should be used in the side and corner holes of water legs, revolving them thoroughly to clean the side sheets and finally clean off all scale and mud from the mud ring by using straight nozzles.

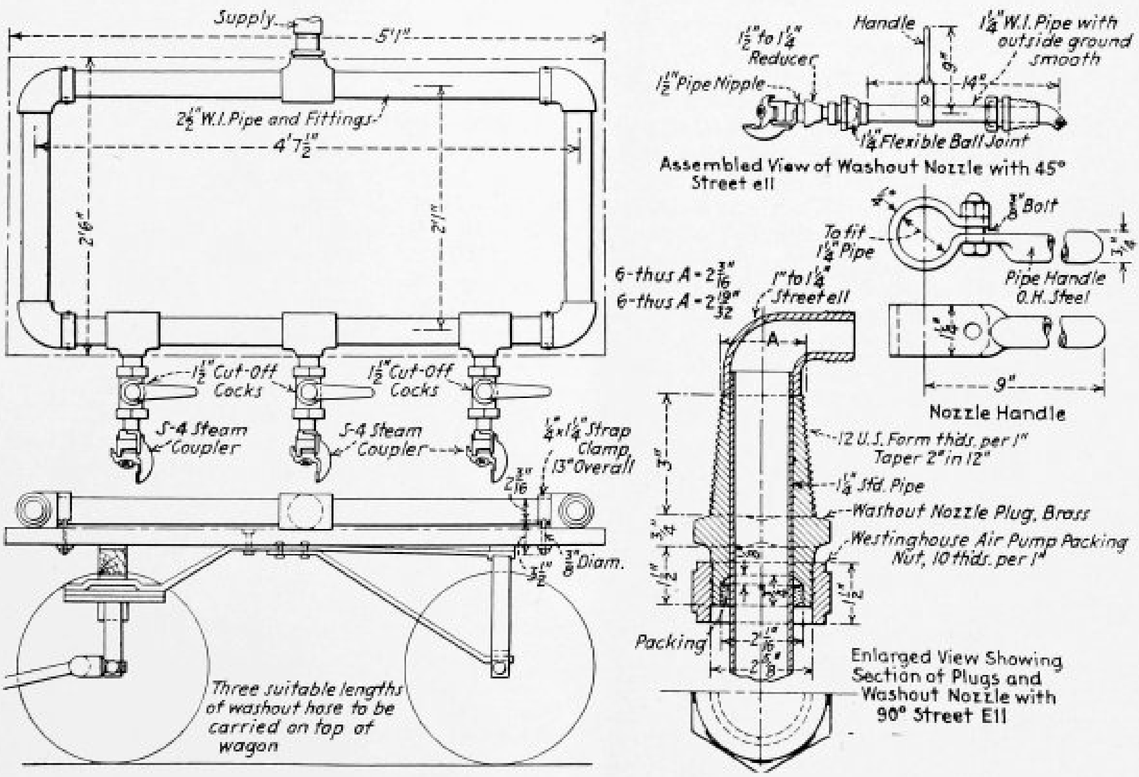


Fig. 7.—Boiler washing machine

It must not be assumed that because clean water runs from the holes, that the boiler is cleaned, but all spaces must be examined carefully with rod and light and if necessary use a scraper or other tool to remove any accumulation of mud or scale. The presence of scale on the water side of arch tubes and firebox sheets can readily be determined by the presence of clinkers adhering on the fire side. It may be stated as a general rule that if arch tubes and firebox sheets are clean on the water side, they will be smooth and clean on the fire side. Any clinker adhering or sand paper roughness on the fire side indicates scale formation opposite.

Filling boilers through the blow-off cock may be permitted at stations provided with hot water, boiler washing plants and when hot water is used. Stations having only cold water systems, when cooling and filling boilers, should fill them through the injector check, and when so doing the injector throttle valve at the manifold should be closed.

It is frequently necessary, on account of foaming conditions, to change the water in boilers. To effect a water change the boiler must be cooled the same as for washing except where hot water boiler washing plants are in operation and the boilers can be filled with hot water. When hot water boiler washing plants are referred to, it means that such plants will maintain a temperature of 100 degrees F. or more. Unless this temperature is maintained, the instructions for cooling down with cold water must be observed. It is important, however, that the temperature of the water used for washing and filling purposes should be maintained as high as the power equipment will supply.

At each boiler wash, the water gage and gage cocks must be removed for cleaning and repairing; the boiler shell openings and water columns must also be cleared of scale and sediment.

Each time a boiler is blown out for a change of water or for any other purpose, the drain valve from the water bottle should be opened and the steam allowed to blow through. Gage cocks should also be opened and steam blown through. This will clear openings, insuring that none of the cocks are plugged.

Washing Watertube Boilers.—The same general rules employed in handling radial staybolt boilers may be applied to the washing and cleaning of both locomotive and stationary watertube boilers. In almost all territories it is necessary to use a mechanical cleaner for cleaning watertubes. Each time this type of boiler is washed, it is important to know that all watertubes are as clean as it is possible to make them. When the watertubes in either locomotive or stationary boilers run in a vertical direction it is possible with some type boilers to perform the tube-cleaning operation from outside the boiler. Fig. 6, shows this operation being performed on a combination watertube and staybolt locomotive boiler. With this arrangement the cleaning of watertube boilers may be handled in approximately the same number of shop hours, as required to clean radial stay and staybolt boilers.

When washing stationary boilers that are connected to other boilers the steam line valves at both boiler and header should be closed to insure safety to men working on the inside of the boiler.

Water Pressure.—Adequate water pressure and volume are essential to good boiler washing. No trouble should be experienced with pressure as high as 150 pounds per square inch. Higher pressures cause hose to become too stiff and unwieldy for handling. A cut-out valve located just back of the nozzle is helpful when using higher pressures, and it also expedites the washing operation.

The use of a boiler washing machine shown in Fig. 7 will be found to effect substantial saving in time and will permit more rapid manipulation than when a single line of hose is used. This machine is recommended only where sufficient pressure and volume is available.

The report was prepared by a committee composed of I. J. Pool, chairman, K. E. Fogerty and W. G. Bell.

Discussion

CHAIRMAN KURLFINKE: One point that is noticeable in this report is the location of the blow-off cocks on the rear end of the firebox. That is not common practice. The general practice in the old days was to put the blow-off cock in the front of the throat sheet. Then they went to each side on the front corners. Here is a report showing the location of the blow-off cocks in the back corners. There must be a reason for this.

The location of the wash-out plugs in this diagram is very good. It agrees with what we are doing. There is no reference to the location of the wash-out plug in the front flue sheet. I suppose you all agree on the location of that plug. But let's have a general discussion of this report.

MR. LAUGHRIDGE: I might give some explanation in regard to locating the blow-off cocks on the back corners. Up to about three years ago I think we had as bad a water condition as there was in the United States, and we treated the water down to the very last limits that it could be treated. At that time we were washing the engines every six days, and getting very heavy scale. After the water treatment got down to where it proved to be successful, we began to experiment with the blow-off cock.

It is very evident that if you put a solution of water treatment into the water it will settle somewhere in the boiler; if you are going to leave an accumulation of that, you had better not treat the water at all. You must blow it off. We began to experiment with the blow-off cock in the front and we were fairly successful. Then we applied it to the back corners with good success.

Now my theory is that when the different salts go out of the solution, when the water begins to rise, the water goes to the back end and when it begins to rise into steam bubbles the salts precipitate, and we have found that they precipitate at the back end. We used to haul scales out by the wagon load, tons of it, every time the flues were reset. Now we run an engine from 80,000 to 100,000 miles on a flue setting, and we don't get a coal scuttle full of scale out of the boiler.

In regard to blowing off, your chemist will have to tell you how much water to blow off at the terminal. In our territory in the central part of Ohio, it requires 40 percent of the boiler water be blown off inbound. When the engine is dispatched we blow off 40 percent more, that is we blow off two glasses of water. Then along the line, if the water gets a little light and foamy, it is strictly up to the engineer. About the middle of the division, where he takes coal, he will blow off one glass of water. Probably he will make the rest of the run without blowing off. That is up to the engineer. We don't know what a leaky engine is any more, compared to what we used to have. In fact, we have had no engine failures on account of leaks for three years and the blow-off cock system has done the stunt.

MR. POOL: We have a man here from the B. & O., one of the pioneers in blowing down boilers and treating water from the boiler maker's end. If time will permit, I would like to hear Martin Murphy say something about the blow-off cock and washing of boilers. He is the man who is responsible for starting the lengthening of boiler washings on the B. & O. from five and six days to thirty days on most of the divisions.

Mr. Laughridge: I omitted saying that we have extended our wash-outs to thirty days.

Martin Murphy: We applied or installed treating plants on what we call our Cleveland Division of the Baltimore and Ohio. We have experienced considerable trouble with foaming. We noticed the Wabash Railroad, a neighbor of ours who, I believe, are the pioneers in the use of the blow-off cock, located the cock in the rear of the firebox. The theory was to prevent foaming and to prevent the formation of scale in the boiler by having it so located.

We applied these blow-off cocks in the back of the firebox and eliminated all foaming. In other words, if properly handled, there is no excuse for a boiler foaming under any condition. Understand, if a boiler is full of scale, this blow-off cock will not remove the scale. We found that in territories where we had untreated water that we could extend our boiler wash anywhere from seven days to fifteen and thirty days, and have clean boilers.

Now there is a difference of opinion as to the construction of the pipe in connection with this blow-off cock. We carried out the Wabash idea in our district. It is an inch and a quarter pipe with quarter inch holes, No. 110. The idea is to have your holes distributed equally the entire length of the pipe in order to draw from all portions of your back water shell. We find that that has been very successful in the territory that I am connected with. The idea of thinking you are going to blow scale out through this pipe is all wrong. You will not blow scale, but it will prevent scale.

M. V. Milton (Canadian National Railways): It has been very interesting to me to note the different methods that our members have had of illustrating the use of blow-offs. Fifteen years ago we developed some inside blow-offs and put them right straight up the barrel and across the throat, but, as one of the members mentioned, we found we got scale in the back.

We found that the trouble is governed by the water condition. The first thing to study is what is in your water. Needless to say, you have two things, the permanent and temporary elements. Your carbonates will be removed from the water at the boiler point but the sulphates will not. You have got to raise the temperature of the sulphates before they will be removed. Therefore, you will have sulphate in the back leg, and where you do have that you require a blow-off across the back leg.

Fifteen years ago we were running as you all were; wash out at one end, change of water at the other. One condition we had was 70-degree sulphate water, but today we are running fifteen days between wash-outs and having a great deal of success. I think, as Mr. Laughridge said, it is a chemist's study, and in my case it has been my study, and we have developed a very efficient blow-off system.

Low-Water Alarm Valve Reconditioning Tools

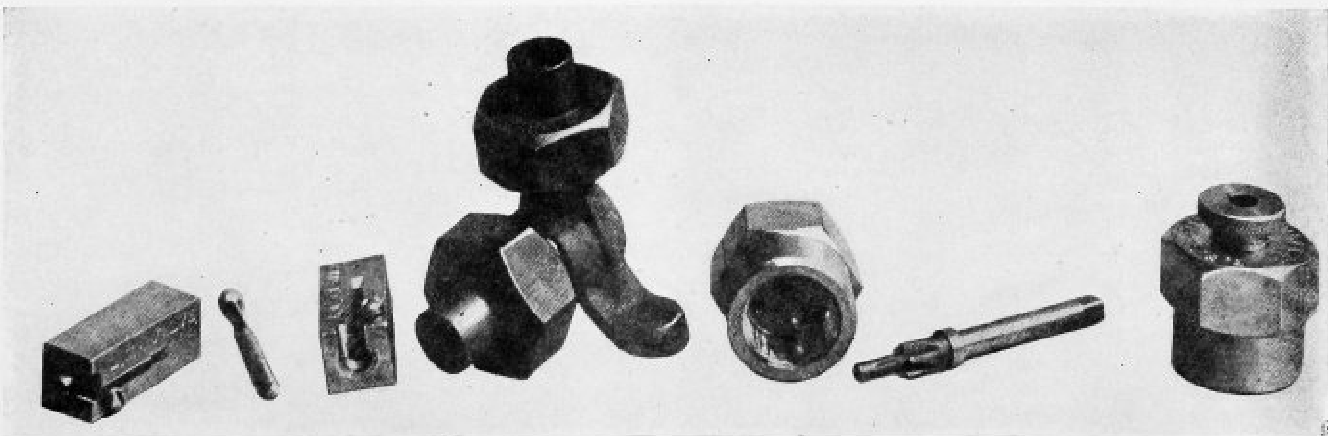
Among the various tools submitted at the 1929 convention of the American Railway Tool Foremen's Association, is a set of tools for reconditioning valves and valve seats on low-water alarms. This device, included in the report of the locomotive shop devices committee was presented by R. B. Loveland, tool foreman of the Norfolk & Western Railroad, Roanoke, Va.

The tools shown in the illustration for reconditioning valves and valve seats on low-water alarms are hand tools, operated with a wrench and screw-driver. The valve-seating tools which are shown at the right are made up of a brass nut which is screwed on in place of the regular gland nut. This nut is tapped to receive the feed screw which carries the counterbore and is made up of one piece of carbon tool steel. The tool has a pilot 13/64 inch in diameter by 5/8 inch long, a 45-degree cutting face 3/64 inch wide, and a flat or 90-degree cutting face 3/8 inch in diameter.

The tool for facing the valve is made up of a 3/4 inch square piece of steel 1 3/4-inch long, with a 3/16 inch hole through the center to support the stem of the valve. The hole is countersunk to receive the valve, and a tool-steel blade inserted and held by a fillister-head machine screw. A chip chamber is milled out in front of the cutter.

In operation, the valve is inserted in the tool and given a few turns to the right at the same time pressure is being exerted on the screw-driver. The valve is then in good condition to grind.

Two sets of tools are shown in the illustration placed in different positions so as to give a clearer idea of their design.



Tools for reconditioning low-water alarm valves and seats

National Board Meeting

Boiler inspectors discuss proposed rules for welding drums or shells of boilers

The eighth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, held at the Hotel Patten, Chattanooga, Tenn., on June 17, 18 and 19, 1930, brought out many subjects of interest to the entire boiler industry. In addition to the statistics of the previous year and the question of support of the A. S. M. E. Boiler Code Committee discussed in the August issue of THE BOILER MAKER, the question box provided a feature of the convention. Two topics were outlined in the previous issue, while the third is as follows:

SECRETARY MYERS: The next question, "Would it not be advisable for the National Board to give more attention to the construction of water relief valves?" I would like to hear some expression on that. The question of water relief valves should be quite interesting.

MR. MILLS: In the last year or so we have gone particularly into the inspection of cast iron hot water boilers, among other boilers, and we had a number of serious accidents in the explosion of cast iron boilers, and in all cases it was due to a defect in the water relief valve. Sometimes this was due to the location and sometimes to the relieving capacity of the valve, also to the fact that the valve, although it might be a diaphragm valve, would stick and not operate. I am inclined to think that it would be advisable to consider the use of a lifting device on the valves. In some cases, though I made no particular laboratory tests, I found that some of the diaphragm relief valves would operate at the pressure on cold water but would go up something like ten pounds on hot water. I do not know what can be done about that, it seems necessary to either change the metal or change the location. We are advising, in Michigan, that they put the relief valve on the cold water side instead of the hot water. We have also had troubles with relief valves in the way they have been installed, so that the sediment would get into the connection to the valve and plug up the connection. Might it not be advisable to require the A. S. M. E. approval on the reducing valve? I am afraid the time will come when some of these reducing valves will cause trouble. I want to mention these things because we are inspecting a lot of cast iron boilers now, hot water especially, and we will run into a lot of trouble.

MR. MCGINNIS: We have a lot of hot water boilers and have had more trouble with the hot water men than we have had with the steam men, and our safety valve is like everything else, if not used occasionally it gets so that you cannot use it at all. We have a connection in our small steam equipment with an automatic cutoff on the gas arrangement that is stepped two or three pounds lower than the safety valve, and one or two below what the safety valve will work, and the result is that the foreign matter in the water bears up until the mass of scale becomes absolutely solid. I have taken them apart and they were filled up solid with scale. We found the same thing on a water relief valve. You might as well not put a water relief valve in unless you have one that will work. I have a water relief valve on my water heater at home, but I have a standard safety valve on that water heater, and every time I pass in on my back porch I trip that lever, so I know that it is working all the time. You go around to the large apartment houses and insist on water relief valves being installed on all these heaters. Sure, they will put them on, they will get the diaphragm type, and what good do they do? You might as well let them go without it, because you cannot go in and show them where they are getting any benefit out of it. I have had it thrown at me "How do you know whether they are going to work or not? You cannot test them out." In San Diego they have compelled them to put a check valve on the line between the meter and the house, and they have got a steam boiler out of it right there. They put on one of these relief valves, and they have a steam boiler on there without a valve on, because your safety valve wont work. I hope something can be worked out that will give satisfaction.

F. A. PAGE: Last October we had an explosion of a hot water boiler, steel construction and closed system. The returns were fed back in the boiler by electrically driven pumps. Being a fairly cool night, the operator started the oil burner late in the evening, got his pump working and then left. During the night a lady living a little way away heard a noise that she thought was the running of a steam engine, and on investigation it appeared to have been the relief valve operating. It appeared from what we could gather after the accident, that the pump had stopped sometime during the night for some reason or other, and that the relief valve had operated all right but had not been of sufficient size to take care of the steam generated, so that early in the morning a milk man coming along saw the steam coming out of the boiler room and went and woke up the owner. The owner went out there and found the boiler room full of steam. He reached down to shut off the oil valve, and the moment he did that, the boiler blew up, blew all to pieces, blew him backwards through two greenhouses, and while it did not kill him instantly, it caused gangrene to set in from the dirt and he died within a few days. There is a case where it appears to me that the relief valve, while it functioned, could not take care of the steam generated, being a closed system, it became a steam boiler. We have been very much in favor of adding a safety valve on installations of that kind to take care of the steam generator. It seems to me that we need a relief valve that can be checked at all times without changing its setting to safety valves from the relief valves.

JOHN M. LUKENS: We have used the diaphragm and the relief valve and we find out that the relief valve is the best valve. Then we are up against the difficulty in reference to pulling that valve, and it is not worth a cent unless it is pulled. The employes as a rule, such as the janitors in the building, are not interested; if the door is locked, it is all right; if it is not, just the same. We had an experience several years ago where a boiler blew out the window because the relief valve did not work. We have not been able to adopt any valve on a low pressure system that we could say is satisfactory. There is another valve proposition, such as the fusible plug valve, and that has been experimented on and was up before our Board at our last meeting, and it looks as if it has possibilities. In other words, this fusible plug is similar to the plug you put into a boiler, but it is protected from the sludge and dirt of the boiler in any case, and therefore, it always is in operation. The only difficulty about that valve is that if it lets go, it continues to discharge water and must be renewed or else somebody must come down and pull the screw down and start the valve over again. We have not had any broad experience from a practical operation standpoint with this valve but we have had experience from testing it in the laboratory at Philadelphia and it works satisfactorily, but between the experimental and the practical there is quite a broad distance. We are more afraid, in our territory, of the low pressure boiler than of the high pressure in dwellings; we have no regulation over it. We go into apartment houses and garages but not into dwellings of which there are between three hundred and eighty thousand and four hundred thousand in the city of Philadelphia. A very large number of these buildings have some hot water heating element. In reference to the check valve, it is compulsory in our city to put a check valve in the line, because as the water backs on the meters, the disks on the meters are destroyed and the expense of renewing those meters has been tremendously high.

Question box brings out problems of water relief valves, location of feed in vertical boilers, objection to countersinking rivet holes in lower girth seams and the use of horseshoe or half-moon patches on horizontal boilers

Secretary Myers: The next question is: "How can a vertical tubeless boiler be stamped N B when the feed line enters the shell approximately three inches above the mud ring and the feedwater discharges directly against the furnace sheet?" I think that is a violation of the code itself; it cannot be stamped.

Mr. Olmstead: We had that question up on that type of boiler I had in Detroit last year. The point was that the water went into the boiler about an inch and a half above the water drain. It is true that the water discharged directly against the inside sheet that the tubes go into, but being so low, it was decided there was no harm in its going in that direction, that is, in our own particular boiler.

Mr. Obert: On a locomotive type or vertical tubular boiler, where there is a furnace and a blow off line connected with the water leg somewhere, it was quite customary in the early days of boiler construction, to run the feedwater line either into the blow-off connection or some part of the water leg just above the mud ring, and a great deal of trouble resulted from the cold water coming up against the stayed surfaces. The expansion and contraction of the stayed surfaces would cause leakage at the staybolts, and that was the reason why this requirement in the code says that the feed water may not be delivered near a heated sheet or furnace sheet. There's a great many ways of getting around it. In the particular case some kind of water pocket or feedwater pan can be inserted in there to prevent the water discharging directly on the furnace sheet, and that would meet the practical requirements of the code. The other way is to deliver it above or away at a position removed from the furnace, and that would meet the code; but the way the requirement is stated, it is impossible to stamp it a code boiler.

Secretary Myers: The next question is "What objection, if any, is there to countersinking the rivet holes in the lower part of the girth seams of horizontal tubular boilers and using mushroom head rivets?"

Mr. Page: Personally I would like to see the code make a requirement along that line, to have all rivet heads, countersunk on the fire side. My experience has been in railroad companies that the seams especially the vertical seams, on the firebox side of the flue sheets, crack. The railroad companies nowadays, in the case of five-eighths inch sheets, scarf these joints back of the rivet hole so that the edge of the rivet is not more than five-sixteenths from the calking edge. They are getting good results and, by removing the big gob of metal at the rivet heads do not draw any heat. When a blacksmith wants to make a junk weld, he puts a couple of big gobs of iron to draw the heat, either sticks them on by inserting them into a dovetail, or has some method of holding them. He turns them over and gets that metal hot, and the same thing holds true in a boiler. If I had a boiler built for my own use, I would ask the manufacturer, if the code permitted, to countersink the boiler seams half way up as well as the heads, and I would be out of trouble.

Mr. Farmer: We have installed a large number of high pressure boilers of varying sizes and thicknesses, and we have adhered strictly to the code. So far as our experience goes, which is quite extensive, it indicates that it is more or less a matter of firing that produces the cracks instead of the construction of the boiler. I am not recommending the thickening of the plates on the girth seam, but every time we run across fire cracks, if we are able to drop the bridge walls we are able to repair that job and succeed in making such an installation that trouble does not recur.

Secretary Myers: The next question is, "Do you consider the following repair a violation of the code? A horseshoe or half moon patch on the shell of a horizontal tubular boiler has been applied by first fitting the patch accurately, then thinning the calking edge slightly, bolting the patch in place, then welding this edge to the shell by arc welding, then driving the rivets?"

Mr. McGinnis: In Los Angeles it will not be accepted.

Mr. Book: That method of repair does not meet the code requirements; the code specifically states that welding is not permitted in lieu of mechanical calking.

Wednesday Morning Meeting

Chairman Thomas: The program this morning states that it is a symposium on "Welded Boiler Drums and Riveted Boiler Drums." Now we have proposed specifications for fusion welding of drums or shells of power boilers. Mr. Obert will open the discussion upon this, or give the introductory remarks.

Mr. Obert: To bring this before you, Mr. Chairman, I am going to read an introductory statement to show what has transpired in the Boiler Code Committee in bringing this specification for boiler drums up to its present status.

Proposed Specifications for Fusion Welding of Power Boilers

The purpose of this symposium is to bring before your organization an important new development in the fabrication of drums for steam boilers which departs from usual constructional methods to the extent of utilizing fusion welding for the joints. The art has developed very rapidly in this direction during the past few years, and you will all undoubtedly agree that fusion welding processes are making a strong bid for recognition. The question now before us all is as to what there is to prevent the use of boiler drums with fusion welded joints, and therefore it may be well to review the fundamentals of this situation.

The A. S. M. E. Boiler Construction Code was formulated in 1914 without provision in the power boiler rules for fusion welding, other than applications where the stress or load is carried by other construction and where the safety of the structure is not dependent upon the strength of the weld. As a result, the Boiler Code Committee has been continually pressed by those interested in fusion welding to open up this matter, and petitioned for modification of the rules which would allow greater use of fusion welding. The Committee held, however, for a long time to the policy of waiting until welded construction could be adequately tried out in unfired pressure vessels, where it was expected practices and procedures would be developed that could be considered for use in boiler construction.

The recent rapid development of higher working pressures and operating temperatures in the steam boiler field has, however, changed the situation materially. Both riveted and forge welded construction have proven inadequate for boiler drums or shells to operate at pressures from 900 to 1500 pounds unless the diameters are kept down to impracticable limits. In addition, the note of alarm that has spread throughout the boiler industry during the past few years as a result of the so-called "caustic embrittlement" failures, has spurred great interest in fusion welding as a possible means of elimination of riveted joints, in which this trouble is most noticeable. Furthermore, there have been rapid developments in the past few years in the fusion welding of plate thicknesses in excess of 2 inches and this appears to point to the solution of the problem.

This changing situation in the boiler field has brought urgent requests to the Boiler Code Committee to provide in its power boiler code for welded construction of drums and shells. Several concerns are known to be prepared and ready to weld such shells and drums of practically any size and plate thickness, and accordingly the Committee has been willing to consider proposed specifications for such fusion welding practice when submitted. Such proposals were made at the September, 1929 meeting of the Committee, and the specifications submitted have since been given careful consideration jointly by the American Welding Society and the A. S. M. E. Boiler Code Committee. The subject has been considered to be too important, however, to act upon precipitately and, before further preliminary work is done thereon, it was felt that they should be published and the benefits of general discussion thereon obtained.

There is one feature of these specifications that is worthy of your careful consideration. They constitute an attempt to regulate welded construction by prescribing tests that are to be carried out after the structure is completed and take no account of the process or procedure under which the welding fabrication is carried out. Practically all of the previous attempts to codify welded construction have, due to the difficulty of the problem of non-destructive testing of welds, been along the line of specifying the process and method of welding, or in some manner controlling the welding procedure. Such attempts have of course, their difficulties, and the result is usually indeterminate as far as the establishment of an actual working stress is concerned. The plan embraced in these proposed specifications is, however, both qualitative and quantitative, and would appear to offer a more definite basis for the actual working stress.

The testing method of inspection and acceptance of welded boiler drums has much to commend it. While it is customary in the usual methods employed in constructing riveted drums to base their design on the weakest known link in the structure, it should always be realized that the safety of such resultant structures has always been dependent upon the allowance of a liberal factor of safety to provide in advance for any indeterminate elements of the structure which may not have the strength expected. These new specifications on the other hand, offer definite means of pre-determining with considerable certainty, the uniformity of the strength of the entire structure, and are quite likely to direct attention to any hidden elements of weakness that might otherwise be overlooked. It remains only for you to determine their practicability in your actual inspection work. I am quite sure that the Boiler Code Committee will appreciate your full and frank expression of opinion concerning this matter.

A. J. Moses: In approaching the subject of fusion welding of drums for power boilers, the long established boiler manufacturer has jointly with you the strong incentive to do so conservatively. While our future depends upon progress, that progress in order to be real must be made without sacrificing any of the profits gained from our joint work with yourselves, the insurance companies and the Boiler Code Committee.

We are convinced that the application of fusion welding to the power boiler field is a progressive and an economically necessary step. We believe that you share this conviction. We are also convinced that the highest development of this art at the present time makes it a safe proposition provided its application to this field is controlled and checked by some governing authority such as yourselves or the Boiler Code Committee. The search for a basis for this control has been occupying the minds of most of us for some time. A solution of this is now demanding our attention.

We consider the recently published specifications, sponsored by the Boiler Code Committee, to be a comprehensive and forward step in the solution of this problem. This paper is intended as a discussion and criticism of these specifications.

For the sake of those who are unfamiliar with the various paragraphs of this proposal by the numbers, I will read those that enter into the discussion.

Paragraph No. 2—"TEST PLATES FOR LONGITUDINAL JOINTS. Two sets of test plates from steel of the same heat as the drum plates, prepared for welding, shall be attached to the shell being welded, one set on each end of one longitudinal seam, so that the edges to be welded in the test plates are a continuation of and duplication of the corresponding edges of the longitudinal seam in the shell. Weld metal shall be deposited in the test plates continuously with the weld metal deposited in the longitudinal joint of the shell."

We agree with the proposed location of test plates. We see no necessity of the requirement that the steel in the test plates be of same heat as the drum plates. They should be of the same grade of steel. We believe the permissible variation within the same grade of steel could have no practical effect on the quality of the weld. Insisting on steel of the same heat would prove a nuisance to the mills, ourselves and the inspectors with no compensating benefits.

Presentation of proposed welding specifications for pressure boilers draws favorable and unfavorable comment from members. In this instalment A. J. Moses analyzes the effect which the various provisions of the code will have in practice

Paragraph No. 3—"TEST PLATES FOR CIRCUMFERENTIAL JOINTS. When test plates are welded for the longitudinal joints, none need be furnished for circumferential joints in the same vessel. Where a drum has circumferential joints and no longitudinal joint, a set of test plates of the same material as the shell shall be welded in the same way as the circumferential joint."

The only objection we have to offer on this paragraph is the same as the one on paragraph No. 2.

Paragraph No. 4—"STRESS RELIEVING. The complete welded structure or such welded parts separately as may be later assembled by means other than welding, shall be heated uniformly to at least 1100 degrees F. The structure shall be brought slowly up to the specified temperature and held at that temperature for a period of at least one hour per inch of thickness, and shall be allowed to cool slowly in a still atmosphere. The test plates shall be subjected to the above stress-relieving operation either attached to or placed within the parent vessel."

We are thoroughly in accord on this provision. However, the manufacturer should be permitted to anneal at least one of the test samples separately so as to determine the quality of the longitudinal weld before proceeding with further work. We also suggest that further experiments may prove it both practical and advisable to raise annealing temperature above 1100 degrees F. so as to normalize and refine the grain structure of the steel. This will not only improve the quality of the steel in the weld but will improve the quality of the steel in the original boiler plate.

Paragraph No. 6—"TENSION TESTS. The tension specimen shall be transverse to the welded joint, and shall be the full thickness of the welded plate after the outer and inner surfaces of the weld have been machined to a plane surface flush with the plate. When the capacity of the available testing machine does not permit of testing a specimen of the full thickness of the welded plate, the specimen may be cut with a thin saw into as many portions of the thickness as necessary, each of which shall meet the requirements. Each tension specimen should fail in the boiler plate, but if failure occurs, in the weld metal or along the line of fusion between weld metal and the plate, then the tensile strength shall not be less than the minimum of the specified tensile range of the plate used."

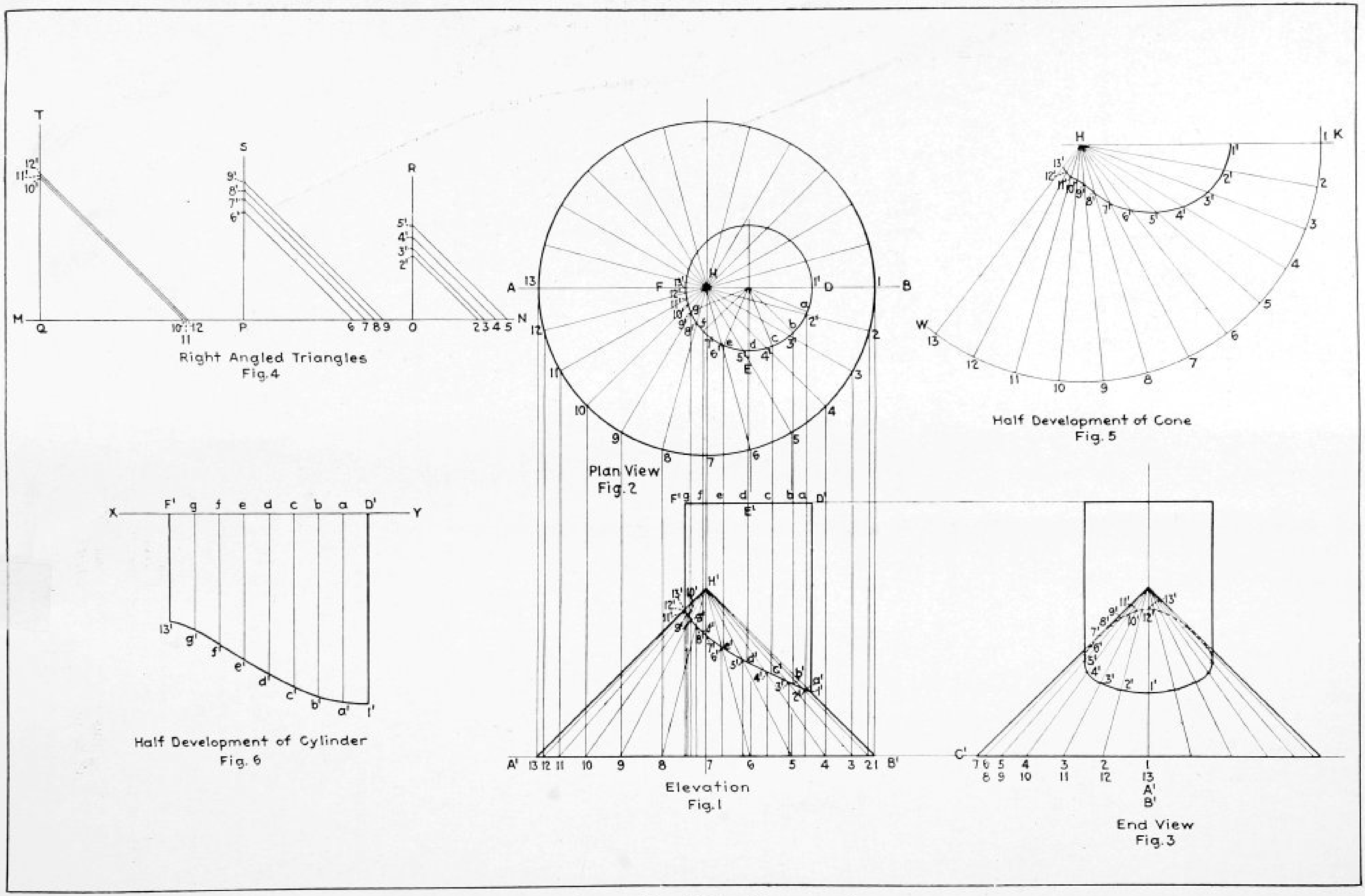
While approving this paragraph in its main features we think it should be permissible to machine both surfaces of the plate $\frac{1}{16}$ inch below the original surface so as to remove any slight surface defects and permit accurate measurements of the size of the specimen. We also recommend that specimens be so machined as to force fracture within the deposited area or adjacent thereto. This will be beneficial to both inspectors and welders in leading to higher standards of workmanship.

Paragraph No. 7—"BEND TESTS. The bend-test specimen shall be transverse to the welded joint of the full thickness of the plate and shall be of rectangular cross section with width one and one-half times the thickness of the plate. When the capacity of the available testing machine does not permit of testing a specimen of the full thickness of the welded plate, the specimen may be cut with a thin saw into as many portions of the thickness as necessary, each of which shall meet the requirements. The inside and outside surfaces of the weld shall be machined to a plane surface flush with the plate. The edges of this surface shall be rounded to a radius equal to 10 percent of the thickness of the plate. The specimen shall then be bent cold under free bending conditions until the least elongation between any two points within and across the weld on the outside fibers of the bend-test specimen is 30 percent, with the width of any surface cracks deducted. No surface cracks shall be longer than 10 percent of the specimen's width, when the elongation of the outside fibers has reached 10 percent (10%)."

This bend test specification leaves much to be desired. First, it requires only one test while two should be required bent in opposite directions as regards inner and outer surfaces of weld. Then there is nothing quantitative except as regards the outer fibers. Many poor welds could pass this test while many undoubtedly good ones would fail. For example many welds may prove excellent across the outer surface showing no defects after more than 30 percent elongation and also after serious internal fracture has occurred. Usually when this is the case, it can be detected by inspection of the sides, or by the extreme elongation of the outer fibers just over inner faults which cause sinks in the outer surface, or by completing the test until failure. On the other hand many welds with a few shallow inclusions will withstand bending to 180 degrees without failure and yet fail in the requirement of 30 percent elongation of outside fibers on account of the width of these surface defects. Of course, an inspector, from his examination, can very closely judge the quality of the weld, but he can not, and it is not desirable that he be permitted to depart from a written code. It may be argued that the tension or other test will throw out such bad welds. Not necessarily so. In case a poor weld as above described, should pass all tests, the inspector would have undoubted evidence of a lack of homogeneity in a weld accepted according to the rules.

We believe it advisable to revise this specification in some way such that its operation can lead only to certain definite conclusions, without calling into play the personal opinions of the inspector. In other words the personal element should be eliminated.

(To be continued)



Development of cone with cylinder off center at the top

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Leaky Boiler Check

Q.—If boiler check leaks, what effect will it have on the injector and injector tubes? E. L. B.

A.—A leaking boiler check could cause the injector to fail to prime.

Leaking Injector Steam Ram

Q.—If the steam ram to injector leaks, what effect will it have on the injector? Will it cause injector tubes to corrode? E. L. B.

A.—The steam pipe to the injector leaking would have no effect on the working of the injector as long as boiler pressure could be maintained in the pipe.

Lift of Boiler Check

Q.—If a boiler check has too much lift, what effect will it have on the injector? E. L. B.

A.—The boiler check having too much lift would not necessarily affect the injector; however this condition would be injurious to the check valve seat.

Coated Injector Tubes

Q.—If boiler check leaks, or steam ram to injector leaks, will that cause injector tubes to coat over with scale or plug up the small holes in injector tube parts? E. L. B.

A.—The boiler check or injector steam pipe leaking should not cause the tubes to coat over with scale, or plug. This condition is no doubt caused by impure water.

Sediment in Branch Pipe

Q.—A boiler check has been leaking for five days and we have been unable to use the injector. (Lifting injector No. 8 or No. 9.) At wash-out, the branch pipe was taken down and found full of soft sediment. What was the cause of so much sediment in branch pipe? E. L. B.

A.—The sediment in the branch pipe is no doubt due to the use of impure water. The impurities in the water not being able to pass through the boiler check valve.

Layout of Cone with Offet Cylinder

Q.—Enclosed please find a section of a cone with a cylinder at the top 6 inches off center. Will you please show me the proper way to develop the patterns for both the cone and the cylinder? I experimented with one of these a short time ago with not very good results. C. C. K.

A.—To develop the patterns for the intersection of a cone and cylinder as outlined in the question, draw the elevation, end view and plan as shown in Figs. 1, 2 and 3.

To develop the intersection line of the cylinder and cone in the elevation and end views, divide the plan of the cone *ABC* into any number of equal parts, 12 being taken in this case; the greater the number of equal parts taken the more accurate the final development. Number the divisions from *1* to *13* as shown; connect these points with the center *H* and where these lines cut the plan of the cylinder *DEF*, number these points from *1'* to *13'* as shown.

Perpendicular to the line *A-B* of the plan and passing through the points *1* to *13*, draw lines cutting the line *A'-B'* of the elevation number these intersections from *1* to *13* as shown and connect these points to *H'* of the elevation.

Perpendicular to the line *A-B* of the plan and passing through the point *1'* of the plan, draw a line cutting the line *H'-1* of the elevation locating the point *1'* of the elevation.

Perpendicular to the line *A-B* of the plan and passing through the point *2'* of the plan, draw a line cutting the line *H'-2* of the elevation, locating the point *2'* of the elevation.

In the same manner draw lines perpendicular to *A-B* through the points *3'* to *13'* of the plan cutting the corresponding lines *H'-3'* to *H'-13'* of the elevation, locating the points *3'* to *13'* of the elevation. Connect the points *1'* to *13'* of the elevation, thus completing the intersection line of the cylinder and cone in the elevation.

The end view can now be constructed by projection, all the points having been located in either the plan or elevation.

The next step in the development of the cone is to construct a series of right-angle triangles to obtain the true length of the surface lines of the cone as *1-1'*, *2-2'*, *3-3'*, etc. of the elevation.

Draw the line *M-N*, Fig. 4, and at *O* erect a perpendicular *O-R* to *M-N*. With *O* as a center and the dividers set equal to the distance *2-2'* of the plan, scribe an arc cutting the line *M-N* at *2*, then with *O* as a center and the dividers set equal to the perpendicular distance between the line *A'-B'* and the point *2'* of the elevation, scribe an arc cutting the perpendicular line *O-R* at *2'*. Connect the points *2* and *2'*, Fig. 4. This line is then the true length of the surface line *2-2'* of the elevation.

With *O* as a center and the divider set equal to the distance *3-3'* of the plan, scribe an arc cutting the line

M-N at *3*, then with *O* as a center and the dividers set equal to the perpendicular distance between the line *A'-B'* and the point *3'* of the elevation, scribe an arc cutting the perpendicular line *O-R* at *3'*. Connect the points *3* and *3'*, Fig. 4. This line is then the true length of the surface line *3-3'* of the elevation. Continue in the same manner until all the right-angle triangles in Fig. 4 have been constructed and the true length of the surface lines of the cone *4-4'* to *12-12'* have been determined.

The next step is the development of the cone.

From the plan view it will be seen that the object is symmetrical about the line *A-B* and therefore a development of one-half the plan would represent one-half the pattern.

Draw the line *H-K*, Fig. 5. With *H* as a center and, with the dividers set with a radius equal to *H'-B'* of the elevation, scribe an arc.

Then with the dividers set equal to one-half the plan, step off 12 spaces on the arc *K-W'* and number the spaces from *1* to *13* as follows: Connect the points *1* to *13* with the center *H*. With the point *1*, Fig. 5, as a center and with the dividers set equal to the distance *1-1'* of the elevation, scribe an arc cutting the line *H-1*, Fig. 5, locating the point *1'*. With the point *2*, Fig. 5, as a center and with the dividers set equal to the length of the surface line *2-2'*, Fig. 4, scribe an arc cutting the line *H-2*, Fig. 5, locating the point *2'*. With the point *3*, Fig. 5, as a center and with the dividers set equal to the length of the surface line *3-3'*, Fig. 4, scribe an arc cutting the line *H-3*, Fig. 5, locating the point *3'*. Continue in the same manner completing the half pattern of the cone.

The next step is to develop the pattern of the cylinder.

Divide *FED* of the plan into any number of equal parts, eight being taken in this case; the greater the number of equal parts taken, the more accurate the final development. Number these divisions *a* to *g* as shown. Perpendicular to the line *A-B* draw lines through the points *a, b, c, d, e, f,* and *g* cutting the line *F'-D'* of the elevation. Number the points *a, b, c, d, e, f* and *g* and extend the lines down cutting the line *1'-13'* of the elevation. Number these points *a', b', c', d', e', f'* and *g'*.

Draw the line *X-Y*, Fig. 6. Step off eight spaces equal to *1'-a, a-b, b-c, c-d*, etc. of the plan view; number these points *D', a, b, c, d, e, f, g,* and *F'* as shown. Erect a perpendicular to the line *X-Y* at each of these points. With *D'* as a center, and with the dividers set equal to the distance *D'-1'* of the elevation, scribe an arc cutting the perpendicular to the point *D'* locating the point *1'*, Fig. 6.

With *a* as a center, and with the dividers set equal to the distance *a-a'* of the elevation, scribe an arc cutting the perpendicular to the point *a* locating the point *a'*, Fig. 6.

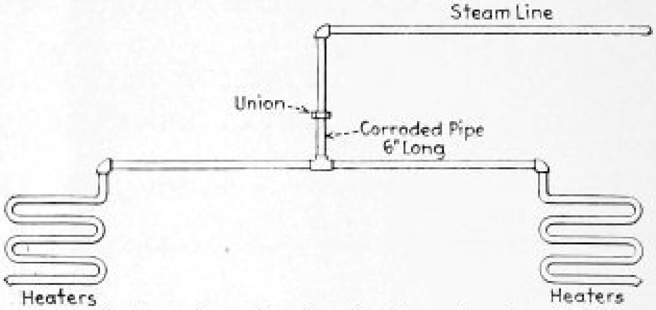
Continue in this manner taking the distances *b-b'*, *c-c'*, *d-d'*, etc. of the elevation and stepping them off on their corresponding perpendicular lines in Fig. 6, until the half pattern of the cylinder is complete.

Steam Leak at Union of Pipes

Q.—A steam pipe to two heaters as illustrated below. A steam leak at the union as indicated. This pipe had to be taken down almost every day and corrosion removed from pipe directly below union and hard scale would stop the passage of steam entirely. The union was then removed and all joints welded. It has not been necessary to clean this pipe since welding, which was about a year ago. What caused this condition? E. L. B.

A.—It is difficult to say just what caused this corrosion in the pipe without an inspection of the union and pipes themselves.

A steam leak will cause corrosion, also burrs on the



Heater pipes showing location of union

ends of the pipe interfering with the flow of steam will start corrosion.

The fact that this condition was eliminated by removing the union would indicate that a steam leak or a poor connection was the cause of the trouble.

Protecting Stationary Boilers

Q.—I shall appreciate it very much if you will suggest the most feasible manner of protecting stationary boilers in seaports when they are not in operation, as the salt air causes serious detriment to the materials, and, if they are maintained full of water, they are also subject to rust. J. G.

A.—The boiler should be emptied, drained and cleaned thoroughly, internally and externally, all soot and ashes being removed from the exterior of the pressure parts and any accummulation of scale removed from the interior surfaces. The boiler should be thoroughly dried after being cleaned. A tray of quicklime should be placed inside the boiler after which the boiler should be securely closed.

The outside of the boiler and the inside of the tubes on firetube boilers should be given a coating of oil for their protection.

Water Heating Surface

Q.—Kindly advise the correct interpretation of water heating surface to stamp on an A. S. M. E. Scotch dryback boiler, as required by Par. 332 of the A. S. M. E. Boiler Code, power boilers, page 74, item 5.

The boiler is 48 inches diameter, containing a 24-inch outside diameter furnace; of ½-inch plate; fifty-six 2-inch by 7-foot 6-inch tubes, No. 13 gage, or, 7 feet 5½ inches over heads; upper tubes to shell, 12 inches.

In your April issue, page 114, you figure the outside circumference of tubes and firebox of locomotive boiler in a question on staybolt heads. C. L. M.

A.—The water heating surface to be stamped on an A.S.M.E. Scotch dryback boiler as required by Par. 332 of the A.S.M.E. Boiler Construction Code, Section 1, should be computed for that side of the boiler surface exposed to the products of combustion, which would be, in the case of the boiler outlined in the question, the total inside surface of the firebox and tubes in square feet.

The answer to the question in the April issue was given for a locomotive-type boiler and the method of computing the heating surface shown is used by locomotive builders, the answer being a general method and not a strict interpretation of the A.S.M.E. Code.

Corrosion of Injector Tubes

Q.—What causes corrosion on the tubes of an injector? E. L. B.

A.—With a lifting injector on account of steam being continually in the body of the injector, the tubes corrode quickly in localities where the water is bad, requiring that it be cleaned frequently.

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

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	

Cities

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

Selected Boiler Patents

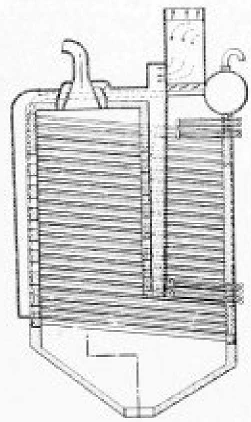
Compiled by
DWIGHT B. GALT, Patent Attorney,

Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,731,428. BOILER FURNACE. EDWIN LUNDGREN, OF FREDERICK, MD., ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

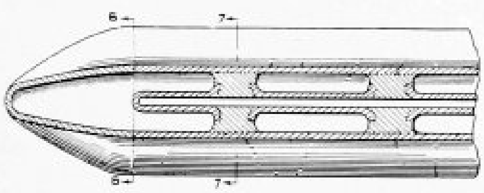
Claim.—In combination, a pulverized-fuel-burning combustion chamber, and a plurality of walls dividing the interior into narrow flameways, said



walls being composed of finned boiler tubes subject to radiant heat, said tubes being spaced so that the fins substantially abut. Two claims.

1,725,485. SUPERHEATER UNIT. FRANK W. SHUPERT, OF SANFORD, FLORIDA.

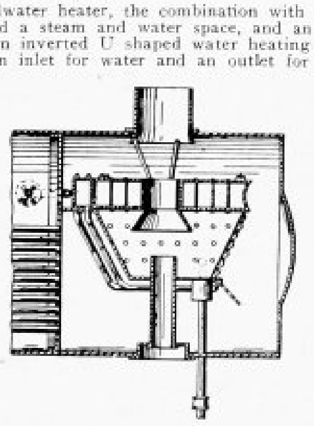
Claim.—In a superheater unit a pair of elongated hollow segmental shaped leg portions providing spaced concentric walls, inlet and outlet means for the outer ends of the leg portions, a hollow cap closing the inner end of the leg portions and providing communication between the



passageways of the leg portions, and stays connecting the crown portions of said walls at spaced points longitudinally of the leg portions and increasingly spaced greater distances apart from the inner ends of the leg portions toward the outer ends thereof. Two claims.

1,723,771. FEEDWATER HEATER. CHARLES G. DUFFY, OF KANSAS CITY, MISSOURI.

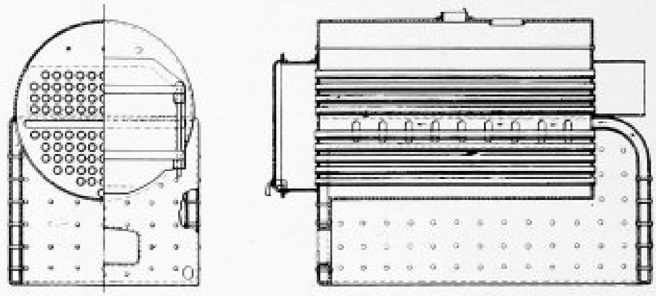
Claim.—In a feedwater heater, the combination with a boiler shell having a smokebox and a steam and water space, and an exhaust nozzle in the smokebox, of an inverted U shaped water heating receptacle in said smokebox having an inlet for water and an outlet for water and having



an opening through its transverse portion between its arms alined with said nozzle, water conducting means connecting said outlet with said steam and water space, and a plate closing the space between said arms at the lower ends and rear edges thereof, and forming with said U shaped receptacle a chamber of which said arms are the side walls of said chamber. Four claims.

1,719,327. BOILER. JONAS H. FOX, OF SEATTLE, WASHINGTON.

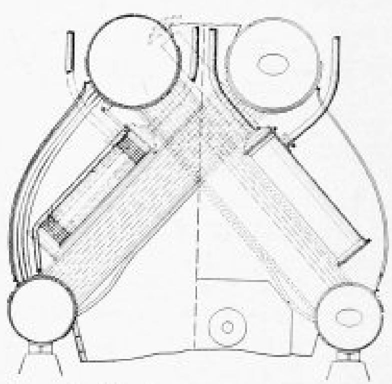
Claim—A horizontal firetube boiler having an upper and a lower set of tubes slightly spaced apart to leave an intermediate, unrestricted area; said shell being provided across one end with a horizontal opening alined with said unrestricted area, water legs connected at their upper ends with the shell at its opposite ends and sides and forming the walls of a firebox;



the legs at opposite ends of the box being adapted, respectively, to contain downwardly and upwardly circulating water with the leg which carries the upwardly circulating water curved gradually at its upper end from vertical to a horizontal direction and connected to the shell through said horizontal end opening so that the flow of water therefrom will be unretarded and delivered horizontally into the shell.

1,699,943. STEAM SUPERHEATER. ROBERT BAYLES ARMSTRONG, OF NEWCASTLE-ON-TYNE, ENGLAND, ASSIGNOR TO ROBERT BAYLES ARMSTRONG, AND R. & W. HAWTHORN LESLIE & COMPANY LIMITED, OF NEWCASTLE-ON-TYNE, ENGLAND.

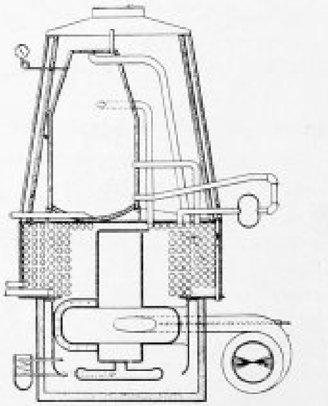
Claim.—A superheater comprising a tubular header having a lateral outlet branch, substantially U-shaped tubes extending from such header, of which tubes those of any single row are nested in a common plane transversely of the header, a dead cover at one end of the header, a



cover at the other end of the header having an axially arranged steam inlet branch, a pipe centrally arranged in the header, which pipe communicates with the inlet branch aforesaid, extends to the dead cover and has a portion removed longitudinally, partitions extending to the header from the divided edges of the tube adjacent the gap thus formed, and other longitudinal partitions also extending to the header, adapted to produce a series flow of steam through the tubes of a row. Two claims.

1,696,892. SEMIFLASH BOILER. CHARLES A. FRENCH, OF CHICAGO, AND GUSTAF W. ENGSTRÖM, OF RIVERSIDE, ILLINOIS, ASSIGNORS TO INTERNATIONAL HARVESTER COMPANY, A CORPORATION OF NEW JERSEY.

Claim.—In a steam generator, the combination of a burner, a casing, a superheater of fixed heating surface, an evaporator of fixed heating surface, a preheater of fixed heating surface, the superheater, evaporator and



preheater all surrounding the burner, a storage drum, means for supplying water to the preheater, a connection for discharging the water from the preheater into the drum, a single connection for taking the water from the drum and delivering it to the evaporator, a pump in said single connection for forcing the water through the evaporator, a connection for delivering water and steam from the evaporator back to the drum above the center thereof, and a connection from the top of the drum for delivering the steam to the superheater. Nine claims.

The Boiler Maker

Name registered U. S. Patent Office

Volume XXX | October, 1930 | No. 10

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

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THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

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Welded Pressure Vessels

Industry has definitely entered upon an age of welding. Progress in the art has been so rapid in recent years, in all fields where metals must be joined into structures of various forms, that unification and standardization of practice alone stand in the way of its general adoption. Limiting this discussion to the field of pressure vessels; the American Society of Mechanical Engineers Boiler Code Committee and the American Welding Society, after extensive studies of the application of welding to such structures, have, within the past few months, presented proposed welding standards for comment and criticism of interested parties. Realizing that the National Board of Boiler and Pressure Vessel Inspectors is one of the groups most interested in the practical application of the proposed rules, the program of the annual meeting of this organization included a symposium on the subject by men prominent in the development of the rules and in the field of pressure vessel manufacture.

Practically all previous attempts to codify welded construction have dealt mainly with specific methods and processes, while the present rules take no account of the process but attempt to regulate the work by prescribing tests to be carried out after the structure is completed. These new specifications will offer definite means for predetermining, with considerable certainty, the uniformity of strength of an entire structure.

The report of this symposium, which appeared in the September issue and is being continued in this issue, should serve to enlighten those readers interested in the matter on the practical effect of the welding regulations, when they are adopted. Should any of our readers wish to obtain copies of the proposed welding rules for study, a request should be sent to the secretary of the American Society of Mechanical Engineers Boiler Code Committee, 29 West 39th street, New York City.

Preventing Embrittlement in Power Boilers

Although the first suggestion, that the caustic content of feed water might cause cracking in boiler sheets, was suggested by C. E. Stromeyer in a paper read before the Iron and Steel Institute of England in 1907, it is only within the past three or four years that the drastic effect of this boiler trouble has been fully appreciated by boiler manufacturers and users. From 1912, when he began investigating the causes of what we now know as embrittlement, Professor S. W. Parr, of the University of Illinois, has conducted exhaustive investigations to determine the means of preventing failures from this source. Professor Parr and F. G. Straub, working in the laboratory and in the field, finally developed and demonstrated the theory which has been accepted generally explaining the effect of caustic on boiler steel.

As now understood, embrittlement cracking can be caused not only by feed water, in which high carbonate and low sulphur contents occur naturally, but also by treated waters where similar characteristics result from the treatment. Whereas originally, embrittlement was confined to boilers operating in a few states, including Illinois, Wisconsin, Texas and Colorado, where the natural waters are caustic, with the increase in pressure and rates of evaporation in modern boiler practice, embrittlement has been encountered in practically every section of the country, when proper feed water treatment has not been followed.

In combating the losses from this source, great credit is due the Hartford Steam Boiler Inspection and Insurance Company for its contribution in recent years to the solution of the problem. While the investigations were progressing at the University of Illinois and elsewhere, the engineering staff of this company applied such developments as were made to practice in the field. As a result of an exhaustive study over a period of time, Assistant Chief Engineer Morrison in 1928 designed what is known as the Hartford rivet hole periscope for the purpose of discovering and examining fine rivet hole cracks, which are the first indications of embrittlement. It previously had been found that an ordinary reading glass in conjunction with proper lighting arrangements would show up fine cracks in rivet holes, after the rivets had been cut out, wherever embrittlement had commenced. With the periscope, cracks so small that they are invisible to the naked eye are magnified twenty-two times by a reflecting mirror and lens. However deep the hole may be, the instrument permits minute examination of every portion of the surface of the metal.

In the past few years, more than five hundred cases of caustic cracking have been discovered by this company's inspectors before the condition of the boilers examined became at all dangerous. By checking the trouble in time, and subsequently supplying proper feedwater treatment, tremendous savings to boiler operators have been realized and many potential disasters avoided.

Shop Practice

While a number of excellent articles describing layout problems have been received and will be published, there are a great many of our readers who, if they would take time to do so, could contribute valuable information on methods of laying out. Problems as worked out by an engineer, for example, mean little to the man in the shop. The manner in which the layerout at his bench puts into practice the design of the engineer is important, and only he can explain satisfactorily how it is done. Our readers welcome practical help of this kind from those of wide experience, and so, if you have done an unusual or interesting layout job, send the description of the various steps taken and a good drawing of it to us for publication.

For another group of readers, descriptions of boiler repair jobs of all kinds have a decided appeal. Here again, only the man in the shop or in the field who is doing the work can describe it to advantage. Write up the details clearly and make as good sketches as possible so that they cannot be misunderstood and send the information to this office. The editors will put such material in good readable form and send you a check for the article when published. Such articles do not have to be very long nor descriptive of complicated jobs. They may be on a new device developed to do special repair operations or a short cut that saves time or money. In fact, any feature of boiler shop work as the man on the job sees it is good material.

Communications

What Inspectors Need

To the Editor:

Mr. Carter's remarks on boiler inspection in the September issue of The Boiler Maker prompts me to offer a review of his various indictments. We will take up the case of the boiler foreman giving his boiler inspectors a test card with the stated result that none of them marked the same bolts as broken on the chart; then the supervisor of boiler inspection goes and marks sound bolts as being broken.

During my thirty-seven years in the business, I have never yet conceded that any boiler inspector is at the same time a staybolt inspector; it takes experience, day-by-day testing, a genuine interest in the job to produce an inspector who finally absorbs that indefinable feel of the testing hammer, which ultimately labels him as an all-round boiler inspector. The cited instances of broken braces and broken staybolts plugged with nails is but a sad commentary on the woeful lack of knowledge regarding the laws governing boiler inspection.

Let these inspectors study the laws and then ask themselves this question: "If I sign a form thereby stating that a boiler is in a safe condition, and knowing at the same time that there are dangerous defects, and there should be an explosion or an accident directly traceable to these same defects, will the railroad stand back of me?" He can rest assured he will not have a friend in court.

What inspectors want, and what is practically guaranteed to them is this: That no supervisor dare discharge or demote them for their insistence upon obeying the Federal laws, and again, I do not believe that there is a superintendent of motive power, or any other high official who would condone such action on the part of shop supervisors. I do not agree with Mr. Carter's suggestion that Federal inspectors be placed in all shops. I believe that the shop supervisors have enough grief as it is. Put the shop inspectors where they will be directly under control of the superintendent of motive power, then with the fear of minor officials removed, you will get better inspection.

Lorain, O. Joseph Smith.

Tough or Brittle Welds

To the Editor:

A young welder, who was "breaking-in" at boiler shop work, was called upon to make repairs to a small portable boiler of the semi-locomotive type and a new piece of shell-plate was welded in at one side of the fire door. The welding operation was seemingly successful, but the first time the boiler was fired a crack developed in the welding, necessitating the patching of the weld by another welding operation, and the door opening was found to be somewhat distorted, so that some fitting was necessary in order to make the fire door close and latch properly.

The young welder did a whole lot of thinking about that repair job and determined, upon the next similar piece of work which came to hand, to try some method whereby the cracking and distortion could be avoided, either largely or wholly. To this end, when a new piece of shell plate had to be welded in around another worn-out fire door, the welder set up a couple of powerful kerosene torches and heated that portion of the little boiler where the new piece was to be inserted, and, after the old sheet had been removed with the cutting torch, the door frame and plate around the hole was heated almost to a dull red. Then the new piece of plate was welded into place while the frame and adjacent plate was still hot. There was no cracking or distortion observed in connection with this job, and the fire door fitted snugly and well, after the boiler had cooled. The young welder figured something like this: "If placing a bunch of welding-hot metal upon a cold sheet caused distortion in the sheet after it cooled, that distortion of the sheet before welding, by the application of heating torches, should result in the sheet cooling flat and normal when it cooled again after the welding and the sheet would be found true and normal, the distortion caused by the intense heat of welding being absorbed in the cooling of the preheated frame and shell plate of the boiler." The results proved that he was right in his reasoning, for there was no distortion or cracking of welded surfaces in the second job.

The young welder taught himself another lesson, during the welding of several long straight seams in some square water tanks. Considerable distortion of the sides and corners appeared after the four-foot long joints had cooled. In the next tank, distortion was entirely eliminated in a very simple manner. The welder started, as usual, at one corner of the tank and, after he had welded a few inches, he purposely distorted the plate or sheets which he was welding, by driving a large cold chisel between the plates about 6 or 8 inches ahead of the weld, thus forcing the plates apart at that point. This caused a stress or distortion of the sheets at the point of welding, which took care of the stresses caused by cooling of the hot welded surfaces.

