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INDEX TO

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THE BOILER MAKER

JANUARY, 1914

Formulas Used in Laying Out Plate Work

Nine Convenient Formulas for Use in Ordering and Laying Out Circular and Conical Sheets—Their Application to a Tubular Boiler

BY C. W. R. EICHHOFF

The following formulas have been used successfully by the writer, and are quite generally used by others in ordering stock for plate work or for laying out such work.

Many layer-outs and foremen find the layout of taper courses in connection with the construction of boilers and other tank work a puzzling problem. From time to time many rules have appeared on this subject, and these have been tried by the writer, but he has found that the following rule is the most accurate and the easiest to handle. When called upon for the first time to order sketch plates for such work, the writer found nothing else to guide him than what is given by "Nichols" and "Courtney," and for this reason the following formulas have been discussed at some length in order to show how they have been derived.

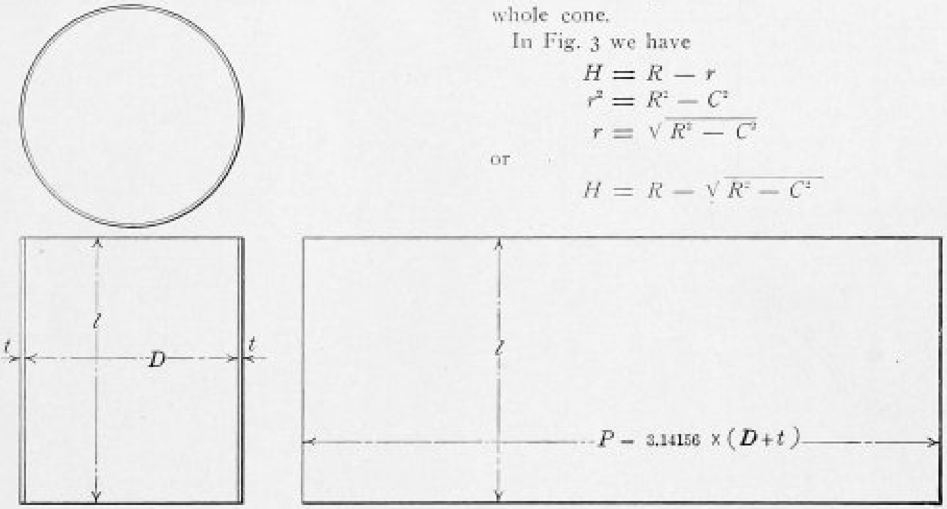


Fig. 1

Most developments necessary for the construction of boilers, tanks, etc., are for cylindrical and conical forms. The layout is considered to be made on the center fiber section or the neutral plane of the plate. To develop the plate for a plain cylindrical shell, Fig. 1, whose inside diameter is D and the thickness of the plate is t, it is necessary to give the plate a length P equal to $(D + t)\pi$, or $3.14156\ (D + t)$. If D is the outside diameter of the shell the length P equals $(D - t) \times 3.14156$.

The development of a conical course is more complicated. Referring to Fig. 2:

D = diameter of large end of conical course.
d = diameter of small end of same.
l = length of course.
R = generating radius of whole cone.

Then we have from the similar triangles CAB and EAF

$$R : l :: D : D - d$$

$$R = \frac{lD}{D - d} \qquad (1)$$

This formula gives the radius R for the development of the whole cone.

In Fig. 3 we have

$$H = R - r$$
$$r^2 = R^2 - C^2$$
$$r = \sqrt{R^2 - C^2}$$

or

$$H = R - \sqrt{R^2 - C^2} \qquad (2)$$

This formula gives the "rise" or height of the large segment.

Now
$$C^2 = R^2 - r^2$$
$$C^2 = R^2 - (R - H)^2$$
$$C^2 = R^2 - (R^2 - 2RH + H^2)$$
$$C^2 = R^2 - R^2 + 2RH - H^2$$
$$C^2 = 2RH - H^2$$
$$C^2 = (2R - H)\ H \qquad (3)$$

or

$C = \sqrt{(2R - H)\ H}$, which gives the length of half the cord.

If the arc belonging to this half cord C is very flat, which is the case when the radius R is very large, $\frac{D\pi}{2}$ can be substituted for C. Substituting this value in formula (3), and considering formula (1), we have

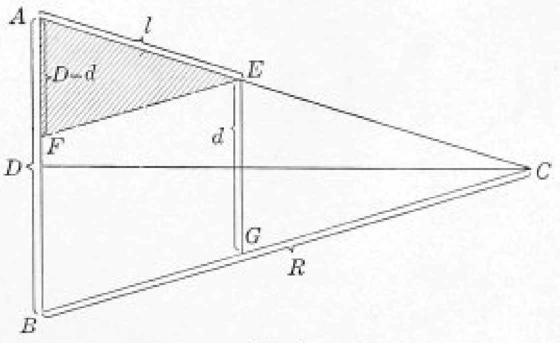


Fig. 2

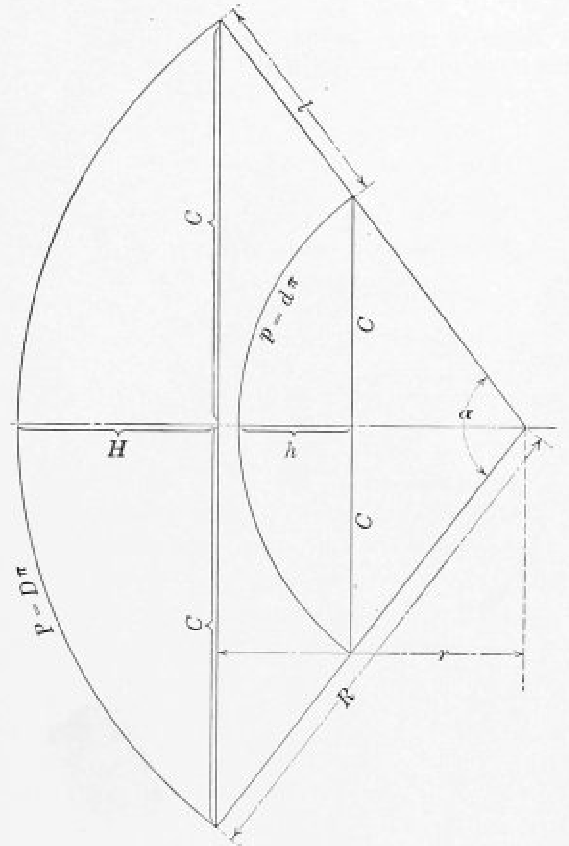


Fig. 3

$$\left(\frac{D\pi}{2}\right)^2 = \left(\frac{2lD}{D-d} - H\right)H \qquad (4)$$

Now H, as a rule, is very small compared with the value of $\frac{2lD}{D-d}$, and therefore it can be neglected. We have then