Several small lugs were required to be welded to the sides of one of these tanks, and, finding one of the lugs slightly "out of square," the welder hit the lug with a hammer, intending to bend it into proper shape, but the weld proved as brittle as glass, and the lug flew off under the hammer blow. One other "brittle" weld was found, but all the other lugs were welded so toughly that they could be hammered at will, without "starting" their welds in the least.

Inquiry, reading and some hard thinking convinced the young welder that he must have used an oxydizing flame in the making of the brittle welds, while a "reducing flame" had been properly employed in the making of the very desirable tough welds. Following out this line of thought the young welder determined to "run down" the matter of the two flames. Accordingly he cut off a considerable number of pieces of light bar, or rather strap steel, until he had secured 10 to 30 pieces, each about 3 inches long, of 1/8 by 1½-inch black steel. Clamping two of these pieces together, end to end, they were welded with a flame carrying as much acetylene and as little oxygen gas as possible, and the pieces were welded in that portion of the flame quite close to the opening in the torch tip, through which the gases issued. The weld completed, the welder tested it with hammer and vise, doubling the weld flat upon itself and even straightening it again without developing a crack.

Another weld was then made upon two other of the 3-inch pieces but, with this weld, the acetylene gas was cut down to the lowest working point, while as large a quantity of oxygen gas as possible was used. The welder did not test this weld very much. At the very first blow of the hammer, the weld flew in pieces as though it had been made with glass rod instead of good welding rod metal.

The above, and numerous other tests of all sorts of gas flame mixtures, convinced the young welder that he could make and use either the oxidizing or the reducing flame at will, with the result that he could produce at will either a tough or a brittle weld according to the type of flame he used.

As a result of the very simple tests above described, which any welder can make and profit by, the young welder feels that he can make steam boiler repairs and be sure of obtaining tough welds, every time, which will always prove safe.

Indianapolis, Ind. James F. Hobart.

Welding Cracks in Boilers

To the Editor:

I believe that the article entitled, "Welding Cracks in Boilers" in the August issue should be answered before it misleads the novices of the boiler maker's trades or causes any serious accidents due to the improper method of repairs.

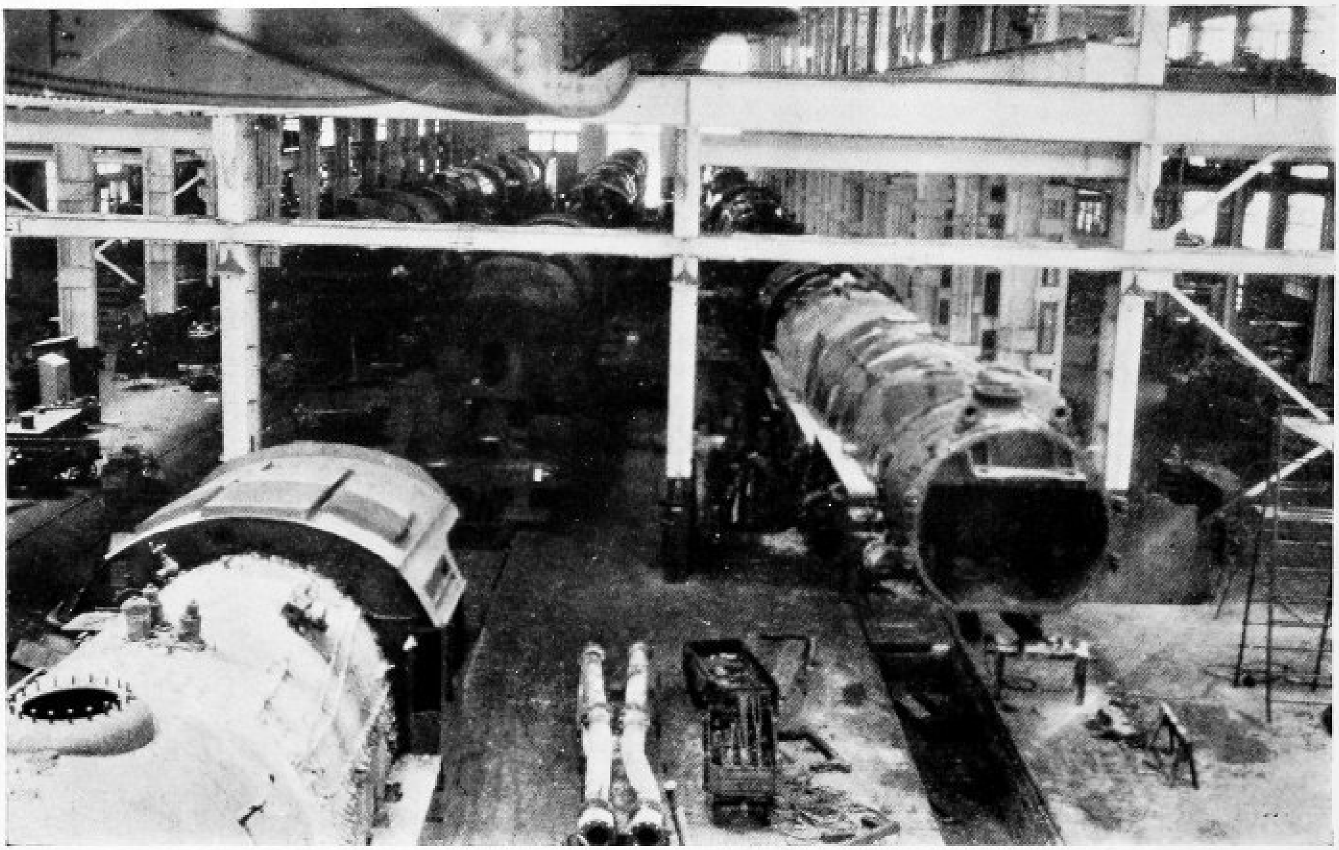
Anyone who is at all familiar with boiler construction knows that the method of applying a welded patch to the head of a watertube boiler or to any surface that is unsupported and dependent upon the strength of the weld is not proper and should not be tolerated at all. I have seen the question answered time and time again that where the human element enters into welded construction the utmost precaution and measures must be adopted, hence I believe that welding of unsupported surfaces is classed as one of these major precautions.

It is noted that the State, in which the writer of the article in the August issue lives, has not come to recognize or adopt the Codes of the A.S.M.E. or to accept the National Board, hence they may have inspectors in that State who might accept the welded patch as suggested, but let it be said that such a method of repairs would not be accepted in States coming under the rulings of said A.S.M.E. Boiler Code.

For the benefit of our readers who may not have seen the paragraph of the A.S.M.E. Code concerning the welding of unsupported surfaces, I will quote the same, and you can readily see that welding of the patch in the head of watertube boilers is a direct violation of the same. Paragraph 186 states as follows: "Autogenous welding may be used in boilers in cases where the stress or load is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld."

A weld of reasonable length might be allowed on a staybolt surface or on one adequately stayed by other construction that meets with Code approval, so that in case of failure of the weld the parts would be held in place by the stays. But welding will not be allowed on any unsupported surface. This rule holds for all States that have accepted the A.S.M.E. or National Board stamps.

Charles W. Carter, Jr.
Binghamton, N. Y. State Boiler Inspector.



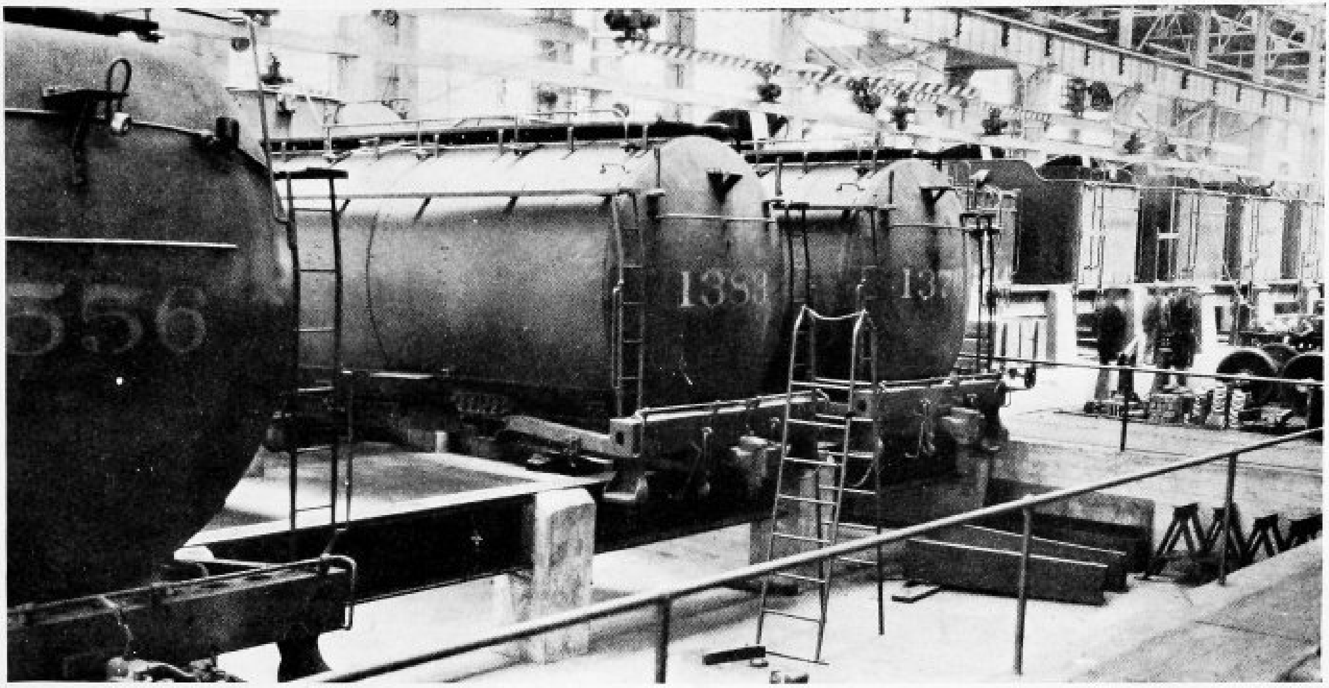
Center track for stripping and tracks on either side for finishing

Stripping and Finishing Locomotives

at the Chesapeake & Ohio Huntington Shops

Since certain boiler operations are carried out in the erecting shop, and in order properly to appreciate the production efficiency of a locomotive repair works, an understanding of the arrangement, facilities and procedure of this department is essential. In the September issue an outline of the scheduling practice at the new Chesapeake & Ohio shops at Huntington, West Va., was published. Following is a description of the application of the scheduling program to stripping and finishing in the new erecting shop.

In 1918, what is termed the longitudinal erecting shop was built at the Huntington works. As the plant now is arranged, this shop is at right angles to the main plant and near the north end. Since its use as an erecting shop ceased with the construction of the new shops, it is now utilized as a stripping and finishing department. In the production scheme, progressive stripping operations are conducted on the center track of this shop, while progressive finishing operations are carried out on the two side tracks.



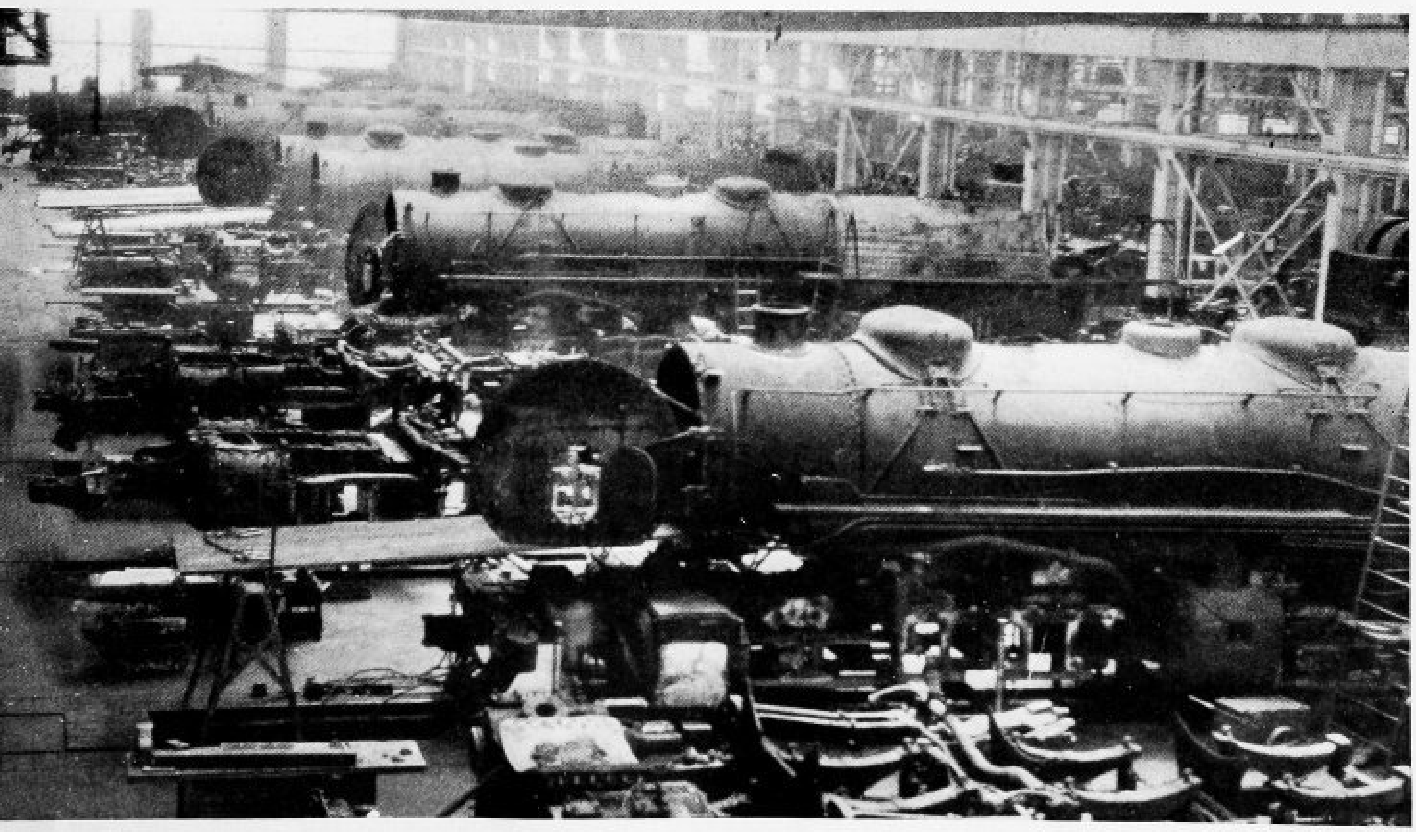
Large tender tanks are repaired in a special pit

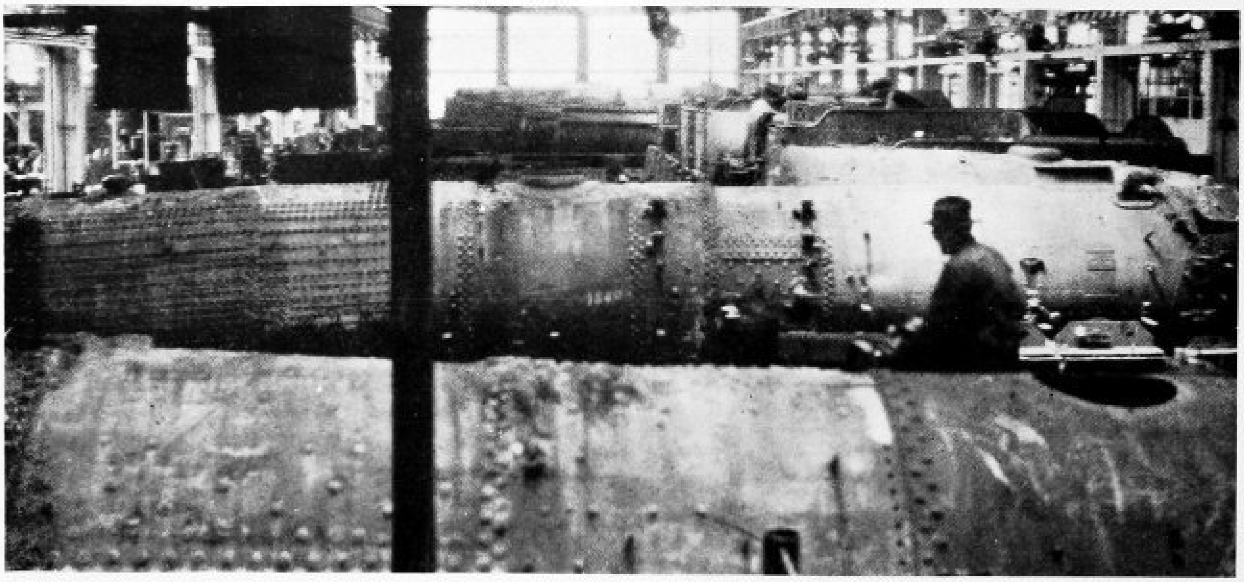
The new transverse erecting shop, completed early in 1930, has 25 pits, with a distance of 24 feet between track centers. As arranged, the bay is 95 feet between the centers of supporting columns. For its entire length this bay is served by a 250-ton overhead electric traveling crane, which, with a locomotive suspended, has ample clearance over both the remaining shop cranes and locomotives on the pits. There are three 15-ton messenger cranes located on a lower runway, which serve to handle light material and parts and fill a very essential function in the servicing system of the shop.

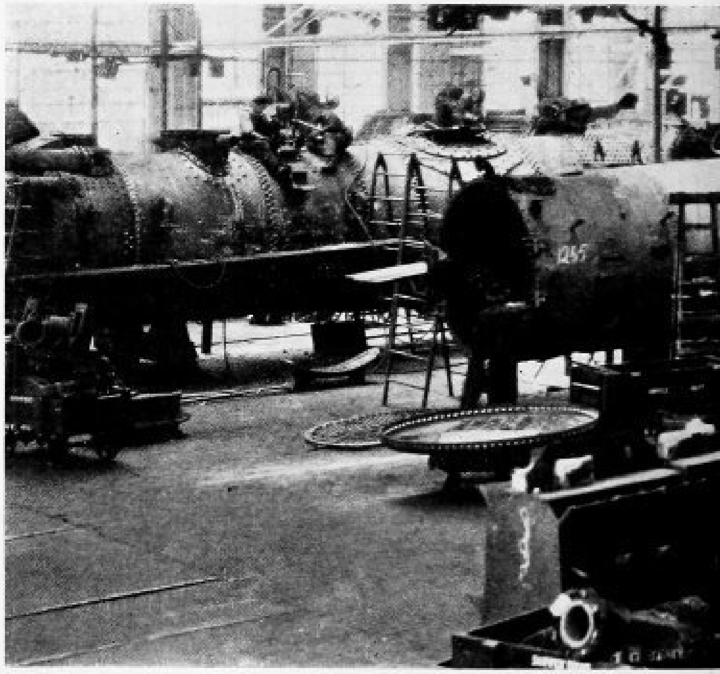
When turning out the maximum production of which the shop is capable; namely, 50 locomotives in a month of 25 working days, two locomotives are received every 8 hours. With this as the working unit of time, it follows that each major operation must be completed in 4 hours.

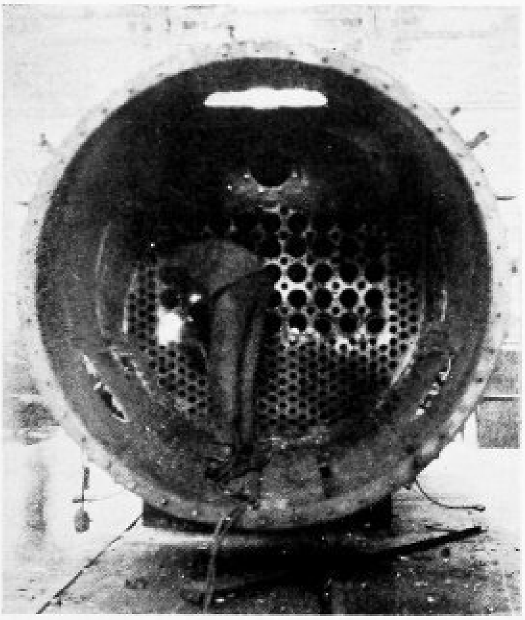
A locomotive and tender are usually received under

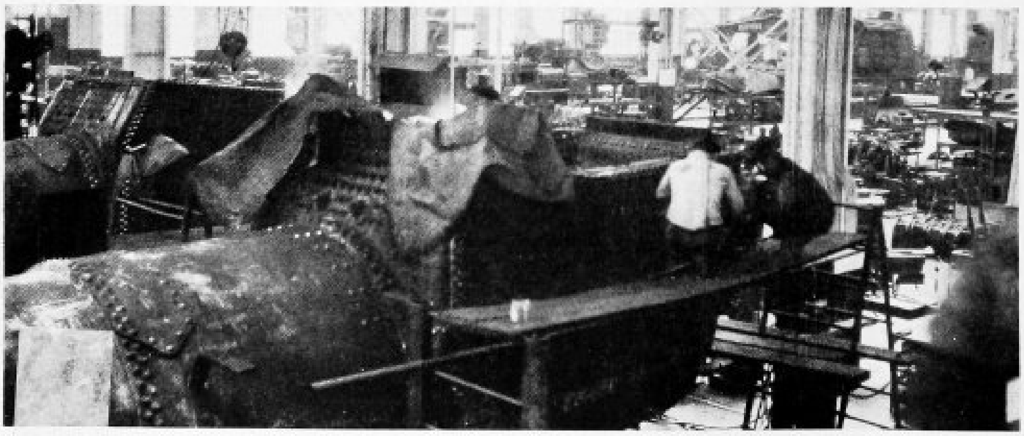
Locomotives are brought to the new erecting shop from the stripping track





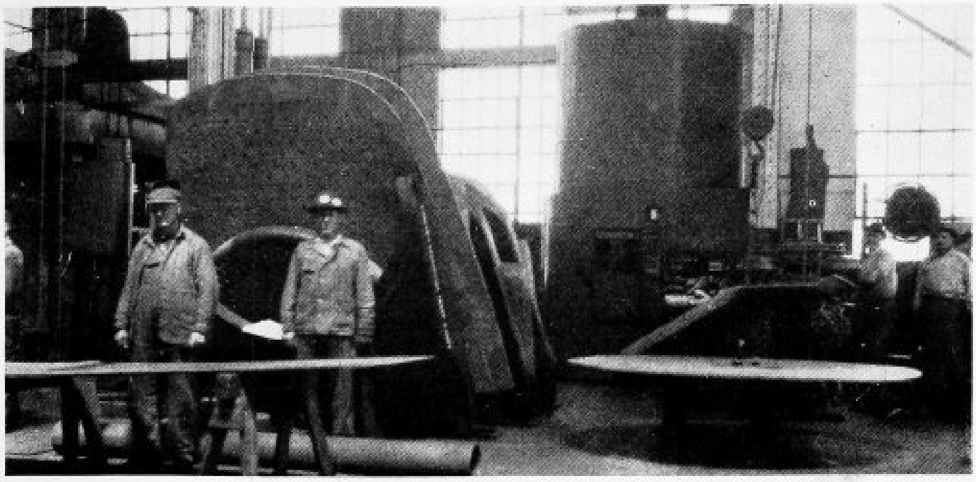


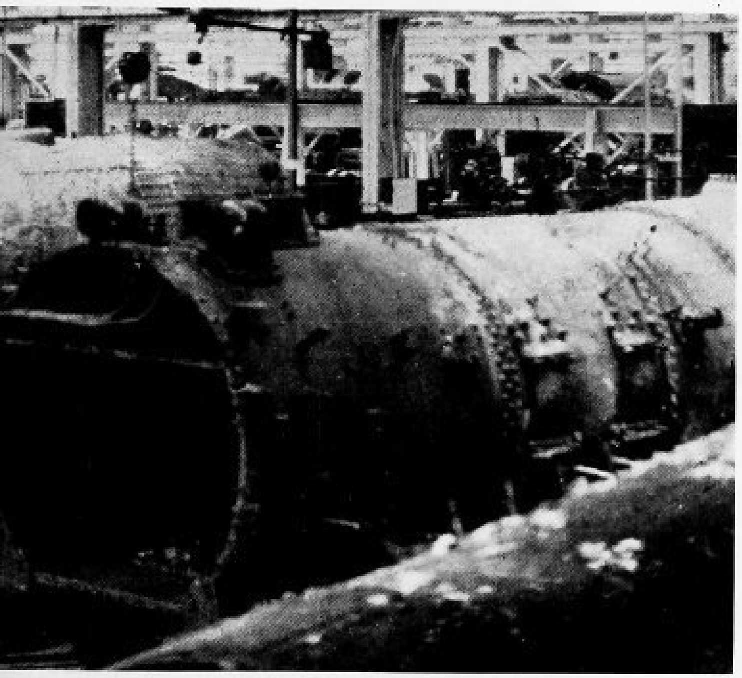


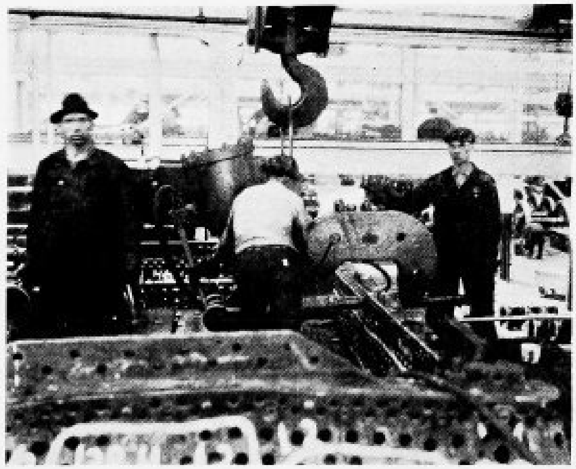


At the top and center are general views of work in the boiler shop at Huntington, while the left center and bottom views show the finishing operations on the front tube sheet and assembly work on the firebox respectively

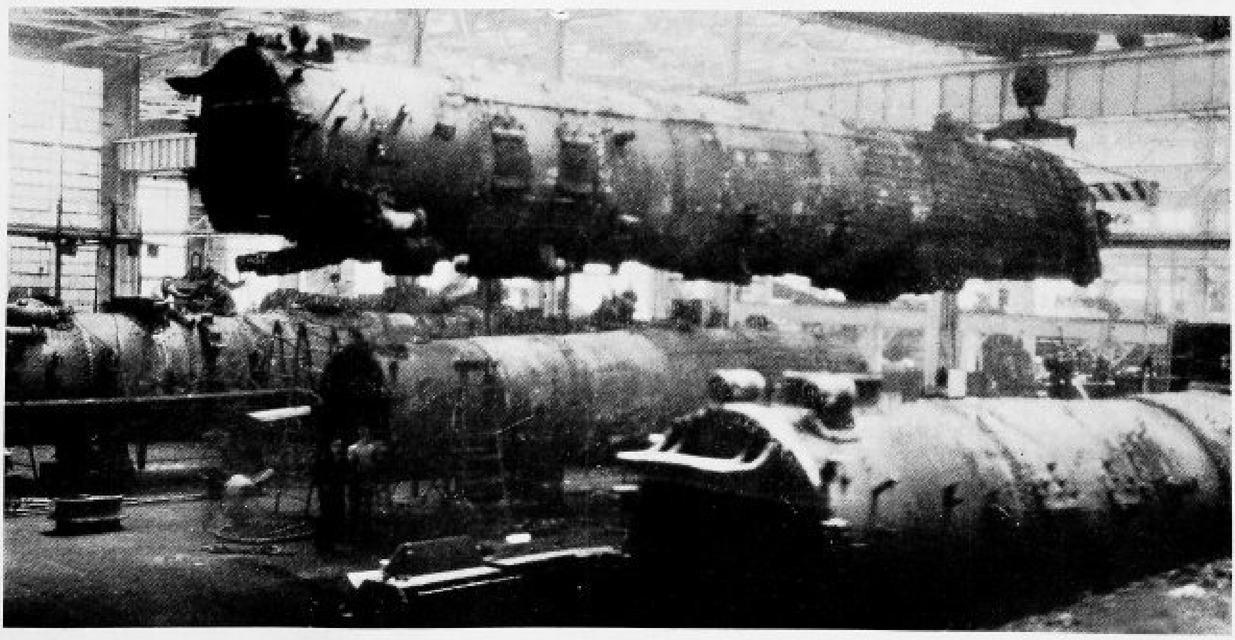
One corner of the boiler shop is devoted to flanging and the view at the right shows members of the staff and examples of work done by this department







A portable pneumatic riveter is used for riveting the mud ring, and this operation is shown above. Below is demonstrated the method of handling boilers from one part of the shop to another



steam at the Huntington roundhouse. After working its way to the receiving tracks, the fire is dumped, ash pan cleaned, boiler blown down, and the water drained. The boiler shop force then carries out the front end washing operation, flushes the ash pan and firebox and washes the outside of the locomotive by the D. & M. process. This series of operations constitutes a unit and must be completed in the 4-hour schedule. After this the yard crew pushes the engine and tender into the west end of the stripping department on the center track.

After the tender is disconnected, a small storage battery locomotive switches it to the coal conveyor where it is emptied of any remaining coal. It is then hauled to the east side of the tank shop and placed on a storage rack until scheduled into the shop for repairs. Since tenders require less time than locomotives for repairs they are scheduled for completion only a few days before the locomotive is outshopped. Inbound tenders pass through the sand-blast house and are handled onto the transfer table and thence to the tank shop by an electric winch. Outbound tenders are finished and painted in the tank shop and then stored until required.

As soon as locomotives are delivered on the roundhouse lead, the back shop inspectors make a thorough examination and determine, so far as possible, the material required to make repairs, checking against the preliminary reports sent in by the master mechanic when the engine was ordered to be shopped. At this time a special report is made of all missing parts that have been taken from the engine before it was sent to the shop, which material is billed against the operating division from which the engine came to the shop for repair.

The engine is then placed on the center track where the tender is uncoupled and handled as previously described. Pipes, gages, and boiler mountings are removed by the shop gang within a 4-hour period. Next the engine, without its tender, is placed in the second position where the jacket is removed, if necessary. Machinery stripping in this position includes main and side rods and valve motion. With this 4-hour period completed, the first major operation or 8-hour unit is finished and the engine is moved to the next spot.

At the next position, the lagging is removed, if necessary, as well as all piping under the jacket, which requires removal. The time for this operation also is 4 hours. During the next 4-hour period the air pumps, power reverse gear, fire door, and feedwater heater pumps are removed and delivered to storage racks outside the shop. Here the cab and the binders are loosened so that they can be dropped quickly at the proper time. The stoker also is loosened preparatory to removal. This operation also completes the second 8-hour unit.

During the next 8 hours the locomotive is spotted on a position in the center track in the erecting shop where binders are dropped into the pit, after which the locomotive is picked up by means of the 250-ton crane and placed on its assigned pit for heavy repairs. An interesting detail of work on the stripping track is that electric winches are used to move locomotives from one position to the next. After the locomotive is lifted from its wheels, the wheels are moved eastward into the wheel shop bay next to the erecting bay still on the same stripping track.

After the locomotive is placed upon its assigned pit for heavy repairs, all necessary stripping is done and cylinder bushings, valve chamber bushings, main brasses, and boilers are examined to determine exactly the extent of repairs necessary. These operations constitute the first 8-hour period on the pit. From this point on the various operations covering mechanical repairs and boiler repairs are carried out in the various departments. Since the details given here are intended mainly to explain the spot system of stripping and assembly, the boiler work entering into the operations will be described in a later article.

The final assembly is carried out in the longitudinal erecting shop on two tracks on either side of the stripping track. All Mallet locomotives and heavy Mikados are placed on the outbound pit in the main erecting shop. In this shop the two units of the Mallet engine are connected, the valves are set and the engine is ready to move on the progressive line. These operations occupy an 8-hour period. The next 8-hour period takes care of the jacket application. Piping also is completed in a third 8-hour period.

At the next point, the completed tender is brought to the shop and connected. The locomotive is then filled with hot water from the boiler washing plant, and steam lines from the power house are connected to bring the steam pressure of the boiler up to 150 pounds pressure. The fires are lighted and the pressure raised to the working point, when the safety valves are set. The engine next is run out of the shop on its own power for a 30-minute trial after which it is returned for final adjustments.

All of the larger classes of engines are placed on the progressive line nearest to the main erecting shop in order to reduce material handling as much as possible. The smaller classes of locomotives are handled on the track farthest away from the main shop but go through the same stages of finishing as the larger locomotives.

Steel cabs are repaired in a department at one end of the boiler shop. When completed, they are stored on suitable racks in the wheel shop bay ready for mounting when locomotives are at the proper stage of completion to receive them. Ash pans are repaired in the boiler shop and returned to their respective locomotives for re-application.

A Strange Tank Explosion

An employee of a plant in Greenville, Texas, recently had a most remarkable escape from death when a welded steel tank used for receiving condensate from a steam line exploded while he was seated on it. The man was hurled to the ceiling and then crashed to the floor, but in spite of a fractured skull, a broken arm, and other serious injuries, he recovered.

The tank was slung horizontally in brackets fourteen feet from the floor, being connected to the steam main by means of a ¾-inch pipe. A 1-inch pipe connected it to a vacuum line through which it discharged the condensate into a feed water heater. There were stop valves in both the inlet and the outlet connections, and the tank was protected by a safety valve set at what was considered a safe working pressure. After the accident this valve was found so blocked with scale and sediment that it could not function.

Immediately prior to the accident the tank had been out of use. It was while preparing to put the tank back into service that the accident occurred. An employee had climbed atop the tank where, after being assured by a helper that the discharge line valve was open, he opened the inlet valve.—*The Locomotive.*

Fourteen wheel truck and trailer used for hauling boilers

Transporting Boilers in England

By G. P. Blackall

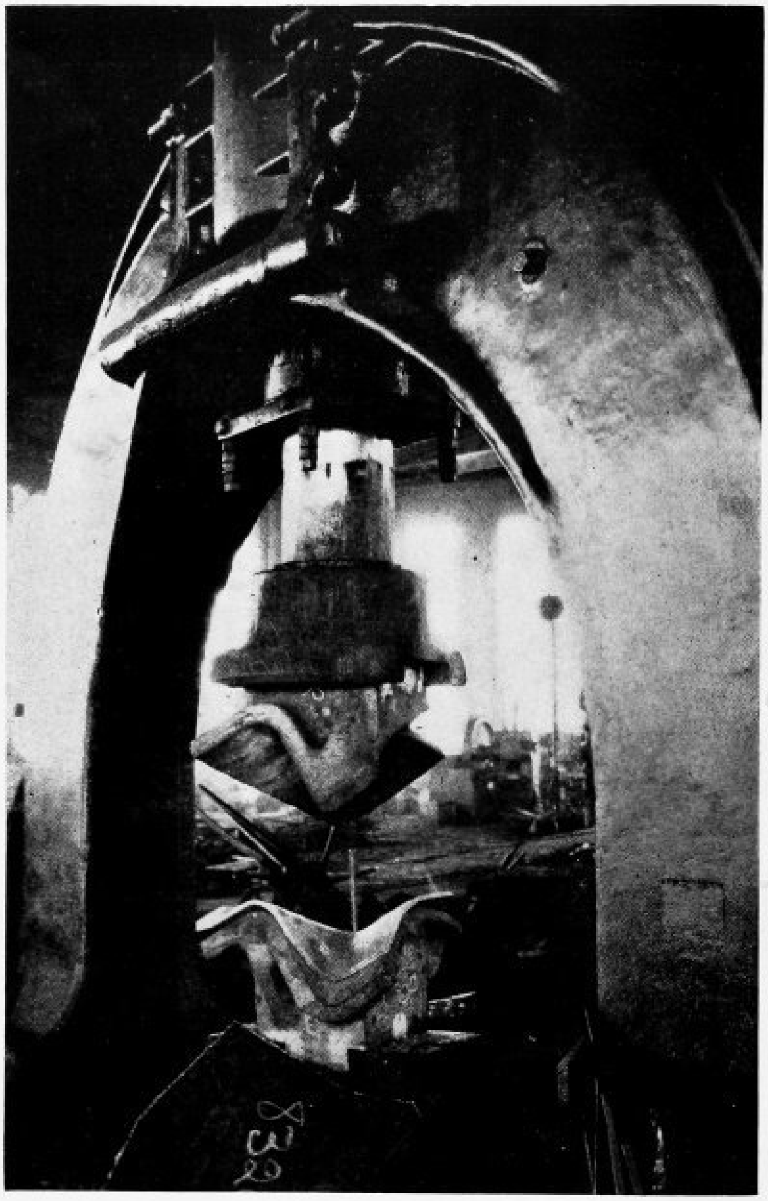
A novel type of boiler and boiler plant transporter has recently been constructed for a British road transport undertaking (Marston's Road Services, Ltd., Liverpool), and will move all sorts of unwieldy equipment weighing up to 112 tons. The transporter can also be used for carrying complete locomotives to the docks when their wheel gage makes it impossible to run them to their destination on British gage tracks.

The truck has 14 wheels, and the power unit develops 80 horsepower, being fitted with standard clutch and gear-box. The final drive is by twin-roller type side chains, arranged in the form of a dual drive with a high and low ratio, so as to give eight forward speeds. The normal maximum speed with a load of 75 tons is from six to seven miles per hour and given a fair surface the truck is capable of negotiating gradients up to one in ten.

The rear wheels are arranged on oscillating axles and are also free to swivel on a vertical axis, controlled by a massive screw and nut steering gear, with large hand wheel, which is operated by the man riding on the platform at the back of the carrier, so that the steering of the transporter is operated both from the front and the back. The brake power of such a machine is a complicated problem, and adequate measures are provided for dealing with all possibilities.

The power unit has a hand-operated screw brake on the drawing wheels, and a pedal-actuated brake on the transmission, which can also be operated by a small hand lever. In addition to the brakes on the power unit, all the wheels of the carrier have internally expanding brakes operated by hand wheel from the rear platform. The driver and the man at the rear are in communication with each other through the medium of a loud-speaking telephone.

Boilers of all types, including watertube, dryback, marine, Lancashire, etc., can be transported with ease on this truck. The work, of course, calls for specialized knowledge, and the firm, therefore has a highly trained staff of skilled men operating its immense transporters. These men are qualified to set up the boiler on arrival. To demonstrate the bulk which can be carried on such a transporter, a tugboat, 70 feet long, 14 feet wide, and 9 feet deep, was transported from one end of the United Kingdom to the other and then successfully launched. A 108-ton steel bridge was also transported from Glasgow to Liverpool.



Forming a single patch under the steam hammer

What Causes Outside Throat Sheets to Crack?

The following report prepared by a committee composed of G. M. Wilson, chairman, M. V. Milton and E. E. Hilliger was presented at the May, 1930, convention of the Master Boiler Makers' Association, held in Pittsburgh, Pa.

We believe this to be the first time that this subject of outside throat sheets cracking has come before our convention. In preparing our report, questionnaires were sent to the heads of the mechanical departments of a number of railroads and, before entering into the subject, we wish through our association to express appreciation of the many and prompt replies received. As a matter of fact, a degree of kindly interest has been shown for which we should be very thankful, for, without such co-operation, success would be doubtful.

Cracking of outside throat sheets is familiar to most, if not all of us. The reasons for this, as expressed, are many and we may say varied. The fundamental cause, however, as agreed to by practically all, is due to design, and variations in expansion and contraction. Higher tension and stresses are set up due to irregular shape at the point of fractures, and the more sudden and more often these conditions (expansion and contraction) come about, the earlier will failure develop. Further, because of the shape of the throat sheet, the strains developing at this point due to pressure and expansion, the tendency is for the irregular shape to straighten out horizontally when boiler is going from zero to full pressure. It then returns to normal, when cooling down. As stated, the more often and more sudden such temperature changes occur, the earlier will fractures develop. Once this checking starts, water conditions undoubtedly have their effect.

I doubt whether there will be any change of design in the near future. Therefore, our aim is to get better results from the present designs. One item that appears uppermost in our minds as being worthy of consideration, is that the throat sheet material used should have a higher tensile strength, say 75,000 pounds per square inch, which might prolong the period of service. After studying present conditions of service, and failures, and methods of repair, on many roads, it would appear, that, where the crack had been V'd out and welded, and, where a patch of the same thickness of material had been applied, there was no further trouble during the life of the original sheet.

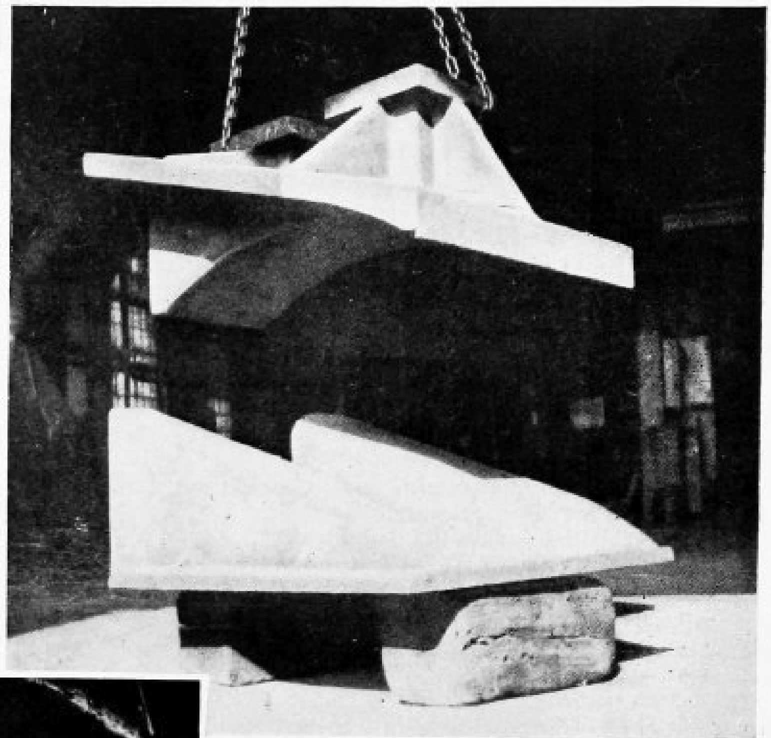
The methods generally followed in patching may be better understood by reference to the illustrations on pages 282 and 283. Naturally there will be differences of opinion as to the best method. The practices followed in forming patches are varied because of the different facilities available. The illustrations on this and the following pages show the method of forming single and right and left patches being formed under the steam hammer and on the flange press. This should be of interest to the members. However, the principle in mind is to form a patch with the least re-heating possible.

In order for members to have some idea of the causes of cracked throat sheets as noted in the questionnaires we have summarized the returns briefly as follows, referring to the different reports by letter only:

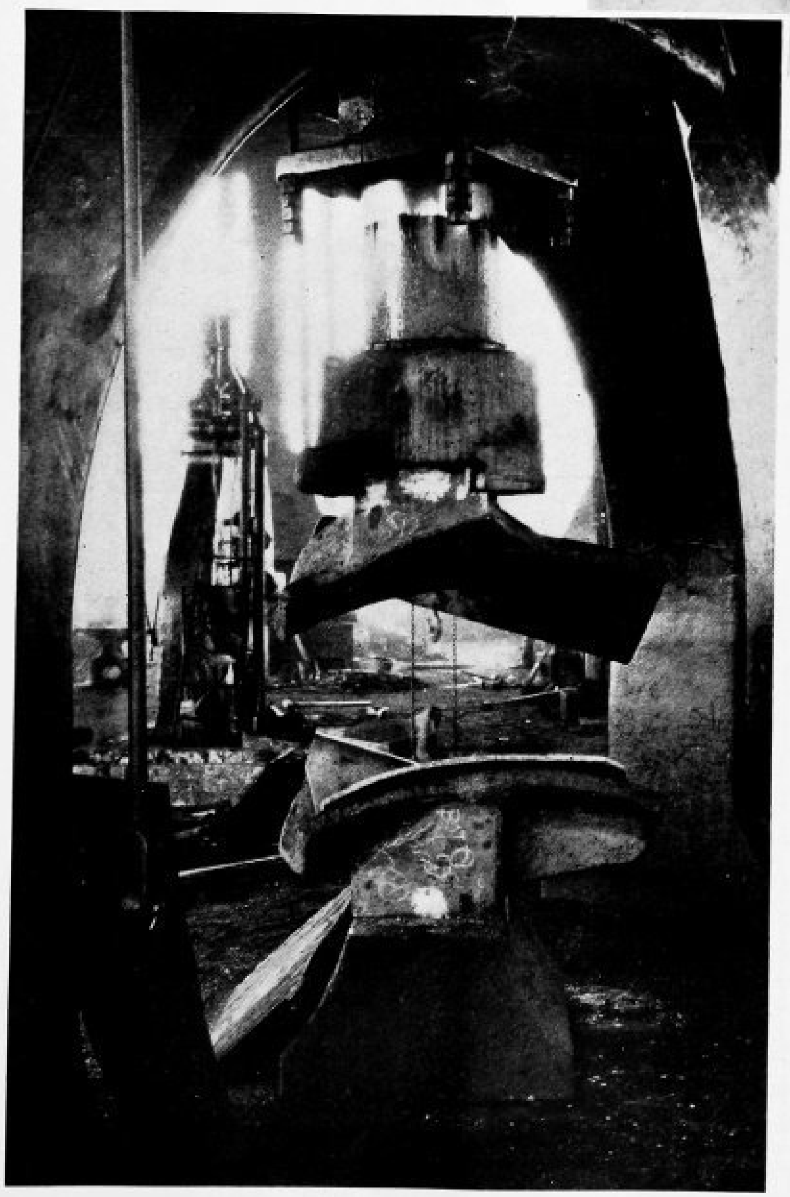
A—The reasons for throat sheets cracking are unequal expansion, tonnage on trains, speed maintained, and long distance runs.

B—Cracks occur because of stresses, brought about by flanging, by the location of this sheet in the boiler, curves, and changes of temperature caused by the flow of water.

C—Restricted expansion; the close proximity of joints, throat sheet, barrel, and firebox casing limits the expansion to the small area between those joints. This movement at one joint gradually develops cracks.



Right and left patch being formed with the flange press



Another view of the forming operation

D—From unequal strains due to expansion and contraction, weakening of material in forming and improper forms (dies). Trouble may be eliminated to a great extent by better design, forming and construction.

E—Throat sheet cracking is due to the rigid position of the flange, the knuckle forming the flange at the casing sheets and the boiler shell.

F—Unequal expansion and contraction, caused by strains transmitted through running gear and frames while working under certain conditions. This embrittles the metal which becomes weakened, then cracking occurs. Cracking cannot be avoided but can be retarded by proper fitting of furnace bearing plates.

G—Throat sheet cracking is due to design of boiler and cannot be avoided after going into service. Water and service conditions do not materially influence cracking of throat sheets; rapid firing may have its effect.

H—There are many reasons; for instance, flanging when material is too hot or working when it is too cold; uneven support of flexible staybolts.

I—Throat sheets crack because sheet is reduced in thickness in process of flanging, therefore it is not strong enough to withstand stress. Life of sheet can be increased by reinforcing with electric weld on water side before cracks start.

J—Throat sheet cracking is due to forming at improper heat. Water and service conditions are not considered as having any influence on cracking. No noticeable difference between combustion chamber boilers and those without. No noticeable difference with any type of firebox.

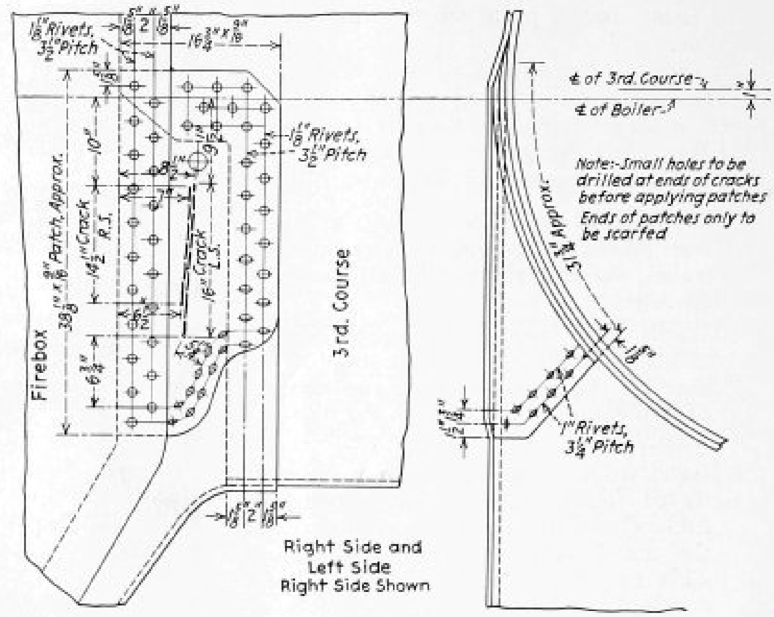
K—We are not having any trouble of this kind with modern locomotives.

L—Due to expansion and contraction, also faulty material. Cracking may be avoided by use of flexible staybolts and jacketing throat sheets.

M—Cracking is due to expansion and contraction and this is at times aggravated by improper design. Cracking may be avoided by proper design, eliminating short bends and sharp flanges. Water has its influence.

N—As the throat sheet is the junction of a circular and a flat section, this necessitates what is commonly called the knuckle, which makes this section very rigid, thus resisting the expansion and contraction stresses, and consequently it cracks. Noted a pronounced reduction in throat sheet cracking after the feed water was discharged into the top section of the boiler.

O—The cracking of boiler sheets at any point is due to two causes; expansion and contraction strains, due to buckling effect on portions of boiler not free to expand and contract with heating and cooling of boiler. Cracking can be eliminated to a certain extent by keeping boiler free to expand on the frame by using sliding blocks on the frame at the throat sheet. Also the barrel courses should be perfectly round when assembled.



Wide firebox

Discussion

W. N. Moore (Pere Marquette): Cracked throat sheets, we all know, come about as a matter of age. Some last longer than others; some crack quicker than others. The crystallization of material is due to the many changes which take place during the time the engine is working, and where the designs are such that there are sharp bends at the corners, of course cracking comes sooner.

However, in another part of the report I note that one of the causes given is the thinning of the material due to forming the patch, or sheet as the case may be. On our railroad we find that cracks occur at the place where the material is really at its original thickness, right at the top of the ear, just below the bottom rivets. Down in the bend where the sheet is really thinner we do not seem to have that trouble.

The engine giving the most trouble is the Sante Fé type. We have fifteen of these and we have applied new ears to about two-thirds of them. What we do is to normalize our material before forming, to 1675 degrees F. We have a Leeds and Northrup control, and an automatic control on the furnace, and we know just exactly how the plates are heated.

After the patch is flanged, made and ready to apply, we put it back into the furnace and again raise the heat to 1675 degrees F. However, I cannot give you any figures on the results of this method due to the fact that this has been going on only about three years, and most any throat sheet will last longer than that. I do believe, however, that prolonging the life of the throat sheets will be brought about by normalizing the material to the proper degree as given to you by your steel manufacturers, and after the sheets are made and ready to apply, to relieve all strain.

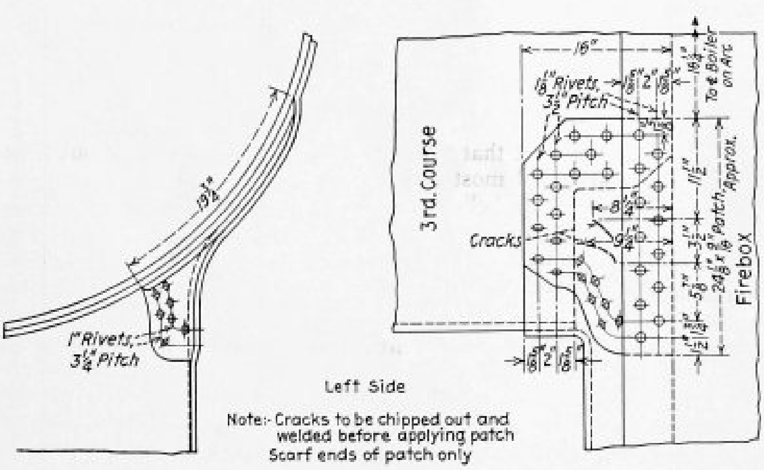
L. E. Hart (Atlantic Coast Line): On our smaller power we have quite a little difficulty with cracks in the knuckle of the throat sheet, but in the larger power, with the knuckle on the outside of the throat sheet, where the diameter is increased and is much greater, we have had very little trouble if any at all. I am of the opinion that the design takes care of the expansion and contraction far better than the older power. According to the sketches that are furnished by the committee, they show mostly the older equipment, and in

Semi-narrow firebox

most of the modern power you will find a larger arc in the flange of the knuckle of the throat sheet.

W. J. Williams (Erie Railroad): We are now having trouble of this kind with modern locomotives. We have a class of locomotives that I consider one of the most modern. It is the new type of boiler that is being built. I am not sure of the type, but I think they call it the Lima type. Anyway, these boilers are about two years old and we are having a lot of trouble with the boilers cracking in the throat sheets. Something is causing that trouble and I would like to know what it is. If anyone can inform us what it is, we will be very glad to hear from them.

O. H. Kurlfinke (Southern Pacific): There is an illustration given in this report that shows a crack vertically on the knuckle of the wing. That is quite an expensive patch to make. I am wondering how many railroads represented by men here would consider, instead of putting a patch on, cutting the old wing out and flanging the wing and welding it to the throat sheet. Wouldn't that make just as good a job? It would cut down the cost.



Narrow firebox

Ira J. Pool (Baltimore & Ohio): I have in mind an incident where we experienced a little opposition to that kind of a patch. Of course, in lots of cases, the government inspectors pass an opinion that they do not think certain things meet the requirements, and this opinion handed down to us probably is not binding at all. But I have in mind a case where we cut the original section of the outside throat sheet out and set in a new section, riveting it to the regular seams, and of course welding it at the bottom. The opinion of the Interstate Commerce Commission at that time, as I remember it, was that welding it across the knuckle in that section of the boiler was equivalent to welding an unstayed surface, and going a little further into it, I think the rule was based on the fact that the knuckle supports itself 3 inches each side of the center line of the heel of the knuckle, and when you get beyond that it is unstayed surface. There was no criticism regarding the workmanship of the patch. It was well applied and holding up good. Since that time we have been riveting all our patches.

W. J. Williams (Erie Railroad): I would like to ask one more question. I tried to find something in the report about reinforcing the throat sheet before it cracked, but did not find any reference to that. What I would like to know is whether or not any member has been having this trouble with cracked throat sheets, and whether they have tried reinforcing the throat sheet before it cracked, and whether that has helped the matter any? If anybody has tried that, I would like to hear from them.

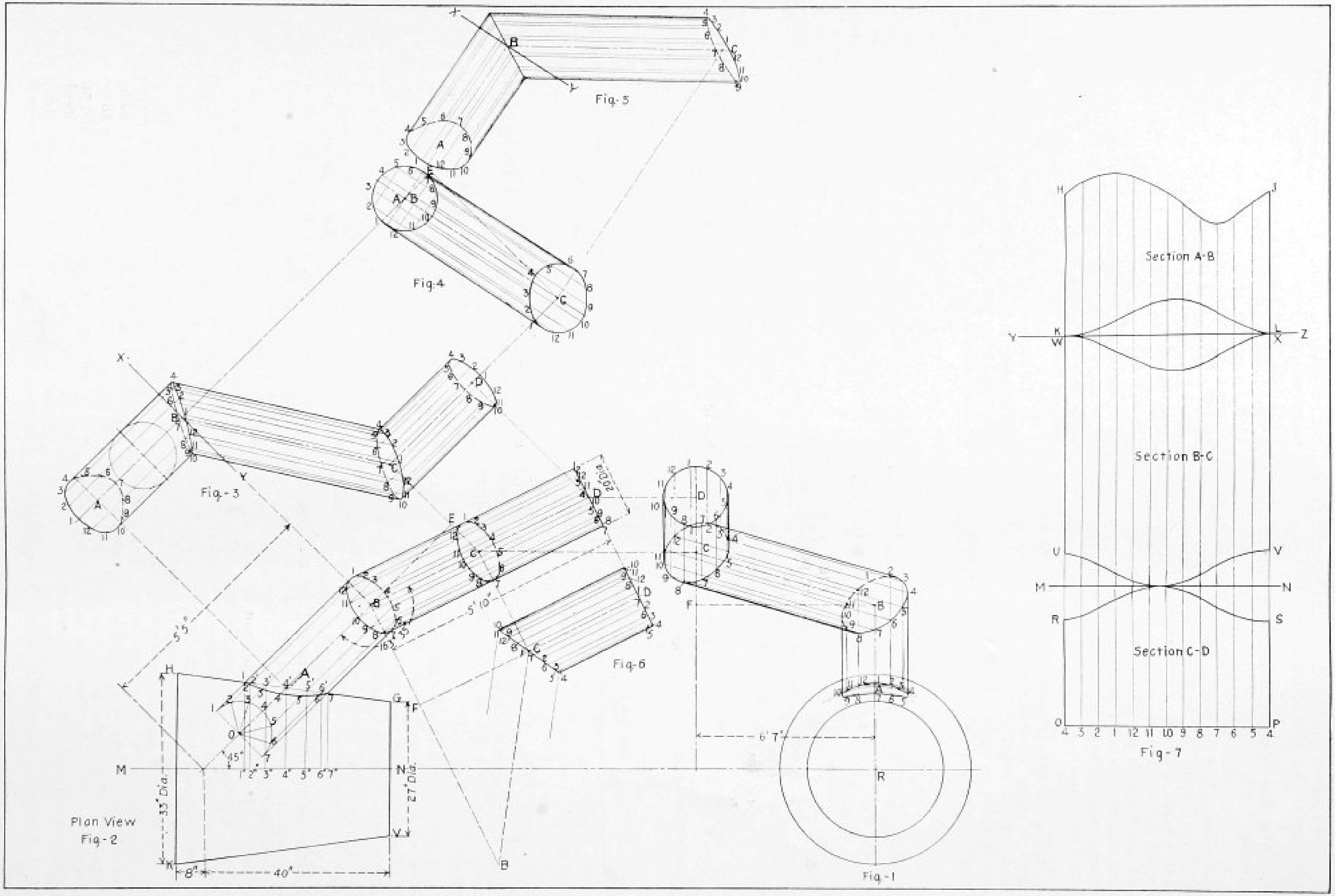
L. M. Stewart (Atlantic Coast Line): Our method of repairing the top knuckle of the outside throat sheet is to put a patch over it and weld on the edges. We have standard prints covering that. It is cheaper and quicker than to cut the top wing of the throat sheet out.

A. T. Stiglmeier (New York Central): I would like to state that Mr. Pool is correct in his statement. When I was on the B. & O. we applied in the neighborhood of 30 patches, but in place of welding them they were put on in a different manner. That is, we did not lap the patch under the wrapper sheet. We put the patch on in the same manner as you see in the illustration at the top of page 282, with the exception that we butted this patch against the wrapper sheet, and in between the crack and the edge of the wrapper sheet, we put a row of rivets and electric welded the patch to the top wrapper sheet. The federal inspector did take exception to the way these patches were applied. I do not know that they had the authority to take engines out of service, but I do know that the officials said that inasmuch as the inspectors took exception to the method, we would discontinue those patches, and from that time on we have applied patches as shown by putting the patch under the wrapper sheet, between the throat sheet and the wrapper sheet.

Two Boiler Units Ordered From Combustion Engineering Corp.

Combustion Engineering Corporation has received a contract from the West Virginia Hydro-Electric Company, a subsidiary of the Union Carbide & Carbon Corporation, amounting to approximately half a million dollars and covering two pulverized-coal-fired boiler units, to be installed at Boncar, W. Va. The equipment comprising the contract includes two Walsh-Weidner single-pass, sectional-header boilers, interdeck Elesco superheaters, boiler and furnace settings, fin tube walls for the four sides of each furnace and plain tube water screens for the furnace bottoms, pulverized fuel equipment, duct work and supporting steel.

The boilers are of high single-pass construction, providing for the most effective use of natural draft, and are designed for 488 pounds pressure, with an operating pressure of 450 pounds, and a superheated steam temperature of 750 degrees F. Each boiler will have 31,500 square feet of heating surface with an additional 4140 square feet per unit provided by the fin tube walls and water screen. The units are guaranteed for a continuous capacity of 287,500 pounds of steam per hour, and a maximum capacity of 325,000 pounds of steam.



Plan, elevation and development of a bent pipe leading from a cone

Laying Out a Bent Pipe

By George M. Davies

The layout of a bent pipe leading from a large cone is one of the most difficult operations in laying out.

The method used is that of projecting Fig. 3 from Fig. 2, perpendicular to the axis A-B; then project Fig. 4 from Fig. 3 in order to get an end view of section *A-B*, so that Fig. 5 may be projected from Fig. 4 perpendicular to both axes *A-B* and *B-C*. For convenience, the last two figures (4 and 5) show only the bent pipe and Fig. 5 shows the pipe with both axes parallel to the drawing itself, so that all lines on the surface of either section will be shown in their true length and the sections can be developed by the simple process of projection or rolling out the surfaces of the pipes directly from Fig. 5. The operations also include a rather simplified system of finding the intersection between the two sections of the bent pipe.