$$\frac{D^2\pi^2}{4} = \frac{2lD^2}{D-d} \times H$$

or

$$\frac{D\pi^2}{4} = \frac{2l}{D-d} \times H$$

or

$$H = \frac{D\pi^2}{4} \times \frac{D-d}{2l}$$

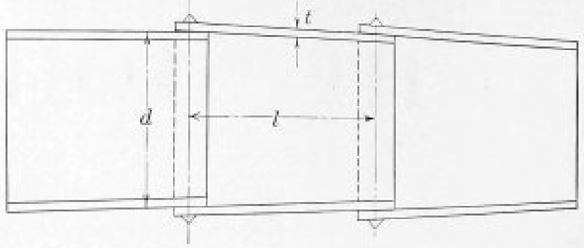


Fig. 4

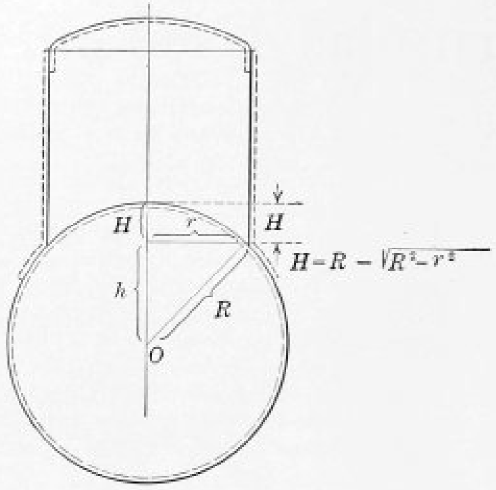


Fig. 5

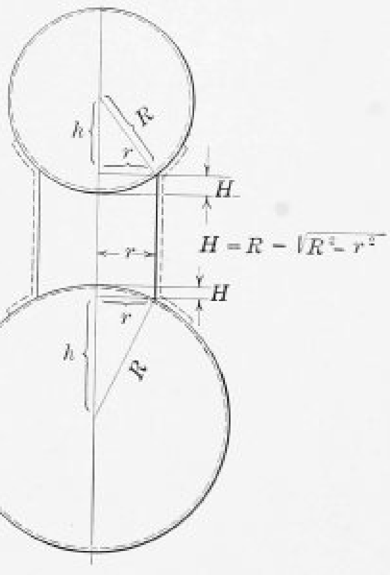


Fig. 6

$$H = \frac{D\pi^2(D-d)}{4\times 2\times l} \qquad (5)$$

Now the perimeter

$P = \pi D$ and $p = \pi d$.