Obtaining the Necessary Views.—In general, the drawing for a bent pipe leading from a large cone would appear as an outline similar to Figs. 1 and 2 which do not show the pipe in the proper position for laying out. In Figs. 1 and 2, *A-B*, *B-C*, and *C-D* represent the axes or center lines of the bent pipe, the part *A-B* piercing the cone at 45 degrees and the part *B-C* making an angle of about 163 degrees with the part *A-B*. Fig. 3 is projected at an angle of 45 degrees from Fig. 2, since *A-B* is at 45 degrees with the vertical and the projection is wanted perpendicular to *A-B*, so that this portion of the pipe will be shown in its true size. Fig. 4 is projected from Fig. 3 by extending the axis *A-B*, Fig. 3, and making some point as *AB*, Fig. 4. About *AB*, Fig. 4, draw a circle equal in diameter to the diameter of the pipe, thus showing an end view of section *A-B*, Fig. 3. From the center *B*, Fig. 4, lay off *B-E*, as shown, equal in length to *C-E*, Fig. 2, and construct a perpendicular *E-C*, Fig. 4, to determine point *C*. Fig. 5 is then projected from Fig. 4 making *A-B* equal to *A-B*, Fig. 3, and *B-C* equal to *B-C*, Fig. 6.

Fig. 6 is determined by erecting perpendiculars to the line *B-D* at the points *B*, *C* and *D*. Draw *C-D*, Fig. 6, at any point parallel to *C-D*, Fig. 2. Extend *C-D*, cutting the perpendicular to the point *B*, Fig. 2, at *F*. Make *F-B* equal to *F-B*, Fig 1. The lines on the surface of this section will be shown in their true lengths.

Determining the Intersections.—The drawings from which Fig. 1 and Fig. 2 were constructed did not show the intersections of the two pipes and the pipe and the cone in anything but approximate outline; also, if the drawings are blue prints, these will not be accurate and should not be transferred in laying out. To find these intersections, first, in Fig. 2, draw the semicircle about point *O*, found by extending *A-B*, and divide its circumference into a number of equal parts in the usual manner for developing a cylindrical pipe. The points of the division are projected as shown, cutting the line *G-H* of the cone at the points *1*, *2*, *3*, etc., and in the lines *1-1*, *2-2*, *3-3*, etc., on pipe A-B. These lines are called elements; and as the outline of the section at *B* has not yet been determined, they should at first be extended somewhat beyond *B*. These elements are constructed on part *A-B*, Fig. 1, in exactly the same manner as in Fig. 2, care being taken that the proper order is followed in numbering them.

The next step is to determine the intersection of *A-B* with the cone; this is done by erecting perpendiculars to the center line *M-N* passing through the points *1'*, *2'*, *3'*, *4'*, *5'*, *6'*, and *7'*. Then with *R*, Fig. 1, as a center and with the compasses set with the radius *1-1"* scribe an arc. Continue in this manner using *2-2"*, *3-3"*, *4-4*," etc., Fig. 2, as radii. Then where the element *2-2*, Fig. 1, cuts the arc *2-2"*, locate point *2*, Fig. 1, and in the same manner points *3*, *4*, *5*, etc., are located. Project the points *1*, *2*, *3*, etc., from Fig. 1 to Fig. 2 locating the points *1*, *2*, *3*, *4*, *5*, etc., Fig. 2, completing the intersection of the cone and pipe.

The intersection at *A*, Fig. 3, is found by projecting the points from Fig. 2 in exactly the same manner.

The line *X-Y*, Fig. 3, is also shown by the circle about *B*, Fig. 4, which in turn is divided by points *1*, *2*, *3*, etc., corresponding to the divisions of the section *A-B* in Fig. 3. The points *1*, *2*, *3*, etc., on circle *B*, Fig. 4, are then projected over to the line *X-Y*, Fig. 5, which is drawn through *B* perpendicular to *A-B* as was done in Fig. 3. Through these points on *X-Y*, Fig. 5, draw elements as shown parallel to the axis *A-B*, extending them from *X-Y* a reasonable distance beyond *A*. Next transfer the distance of each point in the intersection at *A*, Fig. 3, from the line *X-Y* to its corresponding position from *X-Y*, Fig. 5. For instance, in Fig. 3 at section *A*, find the distance from point *2* to line *X-Y* and lay that off in Fig. 5, as shown, on its corresponding element, being careful to lay it off from *X-Y* and not the true line of intersection between the two parts at *B*. Following this throughout, develops the section about *A*, Fig. 5.

The next step is to locate the elements in *C-D*. In Fig. 6 draw a line through point *C* bisecting the angle *DCB*, locate the elements *1*, *2*, *3*, *4*, etc., in their proper relation about the point *D* and extend the elements cutting the line bisecting the angle *DCB*.

Next locate the elements about the point *D*, Fig. 2, extending these lines parallel to *C-D*, Fig. 2. Project the points *1*, *2*, *3*, Fig 6, cutting their corresponding elements in Fig. 2, locating the intersection of *C-D* and *B-C*. Project the points to Fig. 3 in the same manner.

Locating the elements in *B-C*.—In Fig. 5 draw a line through *B* bisecting angle *ABC* and where the elements *1-1*, *2-2*, etc., intersect it, draw elements corresponding for section *B-C* as *1-1*, *2-2*, etc., in Fig. 4. Through points *1*, *2*, *3*, about *B* draw lines parallel to axis *B-C* and these will intersect lines drawn over from points of intersection *1*, *2*, *3*, etc., in section *C*, Fig. 3 giving the points at *C*, Fig. 4, as *1*, *2*, *3*, etc., forming the points in outline about *C*. Project these points to Fig. 5 locating the points *1*, *2*, *3*, *4*, etc., forming the points in outline at *C*, Fig. 5.

Now in Fig. 5 measure elements *1-1*, *2-2*, *3-3*, etc., for *A-B* (not to *X-Y* but as shown) and lay these distances off in Fig. 3 from corresponding points *1*, *2*, etc., in the section about *A*, giving points in outline about *B*.

Then from *1*, *2*, *3*, etc., in section *B*, Fig. 3, draw elements parallel to axis *B-C* and by projecting corresponding points *1, 2, 3*, etc., from *C*, Fig. 4, we connect with the section at *C*, Fig. 3. The section at *B*, can then be projected into Fig. 2 from Fig. 3 and the section at *B, C* and *D*, Fig. 2, can be projected to Fig. 1. The elements and sections for all figures are then determined.

Developing the Pattern.—Referring now to Fig. 5, which shows the sections of the pipe in their true lengths and position relative to each other, this view represents the pipe as it would appear if taken off the large cone and laid on a horizontal table.

Fig. 6 represents the section *C-D* in the same manner and in true relationship to *B-C*, Fig. 5.

In Fig. 7 a base line *O-P* is drawn equal to the circumference of the circular section of the pipe, and it is divided into the same number of parts as the pipe, in this case twelve parts. Perpendicular lines are then drawn through the points of division from this base line *O-P*. From *O-P*, distances *4-4, 5-5, 6-6*, etc., are laid off equal to *4-4, 5-5, 6-6*, etc., of section *C-D*, Fig. 6. The curved line *R-S* is then drawn through the point obtained by so doing, and line *M-N* is drawn tangent to the highest point of the curve *R-S*. This tangent *M-N* will naturally be horizontal or parallel to *O-P*. The curve line *U-V* is obtained by making it exactly opposite to line *R-S*, i.e., the distances from corresponding points on both *U-V* and *R-S* to *M-N* are equal.

This section *B-C*, Fig. 7, is determined in the same manner as outlined for the section *D-C* taking the distances *4-4, 5-5, 6-6*, etc., from the section *B-C*, Fig. 5, locating the lines *W-X, Y-Z* and *K-L*.

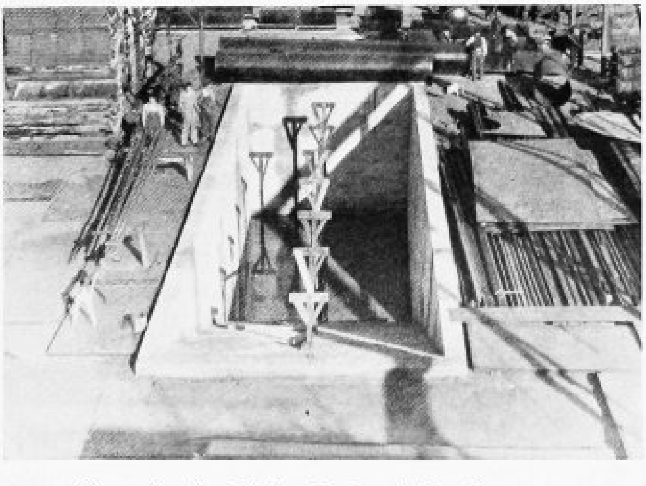
Line *H-J*, which finishes the pattern outline is obtained by laying off *4-4, 5-5, 6-6*, etc., from the line *K-L* equal to the elements *4-4, 5-5, 6-6*, etc., for the section *A-B*, Fig. 5. Then the patterns for the sections of the bent pipe are represented by *O-P-S-R, U-V-X-W* and *K-L-J-H*.

Pit for Building Tanks

Construction of exceptionally large or high tanks is speeded at the Boiler Tank and Pipe Company plant, Oakland, Cal., by use of a concrete pit, 20 feet deep, which was installed at a cost of $5000.

Built in the pit, the tanks, when completed, are loaded directly onto freight cars by a 20-ton electric crane. When not in use the pit is covered by steel plates, supported in the center by a wooden truss. With the aid of the crane, the plates can be removed or replaced in a few minutes.

P. W. McDonough, manager and owner of the firm, is originator of the idea.



Concrete pit at Boiler Tank and Pipe Company

British Boiler Explosions Less Serious In 1929

By G. P. Blackall

It is evident from the very informative summary of the operation of the British Boiler Explosions Acts during the year 1929, which has just been issued in London, that the somewhat rigid tendencies occasionally imputed to the British Board of Trade serve their purpose; for, although the actual total of explosions for the year is higher than usual, the majority of them are comparatively trivial.

The effect of the prolonged frost in February, 1929, for example, was to produce a remarkable crop of trouble with heating boilers, due to interference by ice with the normal freedom of circulation. Incidentally, churches and chapels were the chief sufferers. Marine boiler accidents reported upon include the usual proportion of defective manhole door joints, a complaint which has caused such a large number of exactly similar explosions in the past that any man who is familiar at all with marine boilers might be expected to keep a special watch for signs of deterioration in doors and joints, if only in his own interests. The fact that most of the cases occur in trawlers, drifters, tugs, and similar small craft, in which successive crews hand over to each other much as drivers do on street cars, suggests that it is the absence of the personal touch that is largely responsible. Where one man is in personal charge he will give personal attention to many such details which, with the shift system, are liable to be left undone.

Some shipping companies, more especially some of the regular tug owners, enjoy a freedom from such accidents as would do credit to any liner fleet, but they would be the first to admit that their immunity is only bought by the unremitting vigilance by superintendants, who make a point of visiting each vessel almost daily, leaving very little to the discretion of the individual engineers.

Zeolite Water Softener

The Steel Tank & Products Corporation, 4827 South Whipple street, Chicago, Ill., has obtained that portion of the engineering staff and a coast to coast sales force which formerly designed and sold Zeolite water softeners and pressure sand filters for the Paige & Jones Chemical Company, Hammond, Ind. The mechanical equipment will be sold under the trade name "Aurora."

M. H. Cleaver of New York, formerly district sales representative for the Paige & Jones Chemical Company, will be the district sales representative for the eastern division of the Steel Tank & Products Corporation. O. E. Mitchell of Dallas, Tex. will be the district sales representative for the state of Texas, and John S. Paige, formerly chief engineer for the Paige & Jones Chemical Company will be technical director for the Steel Tank & Products Corporation.

Method of calculating the

Efficiency of Diamond Seams

By Howard P. Gordy

In calculating the efficiency of longitudinal diamond-shaped boiler seams use the following symbols:

L = length of repeating section or length of joint considered.

t = thickness of shell course.

TS = tensile strength of course.

a = area of driven rivet.

s = shearing strength of rivets per square inch (44,000 pounds).

n = number of rivets in single shear.

d = diameter of driven rivet.

p = shortest pitch of rivets.

E = efficiency.

r = radius of course—$38\frac{5}{16}$ inches.

P = boiler pressure—210 pounds per square inch.

As an example, assume the diamond-shaped longitudinal seam as shown on Fig. 1 forms the joint on a locomotive boiler. The diameter of the shell course is $76\frac{5}{8}$ inches and is $\frac{11}{16}$ inch thick. The tensile strength of the course is 55,000 pounds per square inch. Rivets are $1\frac{1}{8}$ inch steel with $1\frac{3}{16}$-inch diameter holes.

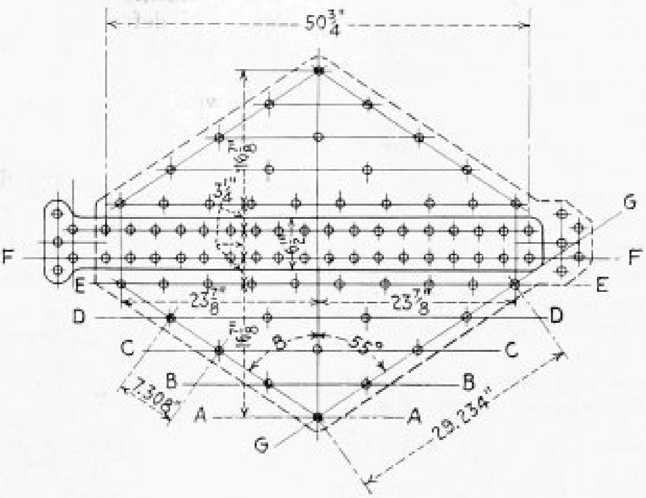


Fig. 1.—Diamond-shaped seam

To find the efficiency of the seam the following method should be used:

(1) Determine the value, in pounds, of the original plate using $50\frac{3}{4}$ inches as length, L. The result is known as strength of solid plate and is found as follows:

Strength of solid plate equals

$L \times t \times TS$ or $50\frac{3}{4} \times \frac{11}{16} \times 55{,}000 = 1{,}918{,}984$ pounds

(2) Determine the shearing strength of rivets within length L. The number of rivets in shear would be 17 in double shear and 20 in single shear, making total of 54 rivets in single shear.

Shearing strength of rivets in shear equals

$n \times a \times s$ or $54 \times 1.1075 \times 44{,}000 = 2{,}631{,}420$ pounds

(3) Tearing plate along line A-A minus 1 rivet hole.

$(L - d)\ t \times TS = (50\frac{3}{4} - 1\frac{3}{16})\ \frac{11}{16} \times 55{,}000$ equals 1,874,081 pounds

(4) Tearing plate along line B-B minus 2 rivet holes, plus the value of 1 rivet in single shear.

$(L - 2d)\ t \times TS + n \times a \times s = (50\frac{3}{4} - 2\frac{3}{8})\ \frac{11}{16} \times 55{,}000 + 1 \times 1.1075 \times 44{,}000 = 1{,}877{,}865$ pounds

(5) Tearing plate along line C-C, minus 3 rivet holes plus the value of 3 rivets in single shear.

$(L - 3d)\ t \times TS + n \times a \times s = (50\frac{3}{4} - 3\frac{9}{16})\ \frac{11}{16} \times 55{,}000 + 3 \times 1.1075 \times 44{,}000 = 1{,}930{,}467$ pounds

(6) Tearing plate along line D-D, minus 4 rivet holes plus the value of 6 rivets in single shear.

$(L - 4d)\ t \times TS + n \times a \times s = (50\frac{3}{4} - 4\frac{3}{4})\ \frac{11}{16} \times 55{,}000 + 4 \times 1.1075 \times 44{,}000 = 2{,}031{,}755$ pounds

(7) Tearing plate along line E-E, minus 10 rivet holes plus the shearing value of 10 rivets in single shear.

$(L - 10d)\ t \times TS + n \times a \times s = (50\frac{3}{4} - 11\frac{7}{8})\ \frac{11}{16} \times 55{,}000 + 10 \times 1.1075 \times 44{,}000 = 1{,}957{,}230$ pounds

(8) Tearing plate along line F-F, minus 17 rivet holes plus the shearing value of 20 rivets in single shear.

$(L - 17d)\ t \times TS + n \times a \times s = (50\frac{3}{4} - 20\frac{3}{16})\ \frac{11}{16} \times 55{,}000 + 20 \times 1.1075 \times 44{,}000 = 2{,}130{,}243$ pounds

(9) No calculations have been made pertaining to crushing of plate in front of rivets, as it is assumed the butt straps in this case are the same thickness as the shell sheet.

In comparison against the solid plate the condition as figured in line number 3 would be the weakest of the conditions shown above. The efficiency for this would be the ratio between tearing plate along line A-A minus one rivet hole, and the strength of solid plate, as follows:

$$\frac{\text{Tearing plate along line } A\text{-}A \text{ minus 1 rivet hole}}{\text{Strength of solid plate}} = \frac{1{,}874{,}081}{1{,}918{,}984} \text{ or } 97.6 \text{ percent}$$

This efficiency is not final as the angular line of rivets along G-G must be taken in consideration. This is determined in the same manner as the efficiency of the outside angular row of rivets for a reinforcing patch and is expressed in the following formula:

Efficiency along row of rivets G-G

$$\frac{2\,(p - d)}{p\sqrt{3 \times \text{Sine } B^2 + 1}} = \frac{2(7.308 - 1.107)}{7.308\sqrt{3 \times .8192^2 + 1}} = 97.8\%$$

The efficiency along the angular row of rivets G-G is higher than along line A-A; therefore, the actual efficiency of the joint is 97.6 percent, which is taken along the line A-A.

After determining the efficiency of the seam, the tension on net section of plate must be found.

Tension on net section of plate equals

$$\frac{r \times P \times L}{(L-d)\ t}$$

or

$$\frac{38.3125 \times 210 \times 50.75}{(50.75 - 1.1075)\ .6875} = 11{,}983 \text{ pounds per square inch}$$

Dividing the tensile strength by the tension, the factor of safety on plate can be found as follows:

$$\frac{TS}{\text{Tension}} \text{ or } \frac{55{,}000}{11{,}983} = 4.58$$

Shear on rivets must not exceed 11,000 pounds per square inch and can be found as follows:

$$\frac{r \times P \times L}{n \times a}$$

or

$$\frac{38.3125 \times 210 \times 50.75}{54 \times 1.1075} = 6827 \text{ pounds per square inch}$$

Bursting pressure can be calculated as follows:

$$\frac{TS \times t \times E}{r} \text{ or } \frac{55{,}000 \times .6875 \times .976}{38.3125} = 963 \text{ pounds}$$

The factor of safety can be determined by dividing the bursting pressure by the working pressure as follows:

Factor of safety equals

$$\frac{\text{Bursting pressure}}{\text{Working pressure}} \text{ or } \frac{963}{210} = 4.58$$

Summarizing, the results are as follows:

Efficiency of seam—97.6 percent.

Tension on plate is 11,983 pounds per square inch, which gives a factor of safety of 4.58.

Shear on rivets is 6827 pounds per square inch which does not exceed the allowed stress of 11,000 pounds per square inch.

Factor of safety with a working pressure of 210 pounds is 4.58, which is above the required factor of 4.

Testing Welds Without Destroying Them

An important advance in methods of testing welds in production without destroying them was explained by T. P. Watts of the Research Laboratories of the Westinghouse Electric and Manufacturing Company in his paper presented on September 24 before the American Welding Society at its fall meeting in Chicago, Ill.

Hitherto, the impossibility of testing welds without knocking them apart has been the greatest drawback to this silent, secure method of uniting pieces of metal to form flywheel rings, motor bedplates, jigs, and tools.

"For butt welds, in which the edges of steel bars or plates are welded together without lapping," said Mr. Watts, "we have developed magnetic methods of testing which can be successfully applied, using only simple easily portable apparatus, and which require very little skill and training on the part of the tester.

"The tests are made by bridging the welded seam with a large horseshoe electro-magnetic and 'exploring' the magnetic field in the vicinity of the weld with a meter.

"This is really a further development of the method devised by M. Roux, a French investigator, to explore the weld by placing iron filings on a piece of paper over the weld and observing the density of the filings as they are affected by the density of metal in the weld. This method, however, is good only when the surface is smooth and the faults are not too far below the surface.

"By passing the meter over the weld and watching the pointer, the quality of the weld can readily be determined. The meter indicates the reluctance of the weld by 'reading' the magnetizing forces across the weld as compared with the magnetizing forces of the steel plate. If the magnetizing forces are about the same, the weld is good; if not, the weld is bad and the meter will tell just how bad it is.

"This method is practically indifferent to the depth of the fault below the surface and is only slightly affected by a rough uneven surface.

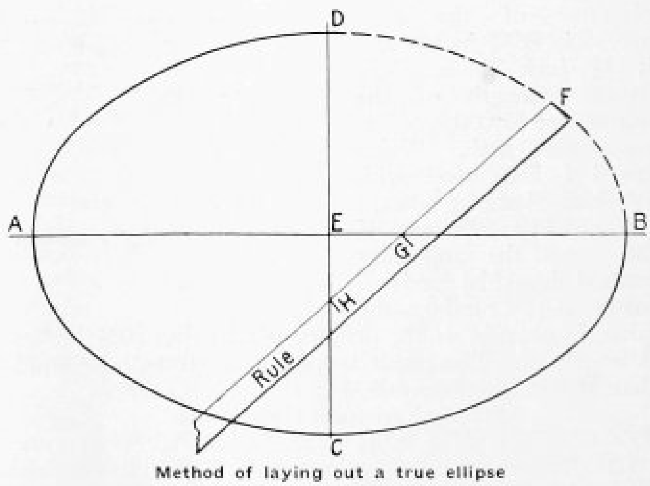
"After several months investigation of both the iron-filing and weld test meter methods by the research laboratories, they are expected to be used in the near future at the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company on large butt welds in structures such as generator frame rings, flywheel rims, and welded pipe."

Layout of a True Ellipse

By I. J. Haddon

An ellipse is a conic section, no part of an ellipse is a part of a circle, therefore it cannot be drawn with the ordinary compasses.

Draw the lines *A-B* and *C-D* at right angles to each other. Set off from *E* to *B* and *E* to *A* half the major



Method of laying out a true ellipse

axis; set off from *E* to *C* and *E* to *D* half the minor axis. Now mark on your rule the length *F-G* equal to *E-D* and mark *F-H* equal to *E-B*, then by moving the rule around and always keeping the point *H* on the line *C-D*, and the point *G* always on the line *A-B*, the point *F* will lie exactly upon the curve of a true ellipse. This is a quick and simple method and is accurate.

Ray P. Tarbell has recently become a member of the firm of Robert E. Kinkead, Inc., consulting welding engineers, Cleveland, O. He was formerly Cleveland district sales manager of The Lincoln Electric Company.

National Board Meeting

A. F. Jensen, T. McLean Jasper and others contribute to the discussion of the advisability of revising the proposed welding specifications for the construction of unfired pressure vessels. Further applications of the code in practice are explained to the members

In this issue the report of the National Board of Boiler and Pressure Vessel Inspectors' convention, held at Pittsburgh June 17, 18, and 19, continues with further discussions on welding of pressure vessels. Previous sections of the report appeared in the August and September issues. The discussion by A. J. Moses continues as follows:

From data obtained from tests on many welded specimens, we are of the opinion that the angle to which a sample will withstand bending around a definite radius without failure, is more indicative of the bending qualities of the deposited metal. Failure, of course, would have to be narrowly defined. Perhaps any defects, visible or otherwise, could be measured or classified by requiring of the bend sample a specified residual resisting moment. Another suggestion is to make the test samples in the form of small cylinders. Ring sections cut from these could be subjected to a combination bend and tension test in the manner of a chain link. They should be pulled over pins of specified diameters. Two tests could be made placing the deposited metal over one of the pins in one and between the pins in the other. We believe such a test could be worked up such as to give unerring results.

Paragraph No. 9—"CHEMICAL ANALYSES. Drillings from the weld metal representing an average sample shall conform to the following requirements:

Manganese 0.30—0.60 percent
Phosphorus not over 0.04 percent
Sulphur not over 0.045 percent
Nitrogen as iron nitride not over 0.020 percent

The nitride content shall be determined by the modified Allen method of the Bureau of Standards (Scientific Paper No. 457 U. S. Bureau of Standards)."

Believing that this test, especially the determination of nitride content, is only necessary in the investigation of causes of failure and in the development of welding processes, we deem it unnecessary to insert it in a test of results.

Paragraph No. 10—"MACRO AND MICRO EXAMINATIONS. Macrographs prepared from coupons taken across the welded joints and etched with suitable reagents shall show no laps, excessive porosity, nor incomplete fusion. Micrographs of polished specimens taken in the same manner shall show no evidence of coarse-grained material."

We consider this as unnecessary accumulation of data as regards production work. Its place rather seems to be in research work in the improvement of processes.

Paragraph No. 11—"RETESTS. Should the bend or impact tests fail to meet the requirements by more than 25 percent retests shall be allowed on specimens cut from the second welded test plate. These retests shall comply with the requirements. Should any of the original tests fail to meet the requirements by 25 percent or more, no retests shall be allowed. If the tension test fails to meet the requirements, additional tension tests shall be allowed on two specimens cut from the second test plate and both of these shall meet the requirements."

This specification is too liberal as regards allowed retest on tension specimens that fail the requirements as much as 25 percent. We consider that 10 percent allowance would be better. A weld showing just 42,000 tensile strength, though just in one spot, is an indication of an unreliable process.

Paragraph No. 12—"NON-DESTRUCTIVE TESTS OF VESSELS. The welded joints of the annealed structure shall be explored by an approved recording no-destructive test, such as an electrical or magnetic fissure detector or X-ray apparatus, which will determine quantitatively the size of a defect."

In the absence of a practical and dependable nondestructive test at the present time, and in view of other requirements, we do not consider this paragraph necessary.

Paragraph No. 13—"FATIGUE TESTS. The annealed vessel shall be subjected to 10,000 cycles of pressure, each cycle varying from zero to one and one-half times the working pressure. These cycles of pressure should preferably be applied at the rate of 10 to 12 per minute. The welded joints shall then be again explored by the approved non-destructive test apparatus. The second set of readings shall show that no change in the welded joints has occurred during the fatigue test."

No approved non-destructive test being available this paragraph is weakened on account of our inability to carry out the second clause. But we must make this test rigid since it is the most important of all. Since we are allowing only 80 percent efficiency to the welded joint, the pressure of one and one-half times the working pressure will cause stresses in the shell plate and longitudinal weld seam of less than one-half the elastic limit of these materials. We can be positive that 10,000 cycles of this stress are not capable of dangerously affecting either the boiler plate or a good weld seam. But, there is a possibility of its dangerously affecting a weld seam that is on the border-land of good and bad. But, some may hold that our other tests are so rigid, that any weld that passes them should be definitely good. If so, why make a final test on the completed structure at all? We must not forget that our preliminary tests are made on samples that may or may not be truly representative of the main weld. Our final test is on the main weld itself and hence it is the most important and should be rigid.

It would be better to test the strucure up to a point somewhere near the elastic limit. This would give a minimum test of two and one-half times the safe working pressure of the drum. Where there are tube holes or other openings to be cut in the drum after testing, the test pressures can be a much higher percentage above working pressure and this would give an added assurance of safety at the allowed pressure. This test should be high enough to develop a fiber stress of 22,000 pounds per square inch of net section at the weakest point in the design and where reinforcements for manhole openings, nozzles, etc. are the weakest part of the design we recommend additional reinforcements to enable making a test of more than two and one-half times the working pressure. In calculating the allowable test pressure the theoretical stresses on head can be used after being assured that the maximum stress around the openings does not exceed the 22,000 pounds. If the fatigue test is used this high pressure test should follow the fatigue test so that if any weakness is developed by the fatigue test this high pressure test would show it up. In making this high pressure test all the designs in any ways different from the former tests are to be checked with strain gage measurements to make sure that the stresses do not run over the 22,000 pounds limit. This wtuld result in havink accurate figures on every design of reinforcements for manholes, nozzles, etc.

Paragraph No. 14—"HOLES. No holes shall be located in a welded joint. When holes in plate are located near a welded joint, the minimum distance between the edge of a hole and the edge of a joint shall be equal to the thickness of the plate, when the plate thickness is from 1 inch to 2 inches. With plates less than 1 inch thick, this minimum distance shall be 1 inch. With plates over 2 inches in thickness, the minimum distance shall be 2 inches."

We believe this clause limiting the placing of holes near weld seams, regardless of efficiencies required, should not apply to circumferential or head seams, provided the latter are placed not less than a specified minimum distance from the knuckle radius of the head.

Paragraph No. 15—"ALLOWABLE WORKING STRESS. When constructed under the above provisions, the maximum unit working stress of a welded joint may be taken as one-fifth of 80 percent, 16 percent of the minimum of the specified tensile range of the plate used."

While we are convinced that welds can be made which are equal to the boiler plate in every respect, we are opposed to allowing more than the 80 percent efficiency in designing. Later under certain conditions this may be increased, but until more abundant data have been collected, we think it unwise to allow more at the present time. After it has been thoroughly demonstrated that unfailingly, deposited metal can be produced as homogeneous as our modern boiler plant, then we can accept 100 percent.

To summarize:—We consider the final test of the completed structure to be the crux of the whole matter, because the attached samples *may* or *may not* be representative of the welding in the main body. We believe that the evidence of the attached samples will be on the side of safety, but we are not in a position to judge since we are unfamiliar with the various welding procedures that may be used. As for the final test, whatever method is settled upon, we feel that it will need supplementing by the demonstrated ability of the manufacturer to make homogeneous welds. The only proof of this ability will be destruction tests of welded drums.

Owing to the necessity of proper equipment and thoroughly trained organizations to eliminate any responsibility of hazardous structures it would seem essential that some governing body such as yourselves, or the Boiler Code Committee, should be empowered to authorize or issue license to those manufacturers wishing to engage in this type of construction. Such license to be issued upon submission of proof, but the manufacturer in regard to proper equipment and demonstrated ability to meet the rigid requirements necessary. This appears more important when we consider that the failure of only a few welded boilers regardless of the manufacturer, would be seriously damaging to all.

Moreover licensing a shop to engage in this type of work needs the further safeguard of systematic checking of required tests to insure that the manufacturer lives up to his proven ability. Inspectors for this service should be specially trained men and should function under special orders. We suggest that the completed code specify the inspection requirements and the manufacturing requirements necessary to obtain permission to build welded shells and drums for power boilers.

Chairman Thomas: We would like now to hear from Mr. A. F. Jensen, of the Hanna Engineering Company, Chicago.

Mr. Jensen: So that you may properly appraise what I have to say to you, I want you to know that I am primarily a riveting man. My company manufactures riveting machinery. This welding-riveting controversy is a nip and tuck affair and is likely to be for some little time. It should precipitate one of the warmest discussions in your convention.

We deem it a privilege to participate in this "Construction Symposium." If you will enter into a discussion of the several addresses, this session should prove one of the most interesting of your meeting and justify its inclusion in subsequent meetings.

Much has been written lately upon the spectacular progress achieved in the art of welding. The able exponents of this comparatively recent engineering development are naturally very enthusiastic about the thrilling achievements of the new art. The enthusiasm and imagination which accompany the introduction of a new process frequently inspire comments that lack the conservatism which should characterize statements relating to technical matters.

So little has been heard about the prosaic art of riveting that the layman might easily gain the idea that the doom of riveting has been spelt by this victorious advance of welding; that the last word has been said in that older method. It is true that a new treatise on riveting practice and riveted joints has not been presented in the past fifteen years. Riveting is taken pretty much for granted; the world is full of it; it lacks the glamour and romance of a new scientific advance.

The claim that a weld is stronger than the material joined is an oft-repeated one. Frequent tests are made upon specimens wherein the cross-sectional area of the weld was greater than that of the material. The welding process fails to maintain the chemical or physical characteristics of the material joined, neither is the joint free from non-metallic inclusions. Annealing, which is not always practical, may reconstruct what might be termed a cast metal joint and relieve initial stresses, the magnitude of which is unknown. An investigation made by comprehensive strain gage readings established that large negative or compressive stresses (frequently beyond the elastic limit of the material) were induced in the plate adjacent to the weld.

If welded seams of a boiler are to have the same margin of safety as riveted seams a radical departure from present designs and practices will be necessary, and this will make the welded construction less attractive to the manufacturer. Even if he himself were satisfied he would still have to satisfy the user that the cost of repairs to leaky seams and corroded joints would be no more than with the usual constructions.

The pressure applied when driving rivets and the length of time the pressure is maintained upon the rivet are two important factors which materially affect the efficiency of the riveted seams of boilers. To those engineers who are inclined to the opinion that the riveting process is an important contributing factor to the so-called "caustic embrittlement" or "caustic attack" of metals we suggest a consideration of these factors.

If plates fit well, only a moderate pressure is required to obtain a tight joint provided the pressure is maintained or "held on" for a sufficient period of time. Prior to 1924 ten of the most important boiler shops in Germany used pressures between 65 and 95 tons per square inch of rivet area. Since that time they have reduced the pressure to less than 52 tons. Assuming a ⅞-inch diameter rivet, they would drive it with 32 tons whereas we would probably use 70 tons, more than twice as much pressure per square inch of rivet area.

It is recognized that the welding practices of many concerns are well advanced beyond those of others. Unfortunately such concerns will for the present be at a disadvantage when manufacturing under a code predicated upon the safety of pressure vessels built under less advanced technique. Code framers are charged with the safety of life and property and to eliminate the confusion and waste experienced in designing and manufacturing pressure vessels in any one shop to meet the varying requirements of political subdivisions. Consequently they must consider not only laboratory results but the probable commercial methods of an industry.

There is a field of usefulness for both welding and riveting and we believe the advancement of both processes lies not in competition but in their supplementing each other.

A new process is seldom the exact equivalent of what it replaces. Welding will replace riveting only when proven more economical, less dependent on skilled labor and assuring equal safety. Economy when proven must be made the decisive factor only when the dependability of the riveted structure is equaled. To meet this requirement, means of inspection must be provided which are as certain and as rapid as are those which determine the reliability of riveted joints.

An investigation of the behavior and ultimate strength of riveted joints under load, performed at the Bureau of Standards and reported for the U. S. Navy by Commander E. L. Gayhart (CC), indicated efficiencies of 81 percent to 85 percent on cross section as compared to 76 percent, the theoretical. Dependable as it is, the time has come to restudy the riveted joint. The American Society of Mechanical Engineers has set itself to the task of reviewing the present state of knowledge of riveted joints together with an extensively abstracted bibliography on the subject. The literature covered is the English and American, the German, part of the French as far as it is available here and several of the important contributions from the Italian, Dutch and Swedish literature. The field covered includes structural, tank and pressure vessel, shipbuilding and boiler riveting. This is a commendable undertaking and will be of material assistance in determining the lines along which research should be conducted.

A program of research might well include the study of stress distribution and concentration, eccentric loading, maximum limit of rivet pitch adjacent to a calking edge, the effect of calking riveted joints by welding, tolerance of rivet and hole diameter, the merits of various types of joints, rivet shapes and heads, and a comparison of joints driven at varying pressures with an increase in the time pressure is sustained on the rivet as driving pressures are decreased.

CHAIRMAN THOMAS: We would like next to hear from Mr. Trainor, of the Babcock & Wilcox Company.

MR. TRAINOR: The interest of the Babcock & Wilcox Company or any other reputable boiler manufacturer, is just the same as that of the National Board. The things that they are primarily interested in is the safety of the products that they manufacure. Until such time as they are sure that the products they put out, which will bear their name, will be safe and as safe as anything they have put out heretofore, I do not believe they will put it out.

We started about five years ago to develop welding. We had to have some premise to start from, and at that time we said that our welded drum must be equal to if not better than our riveted drum. It then resolved itself into finding out just how good is a riveted drum.

We had a good many years of experience back of us; we knew what the riveted drums would stand; we tried to get some quick tests to subject the welded drums to in comparison with the riveted drums. After a lot of thought and discussion on our part, we decided to use what we termed a pulsating pressure test on the riveted drum. That is, we built a riveted drum in strict accordance with the A. S. M. E. Boiler Code and put it on the test block and subjected it to a repetition of pressure one and a half times what it would get in service; in other words, we were stressing that drum through the rivet holes to 16,500 pounds per square inch rather than the 11,000 pounds allowed by the code. We rammed that drum over a million pulsations of pressure, and it was still intact. We have still put this drum on tests again and the pressures are now stressing the drum to 22,000 pounds a square inch, and it is now up to 50,000 additional pulsations of pressure and is still intact.

We then started out with a shell about 4 feet long made so that all the pressure came on the weld and it would not have any effect on the head. We took possibly one of the best welding operators in the country and gave him some of the best wire we could get our hands on, and after considerable practice in welding plates of a thickness of 2 inches, we had him weld up a shell which was 2 inches thick, using all the care we possibly could in producing that shell because we wanted that shell to stand up as well as it could under the circumstances. That shell, as I recall, failed under 6000 pulsations of pressure. That is, cracked for practically the entire length. It first started as a small crack, and then developed quite rapidly, and after about fifty additional pulsations, we had a big failure. That is the weld that you have in the field today and the weld you gentlemen are familiar with is that bare wire weld.

Now there is no comparison between that type of weld and the type of weld that the Boiler Code Committee is trying to set down rules and specifications for at this time; there is no more connection between it than between night and day, and I think it is well for us all to get that fact secure in our minds when we are thinking about the present proposed rules of the A. S. M. E. We then went on with the testing, using different coated wires of commercial grade, and we had failures of shells under the limit of the riveted drum. Then we developed a special process wire which would give us a weld which would stand well over a million pulsations of pressure. As a matter of fact, we ran some of those shells to two million pulsations of pressure, and tested them as high as 22,000 pounds per square inch after the two million pulsations and still had the drums intact. There is no question but what that welding method will meet up to the specifications put down in the present proposed code; in other words, if the wire you are using, the processed wire, will give you that result practically throughout your entire vessel, the big danger in welds of this type is the fact that in the process of welding you might get a crack and how are you going to know that that crack is there? What assurance have you men got who have not watched every bead deposited in that drum, that there is not a crack found in that welded bead? It was with this thought in mind that we have been working with non-destructive tests, because we not only had to prove to you members of the National Board and to the committee, but we had to prove to ourselves and be able to give anybody that bought one of our vessels the assurance that all those welds were perfect in a place where you could not see them.

We have been using the Sperry apparatus and are now prepared to say that the Sperry apparatus will successfully pick a defect ½ inch by ½ inch in a plate 2 inches thick or 2½ inches thick. It will definitely pick up that defect and indicate it. We are also prepared to say that the X-ray will then show you the type of defect that the Sperry apparatus has picked up, and from that you can judge whether or not it is injurious to a point sufficient to condemn the vessel. That covers generally the work which we have done, very briefly.

Chairman Furman: Professor T. McLean Jasper we will hear from you now.

Professor Jasper: The proposed code is the first attempt to bring into use fusion welding for power boilers and is a step along the line, which is sure to be utilized in the future for such equipment.

That the art is not new, and that proper welding is entitled to this recognition is strongly brought out by the fact that the company I represent has in service over 1200 vessels which operate under more severe conditions than those encountered in steam service. Some of these vessels have been in continuous service now for nearly five years. It seems to me that this would be enough reason for the steam user to likewise make use of fusion welding. It is hoped that it is not far distant when he will avail himself of the resultant advantages. As for the proposed code, there are some points which I think could be improved upon, and which then would have a still greater effect in insuring that only safe and dependable equipment can pass and be put in service.

The first point is with reference to the requirement that test plates be attached to the cylinder. It is my belief that such a weld specimen will not necessarily indicate the quality of the weld in the cylinder proper. At least this is true for the arc welding process, because of the effect of the magnetic flux in the proposed test plate, and because of the manner in which it is attached to the cylinder. A more appropriate method of producing arc welded specimens is to weld them as a detached piece using the same personnel and equipment as that used on the vessel.

There is no provision in the code for the final testing of fusion welded vessels, which will indicate the quality of such vessels, except the fatigue test. From published information the fatigue tests available show up the quality of the design rather than the quality of the weld.

The speaker does not believe that the boiler problem is truly a fatigue problem. Had this been so, the present general method of boiler construction would have shown it up as such a problem long ago and fatigue tests would have been adopted as a general testing method. If at this time it is considered that boilers are a fatigue problem, then all boilers should be so tested.

It should not be overlooked, however, that the final test of a steam vessel is very important and can be used to indicate not only the quality of the work of fabrication, but that of the design as well. It is a simple matter to coat all suspected weak parts in designs with lime wash and thus discover if, at an adequate test pressure, the vessel suffers undue deformation. It is believed also that all welds should be adequately hammered under pressure, which is not provided for in the proposed specification.

Another point on which I wish to comment is the proposed chemical analysis of the weld material. It seems that the matter of nitrogen is presumed to take care of the question of ductility in the weld. I might say that we have found the combination of oxygen and nitrogen to be the thing which effects the ductility. Analysis for oxygen is very difficult to make, however, and as a matter of fact, no practical method giving a good degree of consistency has been devised. Yet, oxygen analysis would be fully as essential as nitrogen analysis, and the latter alone can at the best only tell half the story.

What we are after in the vessel is strength, ductility and high impact value of the weld metal, so why not take these physical values as the measuring stick for quality? It seems, that it would be perfectly practical to rely on the strength, ductility, and impact values to indicate the quality of a weld, and not on something, which is only a partial tool for measuring this quality.

The qualities of a weld which are most desirable next to strength, can be measured by its ability to conform to small adjustments of shape and to absorb energy in case of emergency. The physical tests which best define the two last qualities are ductility and impact tests. The strength of a weld, therefore, suggests the taking care of load or pressure under ordinary operation while the last two values are emergency or service factors.

On the matter of elongation, it is obvious that the percent elongation in 8 inches is less than in 2 inches and very much less than in ½ inch across the most stressed or fractured section. Some of our steels have elongations of 75 to 100 percent in ½ inch length across the break, on a ½-inch diameter cylindrical specimen. If we take the elongation of these steels over 8 inch lengths, it means somewhere in the neighborhood of 30 percent. The proposed method of obtaining the percent elongation in the weld accordingly will give values, which are not comparable to what the industry is used to, when dealing with steel. An elongation of 15 to 20 percent in 2 inches of a ½-inch cylinder or 15 to 20 percent in four diameters for cylindrical specimens of less diameter is comparable with what we have been used to. This proposal, to my mind, covers up the true value of ductility in the weld, and has the quality of lacking in honest clearness. The only way to obtain the true elongation of the weld metal is to use an all-weld specimen and take the measurement on a standard length.

The proposed code requires that the pull specimen across the weld shall break in the plate or have a strength equal to the minimum strength specified for the steel used. In other words, the joint must equal the plate in strength. Then, what is the logic in allowing only 80 percent joint efficiency?

Regarding the factor of safety. The proposed specifications demand the usual factor of safety of 5. It is safe to say, however, that the so called factor of safety of 5 in our present power boilers is largely elusory. Yet with proper design, which gives equal strength to all parts of a vessel, the real factors of safety can be materially increased and still have a decrease in the weight of the vessel. The locomotive boiler design is based on a factor of safety of 4, which, with the curious shapes used and with staybolts, etc., there is very reason to believe that it will be considerably less than 3.

One of the paragraphs in the proposed new code states that no holes shall be placed in or even close to a weld. With the demands for quality in the weld this again shows reluctance to take advantage of the weld strength.

Suggestions for Modifying the Proposed Code

I take the liberty to make some suggestions, which might be used to modify certain parts of the proposed specifications or to be added to clarify the requirements which, it is presumed will help to develop the application of welding so as to produce the safest possible structure.

1. MATERIAL
   - (a) Cropping 50 percent.
   - (b) Manganese .40-.70 percent.
     Sulphur not over .040 percent.
     Phosphorus not over .045 percent.
   - (c) Strength according to the steel specified.
2. DESIGN
   - (a) Shape to be such that the construction is equal to 100 percent of the cylinder strength value.
   - (b) True elliptical heads used in a convex manner and with the major axis equal to twice the minor axis.
   - (c) Reinforcing of all openings in the vessel wall.
   - (d) Factor of safety of at least 3 on most stressed section.
3. FABRICATION
   - (a) Welded joint—100 percent of minimum strength specified for the plate material.
   - (b) Elongation: minimum 20 percent in four diameters of test cylinder using all weld material for the specimen.
   - (c) Material adjacent to weld as strong as the minimum specified for the plate.
   - (d) Impact value of weld equal to that of the plate material with a minimum value of 20 foot-pounds. (Charpy machine.)
   - (e) Test samples from test plate equivalent to that offered in vessel.
   - (f) Heat all plates, 1 inch or over in thickness, before rolling into cylinder.
   - (g) Specify that vessels above one inch in thickness should be heated to relieve fabrication stresses.
   - (h) Specify a limit for out-of-roundness of cylinders.
   - (i) Specify a limit for out-of-roundness.
4. TESTING OF FINISHED VESSEL
   - (a) Test all vessels to a stress value based on minimum yield point allowed in specifications for the steel.
   - (b) Subsequently hammer at 75 percent of above pressure with a blow proportional in foot-pounds to the weight of one square foot of the vessel wall.
   - (c) Apply lime wash to all points of probable weakness in vessel design before testing.
   - (d) Record pressure when any chipping or scaling of the lime wash occurs.
   - (e) Reduce operating pressure in proportion to the yielding in any part of vessel if yielding results below test pressure.
5. QUALIFICATIONS FOR WELDING STEAM VESSELS

Before a firm can qualify for welding steam vessels they should demonstrate ability to meet the above specifications.

   - (a) X-ray, magnetic, electric and stethoscope analyses may be useful tools for the development of processes of welding.
   - (b) Fatigue and application of lime wash may have merit in demonstrating the quality of design.
   - (c) Testing to destruction the largest size vessel that a firm proposes to build is believed to be the most satisfactory demonstration of the quality of a welding process and the ability of a firm to construct safe pressure containers.

Sand Blasting Machine

Shown in Fig. 1 of the following drawings is a simply designed sand blasting machine which is easily handled and conveniently moved from place to place. It consists of a drum, 2 feet high and 2 feet in circumference,

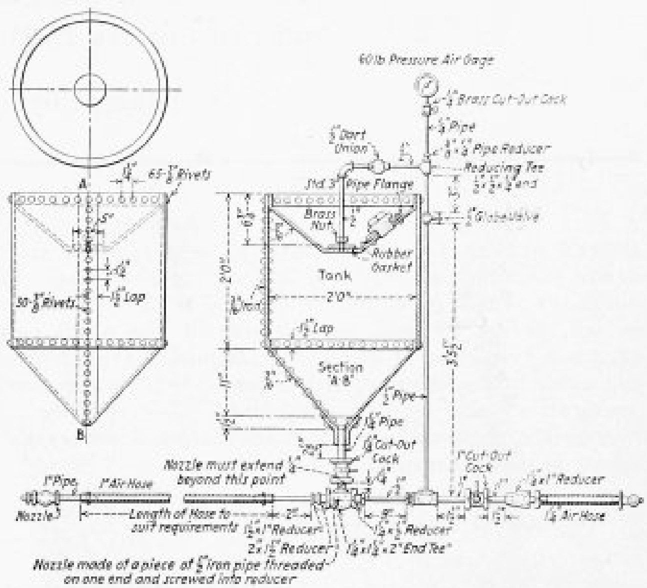


Fig. 1.—The machine assembly, showing the piping arrangement

to which is riveted a cone section with an altitude of 11 inches. Air at 60-pound pressure, supplied from a 1¼-inch line, passes through a 1-inch cut-out cock into a ½-inch pipe leading to the top of the tank where it augments the gravity flow of sand to the nozzle at the base of the cone section. Air pressure from the 1¼-inch line passes through this nozzle, exhausting the sand into the distribution line which is equipped with an air hose for directing the stream of sand at any desired object. Fig. 2 shows the details of the brass nut for pipe connections of the air line leading into the drum, the plug for the hole through which the drum is filled, the nozzle tip for exhausting the sand into the distribution line, the distribution nozzle, the cap for the base of the cone section into which the sand delivery pipe is screwed and also the wooden table which supports the machine when in operation.

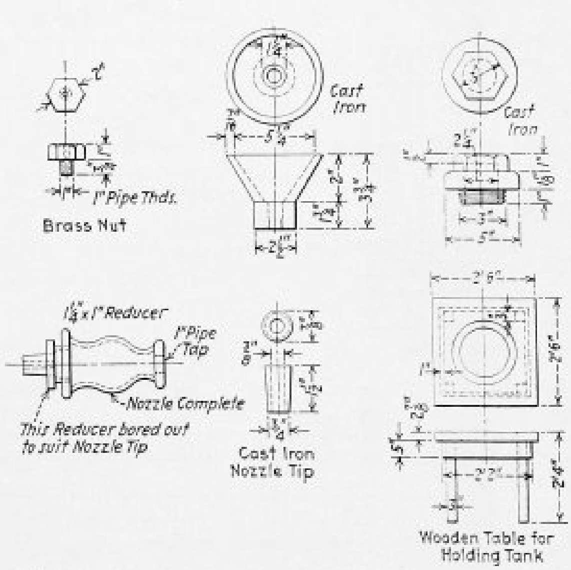


Fig. 2.—Details of special equipment for the machine

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper and sketches furnished if necessary. 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 permission to do so.*

Reinforcement of Crown Sheets

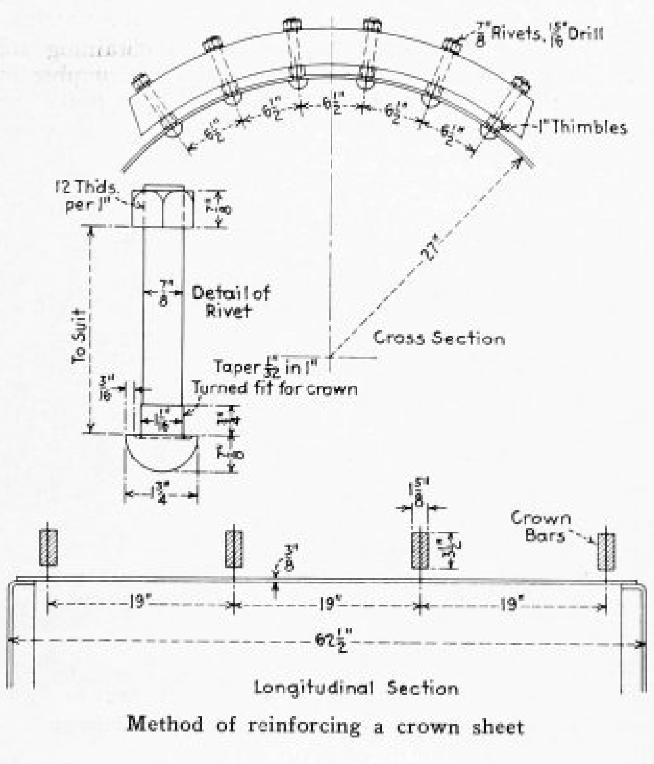
Q.—(a) I will appreciate it if you will publish a list of manufacturers of temperature combustion regulators and pressure combustion regulators that will meet the requirements of the A. S. M. E. Code.

(b) Will you also show the application of *P 230 b* in its entirety, either using a hypothetical case, or preferably a case of a locomotive-type boiler with the furnace 54 inches in diameter, having four 3½ by 1⅝-inch arch bars riveted to the crown with ⅞-inch rivets, pitched 6½ inches by 19 inches longitudinally. The thickness of the sheet is ⅜ inch.

The total length of the furnace is 5 feet 2½ inches, no longitudinal seam in the zone supported by arch bars. W. G.

A.—(a) A complete list of manufacturers of temperature combustion regulators and pressure combustion regulators can be found in MacRae's Bluebook and Hendrick's Commercial Register.

(b) The accompanying illustration has been made to more clearly illustrate the problem as outlined in the question.



Method of reinforcing a crown sheet

For the benefit of those who do not have a copy of the 1927 A. S. M. E. Boiler Construction Code, *P. 230 b* is as follows:

In a form of reinforcement for crown sheets where the top sheet of the firebox is a part of a circle not exceeding 120 degrees in arc, and is braced with arch bars extending over the top and bottom below the top row of staybolts at the sides, these arch bars being riveted to the water side of the crown sheet through thimbles, the maximum allowable working pressure for a plain circular furnace of the same thickness, diameter and length determined by the formula in Pars. *P-239* and *P-240*, the pressure P, is determined from the following formula, which is a modification of that in Par. *P-241a:*

$$P_1 = 10{,}000{,}000 \frac{b \times d^2}{D_1 \times D^2}$$

b = net width of crown bar, inches
d = depth of crown bar, inches
D_1 = longitudinal pitch of crown bar, inches
D = 2 times radius of crown sheet

provided that the maximum allowable working pressure must not exceed that determined by the formula for furnaces of the Adamson type, in Par. *P-242*, when L is made equal to p, and also provided that the diameter of the holes for the staybolts in the crown bars does not exceed $1/3b$, and the cross-sectional area of the crown bars is not less than 4 square inches. Par. *P-199* would govern the spacing of the staybolts, rivets or bolts attaching the sheet to the bars, and Par. P-212*d* the size of the staybolts, rivets or bolts.

Analyzing the problem by steps, the first thing to determine is the pressure determined by the formulae in Pars. *P-239* and *P-240*.

Pars. *P-239* and *P-240* cover the allowable pressure for plain circular unstayed furnaces from 12 inches to 38 inches outside diameters. The diameter of the furnace in the problem being 54 inches, does not permit any allowance as an unstayed circular furnace and therefore the formula

$$P = 10{,}000{,}000 \frac{b \times d^2}{D_1 \times D^2} \text{ should be used}$$

Substituting in this formula, we have:

$$P = 10{,}000{,}000 \times \frac{1.625 - 0.9375 \times 3.5}{19 \times 54}$$

$P = 98.52$ pounds allowable working pressure.

This pressure must not exceed that determined by the formula in *P-242* when L is made equal to p.

P-242. The maximum allowable working pressure shall be determined by the formula:

$$P = \frac{57.6}{D} \left((18.75 \times T) - (1.03 \times L) \right)$$

where

P = maximum allowable working pressure, pounds per square inch
D = outside diameter of furnace, inches
L = length of furnace section, inches
T = thickness of plate, in *sixteenths* of an inch

Substituting in this formula, we have,

$$P = \frac{57.6}{54.75}\left((18.75 \times 6) - (1.03 \times 19)\right)$$

$P = 97.76$ pounds allowable working pressure.

The allowable working pressure previously calculated is therefore reduced to 97.75 pounds and this pressure stands only provided the diameter of the holes for the staybolts in the crown bars does not exceed ⅓ *b*.

The diameter of the hole in the crown bar of the rivets being 15/16 inch, the width of the crown bar must be increased to 2 13/16 inches to meet this condition, also the cross-sectional area of the crown bar must not be less than 4 square inches.

$1.625 - 0.9375 \times 3.5 = 2.40$ square inches.

Increasing the width of the crown bar so that the diameter of the hole for the staybolt does not exceed ⅓ *b* will provide for the following cross-sectional area:

$2.8125 - 0.9375 \times 3.5 = 6.56$ square inches

Par. *P-199* governs the spacing of the staybolts, rivets or bolts attaching the sheet to the bars.

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

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

where,

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

T = thickness of plate in *sixteenths* of an inch.

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

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

Substituting in this formula, we have,

$$P = 150 \times \frac{(6)^2}{(19)^2} = 150 \times \frac{36}{361}$$

$P = 14.9$ pounds allowable working pressure based on spacing of crown bar rivet.

Par. *P-212 d* governs the size of the staybolts, rivets or bolts.

P-212 d. In furnaces over 38 inches in outside diameter and combustion chambers not covered by special rules in this code, which leave curved sheets subject to external pressure, that is, pressure on the convex side, neither the circumferential nor longitudinal pitches of the staybolts shall exceed 1.05 times that given by the formula in Par. *P-199*.

The stress per square inch in staybolts shall not exceed 7500 pounds based on a total stress obtained by multiplying the product of the circumferential and longitudinal pitches, less the minimum cross-sectional area, by the maximum allowable working pressure.

Based on 7500 pounds allowable stress in the staybolts the maximum allowable working pressure would be:

$$P = \frac{7500 \times a}{(p \times p_1) - a}$$

where,

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

a = area of staybolts at root of threads in square inches

p = circumferential pitch in inches

p_1 = longitudinal pitch in inches

Substituting, we have,

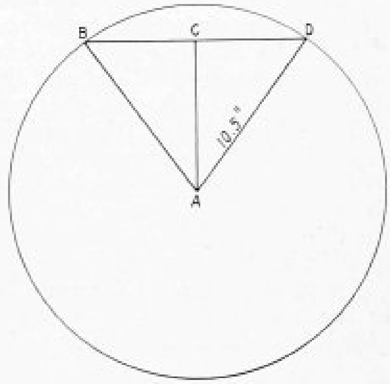
$$P = \frac{7500 \times 0.4193}{(6\tfrac{1}{2} \times 19) - 0.8866}$$

$P = 25.6$ pounds allowable working pressure based on the diameter of the crown bar rivets.

From the foregoing it can readily be seen that the governing condition of the above problem is the longitudinal spacing of the crown bars.

Equal Divisions of a Circle

Q.—The problem in connection with laying out a true ellipse, where you state that circles must be divided into equal parts, sounds easy, but I am unable to obtain the distances to set a pair of dividers in order to space off a given number of sides on a circle. Can you tell me the slide rule settings on a Log-Log Duplex slide rule to get these answers? Here is a problem: A disk is 21 inches in diameter. Find the distance necessary to set a pair of dividers in order to space off, (a) 7 sides, (b) 8 sides, (c) 10 sides, and (d) 13 sides.



Problem in dividing a circle

The angle $DAB = 1/7$ of 360 degrees = 51 degrees 26 minutes

The angle $DAC = \frac{1}{2}$ of 51 degrees 26 minutes = 25 degrees 43 minutes

$$\frac{CD}{AD} = \text{sine angle } DAC$$

$CD = AD \times$ sine angle DAC

$BD = 2 \times CD = 2 \times AD \times$ sine angle $DAC = d$ sine angle DAC, where d = diameter of circle.

Answers are: (a) = 9.11 inches, (b) = 8.04 inches, (c) = 6.49 inches, and, (d) = 5.03 inches. R. G. S.

A.—The problem resolves itself into obtaining the sine of the angle *DAC* corresponding to the number of sides taken.

The method for obtaining the sine of an angle on a Mannheim, Polyphase, Duplex or Polyphase-Duplex slide rule is as follows:

Remove the slide from the groove and place it so that the face marked *S* is uppermost and insert it in the groove with the indices coinciding.

The scale marked *S* is a scale of sines; angles are given on scale *S*, opposite their sines on scale *A*.

Example (1) Find sine 20 degrees.

Opposite 20 degrees on the scale *S* is found its sine on scale *A*. This reads 342. To place the decimal point, a number read on the right half of scale *A* has the first significant figure in the first decimal place, except sine 90 which is 1, a number read on the left half of scale *A* has the first significant figure in the second decimal place.

Hence sine 20 degrees = 0.3420

Example (2) Find sine 2 degrees.

The significant figure is 349.

The reading is on the left of the scale *A*, hence the result is 0.0349.

Obtain the sine of the angles for the various number of sides taken, and multiply by the diameter of the circle to obtain the length of one side.

Improper Lift of Boiler Check

Q.—If boiler check does not have the proper lift, what effect will it have on the injector? E. L. B.

A.—If the boiler check has insufficient lift the injector could not be worked to capacity; the water not being able to pass into the boiler would run to the ground through the overflow pipe.

Bracing a Rectangular Tank

Q.—What is the most economical method of bracing a rectangular tank of welded construction, 11 feet by 11 feet by 25 feet, $\frac{5}{16}$-inch shell, to withstand a test pressure of 30 pounds hydrostatic? J. D. McK.

A.—A rectangular tank of welded construction should be braced similar to the method used for a riveted tank, however with the welded tank it is necessary to support the plates more securely so that the deflection of the plates is reduced to a minimum, thus relieving the weld of the stresses due to the deflection of the plates.

The plates should be supported by angle bars or tee irons, both horizontally and vertically and the pitch of these angle bars must be such that the stress in the plate calculated as a beam 1 inch wide and fixed at the ends, whose span is the center to center of the angles, must be limited to 16,000 pounds per square inch.

The plate is then actually a square plate fixed around the edges. In thin plates with a relatively long span, the horizontal strip in the center of the square does not derive much, if any, support from the angle bars.

Calculating for a plate 1 inch wide, we have from the formula for beams fixed at the ends and uniformly loaded:

$$W = \frac{12 \times f \times z}{L}$$

where,

W = load in pounds = $p \times L$, where p = pressure per square inch

f = stress = 16,000 pounds

z = modulus of section $\frac{t^2}{6}$ where t = thickness of plate

L = pitch of angle bar stay

$$p \times L = \frac{12 \times 16{,}000 \times \frac{t^2}{6}}{L}$$

$$p \times L^2 = \frac{12 \times 16{,}000 \times t^2}{p}$$

$$L^2 = \frac{z \times 16{,}000 \times t^2}{p} = \frac{32{,}000 \times t^2}{p}$$

$$L = \sqrt{\frac{32{,}000 \times t^2}{p}} = \sqrt{\frac{32{,}000 \times t}{p}}$$

The angle bars should be riveted to the plate with rivets not over 4 inches pitch and of a diameter sufficient to carry the load, due to the pressure at 7000 pounds stress.

The angle bar need not be large and can be easily determined by calculating their strength as beams uniformly loaded and fixed at the ends.

The cross stays should be flat bars or angles riveted to the angles, fitting a stay at the intersection of each horizontal and vertical angle.

Calculation will show that these angle stiffeners and cross stays need not be very heavy to carry the load, the main point to watch being to see that they are tightly riveted.

Business Notes

In addition to the complete line of Wilson Colortipt arc-welding wire, a grade of which is available for each particular metal and welding purpose, the Wilson Welder & Metals Company, Inc., North Bergen, N. J., now manufactures a low-priced and exceptionally good general-purpose rod, known as Wilson red-processed arc-welding wire.

Charles Curtiss Coventry, president and treasurer of The Cleveland Tool & Supply Company, Cleveland, O., died at his home in Cleveland on September 18. Mr. Coventry, together with F. C. Wittich and Frank C. White, founded The Cleveland Tool Supply Company, and had been treasurer of the firm from the beginning, and president since 1901.

James W. Owens, an authority on welding, and formerely welding aide for the Bureau of Construction and Repair of the U. S. Navy, has resigned as director of welding at the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., to become associated with the Welding Engineering and Research Corporation, 25 West 43rd street, New York, as its director of engineering and secretary.

The Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, announces that W. A. Nugent, manager of the St. Louis office, has been transferred to Chicago as manager of the Chicago territory. F. J. Passino, manager of the Pittsburgh office, will be located in St. Louis as manager of that territory, while T. J. Clancy, of the Cleveland office, has been transferred to Pittsburgh as manager of the Pittsburgh territory.

Everett Chapman has been appointed director of development and research of Lukenweld, Inc., a division of Lukens Steel Company, Coatesville, Pa. In this capacity he will have general direction of laboratory and investigation work in connection with redesigning machinery parts for the welded steel type of construction. Mr. Chapman received his Master of Science degree from the University of Michigan in 1924. After a year at Purdue he became director of research for the Lincoln Electric Company, Cleveland, O.

WELDING ROD.—The Fusion Welding Corporation, Chicago, has recently published a circular describing its Weldite Green-Surfaced electrodes for metallic arc welding of mild steel. This bulletin describes in detail the effect of green surfacing on the welding arc, the deposit metal and operating characteristics of the electrode, also the action of green surfacing as it is vaporized in the arc and why it so effectively reduces welding costs from 6 to 24 cents per pound of weld metal. It is also pointed out that the cost of using welding rods is four times the cost of the rods themselves since an operator is able to deposit metal during only 40 to 60 percent of the time for which he is paid.

Associations

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

Steamboat Inspection Service of the Department of Commerce

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Assistant International President—William Atkinson, 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.	St. Joseph, Mo.	Memphis, Tenn.
Detroit, Mich.	St. Louis, Mo.	Nashville, Tenn.
Erie, Pa.	Scranton, Pa.	Omaha, Neb.
Kansas City, Mo.	Seattle, Wash.	Parkersburg, W. Va.
Los Angeles, Cal.	Tampa, Fla.	Philadelphia, Pa.
	Evanston, Ill.	

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	

Cities

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

Selected Boiler Patents

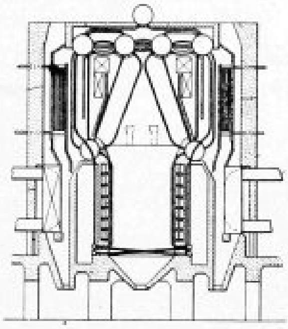
Compiled by
DWIGHT B. GALT, Patent Attorney,

Washington Loan and Trust Building,
Washington, D. C.

Readers wishing copies of patents or any further information regarding any patent described, should correspond with Mr. Galt.

1,729,037. BOILER ARRANGEMENT. HERMANN FECHT, OF BERLIN, GERMANY, ASSIGNOR TO KOHLENSCHEIDUNGS-GESELLSCHAFT M. B. H., OF BERLIN, GERMANY, A CORPORATION OF GERMANY.

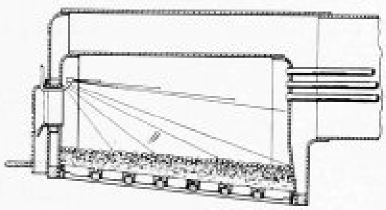
Claim.—In combination, a boiler, a combustion chamber therebeneath, additional boiler tubes defining side walls of said chamber, water-tubes



extending across the bottom of said chamber, headers located outside said chamber into which said side and bottom tubes are connected, boiler flues extending along sides of said boiler and combustion chamber and economizers in said flues, the flues being spaced from the combustion chamber so that access may be had to said headers.

1,721,782. FURNACE FOR STEAM BOILERS. EUGEN HUWYLER, OF VIENNA, AUSTRIA, ASSIGNOR TO THE FIRM: IGNIS A.-G., OF ZURICH, SWITZERLAND.

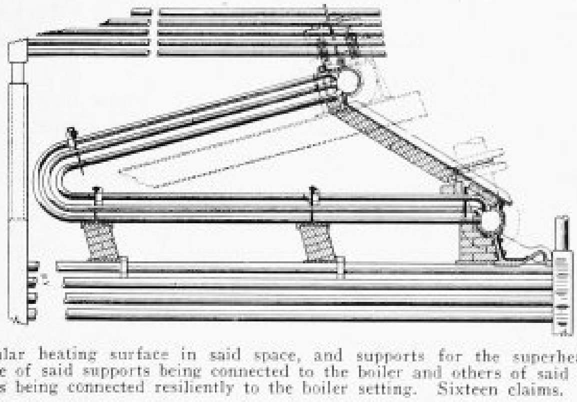
Claim.—In a steam boiler furnace, a grate, nozzle means above the grate having a horizontal row of radially disposed apertures, means to



supply boiler steam to said nozzle means, the diameter of the apertures directed toward the lateral walls of the furnace chamber being larger than the diameter of the apertures directed toward the end of the grate to form a substantially horizontal film-like blanket or stratum of steam over the grate, and means to admit over-grate air below said blanket or stratum. Two claims.

1,727,177. SUPERHEATER BOILER. JOHN PRENTICE, OF BAYONNE, N. J. ,ASSIGNOR TO THE BABCOCK AND WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

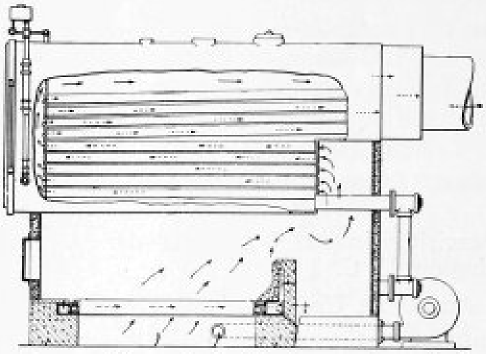
Claim.—A steam boiler having banks of watertubes connected to water chambers with a space between the banks, a tubular superheater having a



tubular heating surface in said space, and supports for the superheater, some of said supports being connected to the boiler and others of said supports being connected resiliently to the boiler setting. Sixteen claims.

1,725,828. BOILER. JOSEPH J. RATHGEB, JR., OF NEW YORK, N. Y.

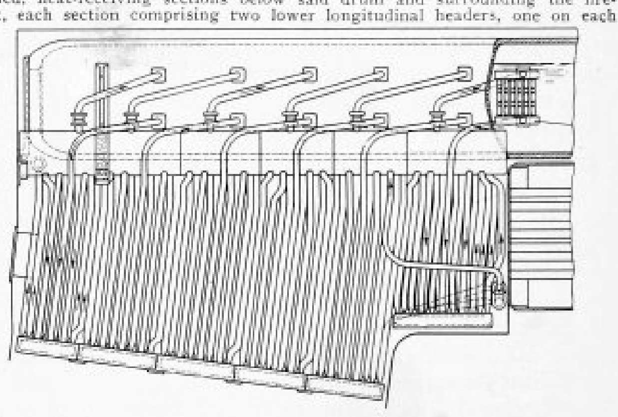
Claim.—In a furnace of the type described, front and rear walls forming a portion of the firebox and provided with slots therein, a grate comprising a plurality of separated hollow units arranged longitudinally and in apposition to each other with spaces therebetween and provided with imperforate



surfaces, nipples on either end of said units entering said slots, supplemental air supply ducts within said walls communicating with said first-mentioned slots, an adjustable gate in each air duct for regulating the admission of air therein and a bridge wall supported by said rear wall and provided with an upwardly and inwardly extending slot therein extending in a direction towards said grate.

1,719,010. APPARATUS FOR INDIRECT GENERATION OF STEAM FOR LOCOMOTIVES. OTTO H. HARTMANN, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-G. M. B. H., OF CASSEL-WILHELMSHOHE, GERMANY, A CORPORATION OF GERMANY.

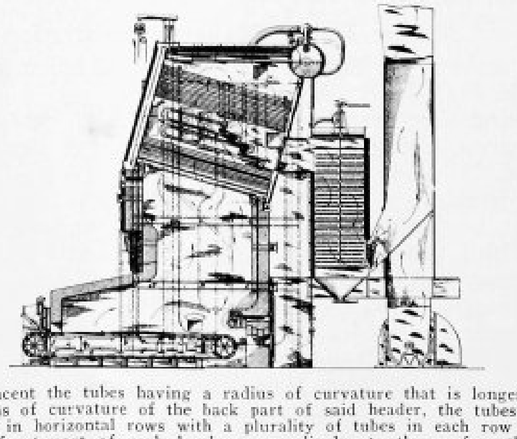
Claim.—A plant for the indirect generation of high-pressure steam for locomotives, comprising a boiler drum, a plurality of longitudinally adjoined, heat-receiving sections below said drum and surrounding the fire-box, each section comprising two lower longitudinal headers, one on each



side of the fire-box, two longitudinal upper headers, one above each of said lower headers, and connecting tubes between each upper header and the lower headers, an individually heating circuit in connection with one side of each heat-receiving section, and an individual heating circuit in connection with the opposite side of each heat-receiving section, each heating circuit comprising a heat-emitting element disposed within said drum, said element being connected in series with an upper and a lower header of its corresponding heat-receiving section. Three claims.

1,729,260. 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.—A watertube boiler, having horizontally inclined watertubes connected at their ends to uptake and downtake headers, respectively, each header having a cross section whose perimeter is curved and the front



part adjacent the tubes having a radius of curvature that is longer than the radius of curvature of the back part of said header, the tubes being arranged in horizontal rows with a plurality of tubes in each row entering the front part of each header perpendicular to the surface thereof. Thirty-three claims.

THE BOILER MAKER

Name registered U. S. Patent Office

Volume XXX November, 1930 No. 11

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

Chicago: 105 West Adams St. Cleveland: Terminal Tower
Washington: 17th and H. Sts., N. W.
San Francisco: 215 Market St.

H. H. BROWN, Editor
L. S. BLODGETT, Managing Editor
WARNER LUMBARD, Associate Editor

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

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Seams or Joints?

A reader asks for information as to the correct use of the terms "seams" or "joints" when referring to the connecting of adjacent pieces of metal together in plate metal work. His inquiry reads as follows:

"In the plate-metal line of work which involves the connecting of adjacent pieces of metals together by various methods such as riveting, welding and bolting there arises considerable discussion as to whether the union of these metal parts should be termed joints or seams. Some contend that they are joints when riveted, welded or bolted, whereas some contend that a riveted or welded union which produces a permanent union is a seam and a bolted union which is made up and taken apart at will is a joint. There may be other types of unions of metals that could be considered in this discussion and variations from the specific types mentioned above.

"The writer would be glad to have the above discussed by the readers of THE BOILER MAKER."

The two terms are used rather indiscriminately in the boiler making field. This is only natural because there is only a slight difference of meaning of the two terms. According to the dictionary, a joint is the place or part in which two things or parts of one thing are joined or united. A seam is the line formed by joining two edges of different pieces of material or of the same piece. In other words, the term "joint" is the broader term and is properly applicable to almost any kind of union or connection of parts, whereas the term "seam" is more generally applied to the joining or connection of the longer edges of plates or other parts.

Further discussion of this question by our readers will be gladly welcomed.

The Lincoln Prize

On October 1, 1931, the second Lincoln Arc Welding Prize Competition, announced by the Lincoln Electric Company, Cleveland, O., will close and upon the results of this competition $17,500 will be distributed among the contributors of the forty-one best papers submitted. Sponsored for the purpose of stimulating designers and engineers in every line of industry to think of the manufacture of their own products by the use of arc welding, the competition affords an opportunity for the display of skill and ingenuity in utilizing the advantages of arc-welded construction.

With the ever increasing use of welding as a method of boiler construction, the boiler-making industry forms a field from which the winners of this competition may be chosen. The application of welding is recognized but the design of welded boilers and methods of welding are subject to improvement in order to guarantee the strength of the vessel in service and to build a boiler or pressure vessel economically and efficiently.

The first Lincoln Arc Welding Competition was won by a man engaged in shipbuilding where the safety of the ship's structure, as in boiler making, is of prime importance. In the power field, where any saving is felt by society at large, the development of a less costly, safer and more efficient boiler can result only in the benefit of all associated with the production or use of power. The benefits of improvements in boiler design and construction are widely felt and to the industry itself must we look for these improvements.

The first prize of $7,500 is waiting for the man who presents the most beneficial application of welding. Why should he not be from the boiler-making industry? The benefit is there, the application is there; it remains for the men in the field to develop the design, the procedure and the equipment for its successful application. Think it over!

Corrosion and Pitting

It is unnecessary, in view of the effects of poor water on the life of boilers, to stress the importance of proper feed water treatment. From the beginning of boiler use the corrosive action of water was noted, but with the advent of higher pressures and higher evaporative rates, the effects of corrosion and pitting form a serious part of boiler maintenance.

Many efforts have been made in the past to combat this form of waste and a resume of the results of such investigations is contained in the article entitled "Boiler and Tender Corrosion and Pitting" appearing on page 313 of this issue. That corrosion is a chemical action set up between water and metal and is dependent upon the composition of metal and water is brought out in this report presented at the May, 1930, convention of the Master Boiler Makers' Association, held in Pittsburgh, Pa.

While the use of non-corrosive metals is prohibitive due to the expense involved, water treatment, metal protection and boiler construction, to reduce the tendency to corrode, have been employed with a certain amount of success during the past twenty years. However, in view of recent developments along this line, chemists and water-service engineers place the cause of corrosion and pitting upon the air content of water. Increased circulation of boiler water to prevent the adherence of bubbles to the shell and tubes has resulted in the increased life of plates and other boiler parts. The use of the air separator in the case of the Southern Pacific Company is said to have increased the life of preheater tubes from 27,250 miles to 36,914 miles of service. While not conclusive, the effect of air in water is clearly indicated.

Corrosion at certain points in a boiler may be reduced by modifications in boiler construction, but in general, deterioration of boiler material is not a factor of the builder's workmanship. High pressures, high temperatures and high evaporative rates serve to promote pitting actions to a greater or less degree. Such action, however, may be reduced, but not eliminated, by the observance of three general precautions: Elimination of acidity in water, elimination of air and gases and increased water circulation.

Communications

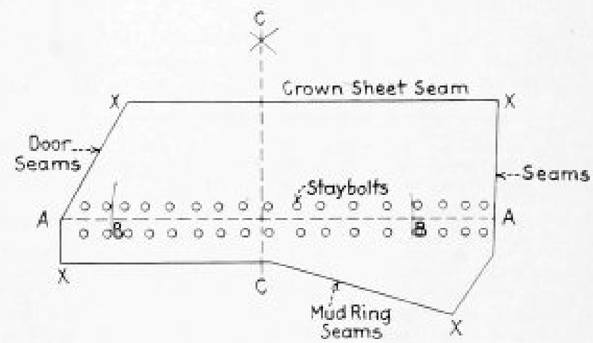
New Fireboxes

To the Editor:

When a locomotive comes into the shops for a new firebox, the boiler is completely removed from the engine frame, as the work can be done much faster and more economically.

While the boiler is being dismantled, the tubes are cut out and removed, this saving time, and the work is generally performed by two boiler makers, one at each end of the boiler. Tubes are removed, either by means of pneumatic cutters, or by acetylene torch for the superheaters, but the smaller tubes are removed by means of pneumatic cutters, the ends of the tubes being removed by air hammer after the same are cut off.

The boiler being received in the boiler shop, the ends of the staybolts outside are cut out by means of a cape



Layout of side sheet

chisel, or else burned out by acetylene. The mud-ring rivets are cut out, and the mud ring removed, after which the boiler is turned on its side and the staybolts broken down by means of pneumatic bars. The crown bolts are next broken off by means of hand-operated bars from the interior of the boiler. The fire-door rivets are also cut at this time. The firebox is now ready for removal.

After the firebox is removed, the burrs in the staybolt and crown-bolt holes are removed, the entire interior of the boiler scaled, and thoroughly examined by the inspector, who carefully notes the plates, braces and riveting for defects. If any defects are noted, they are taken care of before the new firebox is replaced.

We could not use a uniform firebox, that is, one already laid out to a standard form, as the holes in the mud rings are not of uniform spacing and would result in unfair holes.

We always square up our old side sheets as illustrated later, which gives us exactness. The holes in the mud ring are transferred by means of strap templets.

The laying out of the crown sheet, door sheet and tube sheet is done by means of templets, although the seams of the door and tube sheets cannot be done this way. The holes in the flange seams of the door and tube sheet are equally spaced by means of dividers, and later transferred to the side sheets by means of strap templets, while the holes for the mud ring are taken direct from the old mud ring by means of strap templets.

The laying out of the side sheets may appear to be somewhat confusing, but this is not so. Accuracy may be obtained by laying out as outlined below. First draw line A-A between the center of two horizontal rows of staybolts, then about the center of the side sheet (longitudinally) strike arcs B-B, from which points square up a line C-C. To find the important points at X is now a simple matter, and can be accomplished by means of trams and straight edge. This gives the general outline of the side sheets, and the balance of the operation is very simple. The staybolt holes are taken from the blue prints, but the rivet holes in the seams are taken from strap templets copied from the corresponding parts, namely, crown sheet, door and tube sheet. The mud-ring rivet holes are taken from the old mud ring. The above explanation refers to the old firebox sheet.

After the firebox sheets are fully laid out, they are taken to the punch and shears and the machine shop for the various operations necessary there. The side sheets and the crown sheet are taken to the rolls and properly formed. Then the calking edges are chipped preparatory to assembling the firebox. The firebox is assembled within the mud ring, and the corners heated and thoroughly laid up, then corner holes are drilled in position. The firebox is now ready to be riveted and calked.

The boiler is turned upside down, and the firebox is temporarily fastened in place until the mud ring is installed. The mud ring is bolted and then riveted, and plugs inserted in the outside corners. The firedoor seams are welded, whereas they were previously riveted. The staybolt and crown-bolt holes are now tapped and staybolts and crown bolts inserted. After this operation, the tubes are installed (copper ferrules having been inserted in the firebox tube sheet while firebox was at assembly place.) The seams of the mud ring are calked, and the boiler is then ready for the hydrostatic test which is required.

Before giving the hydrostatic test, it is advisable to boil the boiler out with a strong solution of caustic soda to remove all traces of oil.

After the hydrostatic test, all leaks having been made tight, water is left in the boiler, the tube sheet is sand-blasted and the tubes welded. The boiler is now ready for assembling on the frame.

Complete minor details have not been followed out here, yet I believe that I have given enough so that the average boiler maker or helper can follow it out understandingly.

Binghamton, N. Y. Charles W. Carter, Jr.

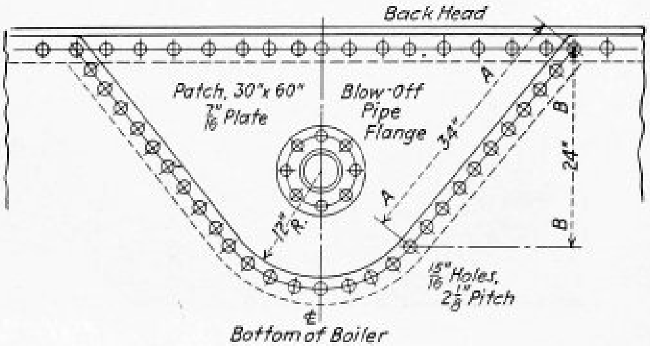
Applying Patch Around Blow-Off Pipe Flange

To the Editor:

It frequently happens that a horizontal tubular boiler develops a bag around the blow-off pipe flange connection, which is connected to the bottom of the rear course near the backhead of the boiler and when such a bag is too large to be set up it is necessary to apply a suitable patch.

The illustration shows a patch as applied to such a boiler. This boiler has a diameter of 72 inches and a length of 18 feet. It is built with 7/16 inch shell plate having triple riveted butts. It carries 125 pounds per square inch working pressure and is rated at 150 boiler horsepower.

In developing a patch of this kind, measure back far enough to take in the defective section of the shell, then strike an arc having a 12-inch radius as noted on the sketch. With a straight edge connect the circle with a point on the backhead so that an angle of at least 45 degrees will be obtained. Note the lines *A-A* and *B-B* which, in this layout, are 24 inches and 34 inches



Patch for horizontal tubular boiler blow-off pipe flange

on the angle line. This will give ample strength for a single-lap seam patch.

When patches of this kind are properly fitted, carefully riveted and calked they give very good service. The blow off pipe should be 2½ inches in diameter and extra strong, no cast iron fittings being used.

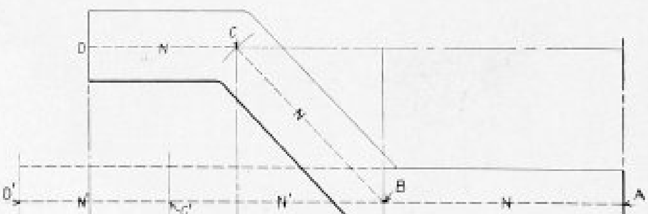
Jacksonville, Fla. Chris S. Handlee.

Stretchout of a Compound Bend

To the Editor:

It is important to know the stretchout length of a shape such as that shown in the sketch. The information is necessary for the economical cutting of material, also to find the exact location of holes and cuts when such are required.

The first step is to make a view of the completed work, either in exact dimensions or in scale. The

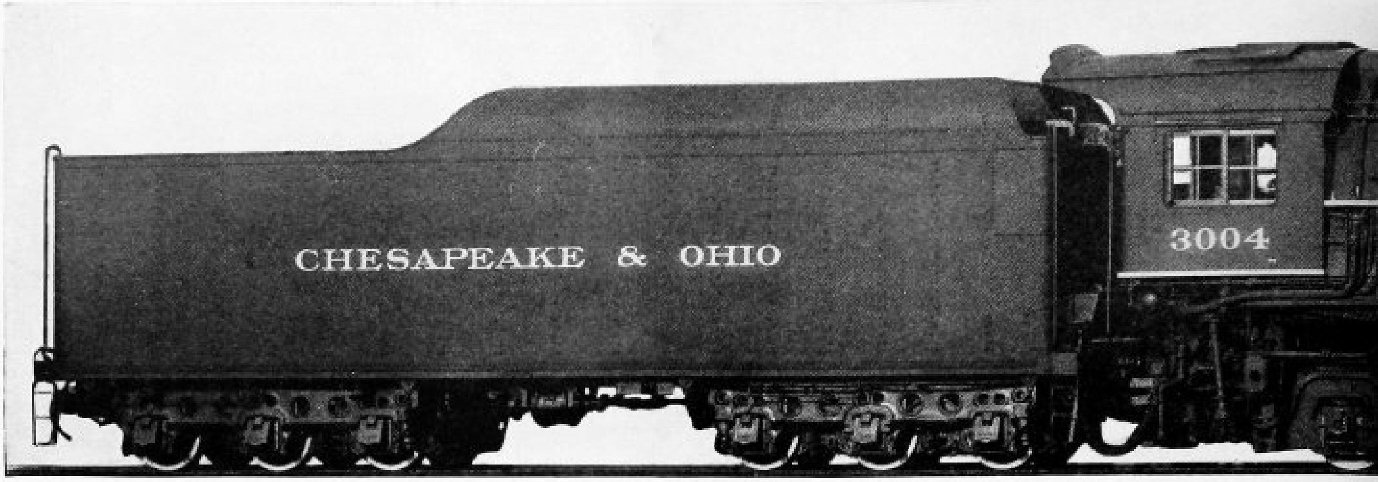


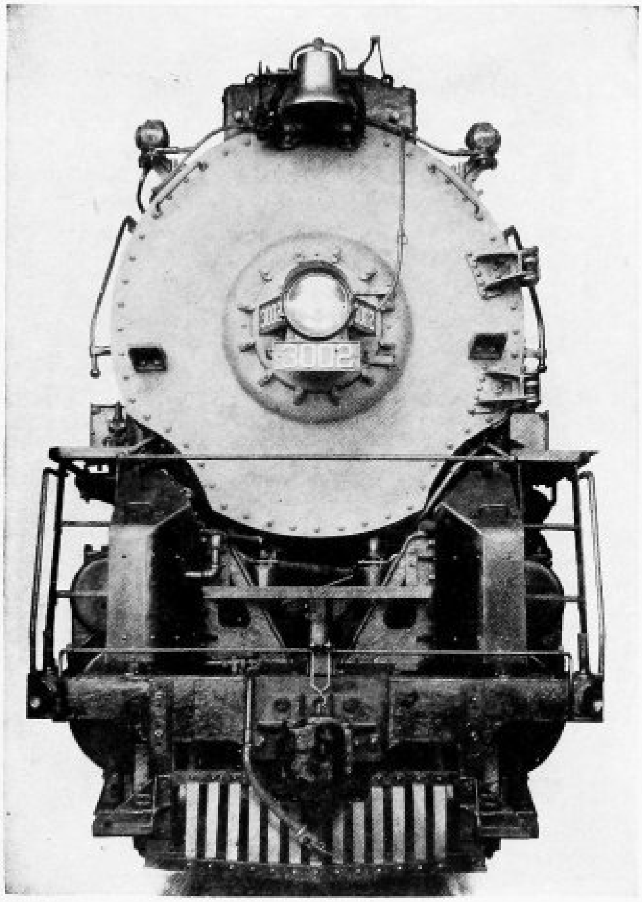
Method of determining true length of bent piece

center line *N-N-N* is drawn. The length of this dotted line is the length of the steel before bending. To arrive at this length, continue the dotted line *A-B* to *D'* or beyond. Set the compasses on *B* to the distance of *B-C*. Swinging around to the straight dotted line, mark off the point *C'*. Again set the compasses, this time on *C* in the bent shape, measuring off the distance *C-D*. Transfer this distance to the straight dotted line as *C'-D'* and the stretchout is complete.

Note that any holes set in the area *B-C* must be placed where such holes intersect the dotted center line *B-C* and that the same rule applies to the areas *A-B* and *C-D*.

C. B. Dean.



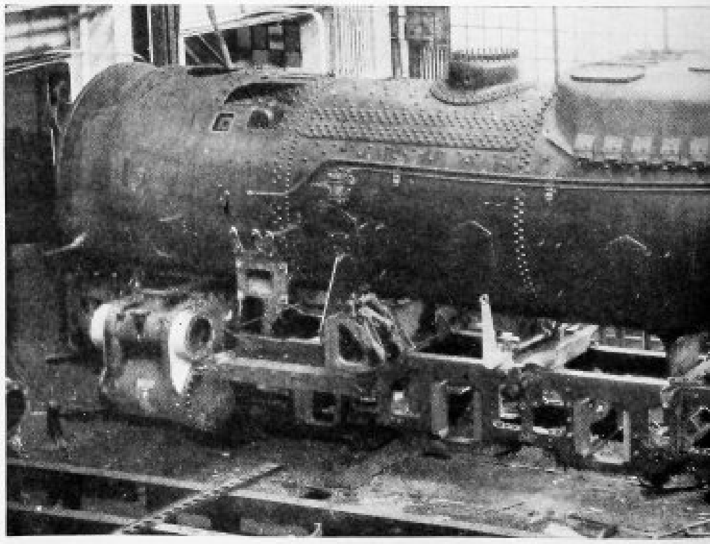


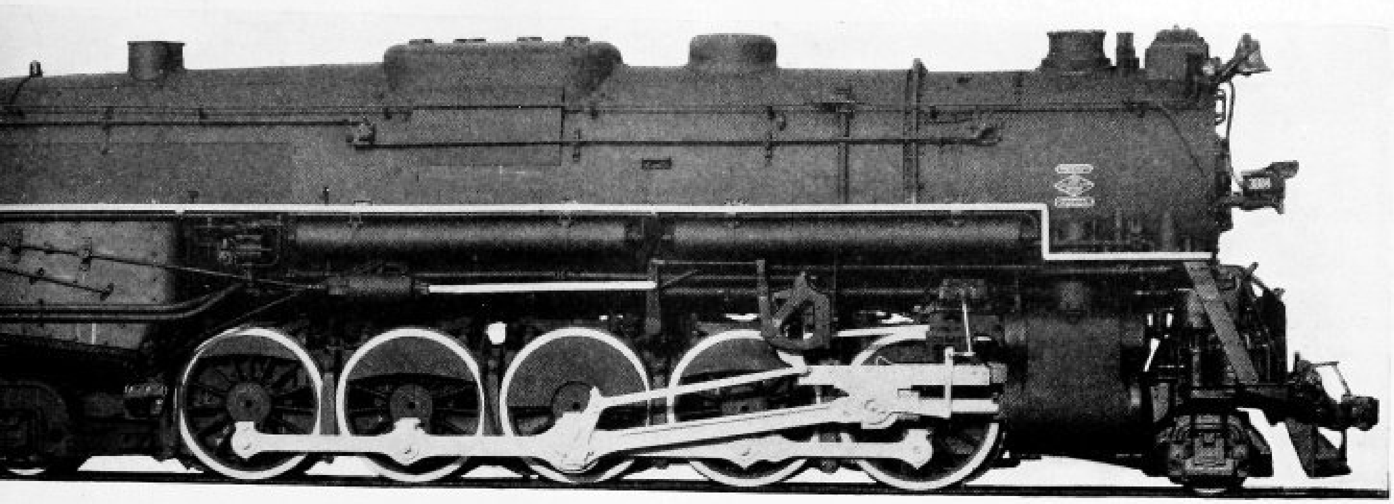
Boilers of New 2-10-4 Locomotive for the Chesapeake & Ohio

The Lima Locomotive Works, Inc., has recently delivered to the Chesapeake & Ohio Lines forty 2-10-4 type locomotives which are believed to be the largest and most powerful two-cylinder locomotives in the world. These locomotives, the first of which were completed in September, 1930, were purchased to replace older type locomotives in hauling coal and ore between Russell, Ky., and Toledo, O. It is expected that the new power will effect a considerable reduction in maintenance and will handle increased tonnage with reduced pusher service.

Each of the new locomotives develops a rated tractive force of 91,584 pounds. They are equipped with Franklin trailing-truck boosters, which gives each unit a rated tractive force at starting of 106,584 pounds. The driving wheels are 69 inches in diameter and the boiler operates at a pressure of 260 pounds per square inch. The cylinders are 29 inches in diameter by 34-inch stroke. The total weight of one of these engines is 566,000 pounds, of which 373,000 pounds is carried on the drivers. The factor of adhesion is 4.07. The cylinders operate at a maximum cut-off of 80 percent. The large diameter driving wheels and long stroke permit maximum running speeds with minimum wear on the running gear.

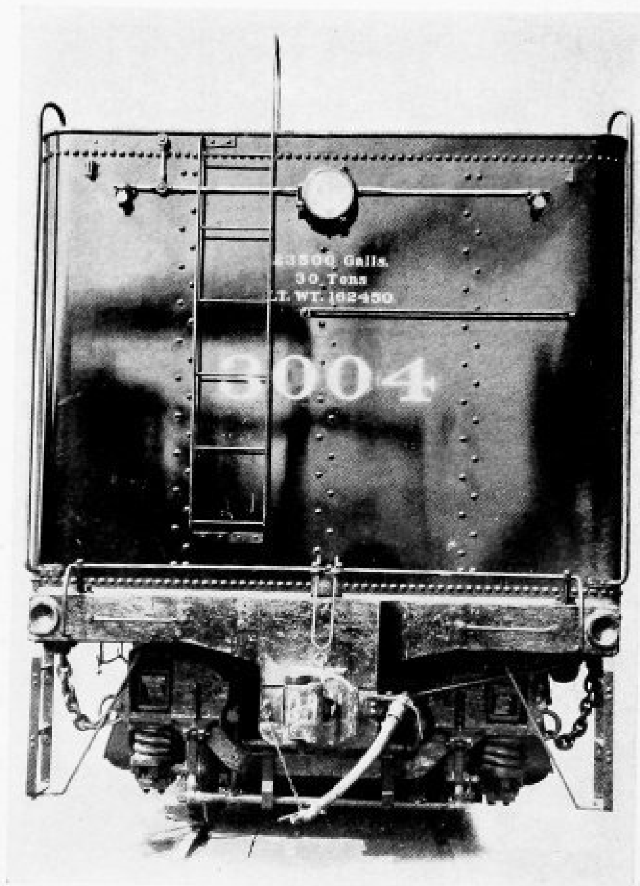
The boiler is of the conical type, with three shell

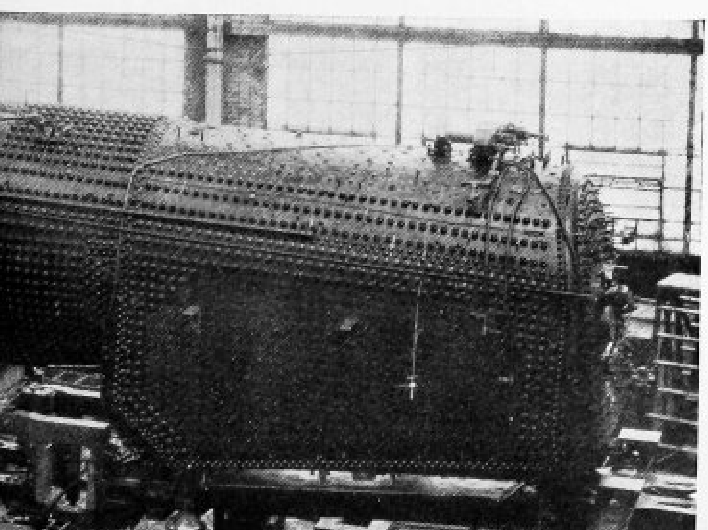




courses. The outside diameter of the first course is 99¾ inches and of the third course is 108 inches. The shell courses are nickel steel, with welt strips for the seams made of the same material. There are 59, 2¼-inch tubes and 275, 3½-inch flues, and the distance over the tube sheets is 21 feet. The dome is located on the first course a short distance back of the front flue sheet. Carbon-steel plate, ⅝-inch thick, is used in the smokebox. Recesses have been built into the smokebox to permit an application of the feedwater heater and its connections free from the smokebox gases. After all the piping is applied, these recesses are neatly covered with plate, giving the front end a smooth appearance.

The general efficiency of the boiler is increased by the application of a Worthington type S-6, feedwater heater with a capacity of 12,000 gallons per hour, a type-E superheater, including a multiple throttle integral with the header, and three Nicholson thermic syphons in the firebox. The evaporative capacity is 113.1 percent of the cylinder requirements, which easily provides sufficient steam for the cylinders and booster without forcing the boiler. Coal is fired with a modified type-B standard stoker, the engine of which is carried on the tender. The grates are of the firebar type and





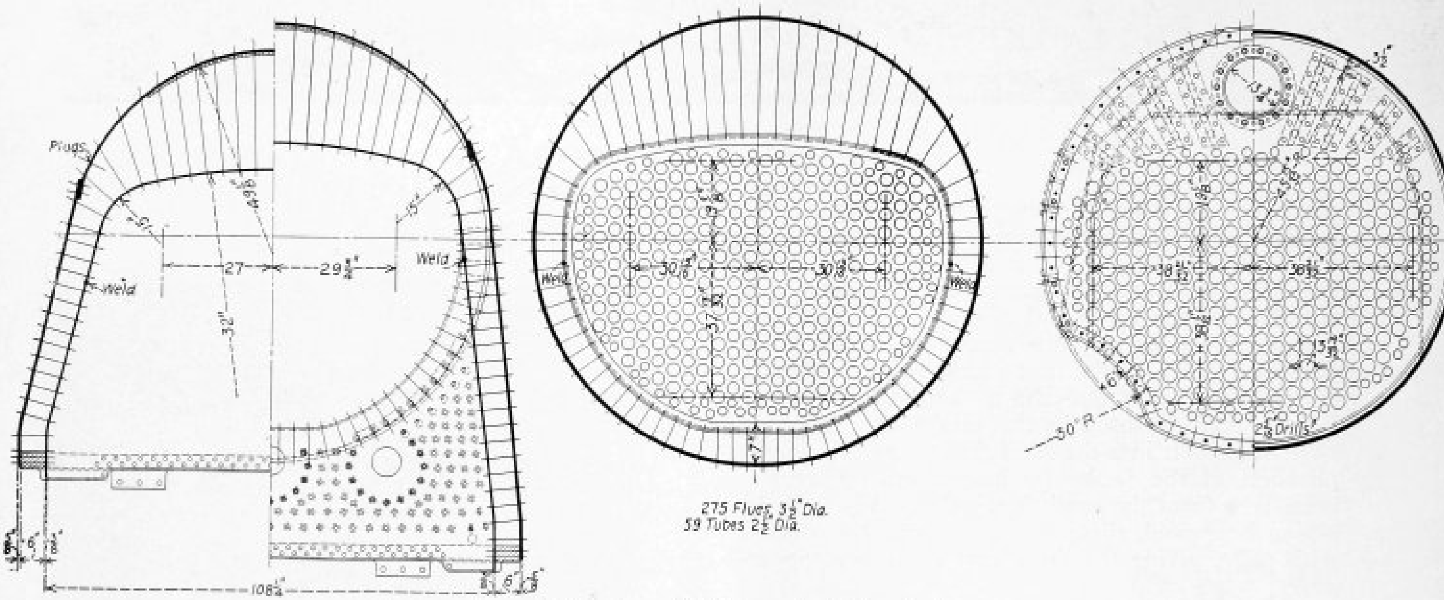
At the top is a general view of the C. & O. 2-10-4 locomotive built by Lima. At the left is the front end; right, the rear view of the tender tank, and below the boiler which has a working pressure of 260 pounds per square inch and is of nickel steel.

are arranged in three sections with two center frames.

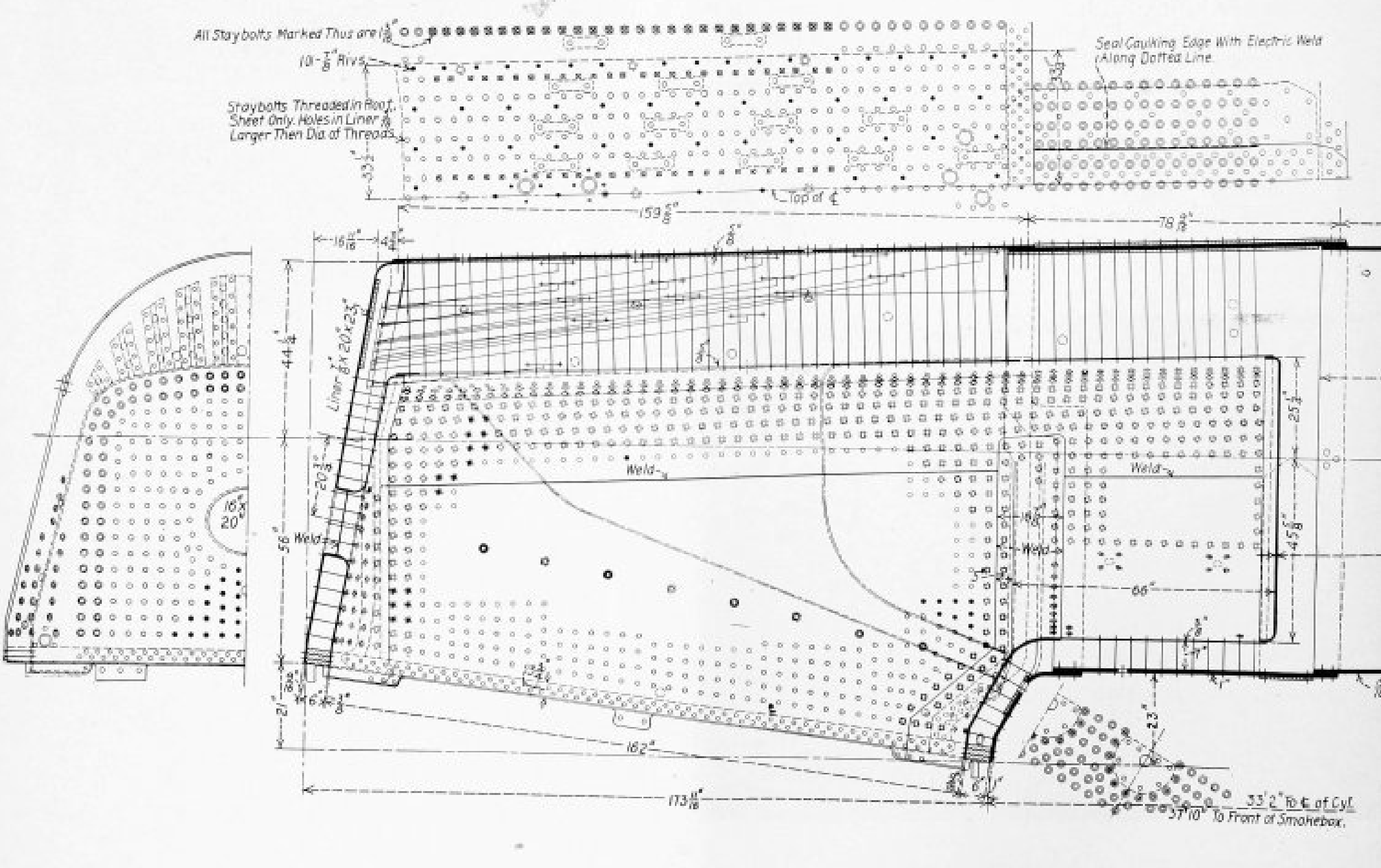
The boiler is supported in the usual manner at the cylinders and is attached to the frame crossties by ¾-inch waist sheets which are bolted to cast-steel waist-sheet saddles. To distribute the load over as much of the boiler surface as possible, the wearing liners underneath these saddles are continued up to the horizontal center line of the boiler. The frame cradle supports the front and rear ends of the firebox by means of sliding furnace bearers bolted to lugs on the mud ring.

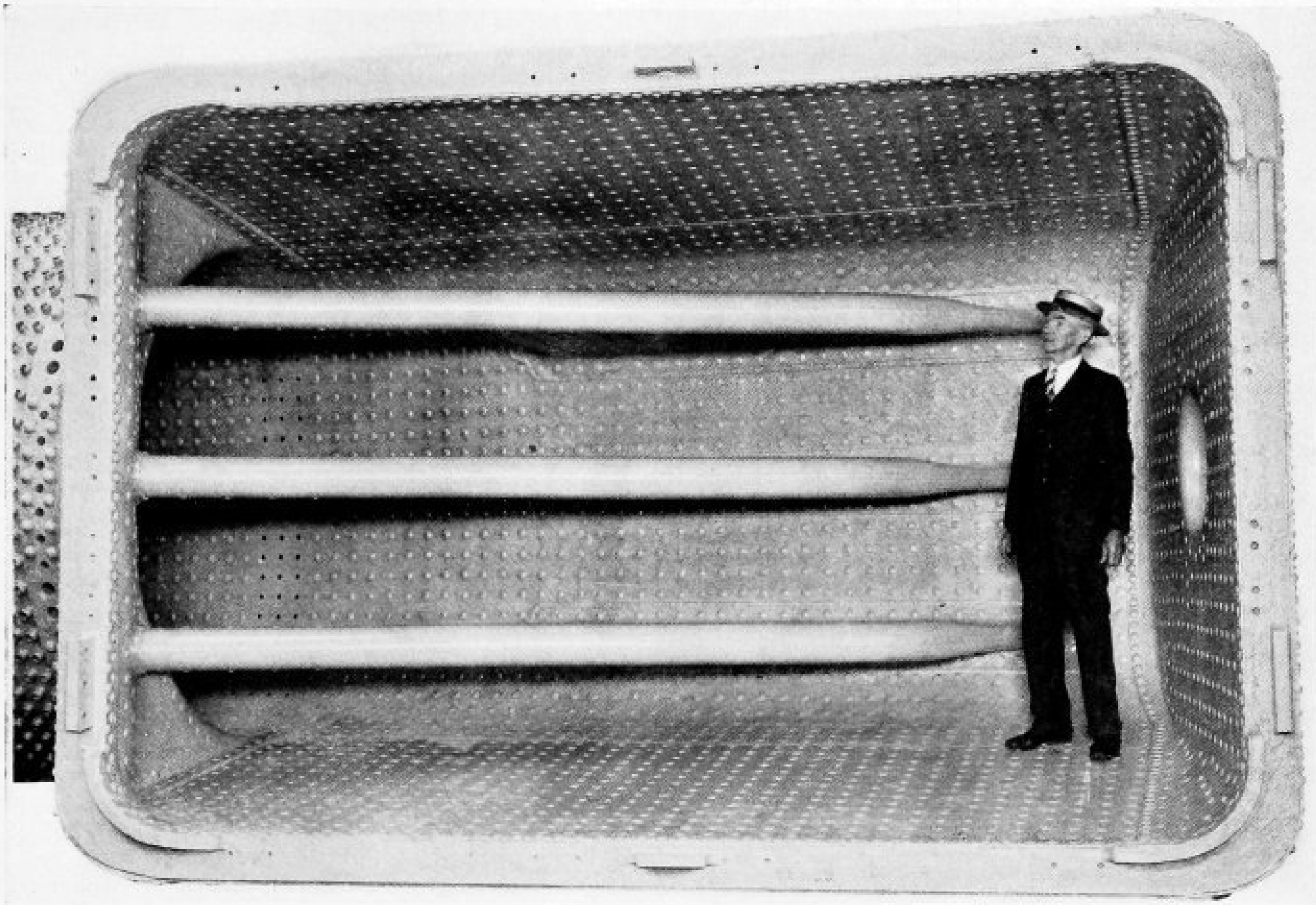
A single sandbox of 72 cubic feet capacity is located on the third course of the boiler and is equipped with five single sanders on each side. With the exception of the booster, the only auxiliaries using superheated steam are the blower and the generator. The air compressors, stoker and the hot-and cold-water pumps of the feedwater heater are operated with saturated steam.

Firing rates at maximum horsepower are kept within an economical range by the extremely large firebox which has inside dimensions at the mud ring of 162 inches by 108¼ inches, providing a grate area of 121.7 square feet. The combustion chamber is 66 inches long. The firebox heating surface is further increased by the application of three firebox syphons. There is a partial installation of Alco flexible staybolts in the fire-



Sections of new boiler through firebox and at tube sheets



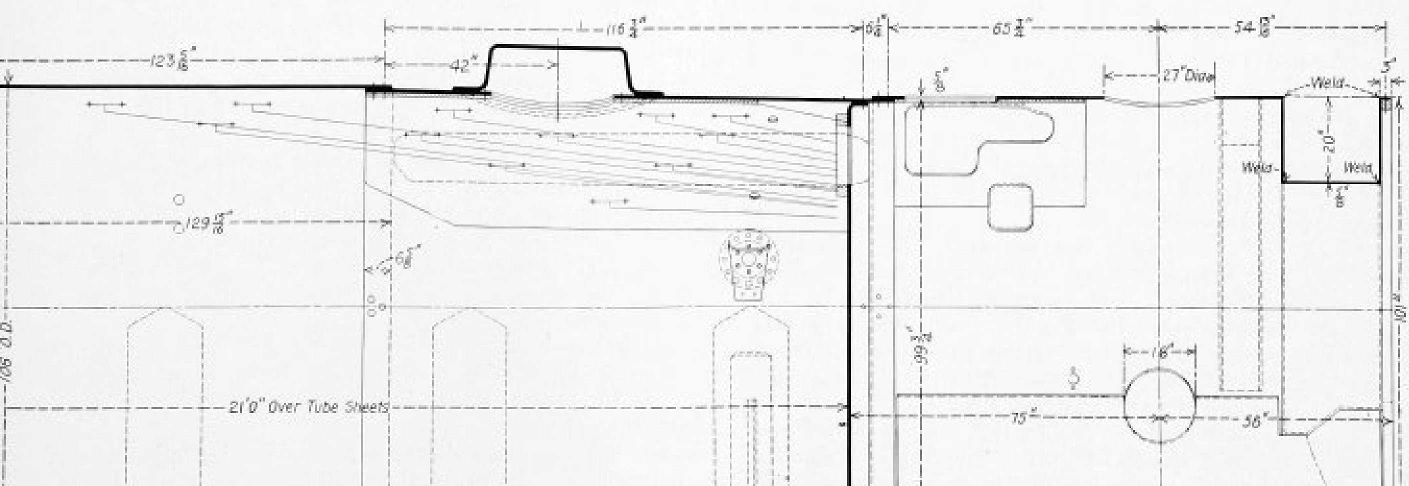


View of firebox showing unusual size, and arrangement of three Nicholson thermic syphons

box and a complete installation of flexible bolts in the combustion chamber.

Heating surface of the firebox and combustion chamber combined is 477 square feet; thermic syphon heating surface 168.5 square feet; heating surface of the tubes and flues together is 5990 square feet. The total evaporation surface of the boiler is 6635.5 square feet. In addition the superheating surface amounts to 3030 square feet, giving a total combined evaporative and superheating surface of 9665.5 square feet.

Steam distribution is effected by a Baker valve gear of the long-travel type, the piston valves of which are 14 inches in diameter. Reversing is effected by means of a precision type-F reverse gear.



Longitudinal section through boiler of new 2-10-4 Chesapeake & Ohio locomotive

In designing the cab, considerable care was taken to obtain a cab of ample size and also to provide the most accessible arrangement of cab fittings for the enginemen. Seats are provided on the left side for the fireman and head brakeman, and in addition to the engineman's seat on the right side, there is a drop seat for an extra brakeman. There is an abundance of headroom in these cabs and all gages are easily visible. The backhead has been made unusually free from congestion by running the majority of the pipes underneath the jacket.

The tender is of rectangular design, having a capacity for 30 tons of soft coal and 23,500 gallons of water. Its large capacity makes it possible to operate these locomotives on long runs with comparatively few stops for fuel or water. The tender trucks are of the six-wheel type with provision made for future application of automatic train control. The tender frame is of the General Steel Castings Corporation's cast steel water-bottom type arranged for radial buffer and unit-type drawbar.

The boiler jacket, outside of the cab, sand boxes, outside of the wheel centers and the tender are finished in black Ripolin, which gives an attractive appearance to the locomotive.

Method of Discovering Rivet-Hole Cracks

By G. P. Blackall

Investigations for the purpose of discovering cracks in boiler-plate rivet holes have hitherto been accompanied by two disadvantages—it was not always possible to detect fine hair cracks following the usual process of etching and there was no way of obtaining a satisfactory permanent record of their size and position. The usual method was to record their approximate position on sketches, while in cases where it was desired to follow up, at stated intervals, the further development of cracks in a boiler more accurate sketches were made as documentary evidence for the purpose of comparison with earlier sketches. This necessitated, however, considerable expenditure of time. Both methods, moreover, were subject to error due to the human element. A new method of finding rivet-hole cracks, which at the same time provides accurate documentary evidence, has recently been perfected in Germany by the Rhineland Steam Boiler Supervisory Association, Dusseldorf.

Silver bromide paper impregnated with sulphuric acid has long been employed to determine the presence of sulphide in steel. Surfaces in which cracks are suspected are smeared with a light oil, which is absorbed by reason of capillary action, the oil reappearing after the surface has been rubbed clean, indicating the position and size of any existing cracks.

The new method is a combination of the two foregoing processes. Instead of oil, a sulphide solution is introduced into the cracks. The application of silver-bromide paper impregnated with sulphuric acid to the surface causes hydrogen sulphide to develop. The sulphur from the hydrogen sulphide and the silver from the silver bromide form silver sulphide of a black color. Even extremely fine cracks can be discovered, the sulphide issuing therefrom being represented on the silver bromide paper as black lines. The finished prints are fixed in the same way as photographs. The surface examined is afterwards treated with sulphuric acid, and as a further precaution washed with water with a view to eliminating any injurious action on the boiler material by the chemicals used.

Tests have proved the superiority of the new method in detecting even the finest cracks. The prints provide accurate documentary evidence, while comparison can be made at different times in order to determine any changes that might have taken place. In addition to its application in the case of rivet-hole cracks, the method can also be used for ascertaining and making a permanent record of cracks or hollow spaces in other machine parts.

Early Tender Tank Building

By C. E. Lester

It was nearly a century and a quarter ago that saw the practical beginning of the mechanical era which brought forth the first practical steam locomotive with its many problems. One of the important problems in early locomotive construction was the consideration of methods and appliances for the transport of water and fuel between bases of supply to propel the locomotive and haul its load to destination. The advent of the locomotive brought with it the trade of the boiler maker and its kindred or branch trade, that of the tender-tank builder.

The building of wooden receptacles for liquids or the trade of copper is an ancient one and antedates the Christian era. To the cooper belongs the distinction of building the first locomotive tender tank. The first tanks used on locomotives were of various sizes and shapes but a plain wooden cylindrical vessel, somewhat convex as are common barrels and casks, placed horizontally on a rack recessed out to fit the vessel seems to have been the most favored. This shape was used on the *Puffing Billy* (1813), Stephenson's *Rocket* (1829) and others of a somewhat later period.

However, rectangular and square tanks of wooden construction were used, each type having its advocates. The favoritism shown the cylindrical tank in the early days of tank construction was, perhaps, due to the fact that a small filling hole could be used that could readily be plugged to avoid the loss of water in splashing when the vehicle was in motion. The first rectangular tanks were open on top and the splashing of the water was somewhat lessened by placing loose boards and planks in the water. The loss of water as well as the wetting of the crew eventually led to the closing of the top except for the filling hole.

The first locomotive being very small and the requirements light, the tanks were built accordingly, that of the *Puffing Billy* having a water capacity of about 300 gallons.

From 1813 to 1830 there was considerable advancement in the art of locomotive building, yet it was not until about 1830 that iron plate was brought into use in fabricating locomotive tanks. Research into the early tank building industry has developed that authentic information is very meager and such as is available is in most instances more of a legend than a known fact.

It is a fact not generally known, (according to the

Lukens Handbook) that the first iron plate made on this side of the Atlantic was made in 1810 by Isaac Pennock on the Brandywine at Coatesville, Pa., in a mill converted over from a saw mill. This mill was on the site of the present Lukens Iron and Steel Company plant. Plate making in the early days was carried on with considerable difficulty. The plates were made from single charcoal-iron blooms made in an old-fashioned forge fire, heated in an ordinary plate fire and rolled into plates. As near as can be determined the plate rolls of that time were about 16 inches in diameter and between three and four feet between housings, and run by an over-shot water wheel. Many times, it is said, the men had to rush out, climb on the wheel to keep the mill from stalling and help the pass through the rolls to prevent a sticker.

Many mills sprang up throughout the middle east and Atlantic states and between 1825 and 1835 the Brandywine mill increased the size of its rolls to 21 inches by 66 inches long so that good size plates were then available. It is, however, a far cry from that to the mills of the present-time rolling plates that are only limited in size by the railroad limitations. The first-class mills of today are equipped with hydraulic lifting tables, cooling tables and mechanical transferring apparatus to move plates to the shears. Straightening rolls take the wavy plate and change it into a perfectly smooth and level one.

It is not strange that so many years elapsed before going to the iron tank from the wood. The crude and costly manner in which plate was made as well as the very small plates available doubtless made the cost prohibitive where lumber that answered the purpose could be secured for six or eight dollars a thousand board feet. The fact that rivets used in this country at that time were either hand forged in this country or imported added to the difficulty and cost of obtaining an adequate supply to successfully construct iron tanks.

The first authentic record of rivets made in this country is by L. Severance who started the manufacture of bolts, rivets and spikes in Pittsburgh, Pa., in 1828. These were all hand forged and, naturally, but a limited supply could be produced. In 1837, patent papers were taken out by Mr. Severance for a rivet machine. This was undoubtedly the first rivet machine in this country and probably the first one anywhere in the world. One of these machines was in operation at Glassport, Pa., from the time it was built until 1902. An interesting feature of the rivet-making industry is that the Mr. Severance who started the rivet business is the grandfather of S. W. Severance president of the S. Severance Manufacturing Company. The company, having operated under the Severance management since its beginning in 1828, ceased to manufacture rivets in 1925 and is now in the process of liquidation.

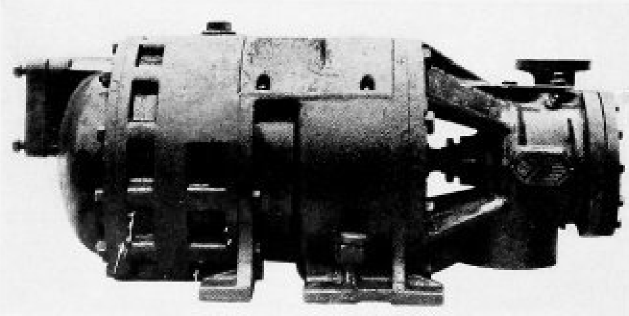
The attempted use of sheet iron for tank building showed the need of a connecting bar shape commonly known as the angle iron. Doubtless the beginning of the general construction of rectangular and square tanks was delayed until this shape made its initial appearance.

Swank, in "Iron in All Ages," says, regarding the forming of the first angle iron: "The Union Rolling Mill was the next mill built in Pittsburgh. It was located on the Monongahela River and was accidently blown up and dismantled in 1829. It is claimed that the first angle iron rolled in the United States was rolled in this mill by Sam Leonard who also rolled the first Z-bars for salt pans."

The first reliable information concerning details of construction is that of tender tanks built about 1845. These were of rectangular shape with two water legs inclosing the fuel space and made from plate about 3/16 inch thick and secured by rivets about ⅜ inch in diameter, spaced about 1¼ inches apart. From such a beginning sprang the round and slope-back tender tank as well as the side tank, the well tank, the bottom tank and the back tank with their various modifications and on through the century to the mammoth tenders of our present-day locomotives.

Locomotive Boiler Feed Pump

The B-A locomotive boiler feed pump has recently been developed by The Bird-Archer Company, New York, for use with their locomotive water conditioner. This centrifugal pump unit consists of a steam turbine, pump and regulating device assembled into an enclosed and compact unit. There are no additional control valves, over-speed trips, or any other parts required in the operation of the pump. Regulation is by means of an ordinary globe valve in the cab. The finished pump unit presents a very simple and pleasing appearance.



Bird-Archer locomotive boiler feed pump

The water end of the B-A boiler feed pump is a two-stage, double-suction, high-efficiency pump. It is assembled from the end and may be completely taken apart and put together on the locomotive in less than 30 minutes, without disturbing any pipe or hose connections.

The ruggedness of the steam turbine is emphasized by the fact that it has a very large diameter steel shaft and that the turbine wheel is a one-piece steel forging.

The bearings of the new feed water pump are of a new but tested design. They use brass spacer blocks carried on the balls instead of the ordinary stamped steel spacer rings. This presents the advantage of having a brass-to-steel bearing in the ball race.

Over-speed protection is provided by a fly-ball governor designed along the lines of a standard governor, which has been used in a large number of turbines in locomotive service. The governor mechanism and bearings run in a constant bath of oil.

Lubrication of the bearings and governor mechanism is accomplished by an ingenious arrangement of the governor shaft which is hollow and has screw-shaped flutes on the inside walls which lift the oil from a large reservoir provided in the center casting and furnishes a continuous spray over all moving parts requiring lubrication.

The pump has a capacity of 9000 gallons per hour and is suitable for all but very high-pressure special installations.