Therefore

$$D = \frac{P}{\pi} \text{ and } d = \frac{p}{\pi},$$

and

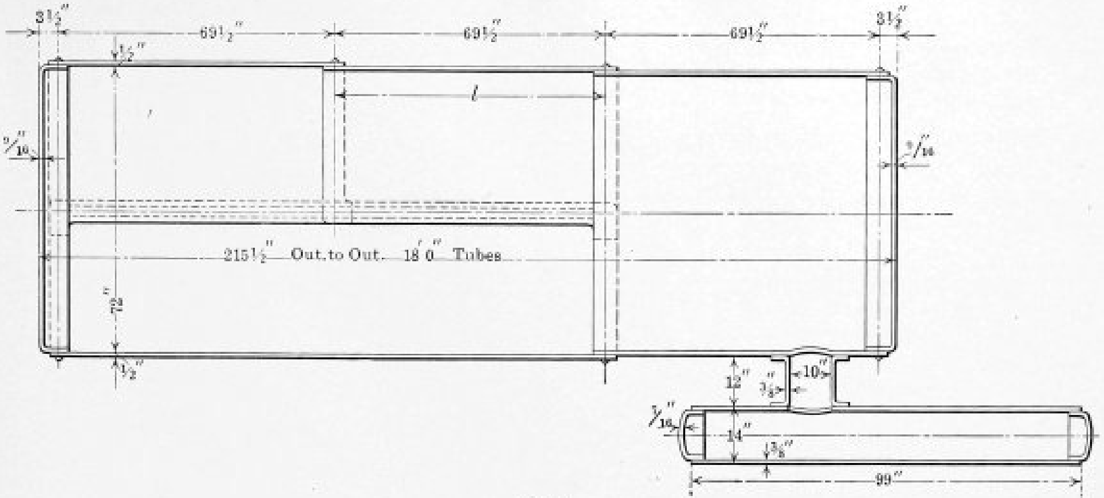


Fig. 7

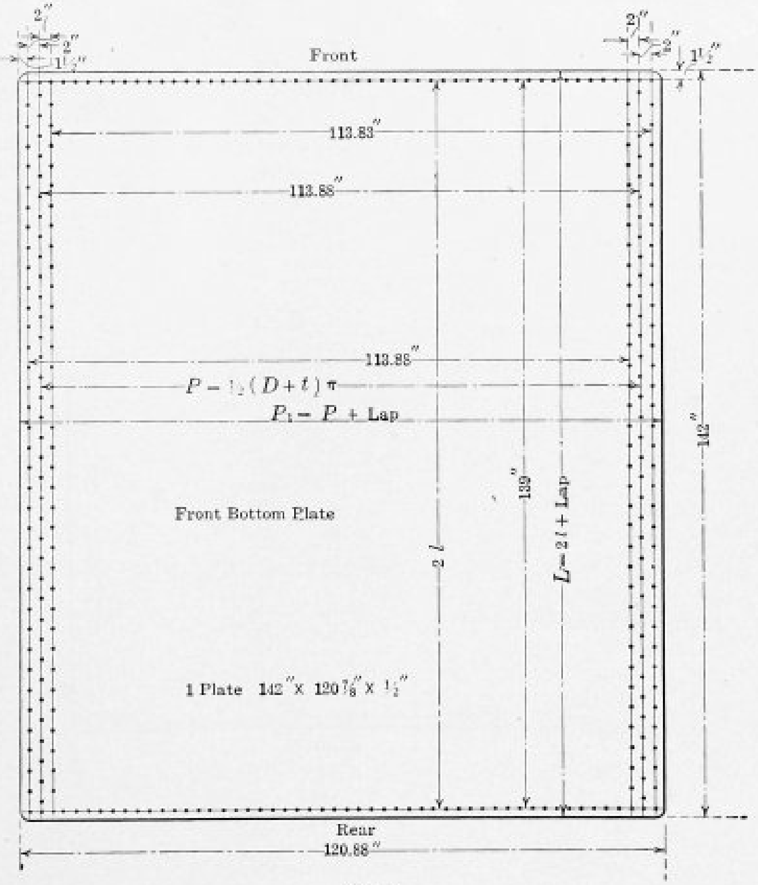


Fig. 8

$$H = \frac{\dfrac{P}{\pi} \times \pi^2 \times \left(\dfrac{P}{\pi} - \dfrac{p}{\pi}\right)}{4 \times 2 \times l}$$

$$H = \frac{P\,(P - p)}{8\,l} \qquad (6)$$

The following formula (7) can be used for cases where H is not larger than $.2D$, or two-tenths of the diameter of the large end of the course:

For any cone we have

$$R = \frac{l\,D}{D - d},$$

and as in Fig. 3, angle $\alpha : 360^\circ :: D : 2R$.

$$\text{Angle } \alpha = \frac{360 \times D}{2R}, \text{ and as}$$

$$\frac{C}{R} = \sin.\ \frac{\alpha}{2}, \text{ we have}$$

$$C = R \sin. \frac{\alpha}{2}$$

$$H = R - \sqrt{R^2 - C^2}$$

The height of the smaller arc is found as follows:

$$\frac{h}{H} = \frac{c}{C} = \frac{p}{P} = \frac{d \times \pi}{D \times \pi} = \frac{d}{D}$$

$$H = \frac{d}{D} \times H,$$

and

$$H = \frac{p}{P} \times H \qquad (7)$$

As an example, the above formula can be applied in developing the taper courses shown in Fig. 4.

Calling d the inside diameter at the large end of the course, it will be necessary to substitute $d + t$ for D and $d - t$ for d in the above formulas. Formula (6) reads:

$$H = \frac{1.235 \times D\,(D - d)}{l}$$

Inserting the new values in this formula, we have

$$H = 1.235 \frac{(d + t)\,[(d + t) - (d - t)]}{l}$$

$$H = 1.235 \frac{2t\,(d + t)}{l}$$

$$H = 2.47 \frac{t\,(d + t)}{l} \qquad (8)$$

If the course consists of n sheets it is necessary to multiply by n^2; n is equal to 1 for one plate, ½ for two plates, 1/3 for three plates, etc., according to the number of sheets in the course. The formula (8) then becomes:

$$H = 1.235 \frac{D\,(D - d)}{l} n^2$$

$$H = \frac{P\,(P - p)}{8\,l} n^2 \qquad (8a)$$

$$H = 2.47 \frac{t\,(d + t)}{l} n^2$$

The above formulas are used for ordering and laying out circular and conical sheets.

The following formula can be used for ordering plates for dome and nozzle plates. In Figs. 5 and 6 we have

r = the radius of dome or nozzle.
R = the radius of boiler or drum.
H = the drop on either dome or nozzle.