Firebox Repairs at Huntington Shops of the Chesapeake & Ohio

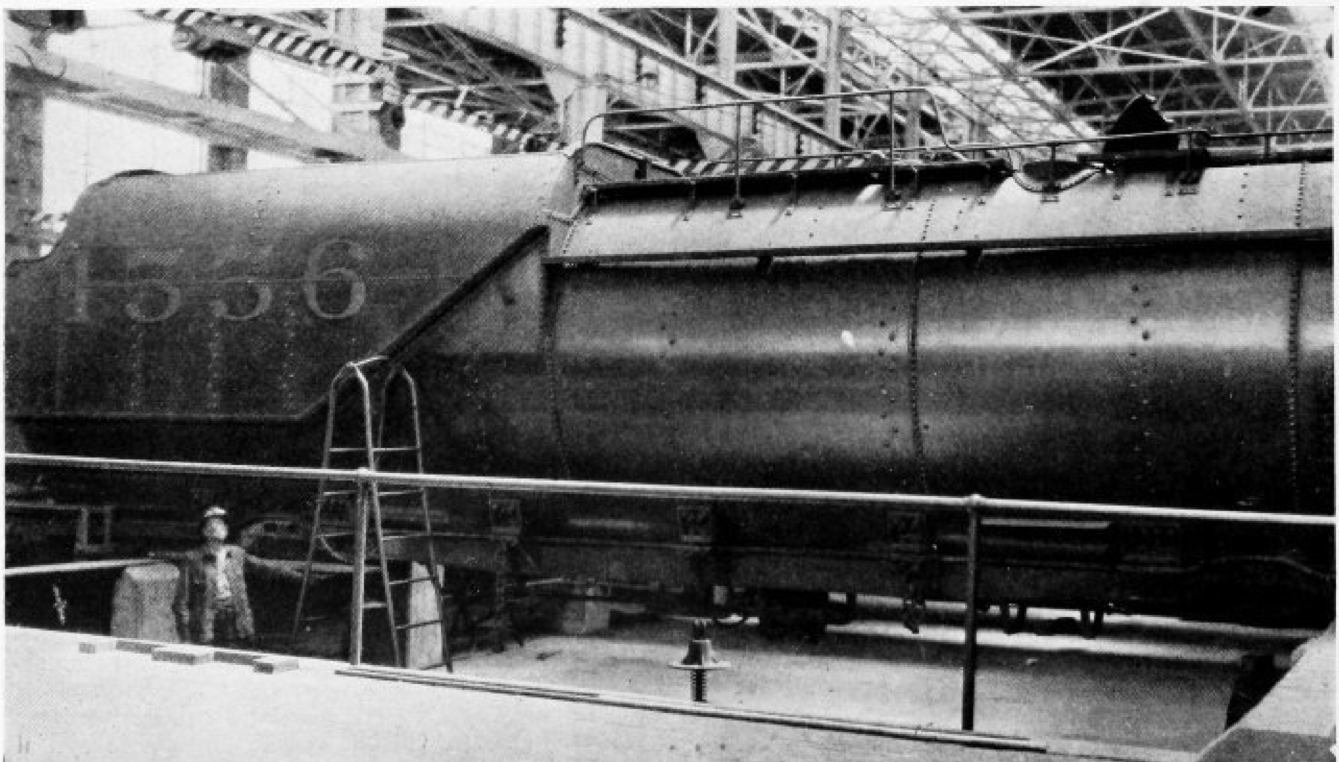
Boiler tapping operation

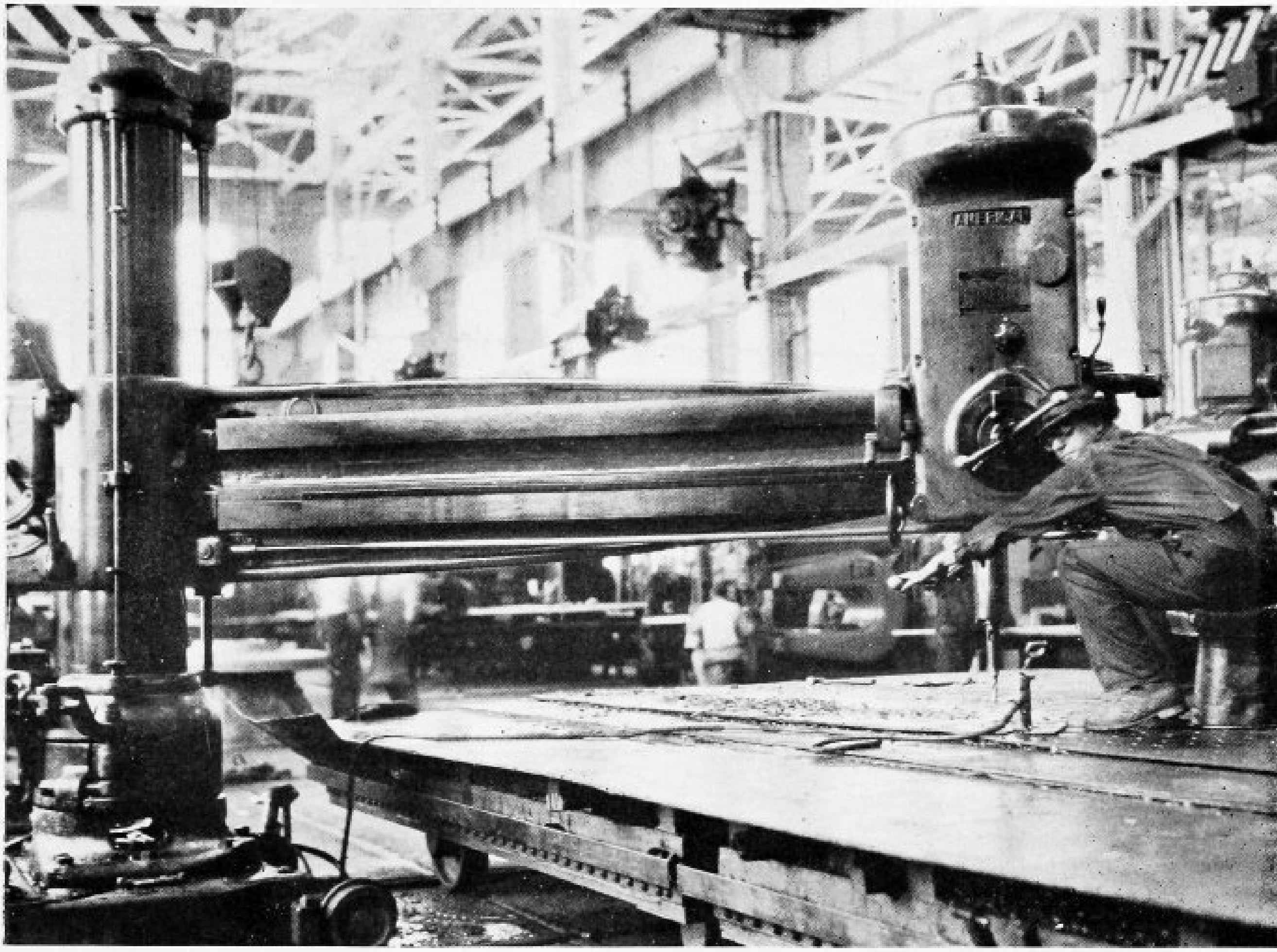
In the August and September issues, details and general operating methods of the new erecting shop of the Chesapeake & Ohio, Huntington, West Va., plant were described. The boiler shop, built in 1926 as the first unit of the new plant, still continues its operation as originally developed. Only such repairs as require the removal of the boiler from the frames are carried out in this shop, the capacity being nine or ten fireboxes a month. Facilities are also provided in the boiler shop for overhauling 50 locomotive tenders a month.

Of the 1900 odd men required at Huntington to produce a balanced output of 50 locomotives a month, 470 are employed on the boiler shop staff. As constituted on this basis, the staff is composed of: One department foreman; two assistant foremen; 7 gang foremen; 3 lead men; 176 boiler makers; 40 apprentices; 217 helpers, and 37 laborers.

In carrying out Class 2 repairs the flues and firebox are removed and the boiler proceeds to the sandblast shed, where it is cleaned thoroughly inside and out. It is then brought back to the boiler shop and the new firebox is applied. When a locomotive is built templates are ordered for all new power from the builders. All builders must conform to the same design in each class, so that all parts are interchangeable in that class. In the boiler shop, fireboxes are built in advance so that, when a boiler arrives for Class 2 repairs, all parts are ready for application. Class 2 and Class 3 repairs are centralized at this shop for the Chesapeake & Ohio System and for the Hocking Valley Railroad. All shop order

Special repair pit—large tender tanks





Practically all sheets are drilled three or four at a time

work—boilers, tanks, and the like, are required to conform to the Interstate Commerce Commission, Bureau of Locomotive Inspection regulations, the American Society of Mechanical Engineers' standards and the requirements of all states in which they operate and are stamped by state inspectors.

Class 2 repairs are carried out with the firebox off the frames. Since considerable interest was aroused at the last annual convention of the Master Boiler Makers' Association on the subject of time required to repair boilers on or off the frames, details of the work and man hours required for renewing fireboxes on heavy Mallet power are given below:

Cutting out flues at the firebox end and cutting the sheet away requires 5 man hours.

Flues are removed in 30 man hours.

The firebox sheets are removed and 3950 bolts are cut out with the oxy-acetylene torch; sheets are also cut away from the mud ring. The total time required for these operations is 85 man hours.

The mud ring is removed, heads of rivets burned off, corner plugs drilled out; a large special air hammer being utilized for removing the rivets. These operations require 30 man hours.

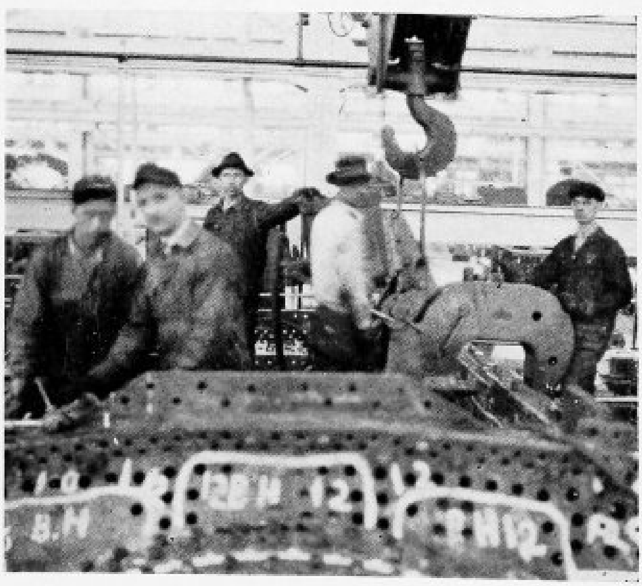
The mud ring is thoroughly inspected and repaired in 8 man hours.

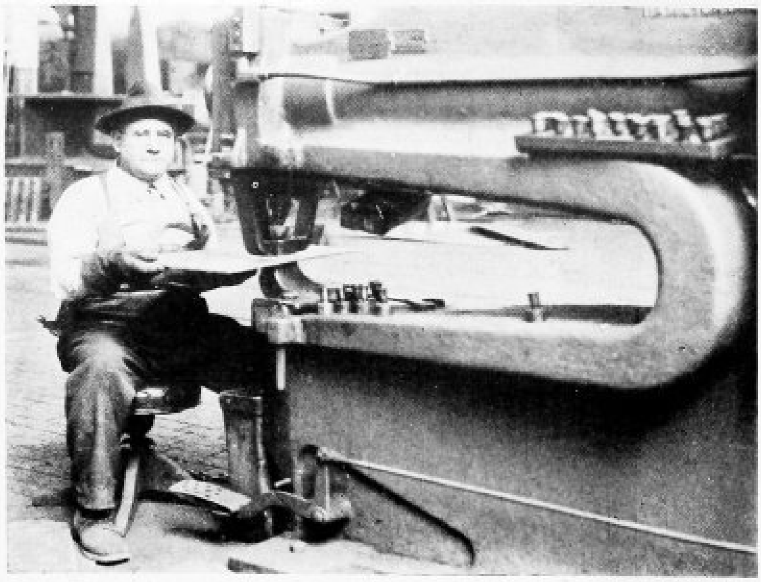
The mud ring then goes to the sandblast house and is cleaned inside and out, the time for this operation varying between 5 and 8 man hours, depending upon the hardness of the scale.

The sheets are placed on the drill press, in most cases two or three of the same class being drilled at a time. The proper template is placed on the sheet and all the holes drilled in the wrapper sheet, except for the mud ring. This requires 32 man hours for three sheets.

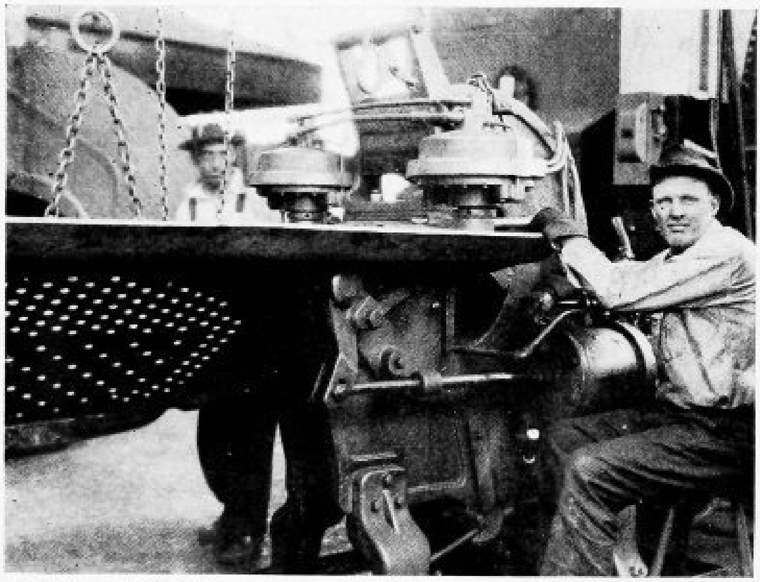
The same procedure is followed in the case of the flue sheets; the template in this case containing lead holes for the flue holes, which are drilled. Three to 5 sheets are handled in this operation at a time; 3 sheets requiring 6 man hours.

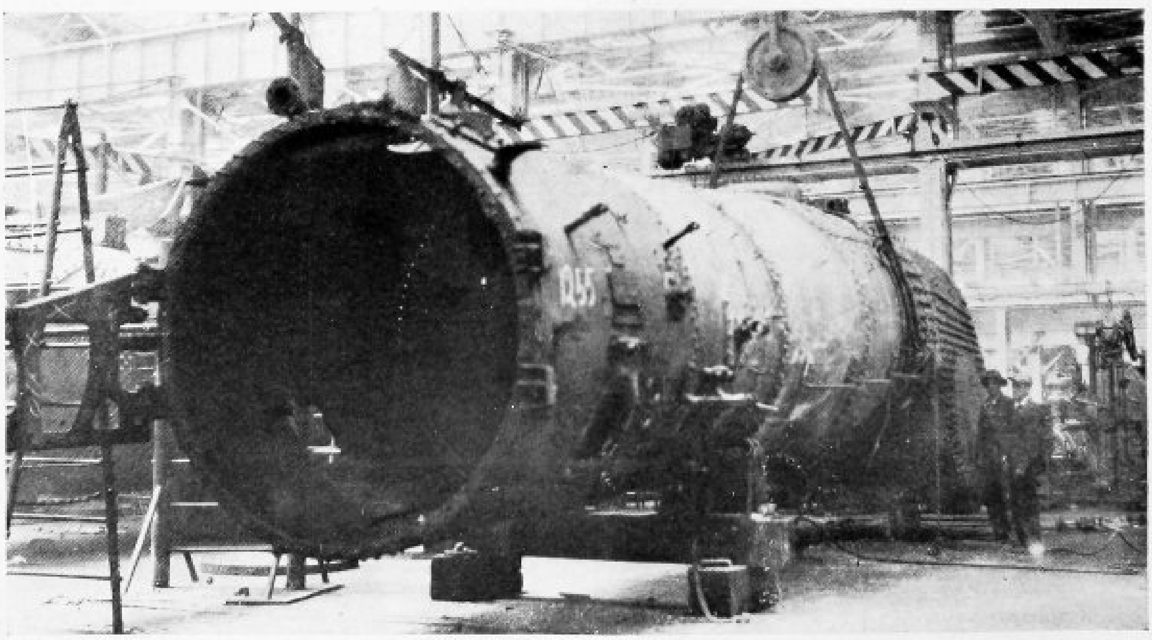
Riveting the mud ring

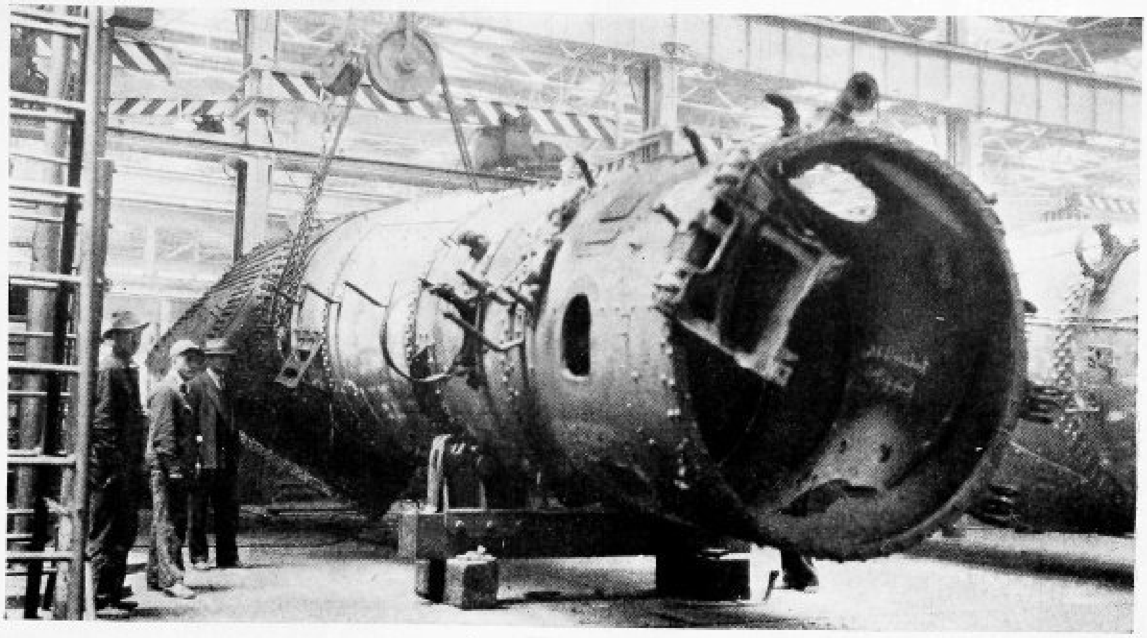


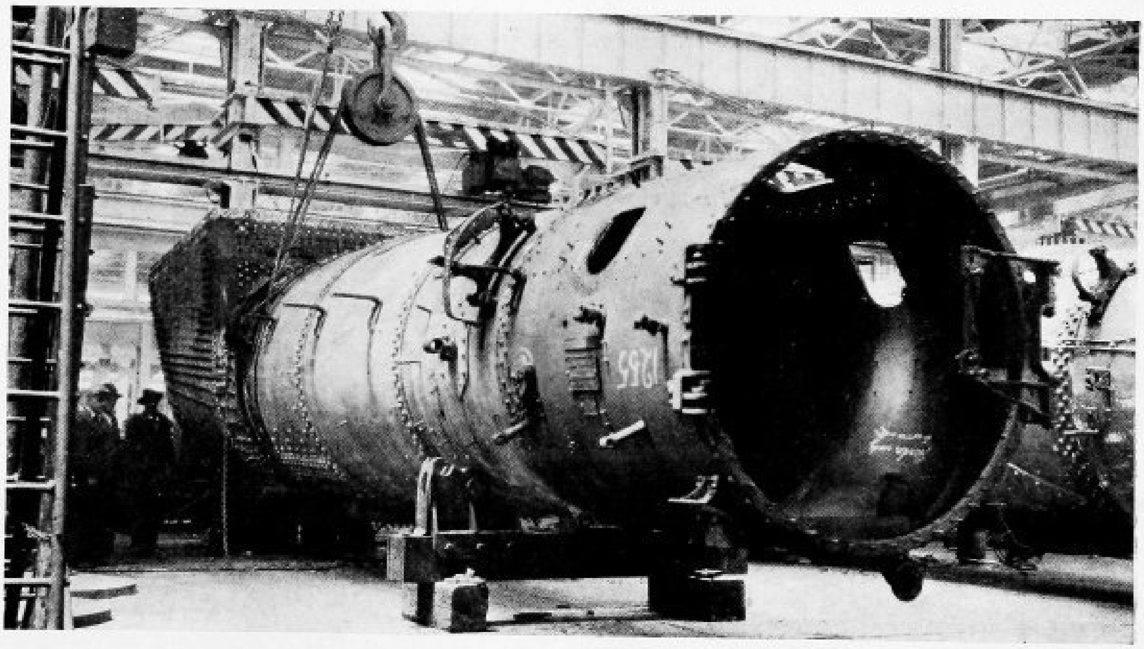


Upper left shows shearing operation on light plate, while below is the McCabe cold flanging machine at work on a firebox sheet. At the bottom is the start of the operation of rolling the boiler to receive the firebox

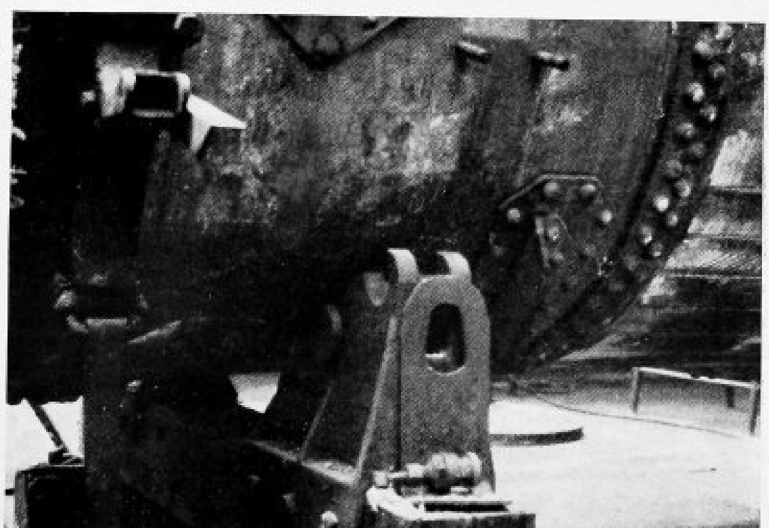








The top view shows the boiler partly turned, while below the boiler rolling operation has been completed and the slings are about to be removed. A detail view of the front end roller device is indicated at the bottom



If the flue sheets are hot flanged, they are pressed under the hydraulic flanging press. If flanged cold, the McCabe flanging machine is utilized. The method of flanging depends on the number of sheets requiring shaping, as it is not considered economical to start the furnace and set up the formers for one or two sheets. If hot flanged, 8 sheets are handled in a day's time with a mechanic and four helpers doing the work. This amounts to about 5 man hours per sheet. In cold flanging, one man can complete a sheet in 1½ hours' time.

In the case of the door sheets, they are placed on the layout table and laid off from templates, after which they are sheared and trimmed in 3 man hours. This sheet is flanged on the McCabe flanging machine in 1½ man hours.

Flanging the doorhole sheet is done on the hydraulic press and requires about 2 man hours.

Holes in the flanges of the door sheet and flue sheet are laid off in 2 man hours.

Burning and chipping the extra amount of flange from the door sheet and the flue sheet to provide calking edges occupy 6 man hours.

The wrapper sheet and combustion chamber, which are rolled in one piece, requires 6 man hours.

When the flue sheet and door sheet are applied and properly brought together with tack bolts, two boiler makers and two helpers complete the operation in 4 hours' time.

The inside throat connection is purchased from the builders already shaped. The laying out of this sheet requires a boiler maker and a helper 8 hours' time.

The drilling is completed in 3 man hours, while the extra lap is cut off and the sheet chipped by one man in 5 hours.

The sheet is next placed in the firebox and tack bolted.

The door sheet, connection sheet and flue sheet holes are all countersunk in the flat before bolting up. This requires 5 hours.

Riveting the door sheet, the throat connections and the flue sheet requires 8 hours' time of two boiler makers and three helpers.

The firebox seams, with the exception of the syphon seams, are welded in 78 hours.

Firebox seams and rivets are calked in 7 hours.

The firebox is next applied to the boiler, the boiler being turned at this point, as shown in the illustrations on page 311. The firebox is then placed in the boiler and the mud ring is applied. All firebox and staybolt holes are lined up with the outside wrapper sheet, after which the sheets are laid up to the mud ring corners and the mud ring rivet holes are drilled in the firebox sheet. These operations require 30 boiler maker man hours and 30 helper man hours.

The mud ring is riveted, using a Hanna portable mud-ring riveter slung from the shop crane. Seven man hours is required for this.

Applying the smoke tube, stoker tube, laying up the fire door to the back head and welding all these requires 36 man hours; the welding operations occupying 12 hours of this time.

Staybolt holes are tapped, the bolts are applied and then cut off with the torch. A total of 3950 bolts of all sizes is required for this class of power.

Holes are tapped at the rate of about 50 per hour for staybolts, while somewhat fewer radial bolts and crown bolts are tapped in this length of time. The total operation occupies 110 man hours.

Staybolts are applied and run in, in 160 man hours. Bolts are cut off with the acetylene torch. Of the total number, 650 crown bolts are cut off at both ends. This operation requires one boiler maker and one helper 24 hours. Bolts are driven in 90 hours by two boiler makers and two helpers.

Approximately 2500 staybolt caps are cleaned with a wire brush in 8 man hours. These caps are applied on a Mallet locomotive by one boiler maker and one helper in 16 hours. A special pneumatic wrench is used for this operation. The bolts are snapped and the flexibles are marked with a center punch by one boiler maker and one helper in 40 hours. The telltale holes in the staybolts are opened by one man in 8 hours.

Mud ring rivets and sheets are calked by one man in 24 hours.

Cement is next applied to the shell of the boiler by a laborer in 4 hours.

Flues are applied, run in, set, rolled and prossered at the back end and rolled and beaded at the front end in 56 boiler-maker man hours and 24 helper-man hours.

The flues are next electric welded in the back end. A total of 256, 2¼-inch tubes and 50, 5½-inch flues are included in this operation by a welder working 29 hours.

Forty-three Huron and Howsley washout plugs are applied to each boiler by one boiler maker and three helpers, working 12 hours. If these plugs previously have been applied, this operation is omitted.

Testing requires three boiler makers, working 8 hours.

Firing up to the allowed working pressure is done by a boiler maker and a helper in 8 hours.

The boiler is then removed from the boiler shop and placed on the locomotive frames for erection.

In fitting syphons the diaphragms are applied to the inside connection sheets by a special former under hydraulic pressure. For this operation one boiler maker and three helpers work 5 hours.

After the firebox sheets are riveted and welded together, the syphons are applied by butt welding the seams to the crown sheet, but leaving them loose in the throat connection until all staybolts are applied. After the staybolt application, diaphragms are electric welded to the syphon neck by one welder in 76 hours. Cutting out, fitting and bolting all necessary clamps and bars during these operations are carried out by one boiler maker and one helper in 40 hours.

Second Lincoln Arc-Welding Competition

The Lincoln Electric Company, Cleveland, O., has announced the Second Lincoln Arc Welding Prize Competition, in which designers and engineers may show their skill and ingenuity in utilizing the advantages of arc-welded construction. As a reward for their efforts $17,500 will be awarded for the forty-one best papers submitted in the competition. The jury of awards, who will judge the papers entered in the competition, will be composed of the Electrical Engineering Department of Ohio State University under the chairmanship of Professor Erwin E. Dreese.

In announcing this competition, which is the second to be sponsored by The Lincoln Electric Company, the sponsors are establishing a biennial competition which should be welcomed by industrial engineers and manufacturing executives throughout the world.

The forty-one prizes, to be given by The Lincoln Electric Company to the winners as selected by the jury of awards are: For the first prize paper, $7500; for the second prize paper, $3500; for the third prize paper, $1500; for the fourth prize paper, $750; for the fifth prize paper, $500; for the sixth prize paper, $250; and for the seventh to forty-first prize papers, $100 each. The closing date for the competition will be October 1, 1931.

Boiler and Tender
Corrosion and Pitting

This article is an abstract of a report on boiler and tender corrosion and pitting and what can be done in the boiler department to relieve the conditions; prepared by a committee consisting of O. H. Kurlfinke, chairman, and C. W. Buffington; presented at the May, 1930, convention of the Master Boiler Makers' Association, held in Pittsburgh, Pa. In years past this subject has been discussed at the Master Boiler Makers' convention under the title of "Boiler Corrosion and Pitting" and reports on it have, in most instances, been prepared along the line of water treatment. In considering the subject this year, the committee has confined its study to ascertaining what improvement may be made in the construction of the boiler and tender and the proper maintenance of each. Problems incident to water treatment are referred to chemists and water service engineers for solution.

Corrosion, which is a chemical action set up between the acids in the water and the metal, varies quite materially, depending upon the composition of the metal in the sheets and the nature of the acids in the water, but can to a great extent be overcome if the water can be kept moving.

Pitting, which is due to dissolved gases, occurs when the boiler is merely warm to a much greater extent than when it is hot and in service.

Preventative measures for both corrosion and pitting lie through the medium of keeping the water moving.

It would appear that the size of a modern boiler has contributed to corrosion and pitting because of the increased amount of water evaporated compared to years past, and because of the difficulty in stimulating circulation of the water, due to the increased length of the boiler.

Fig. 1 shows graphically the square feet of heating surface in designating the comparative sizes of two boilers. One is a 4-6-2 type locomotive without combustion chamber, built 18 years ago, having a total of 2749 square feet of heating surface, and the other is a modern boiler on a 4-8-2 type locomotive, with combustion chamber, having 4556 square feet of heating surface. The former has a maximum evaporating capacity of 32,701 pounds of water per hour, whereas the maximum evaporative capacity of the latter is 56,987 pounds per hour. The increase in heating surface is 65.7 percent, whereas there is an increase of 74.3 percent in evaporating capacity. The reason for the latter being greater is due to the firebox heating surface of the modern boiler being larger in proportion to the total heating surface, due to the combustion chamber. Furthermore, smaller boilers built 25 years ago on eight and ten wheelers had firebox heating surfaces equal to 10 percent of their total heating surface, but had an evaporative capacity of only 24,700 pounds of water per hour.

Fig. 2 shows graphically the relative miles per month made by the 4-8-2 type and the 4-6-2 type locomotives referred to. Considering the enormous increase in mileage made by the modern locomotive in long runs, compared to the manner of operation in years past, together with the increased evaporating capacity obtained and, after making due allowances for various operating conditions, it is estimated that the 4-8-2 type locomotive consumes 325 percent more water per month than the 4-6-2 type locomotive. You may visualize the enormous amount of water involved by referring to Fig. 3, which represents a tank 50 feet diameter in both instances. The larger tank is 56.51 feet high and the other 13.28 feet high.

So far as the past twenty years are concerned, the arch tube of common practice can be considered as the parent of all present-day heated elements, within the confines of a locomotive firebox, which take water from the throat sheet of the firebox and discharge it at a point above its intake in another portion of the water-carrying spaces surrounding the firebox.

Following the arch tube, there came into use the heated firebox elements known as Nicholson thermic syphons now commonly used by the railroads which pro-

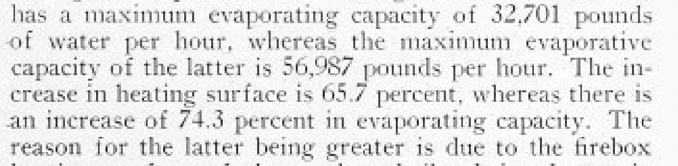


Fig. 1

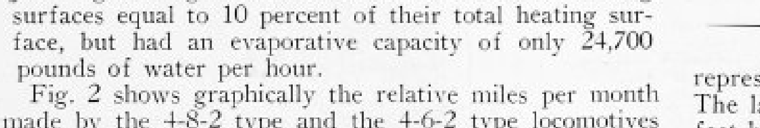


Fig. 2

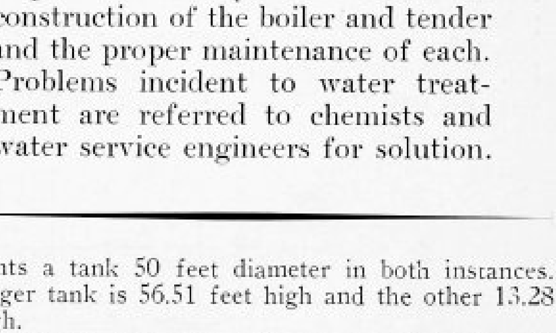


Fig. 3

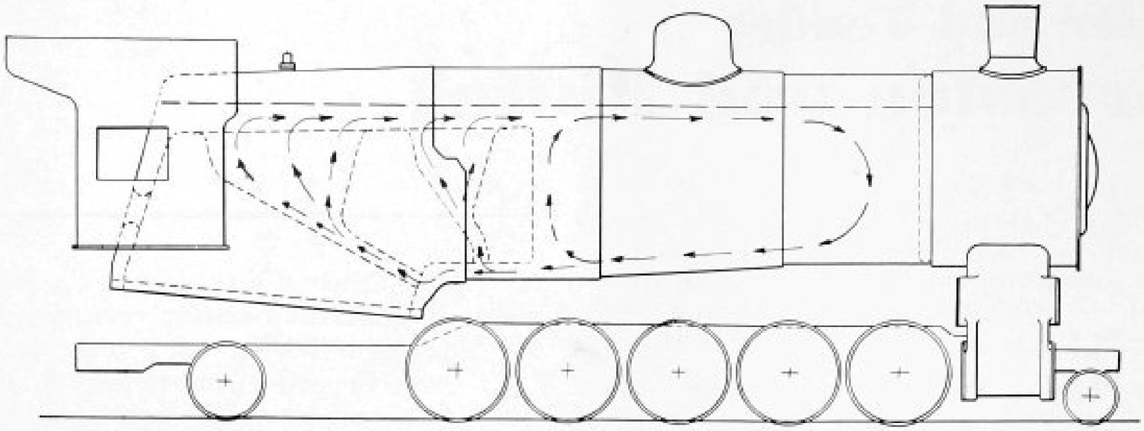


Fig. 4

vide many features and advantages of merit not possessed by the arch tube. This heated element takes its water from the throat sheet of the firebox in a manner similar to the arch tube and discharges it through the crown sheet of the firebox into the water spaces immediately above, Fig. 4.

Following the thermic syphon, there has come into use during the last two years the heated firebox elements known as the Martin circulator, which also, like the arch tube, takes its water from the throat sheet of the firebox and discharges it into the legs of the firebox closely adjacent to the lower portion thereof. In taking water from the throat sheet of the firebox, in the case of the arch tube of common practice, the front water leg resolves itself into a manifold or common water taking point, so that all heated elements connected thereto draw water from the barrel of the boiler via the front water leg, thereby putting into continuous circulatory movement the water in the barrel of the boiler with the water in the spaces surrounding the firebox to which the discharge outlets of the heated elements are connected, see Fig. 5.

From the foregoing it will be clear that, in so far, at least, as the three present-day heated firebox elements are concerned, all take water from the same point and obviously all discharge it above the point of intake. The points of discharge, however, of the arch tube, the Nicholson syphon and the Martin circulator are all different, the arch tube discharging through the backhead of the firebox, the syphon into the space on top of the crown sheet, and the circulator into the side legs of the firebox.

Continuous and rapid circulation of water through the barrel of the boiler means an equalization of the temperature of the water surrounding the tubes, greatly increasing their life and utility and aiding in preventing pitting and corrosion of boiler shell and firebox sheets.

In one locality locomotives equipped with thermic

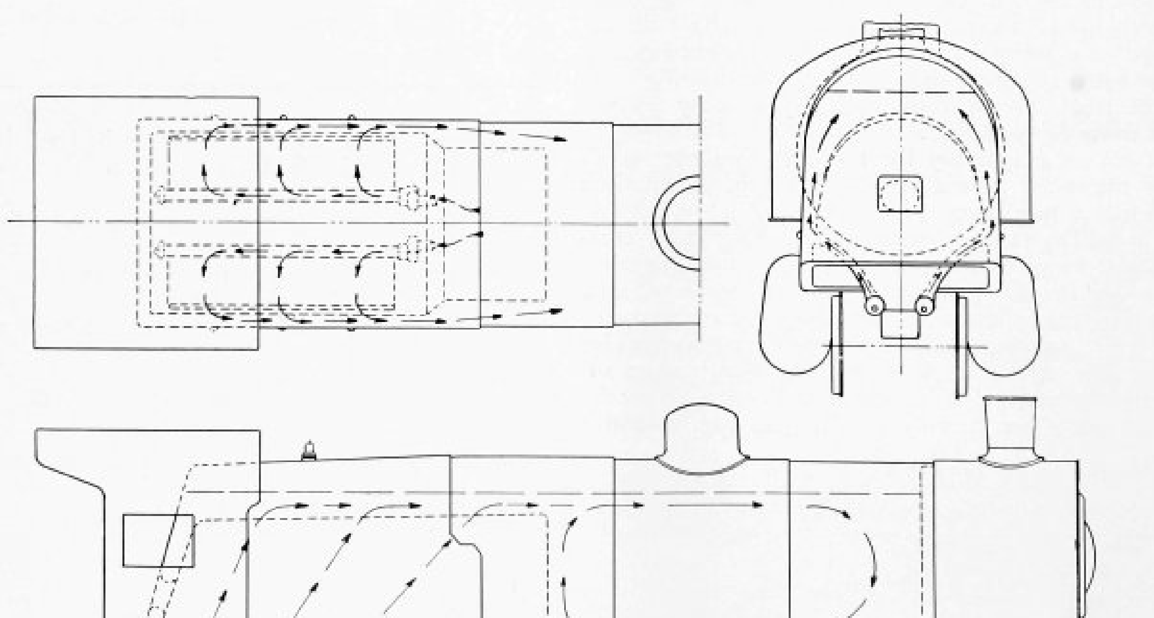


Fig. 5

syphons have shown positive evidence of preventing pitting, which deterioration is considerably more pronounced in other engines of the same class not so equipped, though operating under the same conditions. This is also true of the Martin circulator, it having been brought out in *Railway Age* of January 25, 1930, that there is no indication of corrosion or pitting of the side sheets, boiler tubes or shell in circulator-equipped engines after making double the mileage of a standard engine.

It is not expected that having a rapid circulation in the boiler will be accepted generally as the only means of preventing pitting or corrosion, for the reason that authorities tell us there are eight fundamental causes of pitting and corrosion in locomotive boilers. Any one of these causes, or any combination may produce pitting or corrosion. However, there is no question but, that, by keeping the water moving, considerable improvement will be obtained. It would, therefore, be reasonable to assume that comparatively large boilers built without any mechanical means being applied to stimulate circulation, and where the hand can be kept in contact on the outside barrel course without any ill effect, with boiler at full pressure, will sooner or later develop pitting or corrosion, irrespective of how good the water conditions may be. Circulation is just as essential when firing up a locomotive boiler when it is merely warm as when it is hot and in service. In this connection again refer to the interpretation as given above in reference to pitting.

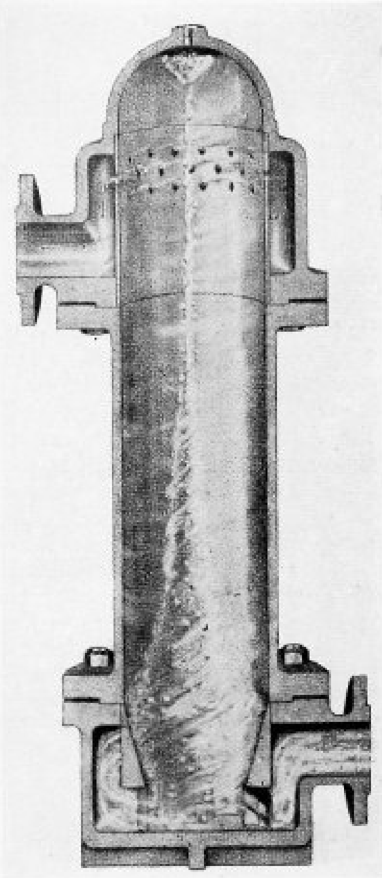


Fig. 6

At past conventions considerable thought and study have been given the "oxygen theory," and discussion brought out in connection therewith indicates that this phase of the topic should be given mention here, since the method concerning its treatment, we believe, centers in the adoption of some mechanical device apart from water treatment itself. Such a device may be a part of the boiler construction or an appurtenance thereto.

Considering the magnitude of this "oxygen theory" we believe this question quite significant and since the detail concerning the construction and the workings of such a device may better be presented by one thoroughly familiar with it, this committee has, therefore, extended an invitation to an able engineer to address you. The device you will hear about is standard equipment on several thousand locomotives on the German State Railways and is reported as giving satisfactory results with all types of waters. It prevents corrosion by the removal of dissolved gases as the feed water enters the boiler, allowing these gases to pass off with the steam. It brings about the precipitation of scale forming minerals and provides for their easy and efficient removal.

There is another known device in use whereby the oxygen is separated from the feed water. Briefly, this separation is brought about by a whirling effect, the centrifugal force displacing the bubbles of corrosive gas, causing them to collect in the vortex and rise to the top of the separator, whence they are drawn off and vented to atmosphere. An illustration of this is shown in Fig. 6.

The Southern Pacific Company, Pacific Lines, is operating Mallet locomotives of the 2-8-8-2 type having boilers constructed in two sections, one the boiler proper and ahead of this, with a chamber between, is located a preheater. The preheater has no steam space. The boiler feed enters the preheater at the bottom and discharges at the top where it is piped over to the check or the side of the boiler proper. The water circulation in the preheater is very sluggish and the boiler tubes, shell and tube sheet pit considerably, whereas in the boiler no trouble of this kind is experienced. The preheater tubes give on the average 27,250 miles while the boiler tubes gives considerably over twice this mileage. The water is of the best.

Several ideas were tried out with a view of overcoming the trouble. However, none were successful, that is, no improvement in the mileage of the preheater tubes was obtained until the air separator was applied. These separators were applied to each injector line in October, 1926, at which time a full set of new preheater tubes were also applied. These tubes were removed in August, 1928, and after 15 months actual service, made 32,074 miles. This engine was again shopped the first of April, 1930, and since August, 1928, has made 36,914 miles. These preheater tubes will be removed at this shopping.

The increased mileage obtained during these two periods, which is consistent, indicates that by the removal of the oxygen from the water, pitting has decreased considerably.

Laboratory tests conducted at the University of California indicate the Vortex type separator, as illustrated in Fig. 6, removes approximately 92 percent of the air.

We submit herewith for further discussion in boiler construction an idea for preparing the lower portion of the girth seams. In Fig. 7, *A* illustrates one of our worst enemies, the grooving of the shell plate at the inside calking edge. It can be said that the cause of this is due to the expansion and contraction of the boiler barrel. The same condition of the plate exists along the outside calking edge, but since there is no water action there to agitate it, deterioration of the plate does not develop.

By improving the design of the seam, this grooving may be overcome, see *B* in Fig. 7. The idea is to extend the lap from 1½ inches or so, the present practice, to say 5 inches or 6 inches, and thin or taper the

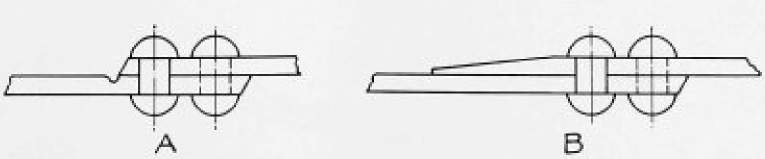


Fig. 7

plate gradually to the edge for the purpose of having this extension of the inner course absorb some of the stress that is now carried by the outer course. Instead of the hinge action taking place but at one point, it will be distributed gradually along the tapered portion of the inner course. This extension need be applied only on the bottom arc of the boiler barrel for about five feet or so and need not extend throughout the entire circumference.

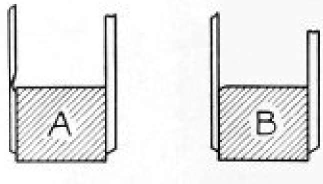


Fig. 8

The work and responsibility of the boiler department in combating the trouble and expense caused by corrosion, begins with the quality and care of the material. We should insist on obtaining the best material possible and it should be furnished in full accordance with specifications which have been approved by the American Railway Association for the purpose that it is intended.

Care should be taken of the materials before they are applied to the boiler, in order to prevent rust and atmospheric corrosion from starting and roughening the surface of the metal. There are a number of products which can be used for coating the steel to effect this protection. Some roads have been using "Oxaline," which is thinned with benzene before application, and good results have been obtained.

Care should be taken of the exterior to see that no leaks exist at seams, connections, or washout plugs, as leakage will cause sediment to adhere and corrosion with possible pitting will follow. Exteriors, where not exposed to direct rays of heat, such as internally fired boilers, should be kept dry and free from rust and painted or covered with lagging and jacketing.

Considerable grooving is experienced at the corners of the firebox at the top edge of the mud ring, principally on the door sheet and inside throat sheet. These are shown in Fig. 8. We believe this grooving is primarily due to the sheet being scarred or marked by a depression being made when the sheets are being fitted up while hot, brought about by the heavy hammer blows driving the sheet up against the sharp corner of the top edge of the mud ring. In Fig. 8, *B* shows the top corner of the mud ring with the edge rounded and the sharp corner eliminated, an arrangement that has proved useful in overcoming grooving at this point.

Where grooving is experienced such as on the top knuckle of the back flue sheet and similar heads, or around flues at the front end of long boilers, and in some cases ring pits around staybolts, improvement can occasionally be effected by application or a change in present bracing to offset the undesirable expansions and contractions which are causing the trouble.

The interiors of boilers should be thoroughly cleaned when repairs are made in the shop. To offset corrosion and pitting on the barrels of boilers, improvement is obtained by coating the barrel, after inspection, with a cement solution composed of three quarts of cement to one gallon of water. This solution is applied with a gun similar to a sand blast or paint spray. Further improvement has been effected by applying 40 to 80 pounds of soda ash in the boiler, depending upon the size, after the boiler work has been completed and the hydrostatic test applied, and before the boiler is fired up. This is done to clean any oil and grease from the surface and also to start a protective coating. After this has been done, then the control of water quality used is a matter for the chemist to frequently check and maintain.

It then remains for the boiler maker to see that proper care is taken of the boiler while in service. The chemist will separate the scalding solids from the water and much of this will go into the boilers in the form of sludge, which will gather on the mud ring principally at the back end. It has been found that this can best be taken care of by the application of blow-off cocks at the back corners, which will certainly keep the boilers clean when used properly, as the suction will draw out the sludge even from the front end of the boiler.

This blowing out of the dirty water must be done regularly and maintained systematically to accomplish best results. In many cases it will permit running engines the full thirty days between washouts, which is found to be of considerable benefit, by reducing the radical temperature changes in the firebox as well as effecting considerable saving in operation and engine time.

It has been noted that some corrosion and pitting was started by atmospheric rust while engines were laid up in storage. To overcome this trouble we have found it good practice to blow soda ash into the washout holes after the water has been let out. The spray gun does very well for this purpose.

Our experience with the prevention of tank and tender corrosion has been limited. Paints have been used which cannot be considered entirely satisfactory. On one road, which has had a test going on for the past two years to overcome serious pitting and corrosion on the interior of steel tanks in boiler washing plants, a coating of cement was applied to the sides and about two inches thick across the bottom. So far the results seem to have been very satisfactory. It would appear that it may be possible to obtain better results by coating the inside of tenders with cement than continuing the use of paint which has been unsatisfactory.

We believe that closer attention should be given to the cleanliness of the interior of the tender. While all the muck and filth may be taken out at certain intervals considerable improvement in preventing deterioration of the tender may be had if the tank is thoroughly washed out, and for this purpose

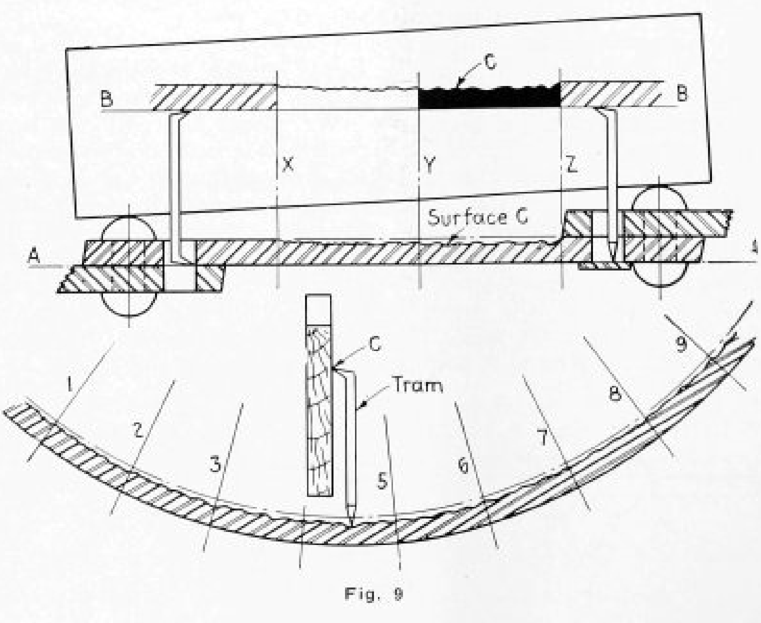


Fig. 9

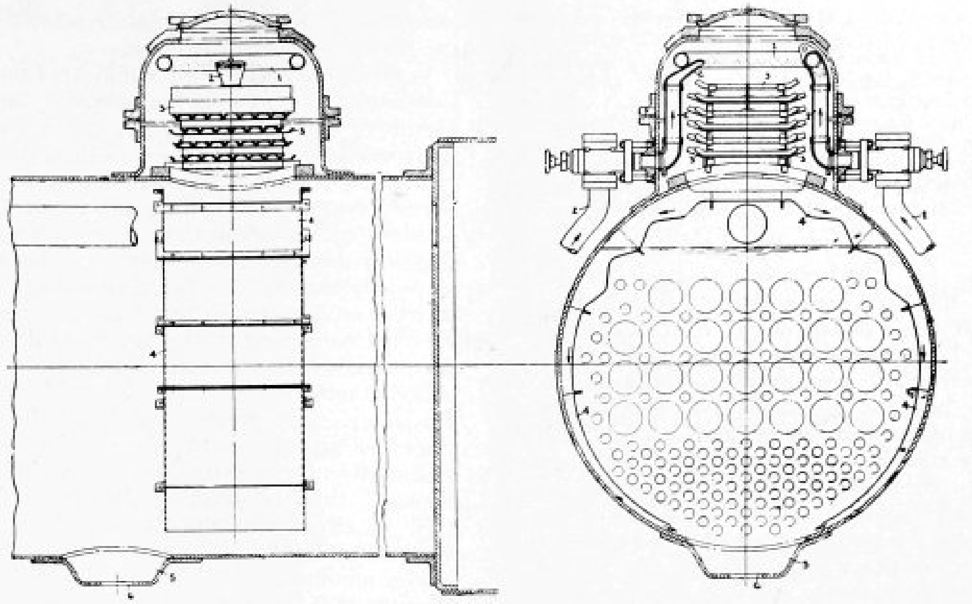


Fig. 10

washout plugs should be applied at advantageous points.

It is believed that one of the most important things that the boiler maker can do to improve corrosive condition is to keep in close touch with the water supply department, advising them promptly when and where pitting trouble appears to be developing, so that they will be in a position to take immediate action in correcting the water conditions where necessary in order to relieve the situation.

Before concluding we desire to present a definite method for calculating the factor of safety of a pitted shell plate. If this method is followed carefully we believe it will save considerable expense, either in the application of new shell plates or in determining the size of patches to be applied. Fig. 9 shows 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*. 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 line *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, whereas 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 five 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 greatest majority of the plate gives a factor below four a new portion of plate should be applied, but when following this method there is no guess work, and the reason for doing the work is easily explained.

In computing the factor of safety, it is best to ascertain if a record of authentic tests of the shell plate in question is on file and obtainable, otherwise the maximum figure of 50,000 pounds per square inch must be used. If authentic tests show the ultimate strength of plate to be around 58,000 pounds, considerable expense may be eliminated and possibly it will be found that a patch will answer the purpose, where otherwise a new portion of the shell course would be necessary.

Discussion

F. B. Horstmann, chemical engineer, Dearborn Chemical Company: It is the well founded opinion of most water engineers that the contributing cause of this corrosion is dissolved gases, particularly oxygen. The gases dissolved in the feed water, such as air, carbon dioxide, etc., can be separated from the feed water before the water enters the water space of the boiler by the installation of a device known as a feed-water purifier. Because of this purification, the following objectives are obtained:

First: The boiler plates and flues in contact with the water in the boiler are not subjected to corrosion and rapid destruction.

Second: The deposit of scale in the boiler is considerably reduced.

Third: With the early precipitation of the scale-forming solids and arrangements provided for their collection, the superheater tubes, valves and cylinders are not subjected to destruction as the boiler is more free from foam and the steam does not carry solids.

By the elimination of corrosion alone, the savings per year by large railway systems have been tremendous.

The feed-water purifier, shown diagrammatically in Fig. 10, is built up from the following parts:

First: A steam dome arranged on the first course of the boiler to be constructed for the individual locomotive according to the railroad's standard practice as a second or additional dome besides the dome for collecting steam.

Second: A feed-water pipe (3) leading from the boiler feed pump (1) through the feed-water heater (2) into the purifier dome and ending here in an annular pipe which is provided with small perforations for discharging the feed water into the dome.

Third: A feed-water pipe (4) which conducts from the injector into the dome, the end of which is constricted to subdivide the discharged water into a fine stream or spray.

Fourth: A set of superimposed grates of angle sections (5) which continue to subdivide the feed water and delay its downfall into the boiler.

Fifth: Two water pipes or separating plates (6) secured to the inner wall of the boiler for receiving the water from the set (5) and extending substantially to the bottom of the boiler barrel where the water is discharged into the water space of the boiler in two streams running one against the other.

The feed water supplied to the purifier dome by the feed-water pipe (3) has been heated from 190 to 220 degrees F. in the feed-water heater; therefore, when discharged into the purifier dome, it will immediately condense such large quantities of steam that a rush of steam is formed which moves towards the top of the dome from the boiler at high velocity. The feed water discharged from the small perforations of the feed pipe (3), and finely subdivided by being thus discharged, is on its way into the boiler intimately mixed up with a tornado-like steam current blowing from the boiler towards the top of the dome. Due to this counter flow, the temperature of the water after leaving the perforated pipe increases instantly and very rapidly. When it arrives at the top row of the set (5), it has been heated to about 290 degrees F., at which temperature not only considerable of the gases are separated from the water but a majority of the scale-forming solids are precipitated. The water now flows down through the set (5) while its direction is varied and subdivided and its particles are exposed to the rushing steam so that finally, upon leaving the set and before arrival at the water level, the feed water is heated practically to boiler temperature. Under these conditions, a majority of the scale-forming solids should be precipitated and, during this heating and purifying process, the speed of the rushing steam will be so great as to wash out the separated gases immediately from the dome into the steam space of the boiler from which they will be discharged with the steam flowing through the throttle into the cylinders to be exhausted into the atmosphere.

With the scale-forming solids in the feed water properly provided for, either by external or internal treatment, and with the mud which accumulates in the boiler regularly removed by the systematic use of the blow-off, flues and sheets have been found practically clean and have almost a bright metal surface after six months' operation.

Corrosion has never been found on the inner walls of the dome and the steam space of the boiler in locomotives equipped with the feed-water purifier but, in exceedingly bad corrosive water districts, corrosion starts on the top row of the easily and cheaply replaced angle sections (5).

Should solids precipitated from the water deposit on the set (5) while water is flowing down or should purifier dome require inspection or any repairs, the opening, cleaning, repairing and closing can be performed by two men in not more than two hours' time. The water leaving the set of angle sections (5) contains considerable separated or precipitated solids; in order to remove the majority of this residue from the boiler, the water is conducted down to the bottom of the boiler barrel by the two pipes or separating plates (6) where, as the water currents from the pipes meet in opposite directions, a sort of backwater is formed which permits the solids to deposit in the mud pocket (7) where they are discharged by the blow-off cock (8).

In the treatment of boiler feed water by the internal method, where reactions develop under operating heat and pressure, the feed-water purifier assists by the removal of excessive amounts of dissolved gases and, at the same time, aids the internal treatment by speeding up the physical-chemical reactions.

C. A. Seley, consulting engineer, Locomotive Firebox Company: The foregoing speaker has outlined what chemistry and chemical means can do to correct some of the conditions that make for pitting, corrosion and other causes for repairs and maintenance, further stating that the structural stresses brought about by unequal temperature conditions in the boiler cannot be controlled by chemical means. These unequal temperature conditions may be eliminated by the installation of the Nicholson thermic syphon, which takes the bottom water from the forward section of the boiler, heats it, and thereby produces a mixture of water and steam within the syphon, which is much lighter than the solid water elsewhere in the boiler. The greater weight of the solid water displaces the lighter mixture by gravity, causing it to flow up and over the crown sheet. In seeking its level it flows forward, thus establishing the forward direction of a cycle of circulation, not accomplished by any other of the heating surfaces.

The amount and extent of the thermo-syphonic circulation thus promoted is not generally understood or appreciated, many regarding the syphon as simply additional heating surface to the firebox, and of similar evaporative value. By reason of the promoted circulation, a great amount of water is passed through the syphons by the operation of the natural law of gravity as above explained, so that all the water in the boiler is circulated several times an hour.

Records of similar thermic syphons applied to Scotch marine boilers showed the remarkable fact, that during operation and lay-overs under steam, the water at the bottom was as hot as the top water, at or close to the steam temperature. This proved there was complete circulation of the boiler water, with all the water hot and put to work, which is not the case generally with Scotch boilers, which have cold bottoms. What little differences there may be in top and bottom water temperatures in locomotive boilers equipped with thermic syphons are due to the greater length of the cycle, method of feed-water introduction, greater radiation from exposure of locomotive use, as compared with the insulated and housed conditions of marine boilers.

That good results have been obtained by the use of thermic sysphons in increasing the life of flues, cleaner boilers and reduction of maintenance and of greater serviceability of the locomotive as a whole, is well attested by the thousands of them in service, and the number of railroads here and abroad that have adopted their use.

F. J. Jenkins, general locomotive inspector, Texas & Pacific Railway Company: The reference in the committee report relative to doubling the life of firebox, tubes and boiler shell by the use of the Martin circulator deals with the locomotives of the Texas & Pacific Railway equipped with this structure. I desire to mention particularly one of the locomotives so equipped as an outstanding example of the value of rapidly circulating water in extending the life of the firebox and boiler by arresting pitting and corrosion. I refer to Santa Fe Type Locomotive No. 533. The average life of fireboxes on our Santa Fe type locomotives is about four years. In November, 1928, when engine No. 533 was shopped, the firebox was three years and five months old. Examination of the firebox showed that the crown sheet was slightly pitted. Martin water circulating tables were applied to the firebox of the engine at this time and engine assigned to service on the Ft. Worth division making 50,149 miles to January 1, 1930.

In February, 1930, engine was placed in Marshall Shops for Class 5 repairs. Personal examination of the firebox, boiler and flues of this engine on February 12th showed that crown sheet was perfectly clean and pitting had not progressed any since the circulating tables were applied. All parts of the firebox, boiler and flues were in good condition and flues would run to another shopping for machinery repairs of this engine. The barrel of the boiler was clean, the flues were coated with very thin scale to much less extent than engines of this class not equipped with the circulating tables show after making this number of miles between shoppings.

Condition of the firebox, boiler and flues of this engine at the present time thoroughly indicate that the life of the firebox and flues is being preserved by the benefit derived from this water circulation. Without the water circulating tables, the firebox in this engine would no doubt be in such condition at this shopping that it would require renewal.

By keeping the water moving which is now dormant in the legs of the firebox and around the tubes and shell of the boiler, corrosion and pitting apparently cannot get started as the amount of air held in solution in the hot circulating water is so little that no concentrated effect is produced against the sheets and tubes.

Ira J. Pool, district boiler inspector, B. & O. R. R.: In order to arrest pitting and corrosion, for the last two years we have been using lime soda treatment quite extensively, and where continuity of treated water could be furnished the results have been very satisfactory. We found it necessary to apply an additional blowout cock to the back quarter of the firebox. All boilers are blown out on arrival and departure from terminals, and directly by the engineman on the road. With that arrangement, we have not only greatly reduced pitting and corrosion, but we have been able to extend the boiler washout period from ten to thirty days.

R. E. Coughlan, Supervisor of Water Supply, C. & N. W. Ry. System: As a rule boiler makers are not in favor of protective coatings in storage as it makes laying out a difficult matter. Protective coatings applied to flues and sheets after being applied are a temporary relief and not the true solution to elimination of corrosion.

Some of the railroads have found that where it is possible to coat the inside of boilers as well as the surface of flues with a slight lime scale using treated water that pitting and corrosion has been retarded. In order to succeed with this method it is necessary to have sufficient softening plants and competent supervision by trained men to supply a uniform quality of water at each plant daily. The ordinary scale found in practically all boilers using natural water will not answer the purpose.

The counter electrical device used in combination with arsenic has made new friends during the past year. It has been our good fortune to have six locomotives in different territories equipped with this device, all of which show decided improvement and while it is not as yet claimed that they are one hundred percent they are without question almost to that point.

The method of carrying high treatment of soda ash still rates very high where operating conditions and facilities enable a uniform quality of water to be supplied at all stations.

The elimination of oxygen by preheating has been very successful in stationary plants and although some of the railroads are claiming excellent results in locomotive boilers, it is my humble opinion that this method is still in the experimental stage with regard to locomotive boilers and that much work is still to be done, before this method will be applicable to all locomotives.

J. B. Wesley, engineer of water service, Missouri Pacific R. R.: While no positive control or preventative of pitting and corrosion has been developed or discovered, progress has been made. Methods for decreasing this trouble have been found. The passing of a properly controlled electric current through the boiler, especially in the presence of a plating solution in the boiler, will undoubtedly produce beneficial effects. The use of open type feedwater heaters, or any other device to rid the water of dissolved gases before it mixes in the body of the boiler, will be of benefit. Close attention to the nature of the metal used in the boiler structure and to the handling of the metal in the course of working will be richly rewarded. Maintaining hydrate alkalinity in the feed water meets various conditions with gratifying results. We of the Missouri Pacific, by softening our boiler waters by the application of lime and soda ash, prevent scale formation and have present in the feed water through the required excess treatment sufficient hydrate alkalinity to protect against corrosion. Thus we find that corrosion prevention is obtained as a by-product of water softening. We do not claim that this is the most practical or the most economical method under all conditions, neither is it a cure-all to be used under all conditions. But it is the method that has produced gratifying results on the Missouri Pacific during a period of years.

In discussing the subject of boiler corrosion it is necessary to mention the benefits derived from the use of hot water for washing. There is reduced contraction and expansion of metal where the boiler is not completely or rapidly cooled, resulting in less metal fatigue with corresponding reduction in corrosion. Our boilers are washed with water having a temperature of 120 to 140 degrees, nozzle pressure being 100 pounds. This produces maximum dirt and scale removal with a minimum of metal contraction, reducing the probability of corrosion.

R. C. Bardwell, superintendent of water supply, Chesapeake & Ohio R. R. and Hocking Valley R. R.: Emphasis in the committee report was placed on the benefits of increased circulation. In the acid water territory in West Virginia, through the coal fields, increased circulation, unless something is done first to neutralize the acid effect of the water, will create a great deal more severe corrosion.

If you can avoid adherent scales you avoid another possibility of corrosion. There is no question but that hard scales on a boiler will cause corrosion, and it is assisted in this by uneven expansion and contraction.

There is also the question of extending the period between washouts. We have found that to be a great help in reducing the trouble. To increase the time between washouts, it is necessary that blowing down the boiler be handled properly.

Dr. C. H. Koyl, engineer water service, C. M. & St. P. R. R.: There are a great many things that will help to prevent excessive pitting, but when it comes down to the final method of preventing iron from dissolving in water, it means this: If you find some method of preventing the hydrogen ions being pushed out of the water, you have stopped all pitting, because an atom of iron cannot get into the water unless it can chase out an atom of dissolved hydrogen.

Now there are various ways of doing that. You have heard them talking this afternoon about stopping pitting by getting the oxygen out of the water. Oxygen doesn't eat up iron in the sense that acid eats up iron. Oxygen in water or the action of oxygen in water is such that it gets these hydrogen ions out. That is the way, the means, by which oxygen increases pitting.

If you can dissolve a few atoms of iron from a flue in the water, the little atoms of hydrogen that are chased out gather around the other parts of the flue. Pretty soon they make a film of gas around the flue, and when the flue is covered the rest of the interior of the boiler is covered by this film of hydrogen. No longer can atoms of electrified hydrogen, what we call ions of hydrogen, reach the flue to give up their electric charge. They can't get through this little film of gas that surrounds the flue. When no more ions of hydrogen can be chased out of the water, pitting is all over. That is the reason oxygen should be kept out of boiler water, simply because it eats up this little film of hydrogen which protects the metal. That is the only reason.

Now there are other methods. A method which is in use quite extensively throughout the country is to cover the inside of the boiler with arsenic. That has practically the same effect as covering the flues with a film of gas. That protects the flues from the hydrogen ions getting to them and delivering up their electric charge.

Howard L. Miller, metallurgist Republic Steel Corp.: The corrosion and pitting of locomotive boilers and tenders presents problems to the maker of steel which involves two questions, namely, efficiency of the metal in resisting corrosive conditions, and the cost of the metal itself. Metals can be produced which will effectually resist corrosion, but whose cost places them beyond commercial application. Other metals have certain resistance to corrosion and are commercially applicable to the locomotive.

In regard to boiler tubes, two different alloys are at present being tried out in service tests in locomotives in different parts of the country. One of these is an alloy of iron containing ½ of 1 percent copper and a small amount of molybdenum. The other contains an addition of 2 percent of nickel, to ordinary low carbon steel. These metals both come in a range of lower cost alloys and are within the realm of commercial application. The results of service tests in most of the localities have shown that they have a definite superiority over ordinary steel or iron tubes.

In regard to staybolts a different problem is reported as staybolts are subjected to both corrosion and mechanical stresses or fatigue. Staybolts can be made of materials which have a high fatigue resistance but low corrosion resistance and when placed in bad water conditions they will fail, due to corrosive attack in the strained portions. Other materials will have high corrosive resistance but low resistance to mechanical stress; in other words, low elastic limit. Bolts of this type will fail due to lack of strength. The ideal staybolt must present a condition of high fatigue resistance and high corrosive resistance.

Materials containing copper and molybdenum or nickel present good resistance to corrosion and fair resistance to mechanical stress in hot-rolled condition. If heat treatment is applied to these materials so as to bring the strength of the bolt, up to or even with the strength of the wrapper sheets, much longer life will be obtained.

In regard to shell plates, recent development in increasing pressures have brought about the use of the nickel alloy steels and some copper bearing steels are being made which have higher physical properties than regular carbon plate and offer increased resistance to corrosion in pitting. Service tests of this material have been in progress during the last two or three years. The time element necessary in making tests of this character is of necessity so long that rapid results cannot be obtained.

Firebox Plates present problems similar to the staybolt, namely corrosion and fatigue; also much higher temperatures are involved with accompanying problems of unequal expansion and contraction due to changes in temperature. The ideal material of firebox plates should have high physical properties, high resistance to corrosion and thermal expansion should be as low as is possible to obtain. Such a material in the form of an 18 percent chromium iron has already been tested out in service for a long enough period to demonstrate conclusively in regard to pitting, corrosion and cracking around the staybolt holes, that it is greatly superior to the ordinary firebox plates now in general service.

The locomotive tender presents a different range of problem than those presented by the boiler. In the water part of the tender we have water containing larger amounts of free oxygen in summer and winter temperatures than in the locomotive boiler. Atmospheric corrosion of the plates is more prevalent due to the splashing action on the sides. Water conditions vary greatly according to the source of water supply and set up different problems in regard to corrosion resistance of the metal in different territories. In the coal part of the tender corrosion is due mainly to the atmospheric oxidation of the sulphur in the coal and the water or moisture contained in the coal itself. Wet coal and the use of the squirt hose are the principal reasons for the high rate of corrosion in the coal bin and the front plate of the locomotive tender. Sulphur in the coal in contact with water and air forms sulphuric acid, heated water from the squirt hose increases the formation of sulphuric acid. Water drip from coal cars standing on sidings has been found on analysis in many cases to contain as high as 5 percent of free sulphuric acid. Also percentages of iron sulphate, which indicates that some of the sulphuric acid had attacked the iron plate of the car and formed iron sulphate which was being carried off in the water which drips down from the coal cars. Tests in the coal mines on pipe lines made by various materials in the last four years have proven in every instance that the iron, copper, molybdenum alloy offers the greatest resistance to corrosion of sulphuric acid in water, which is found in waters in the coal mines. I would qualify this by saying that it offers the greatest resistance to corrosion to be found in a low cost material. Other alloys are made which offer higher resistance to corrosion on this type, but would be commercially of very doubtful value due to the high cost of the material. An experiment has been proposed of applying thin sheets of the high cost metal over the surface of ordinary steel. The high cost metal to be spot welded to the ordinary steel plates. We hope to give you more definite data on this problem at the next meeting of this association.

Dr. R. E. Hall, Director of the Hall Laboratories, Inc.: I will talk from the standpoint of water only. Coming from the field of stationary boilers, I have been trying to size up the points of similarity and of dissimilarity in the problems that face you gentlemen and in the problems that face us in the stationary field.

Your problem is more difficult. We have enough trouble maintaining the conditions we desire in boilers that are stationary. You have to maintain those conditions in boilers that are in motion.

Alkalinity in the water is some help, but you can't prevent the concentrates forming on the surfaces and running down along the sides and intermingling with the other water, causing a difference of concentration and causing corrosion, that it seems practically impossible to obviate completely.

As regards material, I might say, that it is not so much a question of material unless you get a large enough percentage of alloy to be really effective. In other words, iron in contact with water is going to dissolve if it can, and to prevent that dissolution it becomes a problem of keeping the water in such condition that the iron can't get into it.

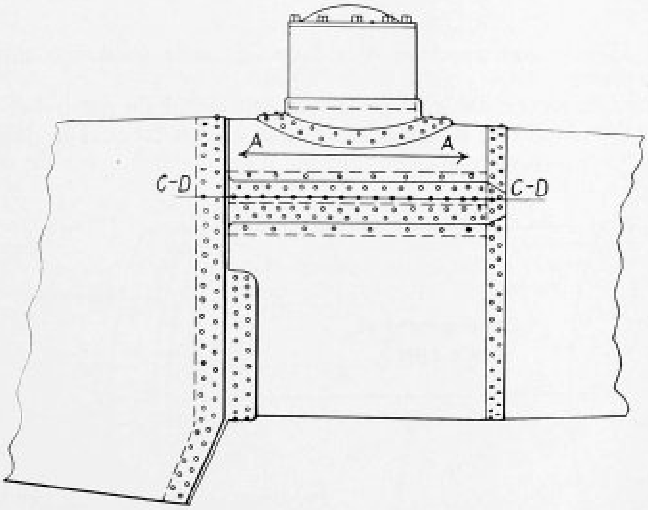
Now in stationary plants, our thought, is deaeration. Get the water as free as you can from oxygen. The limit of oxygen leads to the question of alkalinity and to the question of circulation. If water contains enough oxygen for a bubble to form on the surface and cling there, then under that bubble you haven't the conditions of alkalinity that are in the surrounding water, but you have a limited area of surface on which pure water may condense, and you have all the elements set up for corrosion at that point. If you have sluggish speed then a bubble of air will form and stick more readily than if you have accelerated speed of flow, and so circulation certainly plays a large part.

There is one other point that I might mention and that is stresses. At the Naval Experiment Station at Annapolis they have developed a conception of endurance limits under corrosive conditions as opposed to central strength. For all your common steels, unless you are willing to go to high chromium steels, your endurance limit is about the same for any of those that you are using. Unless you are willing to go to the alloys there isn't any great point in the choice of material.

Renewal of Dome Sheet

By Chris S. Handlee

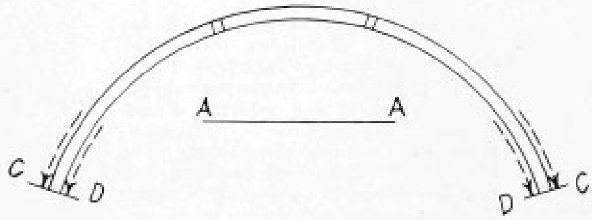
The enclosed sketch represents the dome sheet of a locomotive-type boiler. These sheets frequently require renewal, due to cracking at various points. The method of laying out the same is very simple but accurate. First, after the plate has been cut out of the boiler, measure



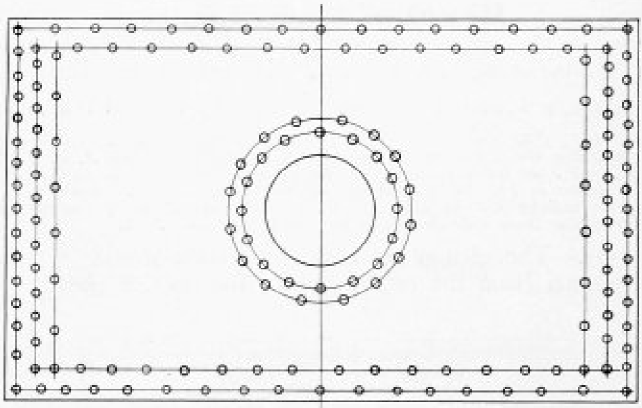
Locomotive boiler showing dome sheet to be removed

the sheet with a traveling wheel on the inside along the girth seam rivet line from *C* to *C* of the outer row of rivets in the longitudinal seam and mark the distance on the wheel. Then with the traveling wheel, measure the sheet over the same points on the outside and mark the wheel.

With these measurements the new sheet can be laid cut. Assuming that the new sheet has been squared up and the girth seam rivet lines established, then run the wheel over the rivet line and mark both the short and long mark, or distance of the old sheet; then divide the difference and said point will be the correct length



Lines C-D Through Outer Row of Rivets in Longitudinal Seam



Layout of new dome sheet

of the new sheet, *c-c-d-d*. It makes no difference if the new sheet is a third of or half a circle. The same method will cover all the parts of the circle.

After the girth seam rivet holes are laid out, and the connections of the new sheet are made to the old longitudinal joints, it is best to make the sheet-iron template and lift the holes, marking the same on the new sheet.

The dome connection can also be laid out by using a sheet-iron template and carefully locating the center holes. The holes on the sides of the dome flanges, however, should be drawn small. The amount can be worked out by measuring the old sheet on the inside and outside and one half the difference will be drawn.

Personal

Charles W. Pendock, president of the Le Roi Company, Milwaukee, Wis., has been elected a director of the Independent Pneumatic Tool Company, Chicago, Ill. The Le Roi Company manufactures the gasoline engines which are used exclusively in the Independent Company's Thor portable air compressors. Mr. Pendock succeeds the late William A. Libkeman, who was a director of the company for many years.

W. S. Stewart, formerly in charge of the Pacific Coast offices of the Lincoln Electric Company, Cleveland, O., has been appointed district manager in charge of the Cleveland territory with offices at the factory, Coit road and Kirby avenue. Mr. Stewart is a graduate of Yale University.

Questions and Answers Pertaining to Boilers

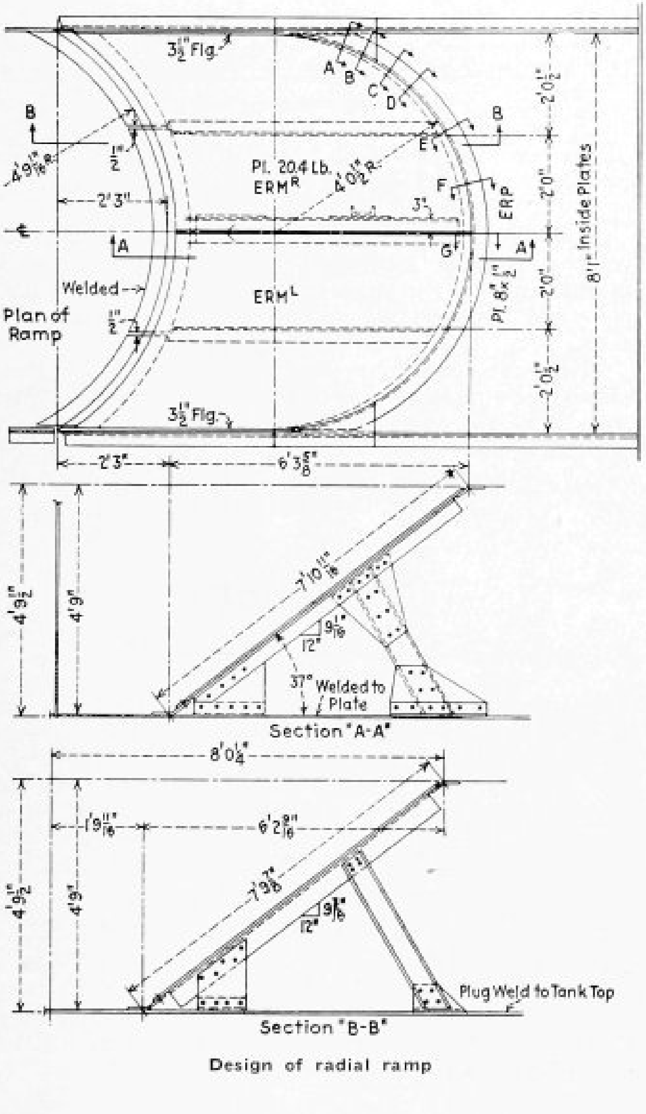
This department is maintained for the purpose of helping those who desire assistance on practical boiler shop problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor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

By George M. Davies

Bevel of Radial Ramp

Q.—The accompanying illustration shows a ramp. It was easy to develop by triangulation the plate *ERM* $\frac{R}{L}$, but the small bent portion 8 × ½ *ERP* was quite difficult so I would like to know just how to determine the change in the bevels as shown by the arrows *A, B, C, D, E,* and *F* or taken as a section thus shown. The bevel at section *A-A* is shown as $9\frac{1}{16}$ over 12 and section *B-B* is $9\frac{3}{16}$ over 12. However, sections radially will be different and I would like to know just how to determine these different bevels for above problem. A. P.

A.—The change of bevel as shown would be continuous from the center line to the outside sheet.



Design of radial ramp

This change can be calculated for any given distance out from the center line by the method as shown in

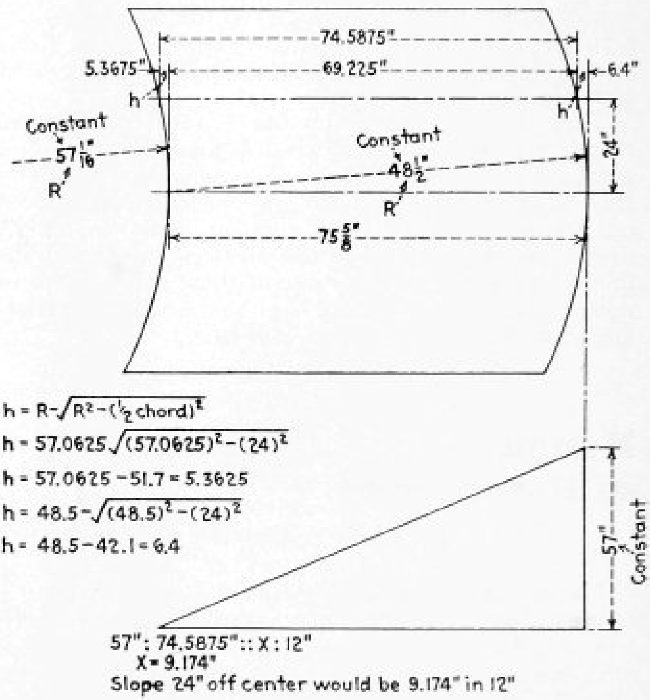


Fig. 1.—Method of calculating bevel in ramp

Fig. 1, and a set of dies may be made to flange this plate.

However, the change is so small that I do not believe this would be necessary. The plate *ERP* could be laid

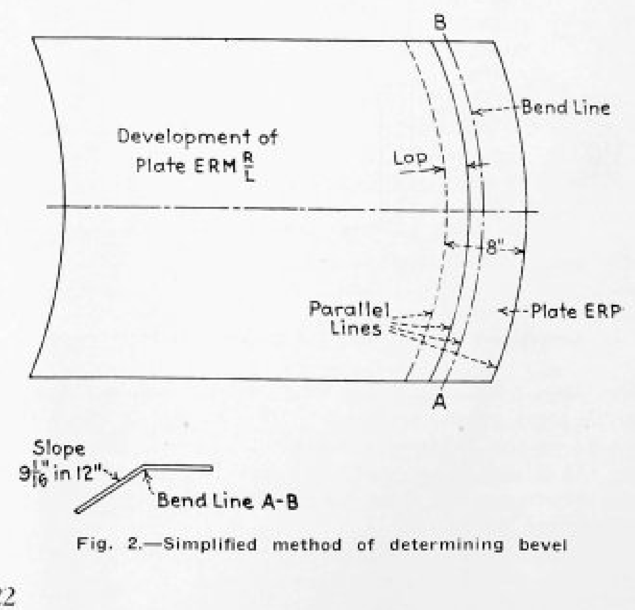


Fig. 2.—Simplified method of determining bevel

out for all practical purposes from the development of the plate $ERM\frac{R}{L}$ as illustrated in Fig. 2.

The slight change in bevel could readily be taken care of when fitting the plate.

Strength of Dished Heads

Q.—The radius of the dish in a head is to equal the diameter of the drum. If we decrease the radius of the dish so as to make it deeper will this give greater strength? If so, will you please print the formula. This is for air tanks on engines; for instance, a 22-inch diameter tank. A. J. R.

A.—The A. S. M. E. rules for the construction of unfired pressure vessels gives the following rules for the design of dished heads:

U-36. The thickness required in an unstayed dished head when it is a segment of a sphere shall be calculated as follows:

For $P \times L$ equal to or less than $1/2S$:

$$t = \frac{3PL}{4S} \text{ for pressure on concave side}$$

$$t = \frac{5PL}{4S} \text{ for pressure on convex side}$$

For $P \times L$ greater than $1/2S$:

$$t = \frac{PL}{2S} + \tfrac{1}{8} \text{ for pressure on concave side}$$

$$t = \frac{5PL}{6S} + 0.2 \text{ for pressure on convex side}$$

where

t = thickness of plate, inches
P = maximum allowable working pressure, pounds per square inch
L = radius to which the head is dished, inches
S = maximum allowable unit working stress of 11,000 pounds per square inch for steel plate stamped 55,000 pounds per square inch and 10,000 pounds per square inch for steel plate stamped less than 55,000 pounds per square inch

Where two radii are used, the longer shall be taken as the value of L in the formula.

Where the radius is less than 80 percent of the diameter of the shell to which the head is attached, the thickness shall be at least that found by the formula by making L equal to 80 percent of the diameter of the shell.

When a dished head has a manhole opening, the thickness, as determined by these rules shall be increased by not less than ⅛ inch over that called for by the formulas.

U-37. When dished heads are of less thickness than determined by Par. *U-36,* they shall be stayed as flat surfaces, no allowance being made in such staying for the holding power due to the spherical form. If a dished head is formed with a flattened spot or surface for the attachment of a connection or flange, the diameter of the flat spot shall not exceed the value of p as given in the formula in Par. *U-40,* or in Table U-3, for the pressure and thickness of head involved.

U-38. The corner radius of an unstayed dished head measured on the concave side of the head shall not be less than 3 times the plate thickness up to $t = \frac{1}{2}$ inch. For thicker plates the corner radius shall not be less than 3 percent of L and in no case less than 1½ inches.

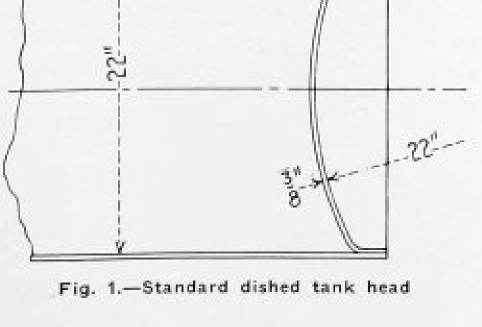


Fig. 1.—Standard dished tank head

U-39. A manhole opening in a dished head shall be flanged to a depth measured from the outside of not less than 3 times the required thickness of the head.

Applying these rules to the problem, we have the following examples illustrating same:

Fig. 1 illustrates the tank head outlined in the question, assuming S = 11,000 pounds and using formula

$$t = \frac{5PL}{4S}$$

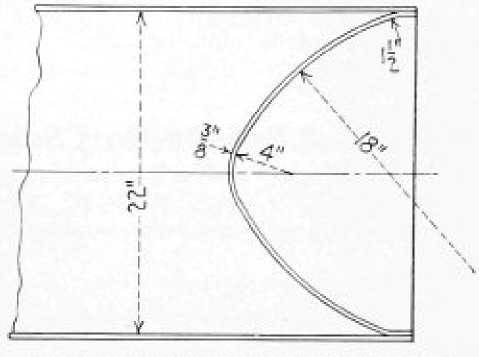


Fig. 2.—Extreme case of dished tank head

and transposing for P, we have $P = \frac{4St}{5L}$

substituting, we have,

$$P = \frac{4 \times 11{,}000 \times 0.375}{5 \times 22} = \frac{16{,}500}{110} = 150 \text{ pounds allowable working pressure}$$

Referring to *U-36,* we find that where the radius is less than 80 percent of the diameter of the shell to which the head is attached, the thickness shall be at least that found by the formula by making L equal to 80 percent of the diameter of the shell.

Diameter of tank = 22 inches.

80 per cent of 22 inches — 17.6 inches diameter, minimum radius permitted for dished head in computing strength of 22-inch diameter tank.

Substituting 17.6 inches as the radius of the dished head, we have,

$$P = \frac{4 \times 11{,}000 \times 0.375}{5 \times 17.6} = \frac{16{,}500}{88} = 187 \text{ pounds allowable working pressure}$$

Fig. 2 illustrates the extreme case as outlined in the question.

Assuming s = 11,000 and in accordance with the second paragraph of *U-36,* L = 18 inches, we have,

$$P = \frac{4 \times 11{,}000 \times 0.375}{5 \times 18} = \frac{16{,}500}{90} = 183 \text{ pounds allowable working pressure}$$

The radius of the dished head can be decreased to 80 percent of the diameter of the tank to obtain the maximum allowable working pressure; all other dimensions being the same.

Water for Hydrostatic Test

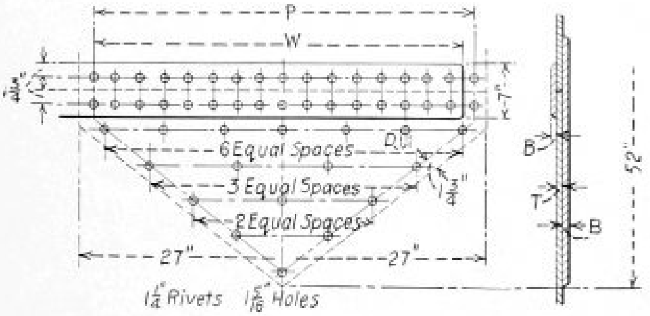
Q.—In applying hydrostatic test to locomotive and stationary boilers what kind of water is used, hot or cold? T. C. H.

Section VI of the 1927 A.S.M.E. Boiler Construction Code, covering rules for the inspection of material and steam boilers, answers this question as follows:

Par. 1-34: Hydrostatic Test:—When a boiler is completed or part of an incomplete boiler is ready for hydrostatic test, it shall be filled with water of a temperature not less than that of the temperature of the surrounding atmosphere and in no case less than 70 degrees. All air shall be allowed to escape so that water will come in contact with all parts that are assembled and the pressure shall be slowly raised until it meets with the Code requirements for the type under test and shall be held constant long enough to enable the inspector to examine all visible parts in order to determine the quality of the workmanship and the safety of the entire structure.

Efficiency of Double-Butt Seam

Q.—Attached hereto please find print showing a longitudinal boiler seam, double-butt-strapped, with a diamond-shaped inside strap. Would be pleased to have you furnish me for personal use a correct formula for calculating the efficiency of this seam, and tension on net section of plate



Double butt-strapped seam with diamond inside strap

for, say, a 78-inch diameter course; ¾-inch plate; TS 55,000; 1 5/16-inch rivet holes; 215 pounds working pressure. J. L. W.

A.—A diamond butt joint as illustrated in the question can fail in the following ways:—

1.—Tearing of plate through rivet hole (one rivet) in outside row.

2.—Tearing of plate through rivet holes in second row and shearing one rivet in single shear in outside row.

3.—Tearing of plate through rivet holes in the third row and shearing three rivets in single shear in first and second rows.

4.—Tearing of plate through rivet holes in fourth row and shearing six rivets in single shear in first, second and third rows.

5.—Tearing of plate through rivet holes in fifth row and shearing 10 rivets in single shear in first, second, third and fourth rows.

6.—Tearing of plate through rivet holes in sixth row and shearing 17 rivets in single shear in first, second, third, fourth and fifth rows.

7.—Tearing of plate through rivet holes in inside and outside welts at sixth row.

8.—Shearing 15½ rivets in double shear and a half rivet in single shear in the sixth row, and 17 rivets in single shear in the first, second, third, fourth and fifth rows.

9.—Tearing of plate through rivet holes in second row and crushing welt strip in front of one rivet in outside row.

10.—Tearing of plate through rivet holes in third row and crushing welt strip in front of three rivets in first and second rows.

11.—Tearing of plate through rivet holes in fourth row and crushing welt strip in front of six rivets in first, second and third rows.

12.—Tearing of plate through rivet holes in fifth row and crushing welt strip in front of ten rivets in first, second, third and fourth rows.

13.—Tearing of plate through rivet holes in sixth row and crushing welt strip in front of seventeen rivets in first, second, third, fourth and fifth rows of rivets.

14.—Crushing plate in front of 16 rivets in sixth row and welt strip in front of 17 rivets in first, second, third, fourth and fifth rows.

15.—Crushing plate in front of 16 rivets in sixth row and shearing 17 rivets in single shear in first, second, third, fourth and fifth rows.

RESISTANCE TO FAILURE

1. $$\frac{(P - D) \times t \times TS}{P \times t \times TS}$$

2. $$\frac{(P - 2D) \times t \times TS + A \times s}{P \times t \times TS}$$

3. $$\frac{(P - 3D) \times t \times TS + 3A \times S}{P \times t \times TS}$$

4. $$\frac{(P - 4D) \times t \times TS + 6A \times s}{P \times t \times TS}$$

5. $$\frac{(P - 7D) \times t \times TS + 10A \times s}{P \times t \times TS}$$

6. $$\frac{(P - 16D) \times t \times TS + 17A \times s}{P \times t \times TS}$$

7. $$\frac{[\,(P + W) - (31\ 1/2D)\,] \times B \times TS}{P \times t \times TS}$$

8. $$\frac{15.5A \times S + 17A \times s}{P \times TS \times t}$$

9. $$\frac{(P - 2D) \times t \times TS + D \times B \times C}{P \times t \times TS}$$

10. $$\frac{(P - 3D) \times t \times TS + 3D \times B \times C}{P \times t \times TS}$$

11. $$\frac{(P - 4D) \times t \times TS + 6D \times B \times C}{P \times t \times TS}$$

12. $$\frac{(P - 7D) \times t \times TS + 10D \times B \times C}{P \times t \times TS}$$

13. $$\frac{(P - 16D) \times t \times TS + 17D \times B \times C}{P \times t \times TS}$$

14. $$\frac{16D \times t \times C + 17D \times B \times C}{P \times t \times TS}$$

15. $$\frac{16D \times t \times C + 17A \times s}{P \times t \times TS}$$

Efficiency = least value obtained in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 or 15, where:

TS = tensile strength of plate, pounds per square inch.
t = thickness of shell plate, inches
B = thickness of welt strips, inches.
P = see sketch.
W = see sketch
D = diameter of rivet after driving, inches, diameter of rivet hole.
A = cross-sectional area of rivet after driving, square inches.
s = shearing strength of rivets in single shear, pounds per square inch.
S = shearing strength of rivets in double shear, pounds per square inch.
C = crushing strength of plate, pounds per square inch.

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

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	

Cities

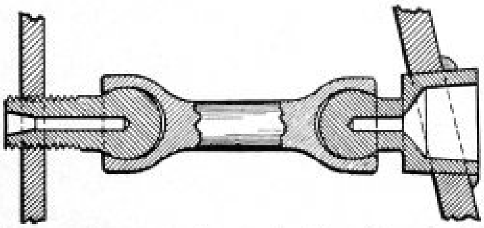
Chicago, Ill.	St. Louis, Mo.	Nashville, Tenn.
Kansas City, Mo.	Scranton, Pa.	Omaha, Neb.
Memphis, Tenn.	Seattle, Wash.	Parkersburg, W. Va.
Erie, Pa.	Tampa, Fla.	Philadelphia, Pa.

Selected Boiler Patents

Compiled by Dwight B. Galt, Patent Attorney, Washington Loan and Trust Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,698,892. METHOD OF APPLYING STAYBOLTS. ARTHUR F. PITKIN, OF SCHENECTADY, NEW YORK.

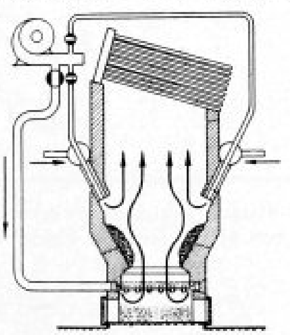
Claim.—The method of attaching a staybolt to a firebox sheet, which comprises screwing a threaded end of a staybolt into an opening in the



firebox sheet; reaming a tapered recess in said end to a depth limited to dispose the inner end of the recess intermediate the inner and outer faces of the firebox sheet; expanding the recessed portion of the bolt into steam tight fit with the walls of the opening in the firebox sheet; and then upsetting the walls of the outer end of the recess, to provide a flange overlying the inner face of the firebox sheet. Two claims.

1,729,217. POWDERED-FUEL FURNACE. CARL HUFSCHMIDT, OF WESTENFELD, NEAR WATTENSCHEID, GERMANY.

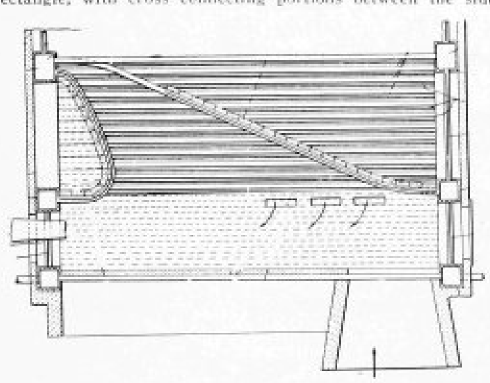
Claim.—In a powdered-fuel furnace the combination of a furnace chamber having secondary air inlets near the bottom thereof, inclined slagging walls above said inlets, inclined burners above said walls directed to discharge, respectively along the upper surfaces thereof, each of said



burners having a tube for injecting primary air and fuel into said chamber and a secondary air pipe within said tube, a blower, delivery conduits connecting said blower to said inlets near the bottom of the chamber and to said pipes within the burners, and valves controlling said conduits whereby air propelled by the blower is delivered to said inlets and said pipes alternatively.

1,724,560. GENERATION OF STEAM. VIRGINIUS Z. CARACRISTI, OF BRONXVILLE, NEW YORK, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

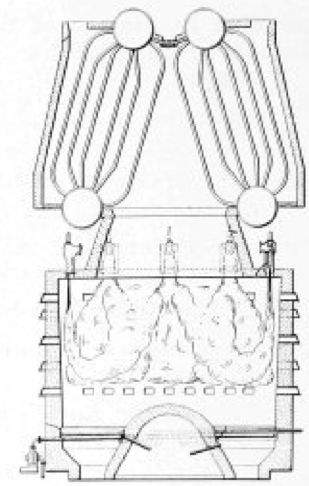
Claim.—A boiler unit including front and rear headers each having connected top, bottom and side portions substantially in the form of a hollow rectangle, with cross connecting portions between the side portions



of each header intermediate the top and bottom portions thereof, tubes connecting the side and bottom portions of one header with the corresponding portions of the other header, and tubes connecting a cross connecting portion of one header with the top portion of the other header. Eight claims.

1,729,024. METHOD OF BURNING PULVERIZED FUEL. JOHN E. BELL, OF BROOKLYN, N. Y. ASSIGNOR TO COMBUSTION ENGINEERING CORPORATION, A CORPORATION OF NEW YORK.

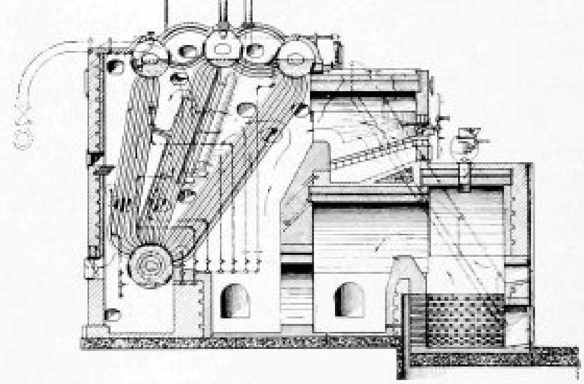
Claim.—The process of burning pulverized fuel in suspension which



consists in admitting the fuel in the form of an attenuated stream at each of the four sides of the furnace in a substantially downward direction and in turning the streams inwardly and upwardly. Three claims.

1,726,050. FURNACE. GEORGE PALMER WARD, OF HABANA, CUBA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO FULLER LEHIGH COMPANY, A CORPORATION OF DELAWARE.

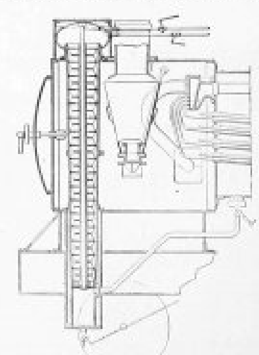
Claim.—In combination, a steam boiler comprising vertically extending tubes with a baffle located near the front thereof and extending substantially parallel thereto, a furnace adapted to burn fuel of low heat value, a passage adapted to lead the gases from said furnace to the upper ends of



said tubes, a fluid fuel furnace located above said first-mentioned furnace and constructed and arranged to deliver heated gases against and among the upper ends of the front tubes, boiler tubes being subjected to the direct radiant heat of said fluid fuel furnace, and means for directing the heated gases over the succeeding tubes of said boiler, both of said furnaces being located at one side of said boiler. Four claims.

1,699,998. METHOD AND MEANS FOR HEATING AND PURIFYING FEED WATER FOR LOCOMOTIVE BOILERS AND THE LIKE. JOHANN STUMPF, OF BERLIN, GERMANY.

Claim.—The method of heating and purifying feedwater for locomotive boilers which consists in introducing the feedwater directly into a confined space positioned above the top of the smokebox, causing said



water to flow from said confined space in a path of travel downwardly through the smokebox to a point substantially beneath the bottom of the smokebox, and thence into the boiler, delivering live steam to the water as it enters said confined space and collecting the scale as the same is separated from the water during its travel. Seven claims.

THE BOILER MAKER

Name registered U. S. Patent Office

Volume XXX December, 1930 No. 12

PUBLISHED MONTHLY BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY
34 North Crystal Street, East Stroudsburg, Pa.
Executive offices: 30 Church Street, New York

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy 35 cents.

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Boiler Disasters

The official report of the Reading locomotive 1705 boiler explosion in this issue gives a graphic account of what is probably the worst disaster of its kind in recent years. A toll of seven deaths, severe injuries to six and minor injuries to four others was exacted through an oversight in checking one of the small details of maintenance—namely—the water indicating devices. As a direct cause, low water was responsible for the explosion. The primary cause for low water, however, was found to be the stoppage or partial stoppage of the steam connection to the top of the water column by a soft blind gasket. Evidently this gasket had been applied to the outlet of the boiler fitting when it was capped preparatory to making a hydrostatic test of the boiler, and was not removed when the water column connections were reassembled after completion of the hydrostatic test. The center part of the soft gasket in the form of a disk was found lodged in the portion of the 45-degree ell which formed the boiler fitting for the steam pipe connection. The investigation did not disclose whether the center part of the gasket became separated from the part which was held between the joint faces at the time of the explosion or whether the separation occurred previously. In any event, the presence of the blind gasket formed a stoppage which caused the water to rise in the water column and indicate a higher water level than existed in the boiler.

The one fundamental lesson to be learned from this disaster and its subsequent investigation is that no item is so small or insignificant that it can be overlooked in the repair of a locomotive and in particular those parts coming under the head of boiler work. Important as the production schedule may be in the operation of a railroad, safety of life should be the determining factor in arranging that schedule. If the present high-speed production of the modern repair shop is tending towards carelessness in the maintenance of the smaller items of equipment, then a revision of policy is essential. The same condition applies to work in the roundhouse as in the back shop. Extreme care in the conduct of all inspection and repair operations is the best insurance against locomotive failures on the road.

Each succeeding annual report from A. G. Pack's office as chief inspector of the Bureau of Locomotive Inspection, for several years past has shown a decided improvement in the condition of locomotives throughout the country, and a gratifying decrease in the number of accidents from boiler explosions. Further disasters of the nature of the present one would absolutely nullify all of the good work that has been done by the railroads in general in bringing about this improvement. It should be the object of every railway mechanical department in the country immediately to check conditions in their shops and to take steps as will avoid the possibility of future disasters of this character.

Tests on Firebox Steel

An interesting study of welded metals under fatigue tests has recently been made by the Engineering Experiment Station of the State College of Washington in co-operation with the mechanical engineering department of the same institution and with the American Welding Society. The field covered in this work consisted of tests of oxy-acetylene welds, resistance welds and flash welds as well as some work on atomic hydrogen and metallic-arc welds. In planning the test, it was decided to obtain a true cross section of the welding field by soliciting welded coupons from companies doing different types of welding. The average of these tests gives a lower result than would be obtained if one experienced man was doing all the welding with the knowledge that his welds were to be examined for test data. The apparatus used in connection with this work consisted of a bank of seven Farmer-type rotating beam testing machines.

The conclusion arrived at from tests conducted on welded specimens of firebox steel is that the endurance limit of the welded material does not equal that of the material unwelded. The three main reasons given for this conclusion are:

Non-homogeneous structure due to oxide spots and pits caused from gas inclusions.

Difference in grain structure between the metal in the weld and the metal in the original bar.

Difference in hardness between the metal in the weld and the metal in the original bar.

In analyzing the results G. E. Thornton of the Engineering Station states that non-homogeneous structure is probably the most important cause of bringing on fatigue. The presence of the small holes in the metal is not so harmful as usually supposed unless present in such large numbers as materially to reduce the area of the cross section piece. The oxide spots and pits caused from gas inclusions during the welding operations can only be overcome by treating the weld. Further study along lines of sheathing the arc by gases or other means in order to eliminate this objection and to increase the endurance limit of welded steels is essential. Difference in grain structure and hardness may be overcome by proper heat treatment. Such treatment is possible in a limited number of short welded articles but from a commercial standpoint will probably never be economical with welds in the field. Heat treatment of the weld will also help to eliminate the locked-up stresses in the bar which have occurred during the welding operation. In certain cases these stresses have been determined as high as 25,000 to 35,000 pounds per square inch. When these stresses are considered in conjunction with the bending action of the metal in the rotating beam of the test specimen, there are present forces in tension, in compression, and in shear. It is therefore evident that the determination of total stresses in untreated commercial welds can never be determined accurately.

The report by Mr. Thornton states that tests will be conducted on different types of shielded metallic arc welds and on specimens of all types of welds which have been uniformly heat treated.

This study being made at the State College of Washington has contributed materially to the fund of information being compiled on the subject of welding. From the results obtained through this and other investigations, the future progress of the art is assured in all its applications to industry.

Communications

Layout Work

TO THE EDITOR:

I have been a subscriber to THE BOILER MAKER for many years, but this is the first time I have written you. I would like to compliment you on your magazine. I think it helps the journeyman as well as it does the manufacturer. When you show a layout it would be helpful if the thickness of the material were figured in. I always give the magazine to someone when I am through with it, and they always ask if the thickness has been allowed for or not. As you know, nowadays it is speed that is necessary and we cannot practice in the shop as we used to. This makes it hard for those unable to obtain an education, as boiler making does not pay journeymen as well as it did in the past.

Covington, Ky. J. H. MONDIRK.

Calculating Boiler Patches

TO THE EDITOR:

I cannot agree with the article on "Applying Patch Around Blow-Off Pipe Flange," as outlined in the November issue of THE BOILER MAKER. If as the author states, he has a 72-inch boiler of 7/16-inch plate, carrying 125 pounds pressure, then he is operating under a low factor of safety, and much depends upon the age of the boiler in question.

We will assume that a triple butt riveted joint is used and that the average efficiency of such a joint is 87.5 percent, therefore the bursting pressure would be 584 pounds. Dividing this 584 pounds by 125, we see that a factor of safety of only 4.67 is secured.

Unfortunately the state from which the author writes has no regulations under the National Board or the A. S. M. E. Boiler Code, and evidently they have no governing code, unless it is a local one.

The author states that, in applying the patch to the shell as he directs, a suitable job is secured, but for the benefit of the readers, if a patch is thus applied, the original construction of the boiler shell has been materially weakened, that is, the efficiency of your patch seam is far too low. Let us assume that a single riveted lap joint is used in the patch, $2\frac{1}{8}$-inch pitch, and $\frac{15}{16}$-inch rivet holes, then the efficiency would be approximately 55.8 percent. The author states that an angle of at least 45 degrees should be used, and inasmuch as the length of the patch exceeds 24-inches measured in line with the longitudinal seam of the boiler, we can increase the efficiency of the patch seam by multiplying 55.8 x 1.26 (constant) which gives us 70.3 percent efficiency of patch seam.

Multiplying we get as follows:

$$\frac{0.4375 \times 55{,}000 \times .703}{36} = 469 \text{ pounds per square inch bursting pressure.}$$

If the original pressure is carried after the patch is applied the factor of safety would be 3.75 which is entirely too low.

The author should have so developed his patch as to have an angle of not over 25 degrees, in order to maintain the required strength of the seam. The constant at 25 degrees is given as 1.62 and with the 55.8 percent patch joint efficiency would give 90.3 percent efficiency of patch at this angle.

I am giving this correction as I see it, in order that boiler makers will not install patches over 24-inches in length without taking into consideration the effect of having the right degree to the girth seam, otherwise the pressure will be cut and he may find himself in legal difficulties.

Binghamton, N. Y. CHARLES W. CARTER, JR.

Inspector's Authority

TO THE EDITOR:

I am deeply interested in the communications in THE BOILER MAKER relative to better boiler inspection. For some thirty years past this writer has from time to time written short articles upon the need of better inspection and inspectors. My idea of a good railroad shop inspector is a really first-class, all-around boiler maker familiar with boiler construction and repairs and with at least 10 years of actual experience as a journeyman; not a man picked at random or because he is the oldest man as to seniority, or because he is the friend of some one higher up; but because that man is bright, alert and intelligent enough to handle the position. Such a man, given the proper authority, not from the shop foreman, but from the superintendent of motive power will be able to follow up his findings.

In my 34 years of actual boiler inspection I have been up against some queer situations. While inspecting in one of the railroad shops in Pittsburgh, it was the custom, when giving a hydrostatic test, to catch the engine coming in off the ash-pit (without the fire); fill her up with her own injector until it would cease delivering more water; then apply the pump, fill the boiler full and apply the required test. Under the above plan it was possible to catch many engines and get them out again without any unnecessary delay. On one occasion, however, the roundhouse foreman in charge had neglected to have the boiler filled up, and instead had the boiler washed and filled up with cold water (this in zero weather) and ordered the test applied. The writer drew his attention to the danger of doing so, but to no avail. The test was applied and just before the required pressure was attained the boiler shell and dome let go. The foreman was a sorry sight when he realized what he had done. The point in this case was just this; the inspector did not have the authority to go over this man's head.

Another case in point occurred down east. In this case there was no hydrostatic test, simply a hammer test. While the writer was attending to some other work, two boilers were filled up with cold water. The writer, who was used to the test, told the foreman to let the water out. He refused to do so. The writer also refused to make the test. After the writer had gone home, one of the helpers was called upon to make the test, which he did, making it O.K., so the foreman said; but the writer saw to it that the reports to the motive power department showed who made the test. Now the strange part of the whole affair was that this helper had for many years worked as a section hand and the boss thought him an excellent inspector, thus showing that some of the officers in charge of work of this kind are lacking in good judgment.

I am sorry to say that there are not as many all-around boiler makers in any of our shops as there were some years ago; therefore there are less good men to select from. I will admit that all the good boiler makers are not found in railroad shops; there are excellent ones in contract shops, but they are dying out fast.

Give the shop inspector the authority; put him on a par with the shop foreman, so that his word has some weight and there should be no trouble of any kind when it comes to a question of what repair shall or shall not be made.

The higher a man is educated combined with the requisite knowledge of the trade, the better he is able to fill the position of boiler inspector.

Pittsburgh, Pa. FLEX IBLE.

Testing Staybolts

TO THE EDITOR:

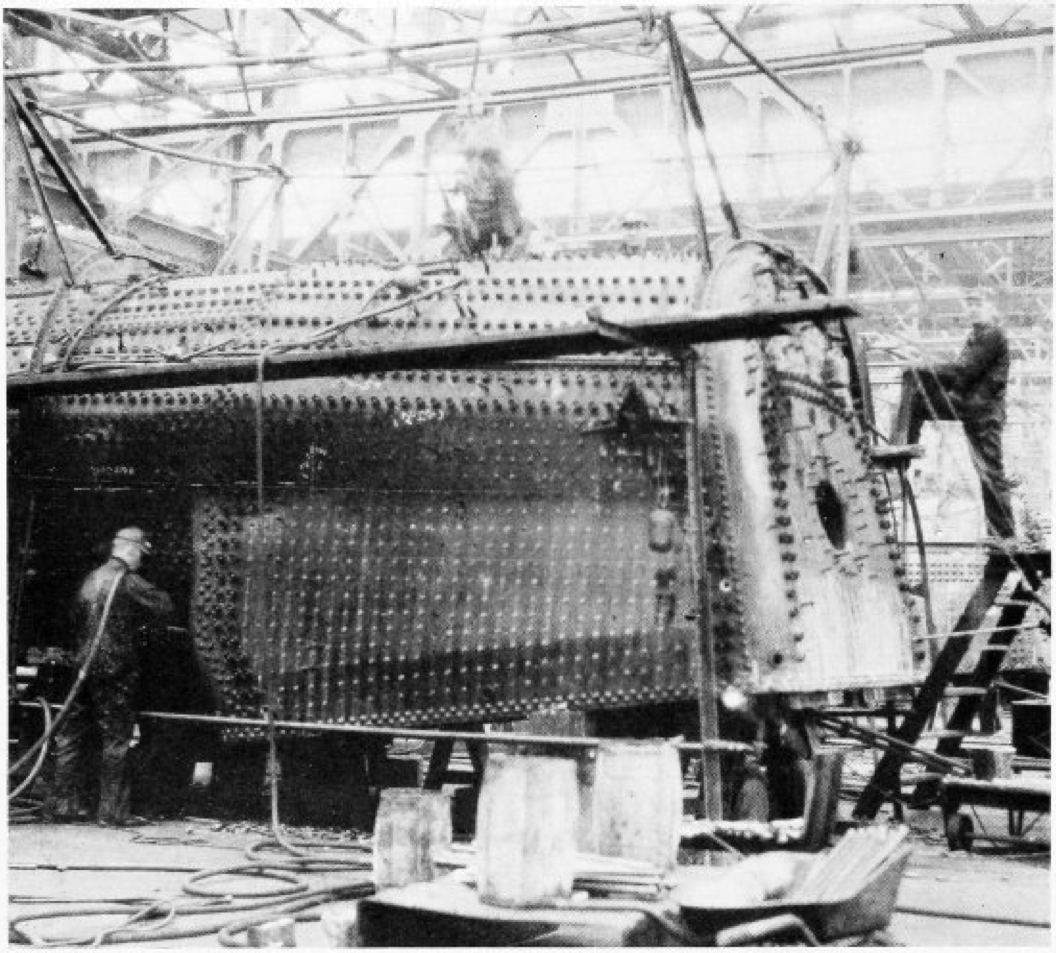
I would like to add a line with reference to the article on inspectors by Joseph Smith in the October issue.

I agree with Mr. Smith as to the inspectors being under the direct supervision of the mechanical superintendent. I have been a boiler inspector for twelve years and have held that position on various roads in the Southwest and believe I know the position taken by shop officials. It is very true, as Mr. Smith stated, that they cannot discharge or demote an inspector for demanding the work to be done, but I can name you a dozen ways by which he can be discharged, and you can rest assured that these are used if the inspector demands too much or refuses to sign the cab card.

I was assigned in 1920 as boiler inspector on a Southwestern road temporarily, while the regular inspector was on leave of absence. During that time a locomotive came into the roundhouse and was due for monthly staybolt test. This engine had been out of the factory only three months. After the firebox had been cleaned for my inspection, I entered the firebox and began hammer testing the bolts. The radial stays were of the taper-head type and riveted at both ends. When I began testing the radial stays I noticed that each one seemed to have a different sound. I asked the boiler foreman if the radials were flexible bolts and he said they were just common radial stays. I told him they had a very peculiar sound, but the rebound of the testing hammer was perfect. Finally I persuaded him to drill out two stays in the crown sheet and when we gouged the burr out of the crown sheet to my astonishment the stays fell on the crown sheet. We then burned out five more with the burning torch. Then we put a sharp long-pointed bar through the crown sheet hole and put a prying pressure sideways on the hanging stays and they would snap off about 1/8 inch from the wrapper sheet and fall. We found 283 of these stays in one engine. On examination we found that the stays at the top ends were cracked on three sides, in nearly all of them about 1/8-inch deep and the stays were badly crystallized.

In the first case there were possibly fifteen radial stays that were solid, which, when burned out of the crown sheet could not be broken. It was because these bolts sounded differently that I felt there was something wrong and I have always thought that a disaster was avoided, for this engine pulled a fast passenger train when in service.

Chicago, Ill. IRA MICHENER.



Boiler repairs at the Paducah shops of the Illinois Central are carried out under the best possible working conditions. The views on this and the facing page show various stages in the renewal of a complete firebox

Welding Practice on the Illinois Central System

During the past few years fusion welding has advanced materially as a major process in the construction and repair of locomotive boilers. In arriving at its present high standard of quality the railroads of the country have observed the greatest caution in applying it and in developing such rules as would insure the maintenance of this standard. The welding practice of the Illinois Central System is an excellent example of a standard high in quality of design and workmanship. General welding instructions for the application of the oxy-acetylene and electric-arc processes will be explained in this and a following article, the present one dealing with general instructions for welding and typical examples of the application of oxy-acetylene cutting and welding.

The following rules have been developed to govern the fusion welding of locomotive and stationary boilers on the Illinois Central:

Fusion welding will not be permitted on any part of a locomotive or stationary boiler that is wholly in tension under working conditions; this to include arch or water bar tubes.

Staybolts or crown stay heads must not be built up or welded to sheet.

Holes larger than 1½ inches in diameter when entirely closed by fusion welding must have the welding properly stayed.

In new construction, welded seams in crown sheets will not be used, where full size sheets are obtainable. This is not intended to prevent welding crown sheet to other firebox sheets.

Only operators known to be competent will be assigned to firebox welding.

Where fusion welding is done, the parts to be welded must be thoroughly cleaned and kept clean during the progress of the work.

When repairing fireboxes between general repairs a number of small adjacent patches must not be applied, but the defective part of sheet will be cut out and repaired with one patch.

The fusion welding of defective main air reservoirs is not permitted.

Carefully fit all patches or sheets, allowing not less than ⅛-inch or 3/16-inch space at the bottom of the V opening. All edges to be welded must be beveled to 45 degrees. When the opening between the plates closes to less than ⅛ inch, welding must be stopped and a full opening made by chipping with hammer and chisel. Do not burn the edges of the plates to enlarge the opening.

No piece of work that is to be welded is properly prepared unless it is thoroughly clean and free from all grease, rust, scale, or other foreign substance. The weld must be made on clean bright metal, and that condition must be preserved throughout the welding operations. Proper tools will be furnished to keep work clean.

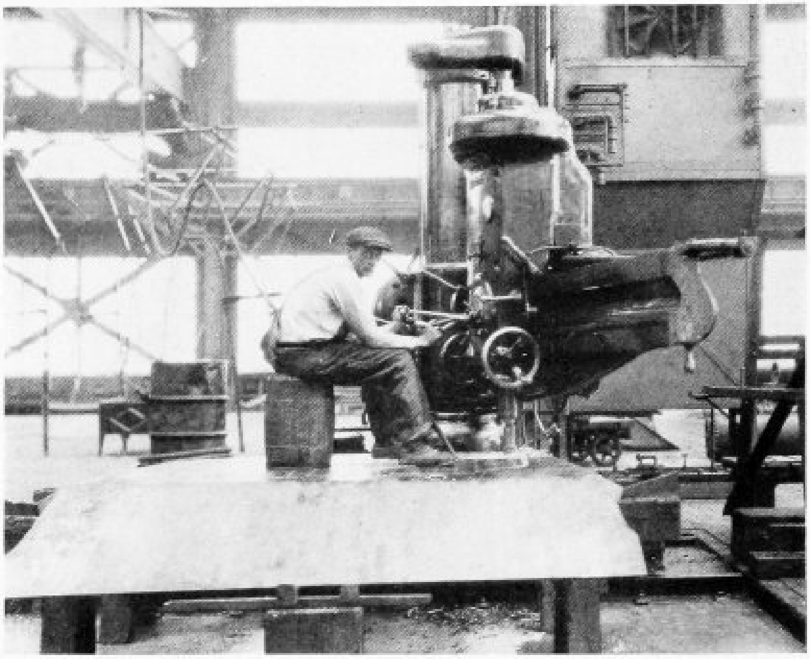
Gloves with gauntlets should be used at all times and it is advisable that sleeves not be rolled up in order to prevent bare arms and skin touching welding wire or holder. Operators should keep face and hands well protected from the welding rays, and should not attempt to weld without having the eyes protected with a suitable hood, which will be furnished for that purpose. All welding operations should be screened from other workmen. Insulation on all lead wires should be maintained in good condition and must be kept dry.

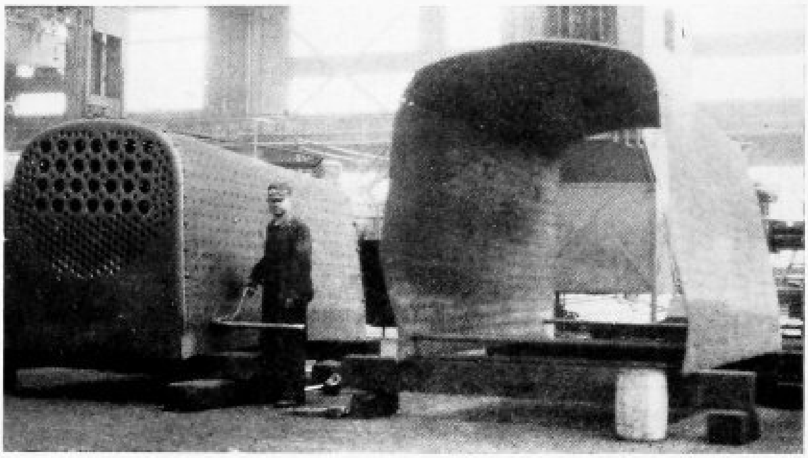
The following instructions should be observed in handling oxygen and acetylene regulators:

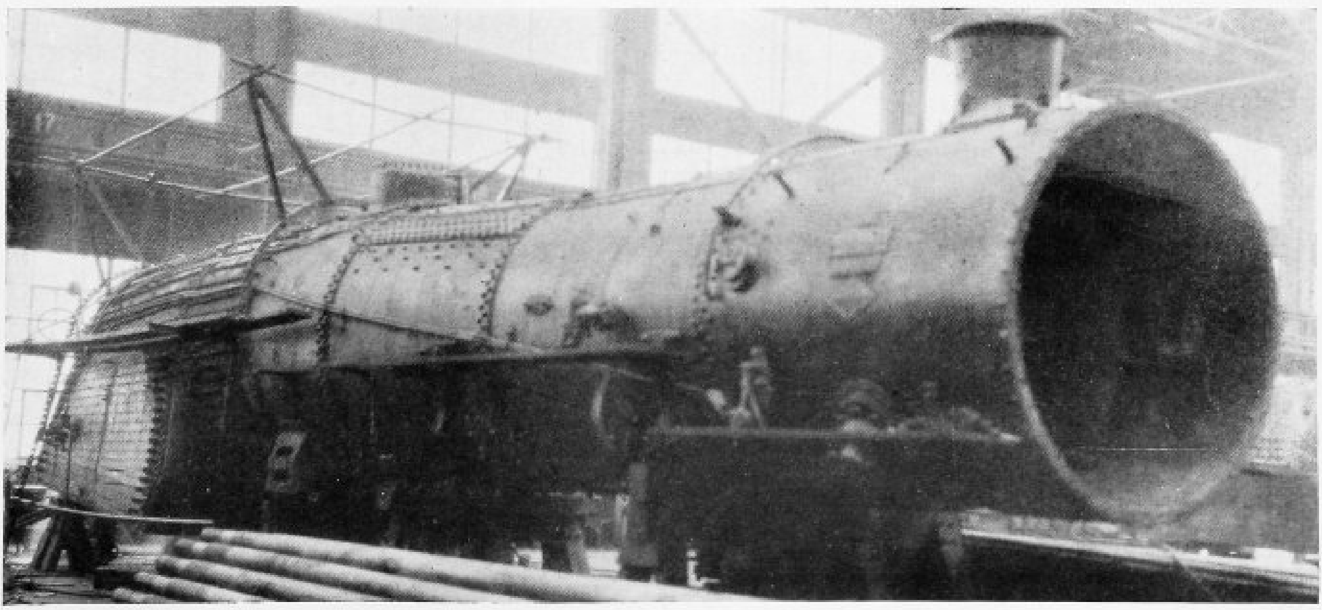
Do not use oil or grease in any way in connection with regulators because oxygen under high pressure in contact with oil will fuse and destroy the regulators and gages.

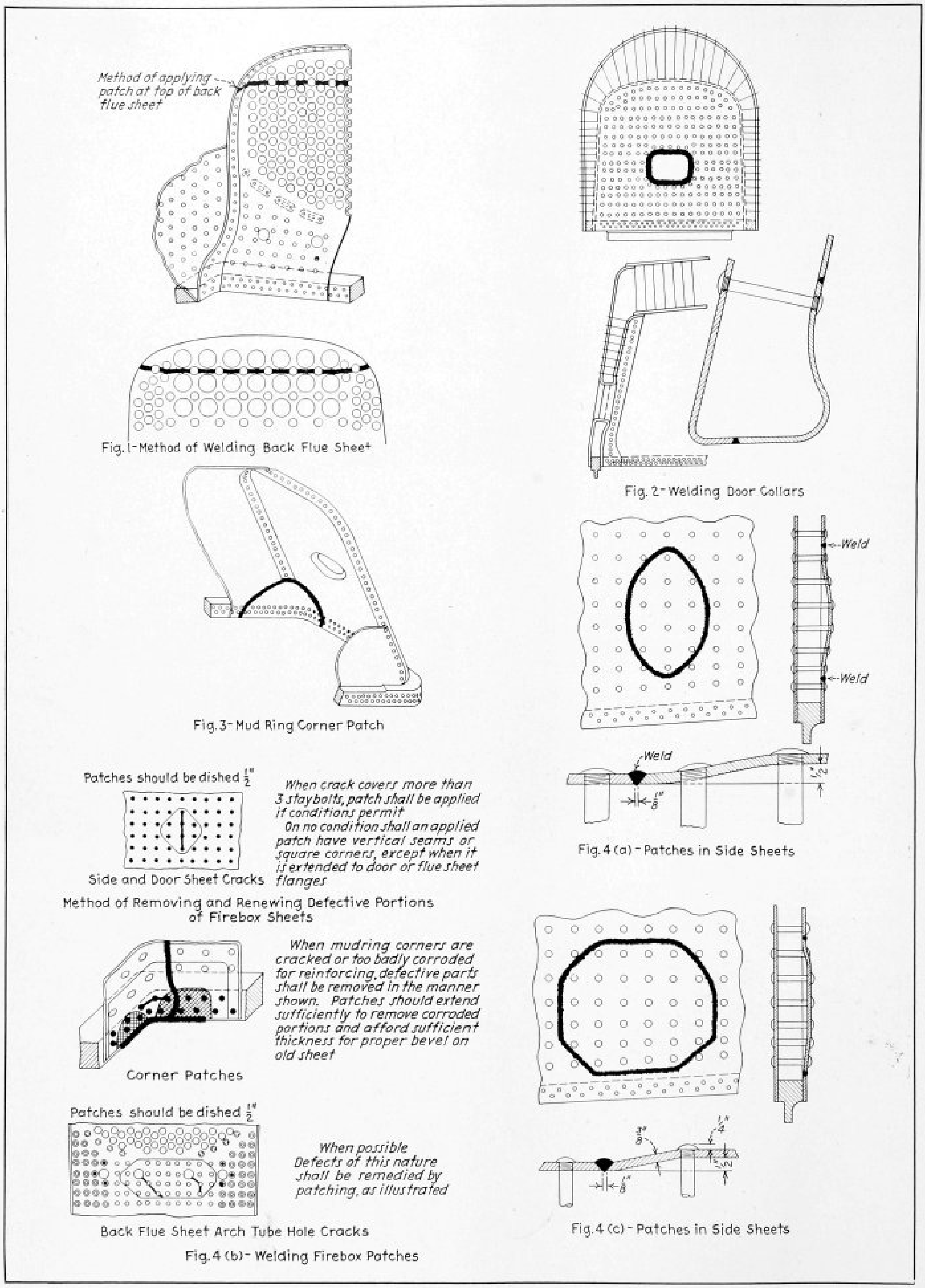
Before attaching oxygen regulator to a cylinder, open the cylinder valve slightly to blow out dirt from the passages. Close the valve tightly and quickly.