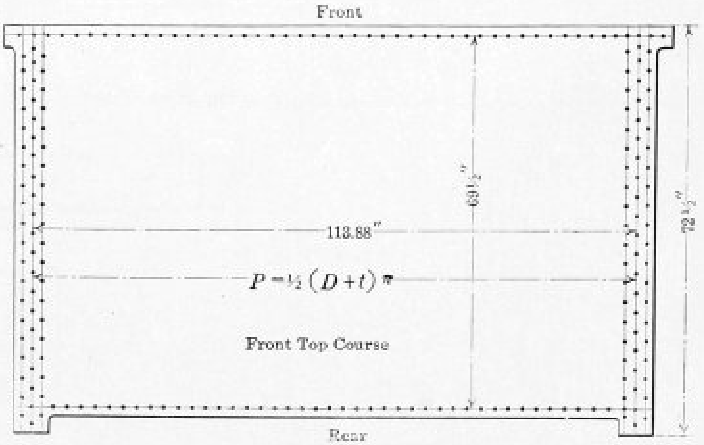


Fig. 9

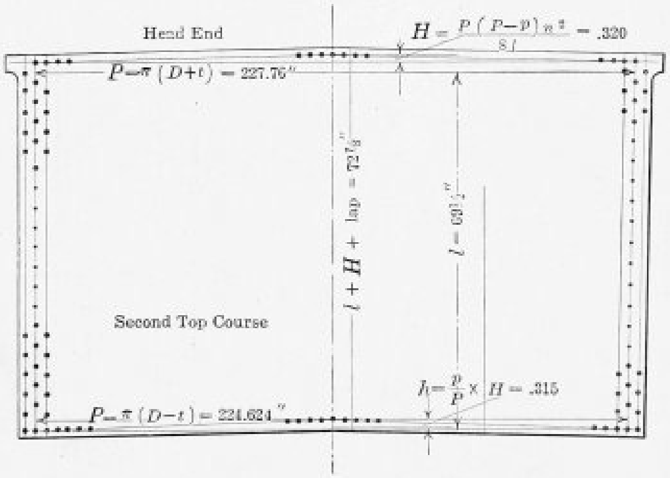


Fig. 10

In both figures the outside of the shell and the inside of the dome or nozzle is taken.

$$R^2 = h^2 + r^2$$
$$R^2 - r^2 = h^2$$
$$R^2 - r^2 = (R - H)^2$$
$$\sqrt{R^2 - r^2} = R - H$$
$$H = R - \sqrt{R^2 - r^2} \qquad (9)$$

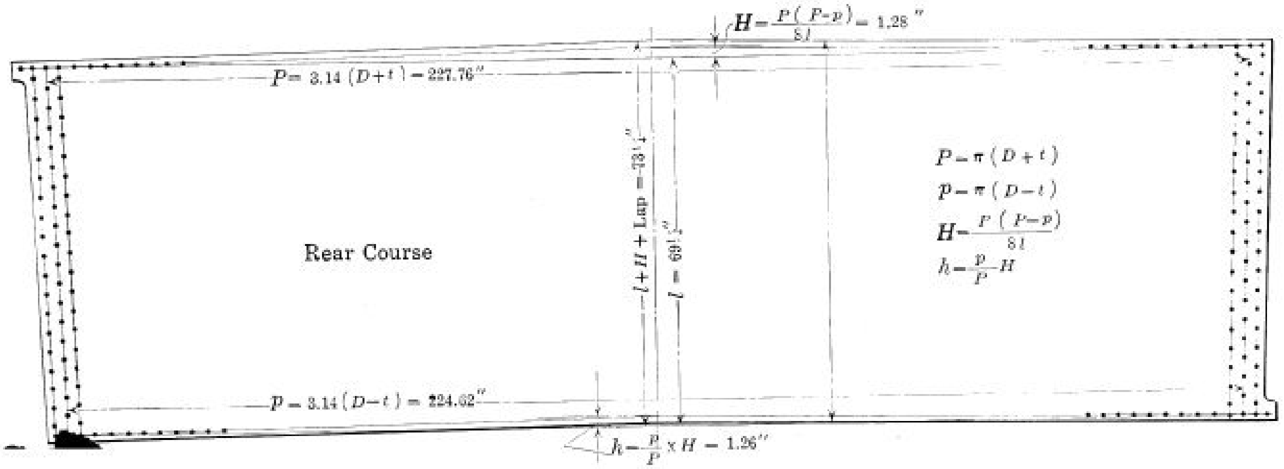


Fig. 11

Now let us [illegible] these formulas to practical examples. Assume, for ins[illegible]at it is required to order the plates for a 72-inch by 18-foot horizontal return tubular boiler, a sketch of which is shown in Fig. 7. There are two heads, 9/16 inch by 78½ inches. The top front course is of circular form, joining the bottom front course at the center of the boiler. The bottom front plate is also of circular form, and the layouts of these two plates are indicated in Figs. 8 and 9.