Attach regulator firmly to cylinder and fully release the diaphragm spring by turning regulating screw to the left before opening the tank valve. Open the tank valve gradually, and while doing so do not face the gages, but stand to one side of the regulator,









Various methods of applying the oxy-acetylene process to the welding of locomotive firebox patches

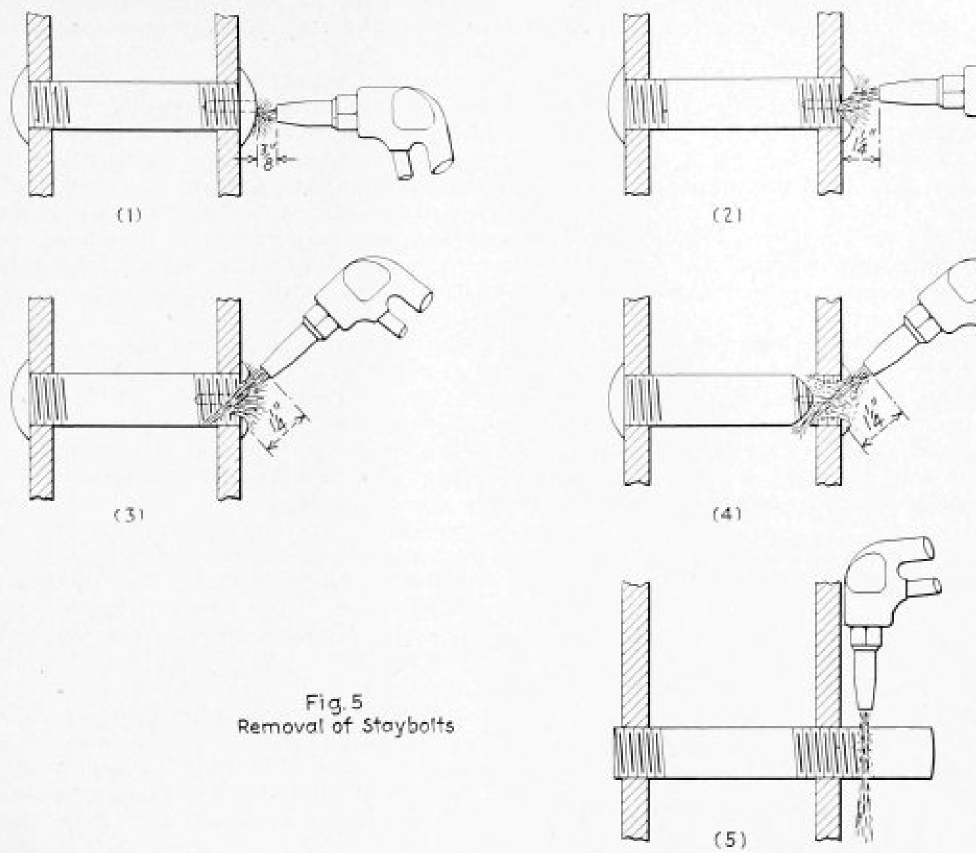


Fig. 5
Removal of Staybolts

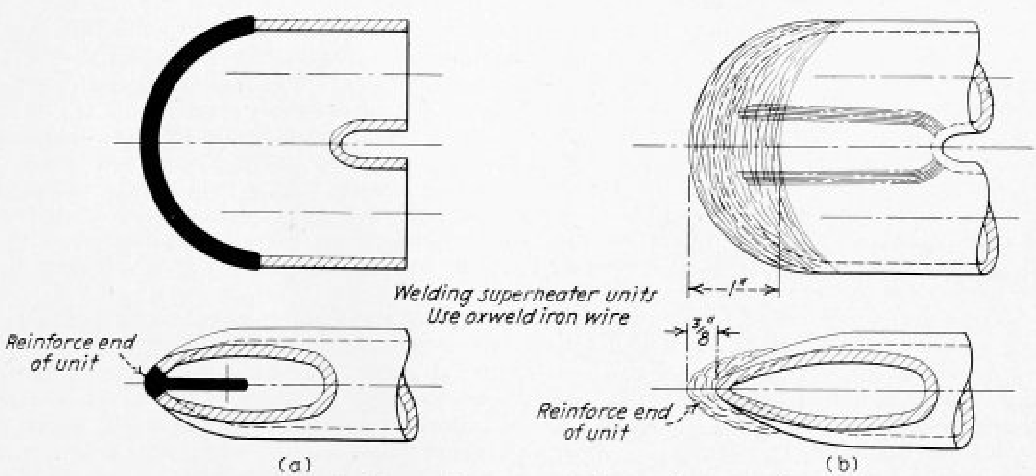


Fig. 6 – Welding Torpedo Type Return Bends

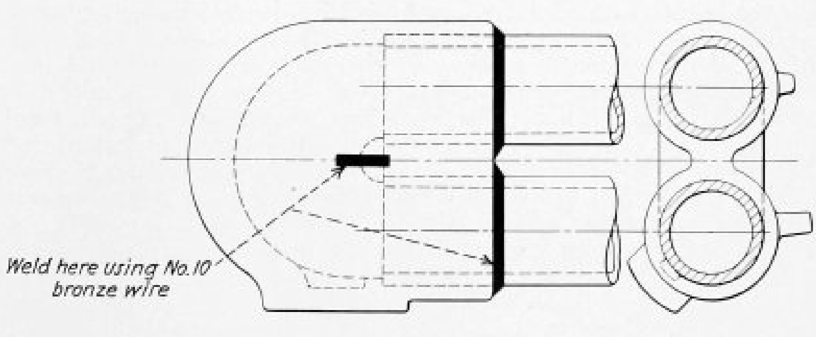


Fig. 7 – Cast Steel Return Bends

Steps in the process of burning out a stay-bolt, and welding superheater return bends because the sudden pressure on the gage may break the glass. Oxygen tank valves should be screwed open as far as they will turn.

In adjusting the oxygen regulators to obtain working pressure, turn the regulating screw to the right, open the outlet valve where the hose attaches and close the oxygen valve on the blow-pipe. Then slowly turn the regulating screw to the right until the proper pressure shows on the little gage.

If any equipment leaks or fails to hold the desired pressure, do not attempt any repairs, but turn the equipment over to your foreman to be returned to the service company.

Acetylene regulators should be adjusted to deliver only enough gas to give a proper cone or preheating flame when the acetylene valve of the blow-pipe is wide open. Do not attempt to connect the acetylene hose directly to the acetylene tanks without using a regulator, as the hose is liable to blow off and cause damage. Do not control the flow of acetylene by means of the valve on the blow-pipe.

Rules for handling blow-pipes follow:

All hose connections should be firmly made and care taken not to pull heavily on the hose, especially while the blow-pipes are burning or any fire is near. Use only the blow-pipes having screw connections for hose. Turn over to your foreman for attention all blow-pipes which do not have screw connections for the hose.

Do not attempt to make repairs to blow-pipes or any other welding apparatus in your shops, but turn same over to your foreman.

If the tip of the cutting blow-pipe comes in contact with the molten metal, backfire occurs, which extinguishes the flame. Where such backfires occur, immediately close the acetylene valve first, then the oxygen valve, and plunge the head of the blow-pipe into a bucket of water until it cools off. This will prevent damage to the blow-pipe. Start as before. Other causes of back-firing are loose external or internal nozzles or dirt on the nozzle seats. This can be eliminated by cleaning the seats and tightening the nozzles.

If the end of the copper tip comes in contact with the molten metal, a backfire occurs which extinguishes the flame. When such backfires occur, immediately close the acetylene valve first, then the oxygen valve, and plunge the copper tip only into a bucket of water until it cools off and then immerse the whole head. Other causes of backfire are loose welding heads or cracked sweated joints in the blow-pipe, and if after tightening the welding head the blow-pipe still backfires, it should be turned over to your foreman for attention.

All gas hose which is used for oxygen and acetylene, should be thoroughly inspected once a week for leakage, perforated hose, poor connections, oil soaked, and other defects. If the hose is oil soaked, it should not be used for any of the above-mentioned gases. All pipe lines and valves should be inspected where permissible, and when found defective, repairs should be made immediately.

All acetylene generator houses or plants, should be kept clean and no oily waste or other inflammables allowed to remain around on floor, cupboards, etc.

Oxygen manifold pipes and connections should be kept in proper mechanical repair. If connections become defective they should be returned to service company, with a requisition covering the repair and return of same.

If diaphragm washers in acetylene or oxygen regulators become defective, do not use a rubber gasket, but return regulator with requisition covering repairs to service company.

Any disregard of the above rules may result very hazardously and may possibly cause serious injury or loss of life.

Rules given below govern the proper method of handling fusion welding equipment:

Where fusion welding process is being used, each man who is assigned to the welding process should be allotted one complete welding or cutting outfit, which will consist of one pair of goggles, one welding or cutting blow-pipe, two lengths of gas hose, two special wrenches, one complete set of welding heads or one complete set of cutting nozzles with a rivet cutting nozzle. When portable outfits are used, it will be necessary to assign one oxygen and one acetylene regulator with an adapter and a wrench in addition to the above-named items. Each electric-arc welder should have one welding hood, electrode holder, 10-foot length of extra flexible cable and one steel wire brush.

Certain general rules for controlling the quality of welds must be observed, the following instructions having been developed for the control of gas cutting and welding operations on boiler work:

Do not start welding operation until all possible allowance has been made for contraction.

If at any time there should be doubt and it is not known what kind of metal you are working, consult the foreman.

In using a welding or cutting blow-pipe, care must be exercised in the lighting and shutting off of the gases. The first operation is to open the acetylene valve, light the torch, open the oxygen valve slowly until the flame reduces itself and a bluish-white flame appears and forms a small bulb, then if the flame is not large enough for the heat required, open the acetylene valve slowly and then the oxygen likewise, until the right size bulb appears. When through the operation, the acetylene valve must be closed first, and when the flame disappears from the torch, the oxygen must be closed immediately. Under no circumstances shut off the oxygen first and the acetylene last; by so doing, the acetylene valve may be leaking slightly and the flame may go internally and when the next operation is started without disconnecting the hose, there is liability of a flash back or backfire into the acetylene line, which may result in serious accidents.

Do not allow the flame to stand too long in one place. Keep the flame moving in a rotary manner and the welding rod as near as possible to the center of the puddle, so that the glance flame will melt the welding rod and allow it to unite into the work, which is held at the fusion point. This will prevent laps from forming in the weld and will also help to control the metal while completing the operation.

Do not under any circumstances, allow the flame to have excess oxygen; if so the metal in the weld will be burned and is of no value. Also do not allow excess of acetylene gas in the flame, only on special occasions, such as welding brass with manganese bronze rod, also when welding malleable castings with Tobin bronze.

A neutral flame is indicated by a clearly defined bluish cone surrounded by a transparent purplish flame. Too much acetylene will be indicated by a ragged white inner flame; to remedy, close the acetylene valve slightly. Too much oxygen will be indicated by a reduced size inner cone of a slight violet color; to remedy, open the acetylene valve slightly. To adjust to a neutral flame always start with a slight excess flame of acetylene, and then close the acetylene valve slowly until the ragged edge just disappears.

Only such iron wire as is furnished on specification and passed by test department should be used on boiler, firebox and steel plate welding, as well as on cast steel.

On the Illinois Central the oxy-acetylene process is used for welding half side and door sheets in some cases. When preparing a sheet for the application of this process it should be dropped at one end so that the top of the mud ring rivet holes in the sheet are 3/16 inch below the top of the rivet holes in the mud ring. Sheets may be prepared with a roll across the top of the sheet ⅜-inch deep and 4 inches wide, this being done to allow for contraction where the staybolts and mud ring are applied before welding. With the acetylene process tack welds are made for every 12 inches to hold sheets together properly. When the welding operation proper is started, it is first applied at the center of the seam and worked towards each end. When a tack weld is reached, it is heated slowly to a bright red and then the welding continued towards the next tack. Vertical seams may be welded in the same manner.

When new half side sheets and flue or door sheets are applied one row of staybolts should be driven next to each flange bar laying it up to the side sheet in order to prevent flanges from pulling away.

When cutting out half side sheets on fireboxes for renewal the sheets should be cut into sections, the staybolts being cut through the top, thus releasing the bolt from the sheet. After the sheets have been removed, bolt heads on the outside of the casing sheet should be heated, while a helper on the inside of the firebox twists the staybolt out of its hole. The staybolt ends must never be drawn through the outside wrapper sheet.

When trouble is experienced from leaky side sheet seams, door collars, flanges or old patches, in which the rivets or patch bolts are bad, such rivets or patch bolts should be removed and the outer sheet cut on a line with the center holes by means of the cutting blow pipe. The edge of the sheet should then be beveled to a 45-degree angle and lap-welded, filling the holes on the inside sheet. This practice should also be followed in preference to a patch when the side sheets are grooved due to excessive calking adjacent to the lap. All sheets must be thoroughly cleaned before welding is started.

Welding of transverse or vertical flue sheet knuckle cracks will not be permitted. A patch should be applied as shown in Fig. 1.* All flue holes should be drilled in the patch after which it is cut to size and properly beveled. The center bridge should be welded first; then the next bridge on either side and continuing on alternate sides as each weld is completed. Finally the flanges are welded on the fire side. Flanges are required to be cut at a 45-degree angle.

Door collars should be applied in accordance with Fig. 2. When a new collar has been secured properly in place, it should be tack-welded to the door sheet after which the welding to the door sheet should be completed. The flange must be butt-welded to the door hole flange of the back head after the inside weld has been completed.

When mud ring corner patches are to be applied, as shown in Fig. 3, the operator must be sure that all defective parts are removed. The sheet is then beveled to 45 degrees with a feather edge at the water side of the sheet, after which the patch is applied leaving ⅛-inch opening between the patch and the sheet. Staybolts should be applied in the patch to hold it in place. Patches must be well laid up in mud ring corners and electric welded to the mud ring along the calking edge after the rivets have been applied. When sheets become thin at the mud ring corners, due to corrosion, they can be built up with bronze, the sheets being sandblasted before welding.

* Details of welding operations appear on pages 332 and 333.

The oxy-acetylene welding process may be used to apply patches in side sheets. In this case the patches of an elliptical or circular shape should be applied as shown in Figs. 4(a), 4(b), where the cracks or checked portions of the sheet do not cover an area greater than three staybolts rows in width. Where the defective part does not require the removal of a large area of plate and yet requires a patch larger than shown in Fig. 4(a) a patch, as shown in Fig. 4(c) may be applied, the edge to be prepared as indicated.

Semicircular patches should be dished to a large radius, when the cracks or checked parts of the sheet cover an area greater in width than three rows of staybolts. When dished patches are applied a sufficient number of staybolts should be screwed into the opposite sheet and the ends forced against the patch to hold it in place as shown in Fig. 4(c). When patches extend to the mud ring it is not necessary to apply the dish type.

When welding patches, the weld must be started at the bottom and continued on around to end on the other side. For general repairs, half side sheets must be applied in preference to such patches.

The removal of scattered staybolts from an engine in the roundhouse may be done according to the procedure indicated in Fig. 5. The flame of the cutting blow-pipe should be directed against the edge of the telltale hole until the metal is heated. The cutting jet of the oxygen is then gradually applied, while, at the same time, the blow-pipe is moved back and rotated so that at a distance of 1¼ inches the full pressure of the cutting jet is being used. After a depth of approximately ½ inch is reached, the flame should be directed at a 45-degree angle to the bolt until the flame pierces the bolt thus completing the operation, as shown.

When it is necessary to weld torpedo-type return bends of Schmidt superheaters the defective metal must be chipped away as shown in Fig. 6(a) and the proper iron wire, as specified, should be used for the operation, welding from the top down, as in Fig. 6(b).

In welding cast-steel return bends on Schmidt superheaters by means of the oxy-acetylene process, Tobin bronze welding rod must be used. Before welding, the metal must be thoroughly cleaned and preheated until it appears orange red. While working in this metal the flame should be slightly carbonized. A similar flux as that used in cast iron is necessary. When the weld is completed the metal should be allowed to cool off slowly. These operations are shown in Fig. 7.

In a subsequent article general instructions and specific applications of the electric-arc process to boiler welding will be discussed.

Annealing Boiler Tube Ends

By James F. Hobart

A boiler maker who had been troubled by the cracking of tube ends while they were being expanded into the heads of boilers, hit upon the scheme, with good results, of annealing the tube ends before placing the tubes in a boiler shell. At first, the tubes were annealed in the shop yard, in sets of thirty-six 4-inch tubes at a time, that number being required for a boiler.

Two pieces of structural steel were placed on the ground about 12 feet apart to receive the 16-foot tubes to be annealed. The tubes were piled crosswise on the steel shapes, eight tubes being placed evenly, side by side, the steel shapes being about two feet from each end of the tubes. A stout piece of round steel was driven into the ground, close to the tubes, and near one of the steel shapes. Three other steel stakes were driven into the ground in a similar manner, thus keeping the eight tubes close together in a neat layer upon the steel bearers. Next, seven tubes were placed upon and between the layer of eight, and then, six more tubes were piled on top of these, and so on, until the 36 tubes had been built up into a pyramid. All the tube ends were thus piled fair and even with each other.

A bushel or so of wood shavings and another basket of lightwood were then procured. The wood was piled against the ends of the tubes and some of the short pieces were thrust into the ends of the tubes. The shavings were then scattered against the wood and tube ends and a lighted match applied. The other ends of the tubes were treated in a similar manner. A careful distribution of a small amount of wood, caused heat enough to be developed to heat the tube ends to a dull red. Then, the fire was allowed to die out and the tubes to cool, after which they were expanded into the tube sheets without developing any cracks.

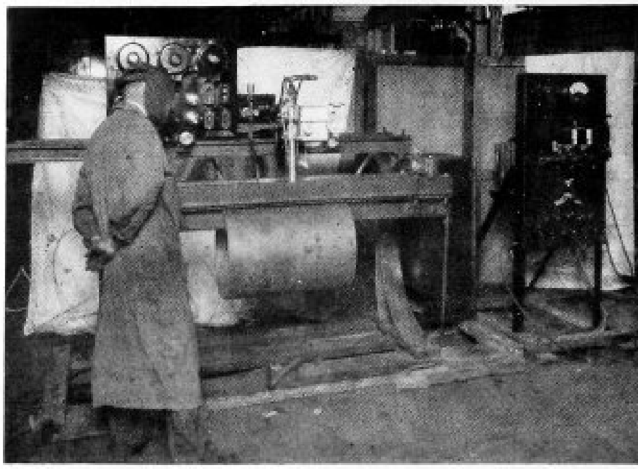
Sometimes, rain, or the scarcity of wood for fuel, led the boiler maker to cast about for other ways of annealing tube ends, and a set of tubes would be sent to the smith fire in the shop. Several tubes would be placed on a trestle, being thrust, one by one, into the fire and heated as evenly as possible by keeping the tubes rolling all the time. As each end was heated, the tube would be turned end for end and that end heated also. It did not require a great deal of time to anneal a set of tube ends in this manner, but it cluttered up the shop's smith fire, and took up lots of room on the shop floor, besides taking the time of a smith and his helper.

After doing a bit of thinking, the boiler maker worked out the following method of annealing the tube ends in a rivet forge:

Two oil-heated rivet forges were taken to the pile of tubes to be annealed and one of these was placed a few feet from the middle of the pile of tubes. The other rivet forge, was placed squarely opposite the first, and just far enough away, so that a tube would reach from one forge to the other. The workman in charge of this job would roll a tube slowly around until its ends were heated to a dull red, then he would remove the tube and place it upon the pile, continuing until all the tubes were completed. In this manner, the tube ends were quickly and cheaply heated, and neither fair weather nor valuable room in the smith shop was required. On a pinch, the work could be done with one rivet forge and a trestle to hold up one end of the tube.

Atomic-Hydrogen Welding Machine

An automatic welder for atomic-hydrogen welding, the first application of automatic equipment to this welding process, has recently been placed on the market by the General Electric Company, Schenectady, N. Y. The welder is designed for longitudinal seam welding of all kinds. It consists of a clamping mechanism for holding the work, an automatic travel carriage, a welding head and the usual control devices, and other accessories. The clamping mechanism and travel carriage are of standard types, while the welding head, control, etc., are of special design to suit the use of atomic-hydrogen welding. In addition there is an auxiliary feeding device for feeding filler rod into the arc, as the tungsten electrodes used to form the arc are consumed slowly and do not contribute metal to the weld.



The General Electric automatic welding machine for use with the atomic-hydrogen welding process

In operation the work is clamped in place in the usual manner, the travel carriage is set at one end of the seam and the start push-button is depressed. The remainder of the operation is automatic. With the pressing of the start button, the line contactor closes, applying power to the equipment and simultaneously opening a valve supplying hydrogen to the arc. The striking of the arc, movement of the travel carriage and length of the arc are all controlled automatically.

The atomic-hydrogen welding process is one by means of which hitherto unweldable metals can be melted and fused without trace of oxidation. Welding can also be performed in some cases on metals as thin as a sheet of ordinary writing paper. The method utilizes the passage of a stream of hydrogen through the arc between two electrodes. The heat of the arc breaks up the hydrogen molecules into atoms and these combine again a short distance beyond the arc into molecules of the gas. In so doing they liberate an enormous amount of heat to produce an effective welding temperature. In addition, since atomic-hydrogen is a powerful reducing agent, it reduces any oxides which might otherwise form on the surface of the metal. Alloys containing chromium, aluminum, silicon or manganese can thus be welded without fluxes and without surface oxidation.

Sand-Blast Helmet

The Pangborn Corporation, Hagerstown, Md., has developed an all-rubber sand-blast helmet which is designated as the Pangborn Type DE helmet. It is designed to protect the wearer's eyes, flesh and lungs. A curved window, protected by a bulged screen, gives true vision. The window glass and the screen are so attached to the helmet that they are both replaceable.

Fresh air is kept circulating inside the helmet at any desired pressure. Also, a fixed jet sprays a stream of air onto a soft sweat band to cool the operator's head while another jet is used to spray air onto the outside of the visor to keep dust from fogging the visor window. Another feature applicable to this helmet is the Pangborn Type B air washer which supplies the operator with clean water-washed air practically at atmospheric pressure.

Layout of Branch Pipe at an Angle to Both Planes

By I. J. Haddon

When lines are drawn through the centers of both pipes and they intersect, then, although they are at an angle to both the horizontal and vertical planes, they still lie in one plane. This may be shown by revolving the pipe *D*, or may be done by using one of the center lines as a new ground line *X-Y*.

I have purposely drawn the plan in full to keep the lines clear and distinct, although only a half plan is necessary as the reader may easily see.

Draw the lines *A-B*, *X-Y* and *X-Y*, as shown. With center *C* and radius equal to half the *outside* diameter of the pipe *D*, describe the circle *D*.

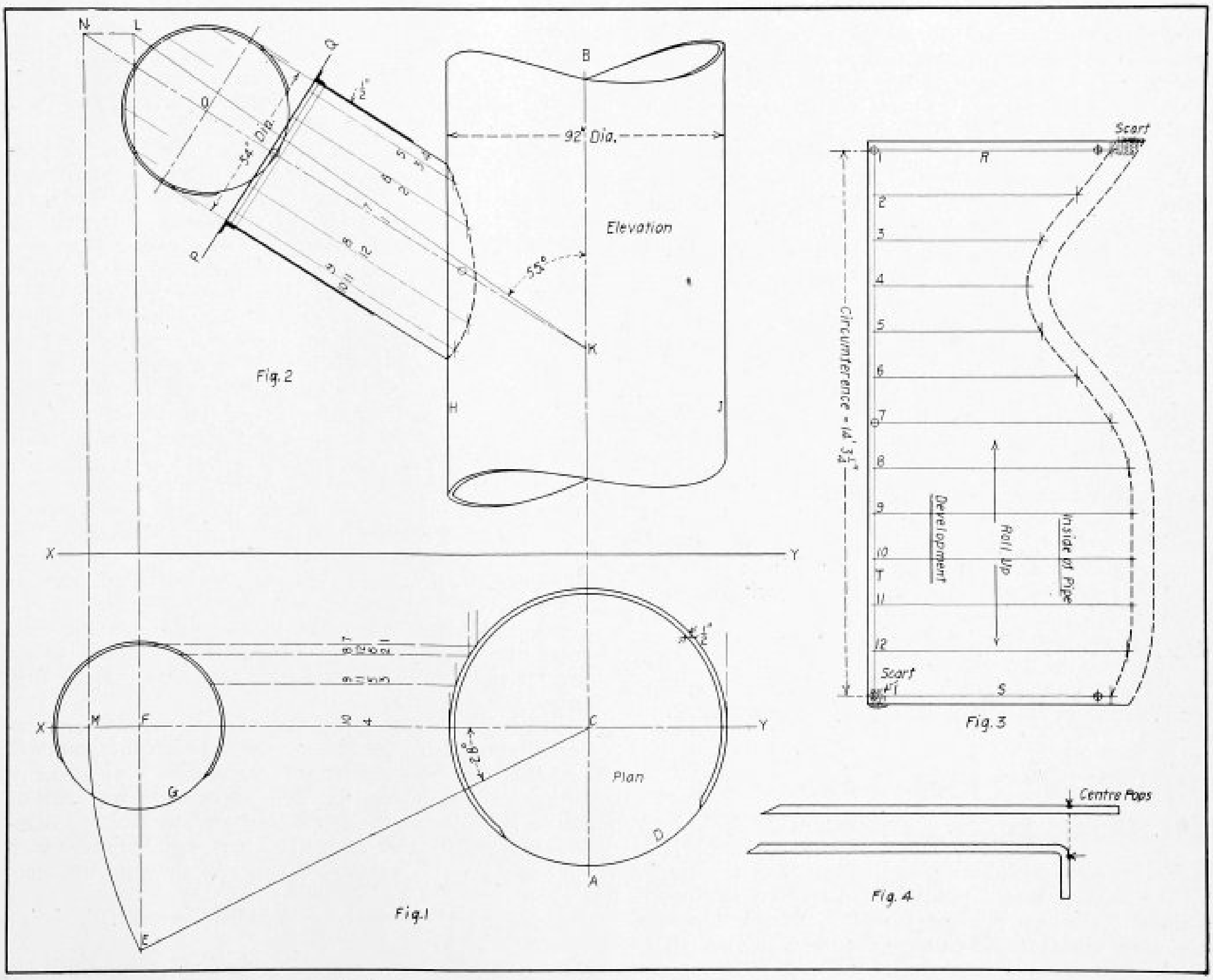
Draw *C-E* at the desired angle, as say 28 degrees. At any point *F* on the line *X-Y*, Fig. 1, draw the circle *G* equal to the *inside* diameter of the branch pipe. Divide one-quarter of the circumference into any number of equal parts, (in the case shown three). Draw lines from these points parallel to *X-Y* until they cut the circle *D*, as shown; then draw lines from these points on the circle *D* parallel to *A-B*, as shown.

Draw the lines *H* and *J* representing the elevation of the pipe *D*. Of course it will be easily seen that it is not necessary to draw the line *J*. It is done so that the beginner may grasp the subject better, and as he advances he will know what lines may be omitted.

From any point *K* on the line *A-B* set out the desired angle *BKL* as say 55 degrees.

Draw *L-E* parallel to *A-B*, then *C-E* and *K-L* will be the plan and elevation of the center line that passes through the branch pipe, but neither of these lines are shown as their true lengths. From *C* in the plan and radius *CE* describe the arc *EM*; draw *M-N* parallel to *L-E* and draw *L-N* parallel to *X-Y*. Now draw *K-N*; then *K-N* is the true length of the center line through the branch pipe and *NKB* is the true angle that the branch takes with the larger pipe.

At any point *O* in the line *N-K* draw a circle equal



Layout and development of a branch pipe which is at an angle to both planes to the *inside* diameter of the branch pipe say 54 inches and divide one-half of it into six equal parts as shown. Draw lines from these points parallel to *N-K* until they cut those already drawn from the circle *D*. Draw a fair curve through these intersections; then this curve (shown dotted) will be the inter-penetration line from which to develop the branch pipe. Number them as shown. Draw the line *P-Q* according to the length of the pipe required. As there is generally an angle ring here, the line should be marked representing the line of rivet holes, and when laying out the plate, measure from the rivet holes as shown in the development and allow the necessary lap.

To develop: Draw the line *T* representing the line of rivet holes to take the angle ring, as shown, Fig. 3. Draw the lines *R* and *S* perpendicular to the line of rivet holes, as shown, and at a distance apart equal to the circumference of the branch pipe (measuring on the center of thickness of material). In this case, by calculation, it is 14 feet 3 7/32 inches. Divide line *T* into twelve equal spaces and number them as shown. Erect perpendiculars at each point and cut them off equal to the lengths shown in Fig. 2, measuring from the line of rivet holes in the angle ring down to the inter-penetration line. Draw a fair curve through these intersections and put a light center pop at each intersection. Allow for the lap at *T;* also allow for the lap at *S* and *R*. This is drawn as if the laps *S* and *R* were a single-riveted seam. Your blueprint may call for a double-riveted seam. Then space your holes accordingly. Allow sufficient material for flanging, as shown; a little more should be added at line 4 to allow for the extra stretching of the material here. Scarf the corners as shown and roll up so that your center pops are on the inside of the pipe. When flanging allow the pops to go over the bend, as shown in the enlarged view, Fig. 4. Of course you will space the holes in the seam and to take the angle ring, just as the blueprint indicates. After the plate is rolled up you may bolt the top part, but one or two rivets should be roughly inserted near the flange to hold the seam together firmly while flanging.

In the course of flanging it should be set down on an old plate that is rolled to the same radius as the large pipe to ensure being a good fit.

Now as regards the hole in the pipe *D;* this should not be cut out until after the plate is rolled up, so that the curvature is correct at all parts.

After the pipe *G* is flanged the holes may be marked on the flange, punched and chipped to bevel for calking, then it should be put on the large pipe in its correct position and the holes marked. Now take the small pipe away, measure the correct lap required from these holes on the large pipe and burn the piece out with the torch, after which the holes may be drilled or punched. This is the practical method, although it is out of date.

The seam of the pipe *G* is generally put where there is the least flanging, such as (in this instance) at line *1* or *7*. It would not be wise to put it at, say, line *4*.

President Elected for Reading Iron Company

Following a special meeting of the Board of Directors of the Reading Iron Company held recently in Philadelphia, A. J. Maloney, chairman of the board, announced the election of P. N. Guthrie, Jr., as president of the Reading Iron Company. Mr. Guthrie has been serving as vice-president, in charge of sales. He succeeds Leon E. Thomas who resigned the presidency on July 31, 1930. Since that time A. J. Maloney as chairman of the board, has performed the executive duties of the president which will now be turned over to Mr. Guthrie.

The Reading Iron Company is a wholly owned subsidiary of the Philadelphia and Reading Coal and Iron Company. The Company, founded in 1836, is nearing its hundredth anniversary, and is the world's largest and oldest producer of puddled wrought iron pipe. More than half of that commodity in the United States is made at its plants. It owns and operates the Keystone Blast Furnaces, The Roe Puddle Mills, Tube Works and Skelp Mills and the Scott Foundry, at Reading, Pa.; the Montour Bar Mills at Danville, Pa., and other companies.

Repairing Circumferential Seam Defects

By H. W. Chandler

Inspection of the shell of locomotive boilers frequently discloses cracks between the rivet holes, and from the rivet holes to the calking edge, of the circumferential seams. Ordinarily these defects occur at the bottom center line of the boiler or for a space of one or two pitches either side of the center and can be repaired by applying an offset patch over the defect. During the past two and a half years a number of boilers have been observed, particularly on heavy consolidation locomotives, on which girth seam cracks had developed over the bottom half or more of the boiler. Further, while these cracks occurred in both sheets, careful inspection of the longitudinal seams and other parts of the shell failed to show any defects.

Repairs were made by cutting out the defective portion of the sheets, and applying a new shell section as shown in Fig. 1. The manner in which this was done without unduly increasing the stresses already existing in the boiler was as follows: The first course sheet was cut out 9-inches ahead of the back edge of the sheet and as far around the boiler as the defects extended. The second course sheet was cut out from the longitudinal seam to a point 13¾-inches beyond the point at which the first course sheet was cut. A new piece of steel 22 inches wide and of the same thickness as the second course sheet was inserted, butting up against the remainder of the second course and lapping over the first course 5½ inches. The original construction of the circumferential seam was duplicated where the new piece lapped over the first course, and a $\frac{13}{16}$-inch cover plate placed over the butt joint on the second course, this cover plate being extended over to the girth seam to form the outside welt plate of the new longitudinal seam at the lower end of the shell replacement. The ends of the replacement sheet were cut so as to form a diagonal seam, the plate efficiency of which was equal to or greater than that of the longitudinal seam of the first course.

Referring to Fig. 1 the efficiency of the new circumferential seam on the first course between the points *B*, and *B'* is obviously the same as the efficiency of the original circumferential seam. The upper and lower ends of the replacement on the first course are identical, the diagonal seam making an angle of 41 degrees 30 minutes with the girth seam. The plate efficiency of the diagonal seam then is $1.3\left(\frac{3.5 - 1.1875}{3.5}\right)$ or 85.8 percent. This is higher than the first course longitudinal seam efficiency of 80.3 percent, therefore the tension in net section of

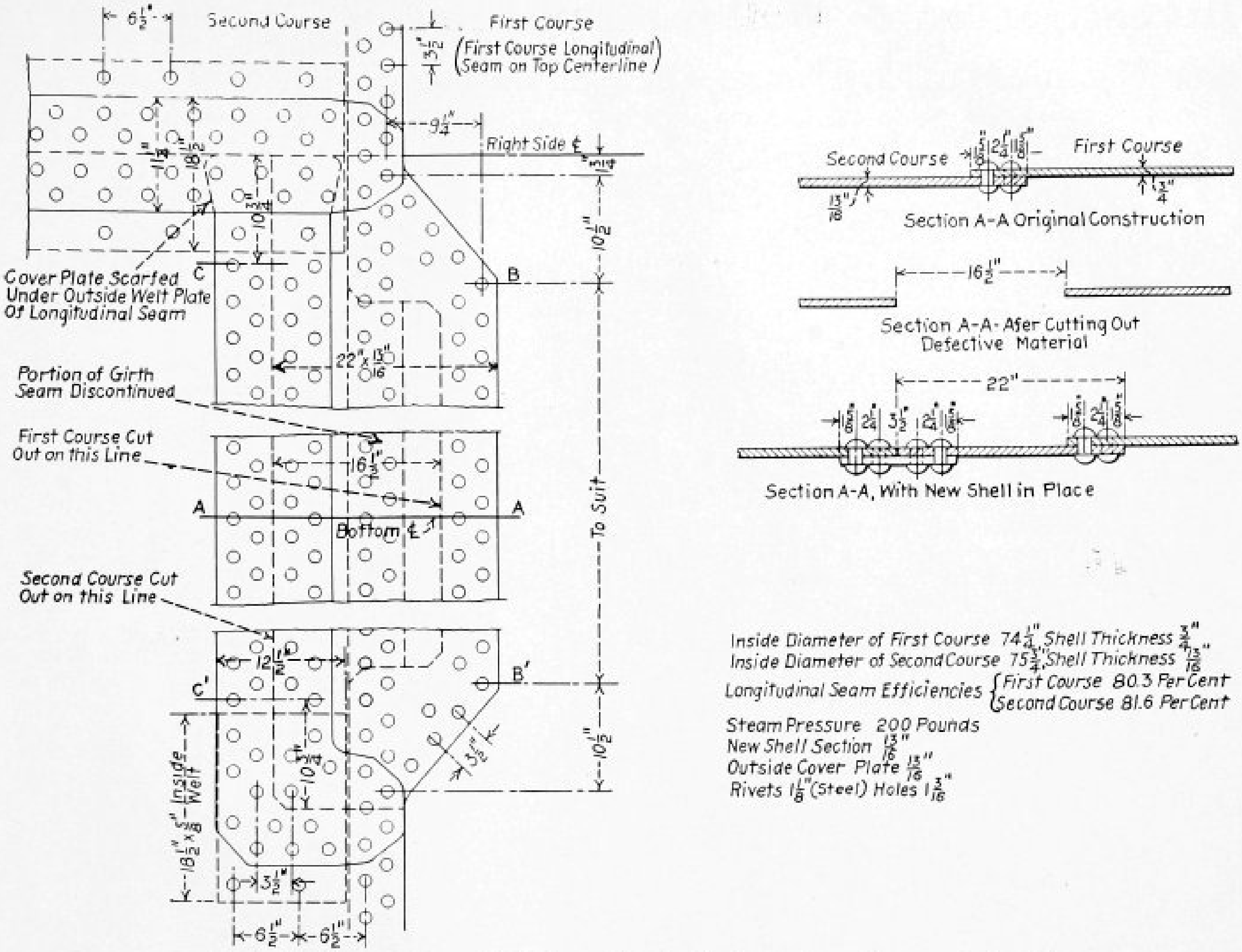


Fig. 1.—Method of cutting out defective portion of old sheets and applying new shell section

plate in the first course is not increased. The load on the 9-inch segment of the first course between the back edge of the original sheet and the back edge of the cutout is $\frac{74.25}{2} \times 200 \times 9$, or 66,825 pounds. This load is resisted by eight $1\frac{1}{8}$-inch rivets in single shear and two $1\frac{1}{8}$-inch rivets in double shear which is equivalent to 13.29 square inches of cross sectional rivet area, the rivets being driven in $1\frac{3}{16}$-inch holes. The shearing stress on rivets as far as new construction in the first course is concerned is $\frac{66,825}{13.29}$ or 5029 pounds per square inch, as compared with a maximum shearing stress on rivets of 5054 pounds per square inch in the boiler as originally constructed.

Considering the new construction on the second course, the two new adjacent circumferential lap seams between the points *C* and *C′* each have the same efficiency as the original circumferential seam. The strength of the second course longitudinal seam after making the vertical cut as shown, is not changed as far as the bursting strength of the boiler is concerned. The end load on the $10\frac{3}{4}$-inches between the point *C* and the center line of the original longitudinal seam is resisted by three $1\frac{1}{8}$-inch rivets in double shear and one $1\frac{1}{8}$-inch rivets in single shear, which is equivalent to seven $1\frac{1}{8}$-inch rivets in single shear, while an equal length of the circumferential seam contains six $1\frac{1}{8}$-inch rivets in single shear. The lower end of the new construction on the second course is practically a duplication of a short section of the longitudinal seam as far as rivet size and pitch is concerned. The pitch of rivets in the outside row being $6\frac{1}{2}$ inches, the same as in the original longitudinal seam, the tension in net section of plate is unchanged. The load on the $7\frac{1}{2}$-inches between the back edge of the first course and the front edge of the second course cut is $\frac{75.75}{2} \times 200 \times 7.5$, or 56,813 pounds. This load is resisted by four $1\frac{1}{8}$-inch rivets in double shear and one $1\frac{1}{8}$-inch rivets in single shear which is equivalent to nine $1\frac{1}{8}$-inch rivets in single shear or 9.97 square inches of cross-sectional rivet area. The shearing stress on these rivets is then $\frac{56,813}{9.97}$ or 5698 pounds per square inch. The stresses introduced due to the shell replacement are practically the same as stresses due to the original construction.

Six boilers have been repaired in a manner similar to that outlined above, the extent of the replacement varying with the extent of the defects in the girth seams. The locomotives are used in heavy transfer service, and have given absolutely no trouble as far as the shell replacement is concerned since being repaired. This method may be considered as a successful means of repair.

Investigation of Boiler Explosion on Reading Locomotive 1705

By A. G. Pack*

On September 9, 1930, about 9.33 a.m., the boiler of Reading Company locomotive 1705 exploded while the locomotive was under preparation for service on outbound engine track about 900 feet from Erie Avenue engine house at Philadelphia, Pa., resulting in the instant death of five employees, the fatal injury of one employee who died 6 hours after the accident, the fatal injury of one employee who died about 33 hours after the accident, the serious injury of six employees, and the minor injury of four employees. The force of the explosion lifted the locomotive and front end of the tender and moved them to the left approximately 12 feet, blocking the adjacent tracks. The locomotive came to rest leaning toward the left at an angle of approximately 45 degrees from upright position. Fig. 1 shows the condition shortly after the explosion.

Locomotive 1705 was of the 2-8-2 type, Reading classification M1SA, built by the Baldwin Locomotive Works at Eddystone, Pa., in January, 1914. The locomotive was 76 feet 3½ inches in length; weight in working order, exclusive of tender, 334,425 pounds; with tender, 496,425 pounds.

The boiler was of the extended wagon-top Wootten firebox type, 84 inches diameter at the first ring, 33 feet 3¼ inches long, and was built to carry 220 pounds working pressure. It was equipped with a superheater, having forty-eight 5½-inch superheater flues and two hundred and twenty 2¼-inch fire tubes. All superheater flues and fire tubes were welded in the rear flue sheet.

The firebox was applied at the Reading, Pa., shops December 25, 1928, at which time the locomotive received class 2 repairs. The firebox was 164¾ inches in length at crown sheet, including a combustion chamber 43 inches in length, and consisted of a crown sheet, side sheets, crown sheet of combustion chamber and upper part of sides of combustion chamber, all in one piece; combustion-chamber sheet forming the bottom and part of the sides of the combustion chamber, rear flue sheet, inside throat sheet, and door sheet. All firebox sheets were of ⅜-inch steel plate except the rear flue sheet, which was ⅝ inch thick.

The rear ends of both side sheets were pieced at the time the firebox was applied with triangular-shaped plates which were fusion welded to the side sheets, the welded seams extending vertically from between the second and third transverse rows of stays from door sheet at the mud ring to between the first and second transverse rows at a point between the eleventh and twelfth longitudinal rows and then back between these rows to the door sheet, each weld being 53 inches in length. The top knuckle of the fire-door hole was patched with a plate 8 by 28 inches; this patch was fusion welded to the door sheet and riveted to the door ring flange of the back head. The combustion-chamber sheet, which formed approximately the lower half of the combustion chamber, was fusion welded to the upper part of the combustion chamber. All other firebox seams were riveted.

The crown sheet, including the combustion chamber, was supported by 16 longitudinal and 40 transverse rows of tapered hammered head radial stays, 1⅛ inches in diameter, spaced 4 by 4 inches. The first six transverse rows of stays in the combustion chamber were expansion stays. Staybolts were 1 inch in diameter and

* Chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission. The above is an abstract of the official report to the commission.

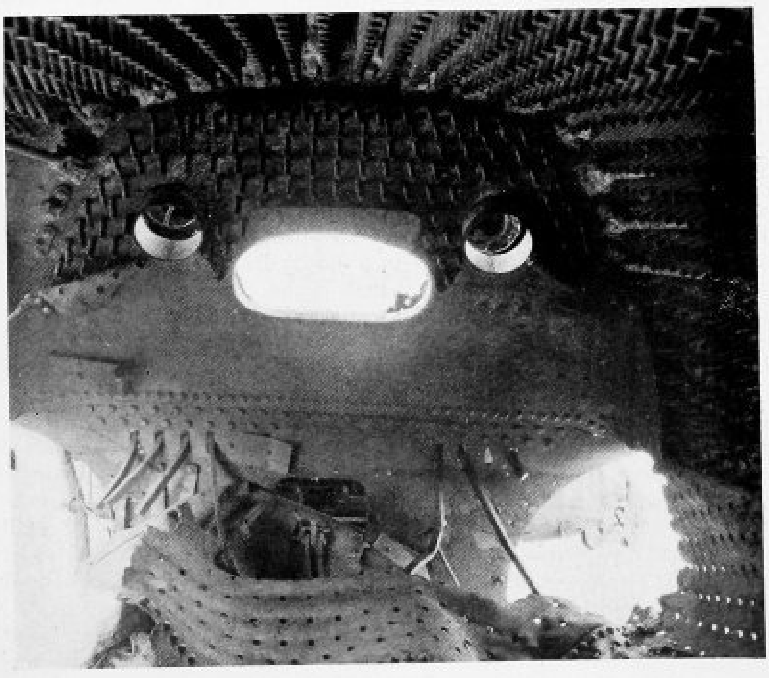


Fig. 1. (left) shows Reading locomotive 1705 and tender after the explosion. Fig. 2. (above) is a view in the wrecked firebox, while Fig. 3 (right) shows the rupture of the door sheet and failure of patch seam on the top knuckle of the firedoor hole

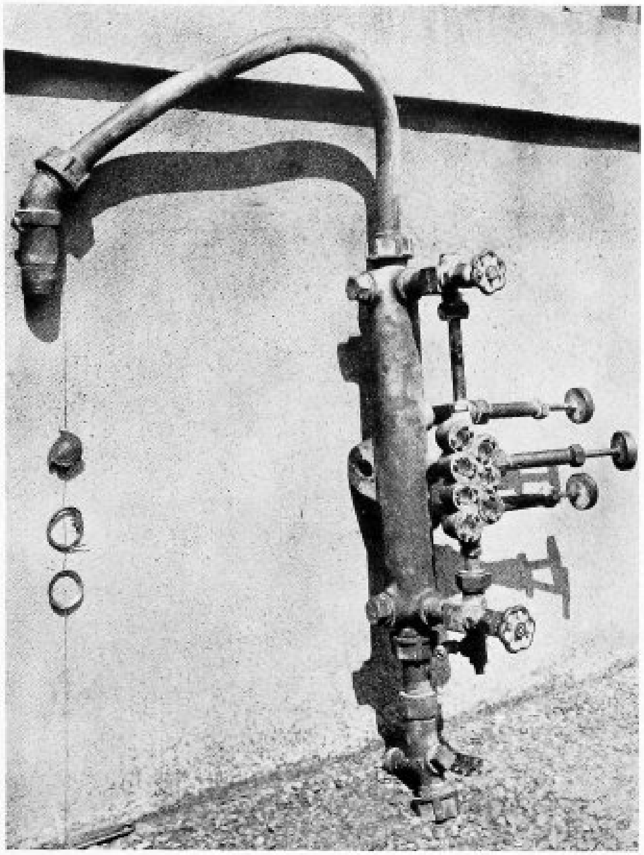


Fig. 4. (above) Water column, including steampipe and top boiler fitting. Fig. 5. (right) Water column connection, completely plugged by scale

spaced 4⅛ by 4¼ inches. The firebox was stayed with a total of 2373 bolts, of which 568 were tapered crown stays, 72 expansion stays, 1133 flexible staybolts, and 60 rigid staybolts.

The external firebox was constructed of a back head, ½ inch in thickness, throat sheet, $\frac{13}{16}$ inch thick, and wrapper sheet $\frac{9}{16}$ inch thick.

The crown sheet had been overheated for its entire length from the ninth longitudinal row of stays on each side of the center line at the flue sheet to the fifth longitudinal row on each side of the center line at the door sheet. The discoloration of the sheet in this area showed evidence of intense overheating, the line of demarcation being well defined for the entire length of the firebox, showing that the water had receded to a level of approximately 6 inches below the highest part of the crown sheet. Ends of crown stays in the overheated section were blue for a distance of ½ inch and some of the crown stay holes were elongated from 1⅛ inches to 2 inches in diameter. Threads in sheets and on bolts were in good condition, except below the overheated area where the threads were distorted due to the sheets pulling from the bolts.

The entire crown sheet was forced from the stays, tearing both side sheets from the staybolts down to the mud ring to a point about 18 inches ahead of the door sheet, leaving small pieces of the side sheets at both rear corners of the firebox. The right side sheet tore away from the mud ring rivets for a distance of 100 inches, then folded down and protruded to a point 8 feet below the mud ring, the fold extending from the lowest longitudinal row and seventh transverse row of bolts from the throat sheet to a point in line with the seventh longitudinal row at the throat sheet. The fold of the left side sheet ran diagonally upward from the mud ring to the fourth transverse row of stays from the door sheet to a point in line with the seventh longitudinal row and first transverse row from the throat sheet.

The crown sheet was ruptured on the right side of the center line, the tear starting at the twenty-second transverse row of stays and extending back through the sixth and seventh longitudinal rows of crown stay holes to the door sheet. Along the edge of this rupture the sheet stretched to a minimum of 5/32 inch in thickness. A hole was punctured in the crown sheet, approximately 6 by 16 inches, where it was pierced by coming in contact with the center grate-rest casting. The puncture was between the twenty-sixth and thirtieth transverse rows from the flue sheet and between the fourth and sixth longitudinal rows to the left of the center line of the crown sheet.

The top part of the door sheet remained attached to the crown sheet and tore through the entire length of the welded seam around the fire door hole patch (44 inches), then around the right and left stoker hole ferrules, and into the riveted seams at the junction to the side sheets.

The rear flue sheet ruptured through the top row of tubes, then tore through the riveted flue-sheet seam into the combustion chamber sheet on both sides; the tears continued in line with the first transverse rows of stays down to a point in line with the sixteenth longitudinal row of stays on each side of center; the combustion chamber then folded down upon its lower part. Rear flue sheet pulled away from 8 superheater flues and 17 fire tubes.

The outside throat sheet ruptured at the right front corner of the mud ring from the bottom edge upward 5 inches into a washout-plug hole.

The right side of the mud ring broke at two places, bulging outward from the normal position to a maximum of 35 inches near the center of its length, one break occurring through the front corner and the other through a point 18 inches ahead of the rear corner.

The wrapper sheet ruptured for a distance of 28 inches on the right side, extending from the mud ring upward in line with the second vertical row of stays from the rear, then diagonally upward and back to the back head seam, then continuing upward through the back head sheet along the edge of the riveted seam for a distance of 12 inches.

Fig. 2 shows a side view of the interior of the firebox and Fig. 3 shows the failed door sheet.

With the exception of two broken back head braces, one broken throat brace, and the blowing out of the smokebox front, parts of the boiler, other than those heretofore described, were not materially damaged.

The boiler was apparently in generally good condition prior to the accident. There was no indication of pitting or grooving in any part, the crown sheet had apparently been free from scale; scale on the lower parts of barrel sheets and lower flues varied from 1/64 to 1/16 inch in thickness. The water level indicating devices consisted of a water column 2½ inches inside diameter, upon which a bull's-eye type water glass and three gage cocks were mounted.

The top boiler fitting of the water column, which had a 1¼-inch opening into the boiler, entered the wrapper sheet at a point between the second and third longitudinal rows of stays on the right of the center line and between the first and second transverse rows, or 9 inches ahead of the rear edge of the wrapper sheet. The lower boiler fitting, which had a ⅞-inch opening into the boiler, entered the back head at a point between the first and second transverse rows of staybolts from the top and the fourth and fifth vertical rows on the right of center, which, according to a drawing of the boiler, was 9 inches below the highest part of crown sheet. The water column steam pipe was 1½-inch copper tubing. The openings at the top and bottom of the water column were 1¼ inches.

The column was equipped with a 1-inch drain valve and pipe. The openings of the top and bottom water-glass cocks into the water column were 27/32 inch, the openings through the nipples at top and bottom of the water-glass case were $\frac{7}{16}$ inch. The water glass was equipped with a ¼-inch drain valve and pipe. Drawing of this class of locomotive shows the lowest reading of water glass and height of lowest gage cock as 6 inches above the highest part of crown sheet.

The lower boiler fitting of the water column was broken off approximately flush with the outside surface of the back head sheet, and the drain pipe was broken off between the lower boiler fitting and the drain valve.

The water column was removed first and found to be clean; the steam pipe was next removed and was also found to be clean. The coupling nut to the boiler fitting contained a copper gasket together with a rubberized fabric gasket, the inside edge of which was frayed. The top 45-degree ell boiler fitting was then removed and found to contain a rubberized fabric disk, or blind gasket, lodged in the bend of the fitting about halfway between the top and lower ends, the circumference of which was torn and frayed. When this disk, or blind gasket, was placed inside of the fabric or soft gasket found in the coupling nut it matched perfectly. It was evident that the steam-pipe connection to the boiler had at some time been blanked by this soft blind gasket and that the center part, corresponding to the size and shape of the opening in the fitting, had been separated from the ring forming the outer circumference, which, together with the copper gasket, was held between the joint faces of the fitting, by being cut by the edge of the joint face and copper gasket and by difference of pressure on the two sides of the gasket. The lower boiler fitting, drain valve, and pipe were found clean and free from obstruction.

The water-glass drain valve was broken off between the lower cock and the drain valve. Top and bottom cocks were open, clean, and in good condition. Water-glass openings were clean, and all bull's-eyes were in good condition, except one which was shattered on the inside face for about 25 percent of its area. The drain valve and pipe were clean.

Gage cocks were clean and in good condition.

Fig. 4 shows the water column, together with the top steam pipe, the boiler fitting, the copper gasket, and part of the soft gasket that were found in the joint of steam pipe and boiler fitting, and the inner part of the soft gasket in the form of a disk that was found lodged in the boiler fitting.

Main turret, right and left injector throttles and overflow valves, and both blower valves were found open. Right and left injector operating valves and water valves were found closed.

Locomotive was equipped with two nonlifting injectors. The left injector was damaged to such extent that it could not be tested; however, examination of the tubes and valves showed them to be in good condition. The right injector was applied to a locomotive of the same type and worked properly. Injector delivery, steam, feed, and overflow pipes were unobstructed.

Both boiler check valves and seats were in good condition; right valve had ⅝ inch lift, and left valve had ½ inch lift.

Boiler was equipped with one steam gage, which was removed and tested on a dead-weight tester. It was found to be correct from 10 to 200 pounds and was from 2 to 5 pounds slow from 220 to 300 pounds.

The siphon pipe and cock were found clean.

The boiler was equipped with three 3-inch safety valves, two of which were of the muffled type and the other was open type. These valves were tested on locomotive 1704, of the same class as locomotive 1705; first valve opened at 171 pounds and seated at 170 pounds; second valve opened at 176 pounds and seated at 168 pounds; and third valve opened at 202 pounds and seated at 198 pounds.

With the first valve open, the boiler pressure could not be raised high enough to open the second valve. With the adjusting stem screwed down on the first valve and the second valve open, the pressure could not be raised high enough to open the third valve. It was necessary to screw down the first and second valves before the third valve would open. This test demonstrated that the safety valves had ample relieving capacity.

Tender capacity was 8000 gallons of water and approximately 13 tons of coal. Tender cistern was empty at time of investigation due to both tank hose being torn off. The interior of cistern, tank wells, and screens were found clean and in good condition. Both tank hose were found unobstructed but damaged by the accident. Both tank valves were found open and in good condition. Both feedwater pipe strainers were found clean and in good condition.

Last annual inspection was made September 8, 1930, and last monthly inspection was made August 11, 1930, both at Erie Avenue engine house, Philadelphia, Pa.

Daily inspection reports on file at Erie Avenue engine house covering the period from August 8 to September 9 were examined. The only defect found reported having any bearing on this accident was on the report made September 9, 1930, at 6:40 a.m., about 3 hours before the accident occurred, showing "Water bottle won't drain." This report had not been approved, as the defect had not been repaired, though the crew had been called and the locomotive marked on the board as available for service.

The next section of the report covers testimony concerning the circumstances leading up to the explosion.

The report concludes that the explosion resulted from an overheated crown sheet due to low water. The primary cause was inability to ascertain the true water level because of the stoppage, or partial stoppage, of the steam connection to the top of the water column by a soft blind gasket. This gasket had apparently been applied to the outlet of the boiler fitting when the outlet was capped preparatory to making a hydrostatic test of the boiler and was not removed when the water-column connections were reassembled after completion of the hydrostatic test.

The center part of the soft blind gasket in the form of a disk was found lodged in the turn of the 45-degree ell that formed the boiler fitting for the steam pipe connection. It could not be determined whether the center part of the gasket became separated from the part that was held between the joint faces at the time of the explosion, or whether separation occurred prior thereto. In either event the presence of the blind gasket formed a stoppage that caused the water to rise in the water column and indicate a higher water level than existed in the boiler.

The sequence of events leading up to the explosion reveals a number of loose practices, any one of which is liable to cause disaster. These follow:

Use of soft gaskets in locations where gaskets may be squeezed out and obstruct free flow of water and steam through water-level indicating appliances.—Obstruction of water-gage glasses by soft gasket material has been a prolific source of crown-sheet failures.

Removal of water column while making hydrostatic test.—Water columns and connections should receive the hydrostatic test each time the boiler is tested because they are subjected to boiler pressure at all times and failure while under steam pressure would result in serious consequences to persons who may be in the locomotive cab.

Setting of safety valves without knowledge that the steam gages have been tested and setting safety valves with water level in the boiler above the highest gage cock.—The impropriety of these practices is so obvious as to require no comment. Rule 35 of the Laws, Rules, and Instructions for Inspection and Testing of Steam Locomotives and Tenders and Their Appurtenances prohibits these practices in the following words:

> Gages shall in all cases be tested immediately before the safety valves are set or any change made in the setting. When setting safety valves, the water level in the boiler shall not be above the highest gage cock.

Failure to blow out the water column.—The evidence shows that attempts to find the water level were concentrated upon attempts to blow out the water glass which was provided with a ¼-inch drain valve that was not of sufficient capacity to make any appreciable reduction in the pressure in the water column because the lower fitting to the boiler had an opening ⅞ inch in diameter. The water-glass drain valve is provided for the purpose of blowing out sediment or other possible obstructions from the water glass. Water columns are provided with a drain or blow-off valve that serves the same purpose with respect to the water column as the water-glass drain valve does to the water glass, but water-column blow-off valves are of greater capacity than the valves used in connection with water glasses. The water column was equipped with a 1-inch blow-off valve which was of sufficient capacity to effect a material reduction in the pressure in the water column. Free use of the water-column blow-off valve may or may not have dislodged the soft gasket; however, indications would have been given to an attentive observer that the water column was not functioning properly. Rule 40 of the Laws, Rules, and Instructions for Inspection and Testing of Steam Locomotives and Tenders and their Appurtenances requires that all water glasses must be blown out and tested before each trip. This rule was promulgated before water columns were in general use on locomotives. However, it is obvious that the same procedure should be followed with respect to water columns, since water columns are subject to the same causes of stoppage as water glasses and can be best kept free only in the same manner; that is, thorough and frequent blowing out to expel loose foreign matter, and reaming of the smaller passages at regular intervals to remove scale and any other matter not removable by blowing out.

Failure to test both injectors.—Rule 43 of the Laws, Rules, and Instructions for Inspection and Testing of Steam Locomotives and Tenders and Their Appurtenances requires that injectors be tested before each trip. The evidence shows that there was apparently no attempt made to test the left injector at the final inspection of the locomotive.

Building the fire in the absence of positive knowledge of the height of water in the boiler and maintaining the fire when doubt existed as to the actual water level.—The height of water in the boiler was not known at the time the boiler was fired up; it was assumed that the boiler had sufficient water because the apparent height was above the height that could be shown by the water glass and gage cocks. Ordinary caution would require that the boiler be drained to bring the water level down to a point where it could be observed before starting the fire. It was known by those responsible for having the water level indicating appliances in proper condition, over a period of about 20 hours prior to the explosion, that some irregularity existed, and it should have been apparent after repeated examinations of the water glass that the cause lay elsewhere. Notwithstanding the doubt that existed as to the true water level, the locomotive was set out for service and a hot fire was permitted to be built up and steam pressure raised in the presence of the foreman having charge of the locomotive, his assistant, and the mechanic who had made ineffectual attempts to find the water level.

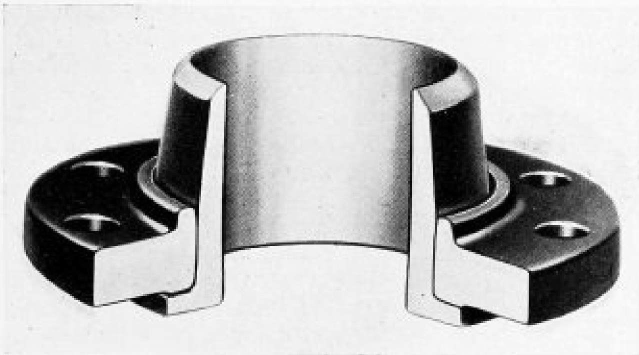
The results of a series of tests made to ascertain the sufficiency and reliability of water level indicating appliances are given in my Ninth Annual Report for the fiscal year ended June 30, 1920. These tests clearly demonstrated that the water level indicating appliances then in general use gave inaccurate and misleading indications under operating conditions, and the recommendation was made, and repeated in subsequent annual reports, that locomotives be equipped with a suitable water column to which shall be attached three gage cocks and one water glass, and one additional water glass located on the left side or back head of the boiler.

The necessity for accurate and dependable water level indicating appliances is universally recognized and the carriers have, in general, adopted the foregoing recommendations. However, some of the carriers have not applied the additional water glass on the left side or back head of the boiler. The boiler that is the subject of this report was not so equipped. Had it been so equipped, the correct water level would have been apparent and the explosion would have been avoided.