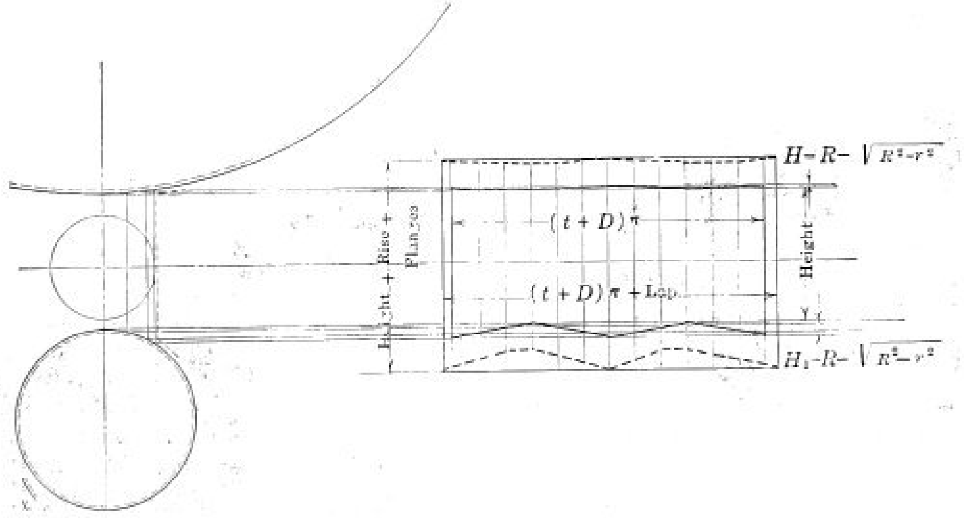


Fig. 12

The second top course is a taper sheet of conical form, and in order to determine the size of these sheets it is necessary to know the "rise" on same. For the whole frustum of the cone, of which this course is a part, we have:

$$P = (D + t)\pi = 72\frac{1}{2} \times 3.14156 = 227.76 \text{ inches.}$$
$$p = (D - t)\pi = 71\frac{1}{2} \times 3.14156 = 224.624 \text{ inches.}$$
$$P - p = 227.76 - 224.624 = 3.136 \text{ inches.}$$
$$l = 69\frac{1}{2}.$$

and $n = \frac{1}{2}$.

Applying formula (8a):

$$H = \frac{P\,(P - p)\,n^2}{8\,l} = \frac{227.76 \times 3.136}{8 \times 69.5} \times \frac{1}{2^2}$$

$$H = \frac{227.76 \times 3.136}{8 \times 69.5 \times 4} = .320, \text{ or about } 5/16 \text{ inch.}$$

And according to formula (7):

$$h = \frac{p}{P} \times H = \frac{224.624}{227.76} \times .320 = .315, \text{ or about } 5/16 \text{ inch.}$$

With these two dimensions known we can proceed to order the plate or to use these dimensions for developing the plate. This is indicated in Fig. 10.

The rear course of the boiler is a plate running entirely around the circumference of the boiler, and is, therefore, a complete frustum of a cone. Here we have given

$$P = (D + t)\,\pi = 72\frac{1}{2} \times 3.14156 = 227.76 \text{ inches.}$$
$$p = (D - t)\,\pi = 71\frac{1}{2} \times 3.14156 = 224.624 \text{ inches.}$$
$$P - p = 227.76 - 224.624 = 3.136 \text{ inches.}$$
$$l = 69\frac{1}{2}.$$
$$n = 1.$$
$$H = \frac{227.76\,(227.76 - 224.624)}{8 \times 69.5}$$

$$H = \frac{227.76 \times 3.136}{8 \times 69.5} = 1.28 \text{ inches}$$

$$h = \frac{p}{P} \times H = \frac{224.624}{227.76} \times 1.28 = 1.26 \text{ inches.}$$

This plate is laid out in Fig. 11.

We now come to the mud-drum and nozzle. For the drum we have two heads, 7/16 inch by 15 inches; one plate, 47¾ inches by 99 inches by ⅜ inch. The nozzle connects a frustum of a cone with a cylinder. As the nozzle is of small diameter, and as the frustum of the cone is tapered only to the amount of ½ inch in 69½ inches, it will be sufficiently accurate if we consider the nozzle as connecting two cylinders. In a later article the writer will show an accurate method of developing such a nozzle when it connects two tapered courses where the taper in the length is not more than the thickness of the plate.