Freedom from boiler explosions caused by low water depends largely on the accuracy and dependability of the water level indicating appliances. Obviously, it is essential to safety that suitable appliances be applied, and it is equally essential that the appliances be maintained in good condition at all times. Too often it is assumed that it is not necessary to exercise the same degree of precaution to see that the steam and water passages to water columns are maintained free of all obstructions as is ordinarily exercised in connection with water glasses and gage cocks. Use of a soft gasket in the steam connection to the water column in the instant case illustrates this tendency. Another example is illustrated in Fig. 5, which shows the vertical member of the boiler connection to the bottom of a water column filled practically solid with hard scale. The condition was found by one of our inspectors after the locomotive had been made ready and set out for service when inspection disclosed that the water glass was not functioning properly. This locomotive was not owned or used by the Reading Company but the illustration is included in this report to emphasize the necessity for proper care of water columns. Water columns and connections should be blown out and tested before each trip and parts where scale or sediment is liable to accumulate should be thoroughly cleaned each time the gage cocks and water-glass cocks are to be cleaned.

Merco Swivel Flange

A new type of flanged joint has been developed for use in connection with welded pipe lines where such a joint is required for the insertion of valves and fittings for the taking off of outlets. It is known as the "Merco" swivel flange and is a unique device possessing fully the inherent flexibility of the Vanstone type of flange plus

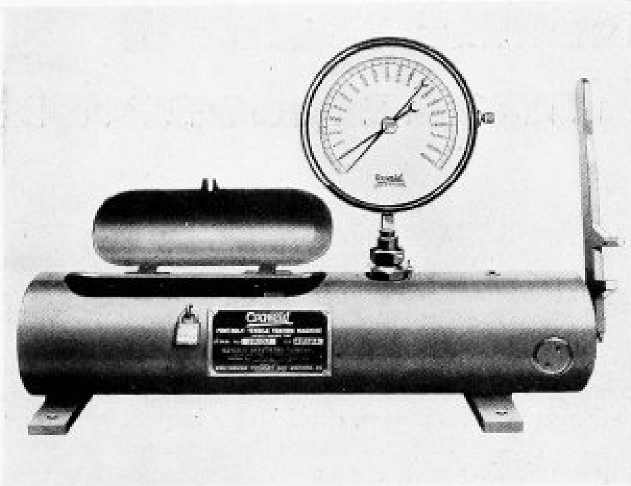


Swivel flange for use with welded pipe lines

the strength of an ordinary butt-welded flange, according to the manufacturers, the Merco Nordstrom Valve Company, 343 Sansome Street, San Francisco. It consists of a drop-forged steel flange, fitted to a drop-forced tapered nipple on which the flange may be rotated, permitting alinement of bolts, etc. The tapered nipple is forged from a solid steel billet and the finished product incorporates a thickness much greater than pipe at the base of the nipple where highest stress occurs.

An advantage of this swivel flange lies in its flexibility. The manufacturers are arranging production to soon make available sizes from 1½ inches to 10 inches, and specifications are to meet the American standards in strength requirements.

This swivel flange offers an additional advantage where service requires a special alloy such as the new chrome-nickel steels. For such service the tapered nipple only is forged from the alloy, while the flange is forged from ordinary steel—which permits a less costly flanged joint.



Oxweld portable tensile testing machine

The machine consists of a tubular compression member with a set of grips in the head and a hydraulic cylinder block in its base. The cylinder block contains a communicating pump and cylinder directly machined into a single block, and the cylinder pressure operates a piston carrying a second set of grips.

The specimen to be tested is placed between the jaws, which have spring grips. The release valve is closed and the pump handle, applied at the end of the cylinder, is moved back and forth. A set of conical blocks has also been constructed to fit into the machine head in place of the grips so that the standard ½-inch diameter round specimens may be tested if desired. The load is measured directly in pounds per square inch by a suitable, calibrated, pressure gage actuated by the pressure in the cylinder. The gage is one of the essential parts of the apparatus. When a test is finished the pressure may be released by a valve and the piston may be returned to its original position by using the pump handle.

This machine makes it possible to secure a tensile test result immediately after welds are made. This is particularly important in connection with qualification tests for determining welding ability. It also facilitates making periodic check tests of the operators and in many cases provides a ready means for testing sections cut at random by the inspector from completed work.

Portable Machine For Testing Welds

Oxweld Acetylene Company, 30 East 42nd street, New York, announces the Oxweld portable tensile testing machine, designed to facilitate the testing of welds in the field or shop. This machine was developed in cooperation with the Union Carbide and Carbon Research Laboratories, Inc., and, having successfully passed service tests over a period of time, is now being sold as a standard piece of Oxweld equipment.

This machine weighs 165 pounds and measures 28 inches in overall length and 6¾ inches in maximum diameter. It is a self-contained, totally enclosed unit. When closed for shipment, there are no projections and the machine presents a comparatively smooth cylindrical surface. The accompanying illustration shows how the machine appears when open and ready for making tensile tests.

Cleveland Establishes Bureau of Inventions

Inventors and inventions are having their day in Cleveland. Through a new service established by the Industrial Development Department of the Chamber of Commerce, inventors may submit descriptions of their devices. These are then listed in a letter which is sent to more than 2000 manufacturers.

The man with an idea only is also encouraged, although it is suggested that he protect himself if patents have not yet been applied for. Several hundred people have already taken advantage of the plan and a number are now negotiating with Cleveland manufacturers.

Those taking advantage of this patent and idea service are urged to submit full details with the first letter. Communications should be sent to Industrial Development Department, Chamber of Commerce, 1704 Terminal Tower, Cleveland.

Business Session of
National Board of Inspectors

A continuation of the question box features the Thursday session of the eighth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, held on June 17, 18 and 19 at the Patten Hotel, Chattanooga, Tenn. Questions of inspection, boiler construction and accessories for both boilers and unfired pressure vessels form the subject matter for interesting discussions.

On June 17, 18 and 19, 1930, the National Board of Boiler and Pressure Vessel Inspectors held its eighth annual meeting at the Patten Hotel, Chattanooga, Tenn. In previous issues of THE BOILER MAKER abstracts of the proceedings of the first two days' meetings have been published and following is presented an abstract of the meeting held on Thursday, June 19 at 9:30 A. M. Chairman C. D. Thomas, chief boiler inspector, Bureau of Labor, State House, Salem, Ore., presided.

In continuing with the question box started at previous meetings, Secretary C. O. Myers read the following question:

"Do you consider that insurance or state inspectors, who hold National Board certificates and are not boiler makers or mechanics, make good inspectors to pass upon new construction of boilers?" I do not know of any boiler inspectors who are not boiler makers or machinists, as you might term it. I do not know any inspector holding a National Board commission who has less than five years of such experience.

J. F. SCOTT, Chairman, Engineers License and Steam Boiler Inspectors Bureaus, Trenton, N. J.: I would answer that yes and no; it depends upon the inspector himself and whether he is good or not.

SECRETARY C. O. MYERS: The next question is, "Do you consider that boilers to be erected in the field, as watertube boilers may still be National Board and be inspected in the field after erection by an insurance or state inspector?" I would say yes.

A MEMBER: Paragraph P-332 of the A. S. M. E. Code takes care of that.

SECRETARY C. O. MYERS: The next question is, "Do you think that butt straps and shell plates should be up metal to metal on watertube boilers when the boiler is completed?"

W. H. FURMAN, Chief Boiler Inspector, Department of Labor, Albany, N. Y.: The answer is yes.

SECRETARY C. O. MYERS: The next question is, "Why are manufacturers allowed to sell National Board boilers as 8 horsepower when they have only 24 square feet of heating surface?" That is a question that is pretty hard for us to answer, as all boiler manufacturers have their own methods of determining the commercial horsepower.

SECRETARY C. O. MYERS: The next question is, "What protection has the National Board on National-Board boilers shipped into non-code states, the boilers being inspected in shops where the code is not being strictly and conscientiously enforced?"

CHAIRMAN C. D. THOMAS: The question contradicts itself when it speaks of it being inspected by a National Board inspector for a non-code state. I don't think we have any condition of that kind.

SECRETARY C. O. MYERS: The next question is, "Knowing of several instances where inspectors hold certificates in code states, do you consider these inspectors entitled to National Board certificates when they are not at all familiar with boiler making or boiler construction?" They could not get a National Board commission.

SECRETARY C. O. MYERS: The next question is, "Do you consider it essential to calk outer butt straps and shell plates, also nozzles, flanges, etc., on watertube boilers?"

CARL WEIGEL, The Hedges-Walsh Weidner Company, Chattanooga, Tenn.: Absolutely no.

SECRETARY C. O. MYERS: The next question is, "In examining for certificates of competency, why should not the practical experience be given superiority over written examination? Many applicants for certificates of competency are well read up on the code requirements yet lack the prime requisite of shop and practical experience which is absolutely essential to secure first-class inspectors."

BLAINE M. BOOK, Chief Boiler Inspector, Department of Labor and Industry, Harrisburg, Pa.: I might state that the practical experience is given its pro rata share of the credit, which I think answers the question.

SECRETARY C. O. MYERS: Here is a question on the unfired pressure vessel code: "Paragraph U-1 of the Unfired Pressure Vessel Code exempts vessels of less than 1½ cubic feet in volume, 6 inches in diameter or 30 pounds pressure. It is indefinite whether a vessel that does not exceed any of these is exempt or whether it must be below all of them. Is it desirable to have the code cover vessels of any size, large or small, carrying less than 30 pounds pressure? Are the size limitations proper and should they be supplementary? A vessel 6 inches in diameter, 7½ feet long has 1½ cubic feet volume; 1 foot diameter, 2 feet long has about 1½ cubic feet volume". In other words, does a vessel, in order to be exempt, have to exceed all the limitations of the exemption, or does any one of the exemptions exempt it from an inspection? There are three or four exemptions; it says "of less than 1½ cubic feet". The next exemption is 6 inches in diameter, another one, 30 pounds pressure. Must it be less than all of them?

E. R. FISH, Chief Engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.: The unfired pressure vessel committee of the Code Committee has under consideration a very extensive revision of the code and the question rises whether we should set any limit at all, or try to put in some exemptions. It seems a little irrational, in some ways, to say anything about exemptions. Why should any vessel be exempt? And yet on the other hand there are a lot of small containers, relatively unimportant, that it seems unnecessary to cover with the code. Is it the Code Committee's business to make those exemptions, or is that your business? That is one of the points I had in mind. The other is as regards the size; is it advisable to try to include vessels of low pressure? Thirty pounds seem to be about a good dividing point, but there are a lot of containers that carry pressures less than thirty pounds and of varying sizes. They may be large or small. Should they or should they not be included and come under the provision of a code for unfired vessels? Then again, should very small vessels less than 1½ feet in capacity, be used as a dividing line when carrying very high pressures? Should a little fellow, say 4 inches in diameter and 5 feet long, which has less than 1½ cubic feet volume, carrying 150 pounds be included in the unfired pressure vessel code?

F. A. PAGE, Industrial Accident Commission of California: I called the Board's attention to the wording of that paragraph some few years ago, and pointed out to them that under that rule gas tanks, say 30 feet in diameter carrying a pressure of 29 pounds would be exempted. We at that time had just such a case to give a decision on. At first the code committee came back with the same wording. I sent it back again and asked them to give me a decision on it and pointed out exactly what I was up against, and they came back and said that if any one of those three exemptions was violated, they then would come under the orders. That satisfied us, because we had at the same time or about the same time, fatalities caused by the explosion of very small tanks, say 10 inches in diameters and about 2 feet long, used for paint spraying and not built according to any rules; the heads were too light and blew out and killed a couple of workmen; so then we had the two extremes, either a small tank with a high pressure or a big tank with a low pressure.

J. F. SCOTT: Answering Mr. Fish and following out Mr. Page's remarks, I do not believe the Code Committee ought to exempt any particular size tank in its program. I think the construction ought to apply, insofar as possible, to all sized vessels coming within the pressure vessel classification. I do not believe that anything under 30 pounds ought to be exempt. I think the dividing line ought to be 15 pounds, 15 pounds being considered at the low pressure line, and any vessel above 15 pounds per square inch to be constructed in accordance with the code requirements; then it is within the province of the state or the municipality to set up, under their laws and regulations, what vessel or size or cubical volume of vessels that should be affected by these regulations in accordance with the code provisions.

SECRETARY C. O. MYERS: At two or three different legislative sessions in Ohio we tried to have the boiler inspection law amended to cover the inspection of unfired pressure vessels. The manufacturing industry in general were somewhat disturbed over the introduction of this bill to the extent that they did not wish a bill to be passed without the proper exemption of pressure vessels which they considered were not dangerous in operation. It would be impractical, and beyond reason, to expect to formulate rules to govern all types of pressure vessels, therefore, some exemption provisions should be adopted which are uniform, and we found in Ohio that the following exemptions satisfied all of the objections to the adoption of such regulations:

The question of water gage glass location on horizontal firetube boilers, as introduced by Blaine M. Book, proves a subject of much discussion, not only by inspectors but by all interested parties. Recommendations were made to the effect that the Boiler Code Committee clarify its rules for water glasses and gage cocks to insure greater safety in the operation of horizontal firetube boilers of the power class.

EXEMPTION: Vessels carrying pressures less than 15 pounds per square inch, and vessels containing only water under pressure, or other liquids whose boiling point at atmospheric pressure is above 100 degrees F. and vessels subjected to temperatures exceeding 750 degrees F, and vessels of less than 5 cubic feet capacity.

Each one of these exemptions is individual, that is, if any one of them is not exceeded the vessel is exempt. If a vessel must exceed all of the exemptions before it is classed as exempt I am of the opinion that no pressure vessel will be exempt from inspection. If you will pause a moment and ask yourselves the question—Why the necessity for regulations governing unfired pressure vessels?—I think that you will agree with me that it is not the type of vessel that I have previously mentioned, that we wish to regulate, and by specific exemptions we can eliminate them and make rules governing the construction of the vessel that should be inspected.

SECRETARY C. O. MYERS: The next question is, "Above what boiler pressure should handhole plates be made of steel?" We have some boiler manufacturers here, maybe they can tell us.

C. W. OBERT: Handhole plates are required to be of steel. The only thing in the code is about manhole plates.

E. R. FISH: If I may say a word, I think the division point is largely psychological. The use of cast iron for handhole plates for even high pressures is very, very widespread, and as far as my information goes, there are very few reports of failures. On the old Heine boiler with which I am most familiar, of course, we rather persisted in the use of cast iron up to pressures of 400 and 450 pounds without experiencing any difficulty at all. However, I think that from the psychological point of view that is a little high. Just as a concrete suggestion, I would say that perhaps 300 to 350 pounds would be a good dividing point and be perfectly safe.

At this point vice-chairman W. H. Furman takes the chair.

SECRETARY C. O. MYERS: The next question is, "Would it not be desirable to have small tapped openings in plus or concave pressure heads in air pressure tanks provided for at the time of construction?" As I understand it, that is to determine the thickness of the head.

C. E. MCGINNIS: City Boiler Inspector, Los Angeles, Cal.: I think that it is as desirable to have tapped openings in the minus as well as in the plus head, because that minus head is back in and welded over; you do not get a very correct measurement. Another thing, the flanging of your sheet, due to a little heavier thickness, is better. There is more weight on your flange than at the radius of your head.

Secretary C. O. Myers: The intent is that an opening be provided so that a field inspector can remove the plug and get the thickness of the head, and there is no provision in the code for it, and I believe I am safe in saying that the party who asked the question would like to have some definite action taken to recommend to the Code Committee.

The recommendation was adopted.

Secretary C. O. Myers: The next question is, "What is the opinion of this Board as to the advisability of the boiler manufacturer submitting blueprints of changes in design or pressure for approval to the inspection authorities of the state or states into which they wish to ship their products?" It seems to me that if the design was unusual, out of line with the ordinary practice, that the manufacturer should submit it to the local authority where he was going to install it, and get their slant on it. I think if a policy of sending all proposed changes for approval were established, it would interfere somewhat with our present method. We have qualified inspectors in all of the shops that are manufacturing these boilers, whom we depend upon to check the drawings of the manufacturer and to apply the provisions of the code in the construction of them. It appears to me that the way we are now handling this, we are pretty safe on it.

F. A. Page: My thought was that perhaps we might come to some understanding and have these blueprints checked by some central body or by some one who might check them over carefully and give us the service. I realize that to require the manufacturer to send in blueprints for every change he may desire to make, to all inspection authorities will not only incur probably unnecessary expense, but will also hamper him in getting his product out on time, because some of the inspection departments might not return them as quickly as they ought to.

Carl Weigel: As a manufacturer, I think we should accept the responsibility for delivering a boiler to your state or anybody's state, that complies with your law, and when it gets there, if it does not comply with the law, that is time enough for you to holler. There is a little difference in every boiler built for some reason that we are ashamed to even try to explain, but at any rate, there is. Now it would be an untold hardship on us to attempt to get an approval from any inspection board on every design of boiler. We start the boiler through the shop before we have our drawings completed. We have to do that in order to make shipments according to requirements, but we could not approve those drawings until they are completed, but we know enough about our designs before we go ahead, and we think that the thing should be put up to the manufacturer and it should be his responsibility to deliver you a boiler that will pass the requirements. I would like to make a little unofficial suggestion, and that is that, as manufacturers, we are more than glad to try to cooperate with the inspection department and that we could, without having any binding rule, have a kind of unofficial agreement that if there is anything out of the ordinary or very new that is going to be brought out, that that thing be taken up with the state inspector in the jurisdiction where it is to be delivered. I have done that numbers of times in our business and have found that it worked very satisfactorily. It does not work any hardships on the manufacturer, it helps him out wonderfully and I think it can be worked in those cases.

Secretary C. O. Myers: The next question is "A manufacturer is contending that Paragraph P-323 conflicts with itself inasmuch as four holes may be drilled in line for a pair of hangers, yet it will not permit four holes in line on a single hanger, although the pitch of a single hanger rivet is the same as on the double hanger. I would like to hear this discussed." Is there any conflict that you know of?

C. W. Obert: There is nothing to prevent making four holes in a longitudinal line. Perhaps you all recall this little sketch that appears in figure P-20, Paragraph 323, that shows two tilted brackets side by side. The only restriction that they are trying to put in there, as I understand it, is in the next to the last sentence, where it says "The distance girthwise of the boiler from the center of the bottom rivets to the center of the top rivets attaching the hangers shall not be less than 12 inches." That was to give a spread of the rivets sufficient so that there is enough leverage to make it strong, so that it will not tend to pull out. Of course, a series of holes in a longitudinal line on a cylindrical shelf would have a very serious weakening effect, but the assumption of the committee is that if they do have two brackets in line and there are four levers in line, the weakening effect on the shell in a longitudinal sense would not do any harm. I cannot see that there is any conflict; the limitation is distinctly on the girthwise distance that is stated in this next to the last sentence, and nothing at all is said about the spread of spacing in a longitudinal line, the assumption being that there would not be enough metal removed along the longitudinal line to weaken the shell below the joint efficiency in any case.

Secretary C. O. Myers: The next question is, "A cylindrical cooker, with an inner and outer shell, has the inner shell supported against collapsing by continuous tee-iron rings, which fit snugly to the outer surface of the inner shell. Both edges at the base of the tee are welded to the shell. Will this construction meet the requirements of the code?" I would say that it does not meet the code requirements.

C. W. Obert: I do not see just where it violates the code. I can say that a construction very similar to that is now before the Boiler Code Committee, and I do not recall just what action was taken on it, but I think the Hamler Boiler and Tank Company, in Chicago, put that question up and it was given consideration at a meeting a few months ago. They submitted a test to show the deformations under hydrostatic test, and as I recall the discussion in the committee, it was of the opinion that the welding of the reinforcing bar was somewhat the equivalent of one of these reinforced furnaces, Adamson ring type, so I would like to have Mr. Myers give us the point of violation as he sees it.

Secretary C. O. Myers: The Unfired Pressure Vessel Code is silent upon construction of this kind, the power code limits such welding to three inches, and therefore I would say that it does not comply with code regulations.

C. W. Obert: The three inch limitation is for boilers only, so that particular limitation was not intended to apply to these.

E. R. Fish: This whole question is one that is not covered by the code at all; it is one of the shortcomings, because there are a considerable number of vessels of that sort carrying pressure, which should be covered in some way but they are not. There is not much known about the dimensions required to resist lap in pressure, and that is one of the questions now under consideration by the research committee of the A. S. M. E. in co-operation with the Boiler Code Committee. But if a shell with the pressure on the outside is truly circular, it has to resist only compression stresses. There is no tendency to deform. It is practically impossible to get it exactly round; consequently some reinforcement around the outside is desirable to keep down the thickness and resist the tendency to re-lap due to this little lack of rotundity. It does not take a great deal of reinforcement to provide for that. The way to determine whether or not that form of construction is to be permitted is to make actual tests under the provisions of the code, and that has been carried out in several instances and tests have been made to determine whether that form of construction was sufficient and it has been found to be so in the vessels that I have referred to.

J. P. Morrison, superintendent of inspection, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.: May I add a word to what has been said on the subject? I am particularly interested because I witnessed a test on similar vessels, and the code rule in Paragraph 247 is being followed. The results of one test have been submitted to the Code Committee, as Mr. Obert and Mr. Fish have stated. Another test was run within the last two weeks with great success. Briefly, the tee iron used in the first test was spaced 30 inches apart; the internal shell stood 465 pounds without permanent set. In the tests the other day on a similar vessel, if I remember rightly, the internal shell was about 54 inches in diameter, possibly 12 feet long, of ¾-inch steel. It was rolled to a circle within ⅛-inch variation in diameter, so it was comparatively true. Channel irons rolled with the width towards the shell were welded to the inner shell. That vessel stood 400 pounds without permanent check. The temporary deflection between the rib was twice as much as it was at the rib, so that the ribs are performing a real function there as shown by the tests. Now, theoretically this welding is merely holding those ribs from moving around on the shell. If they were a perfect fit, which we concede they are not, and were spaced the proper distance apart and stayed there, you would not need any riveting or welding or anything else to hold them, and they would have fully as much strength as they have welded on. You could spot weld the irons here and there and it would answer the same purpose, so the test under paragraph 247 of those two vessels has been conducted and a similar proceeding is to be used with us. They are planning to demonstrate according to the code rules submitted to the Code Committee, the results of those tests, and, personally, I believe they are amply strong. We have been passing lots of them; we have not been stamping them as code because we did not consider that they literally met those requirements.

Secretary C. O. Myers: The next question is "What is the proper elevation of the lowest visible point in the water glass of horizontal tubular boilers with firetubes?"

Blaine M. Book: The location of the water glass on horizontal firetube boilers has been the subject of much discussion, not only by boiler inspectors but by all interested parties. You no doubt recall that this question was voted on at Detroit last year without proper discussion or consideration.

The proper elevation of the fusible plugs and water glasses in boilers of the horizontal-return-tubular type is a source of misunderstanding and vague interpretation, not only by the members of the A. S. M. E. Boiler Code Committee, but by all other interested parties.

If the real purpose and intent of these appliances is studied, we must conclude that the purpose of the fusible plug is to prevent overheating or damage to the boiler in the event that the water falls below the safe level. The escaping steam and water from a fusible plug when it functions is to effect an immediate stoppage of the firing or to retard, so far as possible, the effect of the furnace fire on the shell plates and tubes, before these parts of the boiler become no longer submerged. If the water-heating surface of a steam boiler can be overheated by low water before the fusible plug blows, then the fusible plug has accomplished nothing further than to disprove the alibi that there was plenty of water in the boiler.

It is not practical, nor desirable that the fusible plug functions before the water reaches the lowest safe working level because if it did then not infrequently the boiler would be unnecessarily shut down for renewal of the fusible plug. Therefore, to prevent the frequent and unnecessary melting of the fusible plug it is intended to have the plug submerged at the lowest visible range of the water in the gage glass, in order that the further admission of feed water be expedited by other means or that the firing be stopped or the fires drawn.

A horizontal-return-tubular boiler, say 72 inches in diameter by 18 feet long, if operated at a normal rated capacity of 150 horsepower, would evaporate approximately 5100 pounds of water per hour or 85 pounds per minute. The amount of water per inch of depth at an elevation of 3 or 4 inches above the tubes is around 420 pounds of water per inch of depth, which amount of water would be equal to 5 minutes operation at normal rating. If the boiler was operated at 150 or 200 percent of the rated capacity, the time required to lower the water level 1 inch in the event of stoppage of additional feed water would be correspondingly reduced. Therefore, if the highest point of the tubes was submerged 2 inches at the lowest visible range of the water in the gage glass there would be a time interval of about 10 minutes in which to restore the water level or to stop firing and check the fire, which means fast work by the operator, if he were actually observing the water when leaving the lowest visible range of the gage glass. A quarter of an hour or an additional 5 minutes would, I believe, be better and would promote safety as well as continuity of the boiler service.

In Paragraph A-21 of the Appendix, the location of the fusible plug is stated for boilers of various types. We in Pennsylvania have no deep interest or concern in fusible plugs for this type of boiler and further the wording of the first line of Paragraph A-21 is not specific, inasmuch as it states that fusible plugs may be used. In view of the wording of this sentence, the use of fusible plugs is not mandatory. As I understand it, the fusible plugs under the wording of the paragraph may be located in a horizontal-tubular boiler anywhere above the top of the uppermost row of tubes. Apparently it is thought by the authors of the Boiler Code that there should be not less than 2 inches of water above the fusible plug in any firetube boiler set in a horizontal position. This is evident in Paragraph A-21, (C), (P), (Q) and (R). All these Sections establish the fact that the fusible plugs shall project through the crown sheet or combustion chamber top not less than 1 inch and all of which plugs are in a vertical position. In a boiler of the horizontal-return-tubular type, the fusible plug is in a horizontal position, which actually creates a difference in elevation of 1 inch.

Therefore, if a fusible plug is used and located 2 inches above the tubes at the rear end of the boiler and the boiler is pitched 1 inch toward the rear and the lowest visible range of the water glass is 2 inches above the fusible plug, then there would be a submergence of 3 inches at the front end of the boiler when the water is visible in the gage glass or a volume of water in the boiler equivalent to the evaporation that occurs in 15 minutes at normal rating. This in my judgment is reasonably safe and in line with the requirements for other types of boilers having flat crown sheets or combustion-chamber tops.

In the foregoing example, I have referred to a boiler of 150 horsepower, but if a larger or smaller boiler be used for the example, the time element would be about the same for any boiler of that type operated at a pressure over 100 pounds per square inch.

Elsewhere in the Code, the requirements for calculating safety valve capacities are predicated on an evaporation of 50 percent in excess of 85 pounds of water per minute or 1 inch of water level in 5 minutes. Further, as the steam pressure in the boiler reduces and the temperature of the water in the boiler falls there is a shrinkage in weight of this water of 10 percent by volume, which would further effect a still lower water level as the steam pressure is reduced. Inasmuch as the practice of pitching horizontal tubular boilers 1 inch to the rear is not strictly adhered to, and these boilers are now in many cases set level or inclined to the front, as well as the fact that the use of a fusible plug is optional, I am of the opinion that Paragraph P-291 of the A. S. M. E. Code should be clarified in order that all interested parties may intelligently interpret it.

I believe the motion which I propose to place before this meeting will simplify Paragraph P-291 of the A. S. M. E. Code and will eliminate its misinterpretation. It will also permit the unrestricted use of fusible plugs when and where their use is mandatory or desirable, therefore, in the furtherance of safety, uniformity and clarification, I wish to present the following motion, which is a revision of Paragraph P-291, as a recommendation from the National Board to the A. S. M. E. Boiler Code Committee:

WATER GLASSES AND GAGE COCKS. 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.

Where boilers have horizontal firetubes, the highest point of the tubes, flues or crown sheet shall be covered with not less than 3 inches of water when the water is at the lowest reading in the water gage glass. When the distance between the inside of the shell and the top of the tubes, flues or crown sheet is 13 inches or less, the tubes, flues or crown sheet shall be covered with not less than 2 inches of water when it is at the lowest reading in the gage glass.

CHAIRMAN C. D. THOMAS: I think the wording of this should be slightly different, you should say in power boilers the highest point of the tube.

The executive session of the National Board was opened at 2 P.M. at the Patten Hotel, Chattanooga, Tenn. During this meeting the reports of the various committees were read and approved. A discussion of non-destructive and fatigue tests of welded vessels followed.

Calculating Strength of a Dome Course

By Howard P. Gordy

In calculating the strength of a dome course and liner use the following symbols:

D — Diameter of hole in shell and liner — 28 inches.
d — Diameter of rivet holes — 1 1/16 inches.

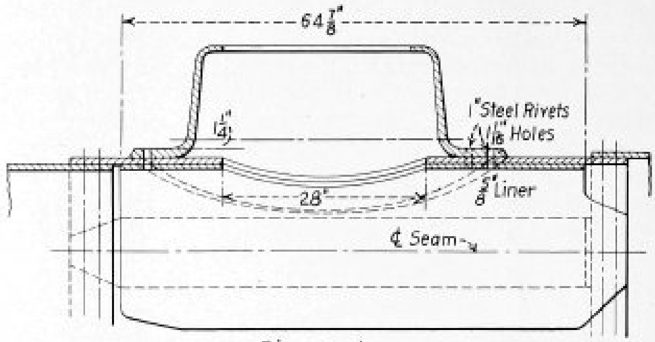


Figure.- 1

Dome section showing metal removed

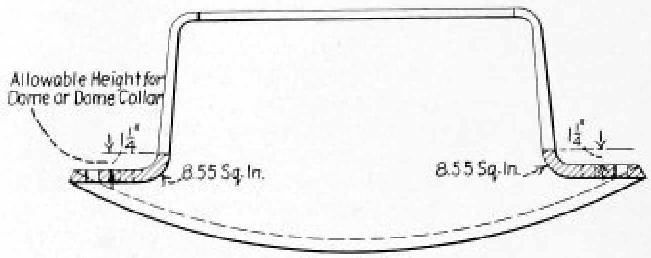


Figure - 2

Strength section of a dome

L — Length of shell or liner — 64⅞ inches.
T — Thickness of shell sheet — 13/16 inches.
t — Thickness of liner — ⅝ inch.
r — Radius of boiler — 42⅝ inches.
Boiler pressure — 220 pounds.

Rivets on top center line—Two 1-inch rivets in 1 1/16 inch holes.

The cross sectional area of metal removed from a dome course, because of the opening for the dome and rivet holes, etc., must be replaced by a liner of sufficient cross sectional area, together with the allowable cross sectional area of the dome base or dome collar and must equal the cross sectional area of metal removed.

With Fig. 1 as an example, it is first necessary to find the cross sectional area of metal removed from the shell, which is:

Metal removed from shell equals

$$(D \times T) + (2 \times d \times T) \text{ or}$$
$$(28 \text{ inches} \times .8125) + (2 \times 1.0625 \times .8125) =$$
$$24.4765 \text{ square inches}$$

After determining the area of metal removed from the shell it is next necessary to determine the area of metal replaced by the liner, which is:

Metal replaced by liner equals

$$[L - (D + 2d)\ t] \text{ or}$$
$$[64.875 - (28 + 2 \times 1.0625)]\ .625 =$$
$$21.7187 \text{ square inches}$$

The sectional area of the dome base or dome collar permitted to be calculated as an additional reinforcement for the dome opening, as example shown in Fig. 2, has a total area of 17.10 square inches.

The total number of square inches replacing the metal lost by dome opening and rivet holes is:

Cross sectional area replaced by liner	21.71 square inches
Cross sectional area allowed for dome base ...	17.10 square inches
Total cross sectional area replaced	38.81 square inches

The total cross sectional area replaced by liner and dome base, is greater than cross sectional area removed by dome opening, rivet holes, etc. Therefore, the condition shown meets the requirement for replacing the cross sectional area removed.

The stress in pounds per square inch on the length L would be the sum of the cross sectional areas of the metal remaining in shell, liner and dome base or collar, divided into the load.

The cross sectional area of metal remaining in shell is as follows:

$$[L - (D + 2d)\ t] \text{ or } [64.875 - (28 + 2 \times 1.0625)\ .8125] = 28.23 \text{ square inches}$$

Total cross sectional area of metal supporting load is as follows:

Liner	21.71
Dome base	17.10
Shell	28.23
Total	67.04 square inches

Load on length L is:

$$L \times P \times r \text{ or } 64.875 \times 220 \times 42.625 = 608{,}365 \text{ pounds}$$

Stress in pounds per square inch on length L equals:

$$\frac{\text{Load}}{\text{Supporting cross sectional area}} \text{ or } \frac{608{,}365}{67.04} = 9074 \text{ pounds per square inch}$$

Factor of safety can be determined by dividing the stress into the lowest tensile strength of the sheets used.

Factor of Safety equals:

$$\frac{\text{Tensile Strength}}{\text{Stress}} \text{ or } \frac{55{,}000}{9074} = 6.06$$

The strength of the rivets in shear on each side of the opening shall be at least equal to the tensile strength of the maximum amount of the shell removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell.

Arc-Welded Tank Has High Working Pressure

In many small communities where liquid artificial gas is used instead of natural or other artificial gas, means must be provided for storing this liquid and distributing it to the users in the community. The large tank in the illustration shows the method used in one community for storing this gas.

This large tank is fabricated completely of steel plate joined by the electric arc-welding process. It is 30 feet long and 90 inches in diameter, is fabricated of $\frac{5}{16}$-inch steel plate butt welded together and has a capacity of approximately 50,000 gallons of liquid gas. It was manufactured by Morrison Brothers, Dubuque, Ia. On the inside of the tank, steel bands or butt straps are arc welded into place over the seam all the way around the circumference. The welding current for arc welding this large tank was furnished by stable-arc welders manufactured by The Lincoln Electric Company, Cleveland, O.

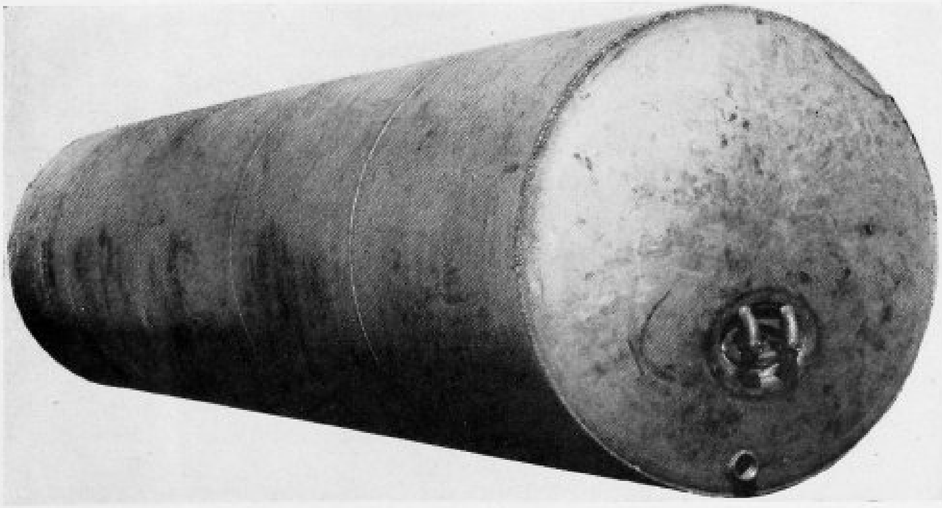
When completed this large arc-welded tank was tested under a hydrostatic pressure of 135 pounds. It will be used to store Skel-gas, a liquid inflammable product obtained by the condensation of natural gas under pressure, and will have a working pressure of 90 pounds per square inch.

The use of the electric-arc welding process in the construction of this large tank simplified its fabrication considerably because of the elimination of laying out and punching for riveted construction. The high working pressure of this tank, which is unusual in such large tanks, was also made possible by the arc-welded construction.

Ryerson Expands Boston Facilities

Joseph T. Ryerson & Son, Inc., Chicago, Ill., has recently acquired the stock and good will of the sheet metal division of the Richards Company, Inc., Boston, Mass. Stocks taken over by Ryerson include Armco black and galvanized sheets, lead coated, galvannealed, and Bay State blue sheets in addition to a diversified line of standard and special sheets which have been carried regularly in the Ryerson warehouses at Third, Binney and Munroe streets, Cambridge, Mass.

In 1926 the Ryerson organization first entered the Boston territory through the purchase of the reinforcing bar division of the Penn Metal Company. Two years later the plant, good will and steel merchandise of the E. P. Sanderson Company were added. With the recent purchase, increasing Ryerson sheet metal facilities, this company has one of the largest and most complete steel-service plants in the New England States.



Tank 30 feet long and 90 inches in diameter, fabricated from steel plate and is completely arc welded. It is used for storing liquid artificial gas; has a working pressure of 90 pounds per square inch

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

Qualifications for Federal Boiler and Locomotive Inspector

Q.—I am a reader of your Questions and Answers Department in THE BOILER MAKER and enjoy it very much. I want to ask your advice and hope you will favor me. I desire the position of Federal boiler and locomotive inspector. I would thank you to tell me what course of study to pursue which would enable me to pass the examination. Perhaps you could tell me of some book which contains the necessary information, also the steps to take in making application for examination. C. L. A.

A.—Federal boiler and locomotive inspectors for railroads must have several years experience as locomotive firemen before they are qualified to take the civil service examinations. The examinations cover a wide range of subjects relative to mechanics, engines, boilers, boiler accessories, locomotive firing and general mechanical subjects.

"Locomotive and Boiler Inspectors Handbook," by A. J. O'Neill, gives a list of questions and answers typical of those given in the civil service examinations for this position.

A complete knowledge of the laws, rules and instructions for inspection and testing of steam locomotives and tenders and their appurtenances as issued by the Bureau of Locomotive Inspection of the Interstate Commerce Commission, also a practical knowledge of the A.S.M.E. Boiler Code is essential for anyone seeking this position.

Write to your nearest Civil Service Commissioner or to the Civil Service Commission at Washington, D. C., for information as to the next examination for Federal locomotive and boiler inspector.

Capacity of Air Reservoir

Q.—I have an air reservoir that holds 300 cubic feet of air at atmospheric pressure. How many cubic feet of air will the reservoir hold at 100 pounds safe-working pressure? The atmospheric temperature is 70 degrees. The air compressor is 600 feet from tank and air passes through coils of pipe near the compressor to cool the air off en route to the air reservoir. The compressor is a Norberg cross-compound type, 2800 cubic feet of free air capacity. Low pressure cylinder, 40 inches diameter; high pressure, 28 inches diameter; steam pressure, 100 pounds per square inch; air cylinders water cooled. What would be the approximate temperature of air in pipe as it enters the air reservoir? Under the distance and conditions stated above, please give formula on this if there is any and also formula and working explanation of the first part of the problem. The air reservoir is made of boiler steel and exposed to the weather both summer and winter and is not covered or insulated from the elements. W. M. W.

A.—The formulas for the relationship of pressure, temperature and volume of air indicate that when the pressure remains constant the volume is directly proportional to the absolute temperature. If the temperature remains constant, the volume is inversely proportional to the absolute pressure. Theoretically, air (as well as other gases) can be expanded or compressed according to two different laws. Adiabatic expansion or compression takes place when the air is expanded or compressed without the transmission of heat to or from it; as for example, if the air could be expanded or compressed in a cylinder of an absolutely non-conducting material. Let:

P_1 = initial absolute pressure in pounds per square foot
V_1 = initial volume in cubic feet
T_1 = initial absolute temperature in degrees F.
P_2 = absolute pressure in pounds per square foot after compression
V_2 = volume in cubic feet, after compression
T_2 = absolute temperature in degrees F., after compression

Then,

$$\frac{V_2}{V_1} = \left(\frac{P_1}{P_2}\right)^{0.71} \qquad \frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{1.41} \qquad \frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{0.41}$$

$$\frac{V_2}{V_1} = \left(\frac{T_1}{T_2}\right)^{2.46} \qquad \frac{P_2}{P_1} = \left(\frac{T_2}{T_1}\right)^{3.46} \qquad \frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{0.29}$$

These formulas are also applicable if all pressures are in pounds per square inch, or if all volumes are in cubic inches.

Isothermal expansion or compression takes place when the gas is expanded or compressed with an addition or transmission of sufficient heat to maintain a constant temperature.

Let

P_1 = initial pressure in pounds per square foot
V_1 = initial volume in cubic feet
P_2 = absolute pressure in pounds per square foot, after compression
V_2 = volume in cubic feet, after compression
C = constant depending on the temperature

$$\text{Then } P_1 \times V_1 = P_2 \times V_2 = C$$

For a temperature of 32 degrees, constant C equals 26,000 foot pounds and for other temperatures it may be found from the formula $C = 53.3T$, in which T is the absolute temperature which is maintained during the expansion or compression.

Substituting in the formula for isothermal compression and considering one cubic foot of air under the conditions outlined in the question, we have,

$$V_2 = \frac{P_1 \times V_1}{P_2} = \frac{14.7 \times 144 \times 1}{114.7 \times 144} = .128 \text{ cubic feet}$$

Thus one cubic foot of air in the reservoir has been compressed to .128 cubic feet.

$300 \div .128 = 2343$ cubic feet, capacity of reservoir at 100 pounds pressure.

This answer is assuming that the air after being compressed reaches that reservoir at the atmospheric temperature, this can be ascertained by taking the temperature of the compressed air at the reservoir.

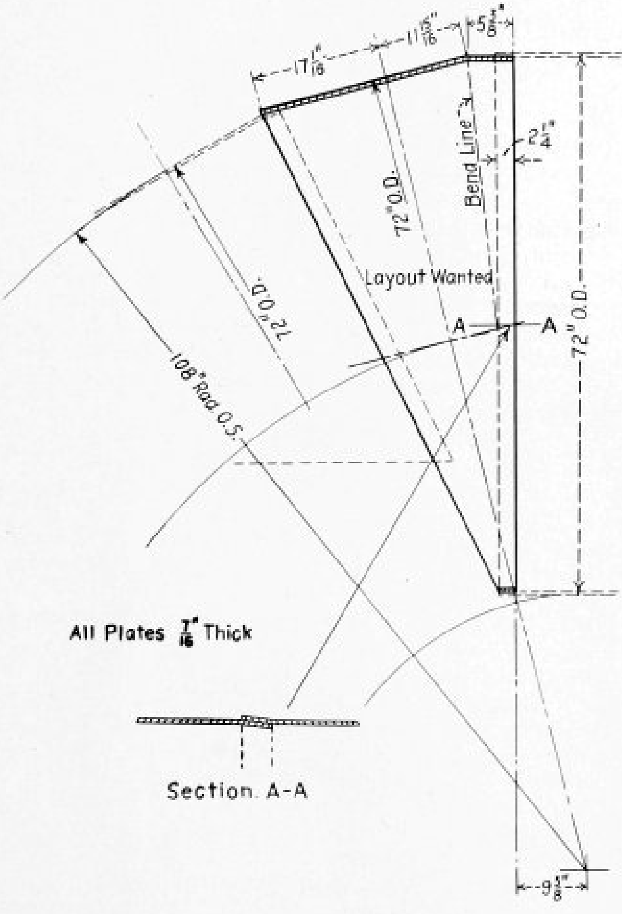
If the temperature changes, the capacity should be computed with the formulas for adiabatic compression.

Layout of Elbow Section

Q.—Will you please print the layout of the plate as shown in the enclosed sketch? I find your magazine a very essential one. P. F. S.

A.—The sketch submitted in the question shows the end section of an elbow and should be developed in the usual manner.

The fact that the outside diameter of the pipe into which the elbow fits and the outside diameter of the



Layout of an elbow plate

elbow are the same, namely 72 inches diameter, would indicate that what is intended by the straight portion of 5⅜ inches, and the bend line, is the fitting of these two pieces together.

The section should be developed as the end section of an elbow, and the fit all around taken care of by flaring the sheets in a manner as indicated in section *A-A*.

Rating of Boilers

Q.—I would greatly appreciate your advising me, of the method used by manufacturers in rating (commercial horsepower) vertical multi-tubular, vertical single-flue and stationary firebox-type boilers under natural draft, also under forced draft conditions. An early reply will be appreciated. J. T. F.

A.—The term "horsepower" as applied to a steam boiler is somewhat indefinite, as the boiler does not develop the power, but is simply a medium that receives and restores the heat so that it can be delivered to the engine. But, in order to have a basis of comparison and to establish a relationship between the boiler and the engine, the term "horsepower" is now applied to boilers as well as to engines.

As a matter of historical interest, it should be noted that the committee of judges in charge of the boiler trials of the Centennial Exposition in 1876, at Philadelphia, Pa., found that a good engine of the type prevalent at that time required approximately 30 pounds of steam per hour for each horsepower developed by the engine. In order to establish a relation between the engine power and the size of the boiler required to furnish the steam to the engine, this committee recommended that an evaporation of 30 pounds of water from the initial temperature of 100 degrees F., to steam at 70 pounds per square inch gage pressure, be considered one boiler horsepower.

It is now customary to consider the standard boiler horsepower in terms of equivalent evaporation from and at 212 degrees F. This equivalent evaporation from and at 212 degrees F., is a more logical and convenient basis to work from than that from 100 degrees. This equivalent is found by multiplying 30 pounds by the factor of evaporation for 70 pounds gage pressure, and 100 degrees temperature of the feed water. The factor evaporation is given in steam tables and is 1.1494. Therefore $1.1494 \times 30 = 34.482$ or approximately 34.5 pounds. This means that in any given case and for any given steam pressure and feed water temperature, the equivalent evaporation from and at 212 degrees F. may be found by multiplying the actual evaporation determined by trial by the factor of evaporation for that particular set of conditions.

With this understanding of the term we can find the commercial horsepower of any boiler from the following formulae:

The equivalent evaporation from and at 212 degrees F. may be found from the formula:

$$W = \frac{w(H - t + 32)}{966.1}$$

where W equals the equivalent evaporation in pounds per hour, w equals the actual evaporation in pounds per hour, H equals the total heat of steam at the observed pressure, as found from the steam table, and t equals the temperature of the feed water as it enters the boilers.

Divide the result obtained from the formula given above by 34.5 to get the horsepower. As an example take the following:

A boiler generates 2200 pounds of steam per hour at a pressure of 120 pounds, and the temperature of the feed water is 70 degrees F. What is the horsepower of the boiler?

Solution:—The total heat H, as found from the steam table, is 1188.64 B.T.U., then the equivalent evaporation is:

$$W = \frac{2200(1188.64 - 70 + 32)}{966.1} =$$

2620 pounds of steam per hour, as compared with the 2200 pounds given before. Therefore

$$2620 \div 34.5 = 76 \text{ horsepower}$$

The factor 966.1 which appears in the formulae is the latent heat of steam at atmospheric pressure and the temperature of 212 degrees F.

All the foregoing relates to the evaporation method of finding the horsepower of the steam boiler, and it is the best method to use where it can be used. However, there is still another method used by manufacturers that is somewhat more convenient and which may be called the buying and selling standard of boiler horsepower, based on the number of square feet of heating surface of the boiler. It has been found by careful experiment that from 10 to 15 square feet of heating surface constitutes one horsepower in a boiler.

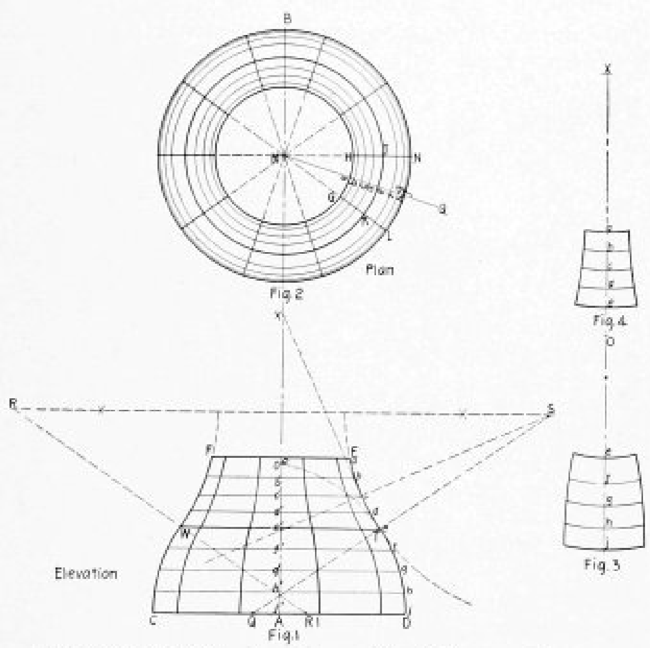
When speaking in general, the horsepower depends upon how the boiler is driven, what kind of fuel is used, how it is burned, etc. The 10 to 15 range of values of the heating surface covers the majority of cases close enough for practical purposes.

This rating has become somewhat standardized at 10 square feet of heating surface per horsepower for watertube boilers, 12 square feet for tubular boilers and 8 square feet for Scotch marine boilers.

Development of Surface With Double Curvature

Q.—I would like to have you print a solution to the enclosed problem in an early issue. G. P. S.

A.—For the development of the surface of a sphere or any other arched construction that has a double curvature, a pattern for the plates can only be approximate. Much depends upon the manner in which the different sections of the object are to be worked up. Where the sections are heated and pressed to shape in dies, a pattern can be struck out for the sections with a good degree



Plan and elevation of surface with double curvature

of accuracy. Where the sections are to be made by hand, it would be a difficult matter to bring out each section alike. Another point to be considered is the number of sections taken, the greater the number of sections, the greater the uniformity of the finished head.

Figs. 1 and 2 show the plan and elevation of the object submitted in the question. *Q-T* is the inside radius of the lower half and *S-T* is outside radius of the upper half. The line *Q-S* is drawn between the centers of the two radii. The point *T* is the tangent point of the two radii forming the outline of the object.

Parallel to the base line *C-D*, draw the line *W-T* through *T*, dividing the object into two halves.

The plan view is then divided into any number of equal parts, ten being taken in this case, as each of these parts is an equal part of the total circumference of the object, a development of one part will serve as a development of each of the other sections.

To develop the section *KLNJ* of the plan. Extend the radius *Q-T* of the elevation until it cuts the line *A-B* at *O*. Divide *T-D* of Fig. 1 into any number of parts, four in this case, and number the same *e, f, g, h* and *j*.

In the plan, bisect the angle *LMN* drawing the line *M-Q* which divides the sections *KLNJ* and*KJHG* into two parts. Draw a series of circles in the plan with *M* as a center and radii equal to *h-h' g-g' f-f'* as taken in the elevation.

The development of the pattern for the section *KLNJ* is shown in Fig. 3.

Draw a vertical line, and with any point on this line as *O* as a center and the actual distance (measure this distance on arc) *O-e* of Fig. 1 as a radius scribe an arc, in the same manner scribe a series of arcs using *O-f, O-g, O-h* and *O-j* as radii.

Each side of *e*, Fig. 3, step off a distance equal to the corresponding width of the section measured on the arc *e* in the plan; in the same manner at *f* step off a distance equal to the corresponding width of the section measured on the arc *f* in the plan, doing the same at *g, h* and *j*, completing the pattern.

To develop the section *KJHG* of the plan, divide the arc *E-T* into four equal spaces, number same *a, b, c, d* and *e*; connect *c* with *S* and at *c* erect a perpendicular to *c-S* cutting the line *A-B* at *X*.

In the plan, draw a series of circles with *M* as a center and with radii equal to *a-a', b-b', c-c', d-d'* and *e-e'* as taken in the elevation.

The development for the section *KJHG* is shown in Fig. 4.

Draw a vertical line and with any point on this line as *X* as a center, and with a radius equal to *X-c* scribe an arc, locating the point *c* on the vertical line. Step off *c-b* equal to *c-b* in the elevation, also *b-a, c-d* and *d-e*, as shown. These distances are also taken from the elevation. Scribe arcs each side of the vertical line, through *a, b, d* and *e*, with *X* as a center. Complete the development using the same method for the width of the plate as outlined for the development of Fig. 3.

The complete object will consist of ten patterns similar to Figs. 3 and 4.

Welding Seams and Rivets of Pressure Vessel

Q.—Could you give me any information about removing the scale from rivets heated in an oil furnace? Do you consider the welding of seams and rivets in a pressure vessel good practice? By welding the seams with the water in the vessel, the rivets started to leak, caused from the heat of the weld. It seems to me as though this will reduce the efficiency of the joints, especially when the vessel is subject to changes in temperature. I have reference to steam pressure vessels up to 938 pounds test pressure. G. W. M.

The scale on a rivet when being taken out of the rivet heater is generally quite loose and is customarily removed by knocking the rivet. Reasonable care in heating the rivets would overcome this trouble; the rivets should be heated with a soaking non-scaling heat which can be obtained with a properly regulated oil furnace.

I do not consider that welding seams and rivets for tightness is good practice, although there is nothing in the A.S.M.E. Code that prohibits it. Welding on the shell of a pressure vessel can be injurious to the shell plate and for this reason should not be used. The efficiency of the seam would not be materially affected due to the rivets in the outside row leaking.

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.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—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, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, suite 522, Brotherhood Block, Kansas City, Kansas.
Assistant International President—William Atkinson, 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—John J. Dowd, 142 Pearsall Ave., Jersey City, N. J.; M. A. Maher, 2001 20th St., Portsmouth, O.; R. C. McCutchan, 226 Lipton St., Winnipeg, Man., Canada; H. J. Norton, Alcazar Hotel, San Francisco, Cal.; C. A. McDonald, Box B93 Route 2, Independence, Mo.; J. N. Davis, 1211 Gallatin St., N. W. Washington, D. C.; M. F. Glenn, 1434 E. 93rd St., Cleveland, O.; W. J. Coyle, 424 Third Ave., Verdun, Montreal, Canada; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; J. F. Schmitt, 25 Crestview Rd., Columbus, O.

Master Boiler Makers' Association

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Third Vice-President—Ira J. Pool, division boiler inspector, Baltimore & Ohio Railroad, Baltimore, Md.
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Executive Board—Charles J. Longacre, chairman, foreman boiler maker, Meadow Shops, Pennsylvania Railroad, Elizabeth, N. J.

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American Boiler Manufacturers' Association

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Vice-President—Owsley Brown, Springfield Boiler Company, Springfield, Ill.
Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.
Executive Committee—Homer Addams, Fitzgibbons Boiler Company, Inc., New York; H. E. Aldrich, The Wickes Boiler Company, Saginaw, Mich.; George W. Bach, Union Iron Works, Erie, Pa.; Sidney Bradford, Edge Moor Iron Company, Edge Moor, Del.; F. W. Chipman, International Engineering Works, Framingham, Mass.; Robert E. Dillon, Titusville Iron Works Company, Buffalo, N. Y.; C. E. Tudor, Tudor Boiler Company, Cincinnati, Ohio; A. C. Weigel, The Hedges-Walsh-Weidner Company, Chattanooga, Tenn., and E. G. Wein, E. Keeler Company, Williamsport, 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.	St. Joseph, Mo.	Memphis, Tenn.
Detroit, Mich.	St. Louis, Mo.	Nashville, Tenn.
Erie, Pa.	Scranton, Pa.	Omaha, Neb.
Kansas City, Mo.	Seattle, Wash.	Parkersburg, W. Va.
Los Angeles, Cal.	Tampa, Fla.	Philadelphia, Pa.
	Evanston, Ill.	

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	

Cities

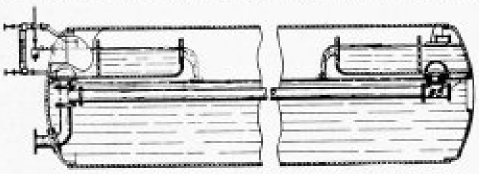
Chicago, Ill.	St. Louis, Mo.	Nashville, Tenn.
Kansas City, Mo.	Scranton, Pa.	Omaha, Neb.
Memphis, Tenn.	Seattle, Wash.	Parkersburg, W. Va.
Erie, Pa.	Tampa, Fla.	Philadelphia, Pa.

Selected Boiler Patents

Compiled by Dwight B. Galt, Patent Attorney, Washington Loan and Trust Building, Washington, D. C. Readers wishing copies of patents or any further information regarding any patent described, should correspond directly with Mr. Galt.

1,721,482. METERING BOILER. HERMAN C. HEATON, OF CHICAGO, ILLINOIS, ASSIGNOR TO YARNALL-WARING COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

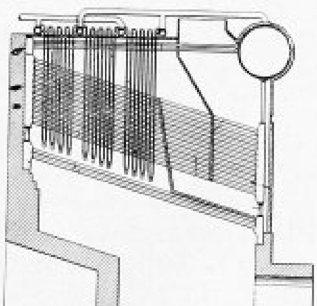
Claim.—The combination of a boiler, a weir box and weir in the steam space thereof, using the water space of the boiler as a catch basin,



means including a float, connecting said weir box to a measuring device and a feed-water inlet arranged to discharge into said weir box. Eight claims.

1,722,785. BOILER HAVING SUPERHEATER. BENJAMIN N. BROIDO, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

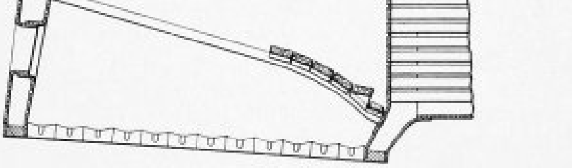
Claim.—A boiler of the type wherein a plurality of rows of water-tubes are arranged to extend substantially horizontally over the boiler



furnace, a plurality of baffles extend transversely across said tubes to provide a plurality of gas passes and a plurality of superheater elements are located in the gas pass nearest to the furnace, characterized by the provision of a plurality of superheater headers supported at the top of the boiler from which said superheater elements are freely suspended, said elements extending vertically into said nearest gas pass in the spaces between adjacent rows of said tubes, and said baffles being unequally spaced longitudinally of said tubes to compensate for the presence of said elements and so that the effective cross sectional areas of the gas passes formed between said baffles are equivalent. Five claims.

1,721,267. ARCH BRICK. JAMES T. ANTHONY, OF SOUTH ORANGE, NEW JERSEY, ASSIGNOR TO GENERAL REFRACTORIES COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

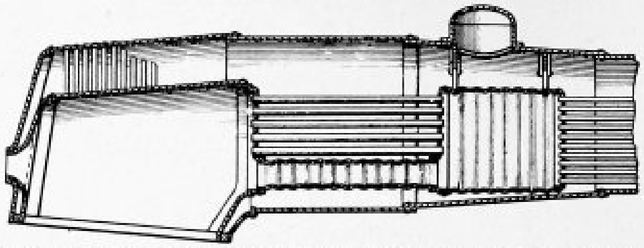
Claim.—In a locomotive firebox, the combination with the grate and throat sheet, of circulation tubes extending upward from the throat sheet



and a row of bricks extending between the circulation tubes and positioned adjacent to the throat sheet, the tubes being inclined downwardly and forwardly at their point of engagement with the throat sheet, the bricks having depending side flanges of increasing depth forwardly and provided with tube engaging sockets extending parallel to the bottom edge of the flanges. Three claims.

1,698,133. BOILER AND THE LIKE. JOHN F. HOTTMAN, OF CHICAGO, ILLINOIS.

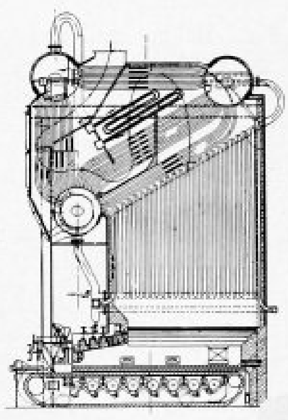
Claim.—In a steam boiler, the combination with the firebox and the flue sheet at the front end of the same, together with the flue sheet at the



front end of the boiler, of a cylindrical combustion chamber within the barrel of the boiler between said flue sheets, flue sheets at the front and rear ends of said combustion chamber, a series of large flues or tubes reaching from the firebox flue sheet to the rear combustion chamber flue sheet, including a flame flue of relatively larger size, a series of flues or tubes reaching from the flue sheet at the front end of the combustion chamber to the flue sheet at the front end of the boiler, and a series of straight flues or tubes reaching from each side portion of the firebox flue sheet directly forward to the side portions of the flue sheet at the front end of the boiler and extending directly past the side portions of the combustion chamber. Five claims.

1,720,469. WATERTUBE BOILER. PERCIVAL FRANCIS CRINKS, OF SIDCUP, ENGLAND, ASSIGNOR TO VICKERS BOILER COMPANY LIMITED, OF LONDON, ENGLAND, A COMPANY OF GREAT BRITAIN.

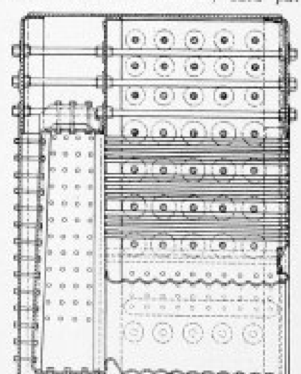
Claim.—In a watertube boiler, a main steam and water drum, a water drum comprising an outer shell and an inner shell secured within and spaced from the outer shell to define an annular water-circulating cham-



ber, said inner shell constituting a settling chan[illegible] a stabilizing drum, tubes connecting said settling chamber with the main drum, tubes connecting said main drum with said annular chamber, a longitudinal baffle in said main drum disposed between the ends of the tubes connecting said main drum with the settling chamber and annular chamber respectively, said baffle terminating short of the ends of the main drum and having shaped ends disposed between the ends of said main drum, tubes connecting the stabilizing drum with the main drum, tubes connecting the stabilizing drum with the annular chamber, and a longitudinal baffle in said annular chamber disposed between the ends of certain of the last mentioned tubes. Fifteen claims.

1,736,462. STEAM GENERATOR. MARK ROBINSON, OF WATERLOO, NEAR LIVERPOOL, ENGLAND.

Claim.—A steam-generator having a plurality of generator units capable of being independently worked, comprising a common boiler shell formed as a horizontal cylindrical drum with closed ends; two vertical longitudinally-extending partitions in said drum, said partitions being of less



length than the length of said drum; a transverse partition connecting said vertical partitions and separating the central space within the partitions from the remaining space in the drum, so that said remaining space forms a U-shaped unit, and the central space the central unit; staybolts connecting and spacing said partitions; and heating means and feedwater supply means in each of said generator units. Six claims.