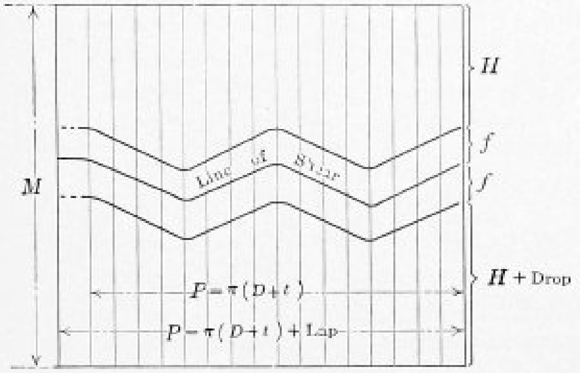


Fig. 13

For the top of the nozzle we use formula (9).

$$H = R - \sqrt{R^2 - r^2}.$$

$$H = 36 - \sqrt{36^2 - 5^2} = .35, \text{ or about } \tfrac{3}{8} \text{ inch, and}$$

for the bottom of the nozzle

$$H = R - \sqrt{R^2 - r^2}.$$

$$H = 7 - \sqrt{49 - 25} = 2.1, \text{ or about } 2\tfrac{1}{8} \text{ inches.}$$

The plate to be used in the development, allowing 3 inches for each flange, is of the following size:

12 + 2⅛ + ⅜ + 6 = 20½ inches wide, and therefore the whole plate is 35⅛ inches by 20½ inches by ⅜ inch. The development of the plate is shown in Fig. 12.

The rule (Drop $= R - \sqrt{R^2 - r^2}$) can also be used in ordering stock for a dome. Simply add to the height of the dome (head excluded) the "drop" found by the formula, and add to this the proper allowance for the flange of the dome for either single or double riveting, as the case may be.

In case stock should be ordered for two domes in one plate, we have for the width of the plate (Fig. 13):

$$W = 2 \times H + \text{drop} + 2 \times f.$$

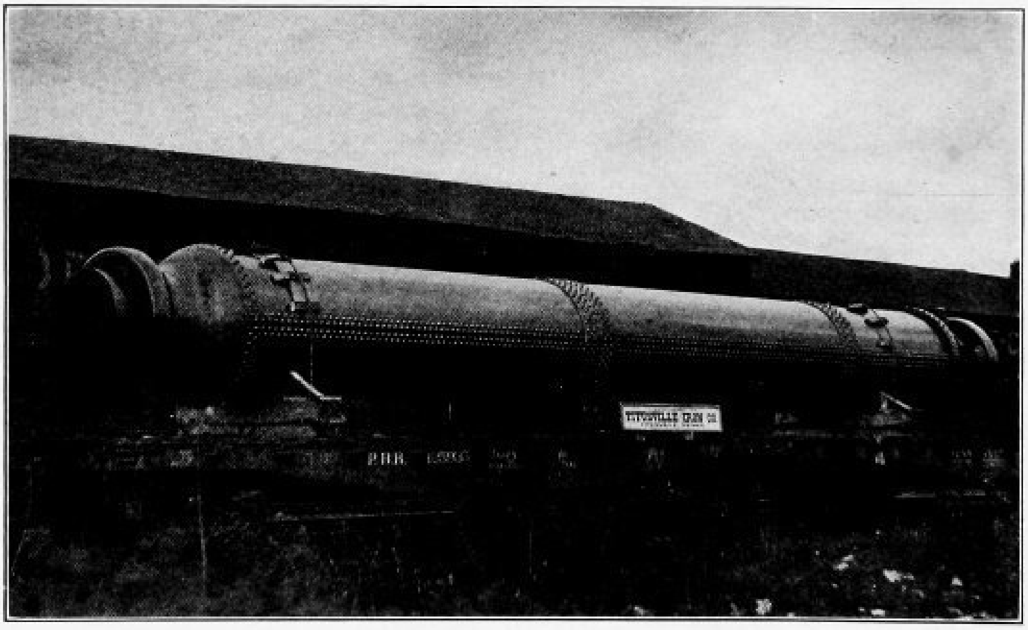
$f =$ allowance for one flange.

In a subsequent article will be shown how the formulas for the devlopment of the frustum of a cone are applied to the laying out of the conical parts in a vertical boiler with submerged tubes.

Heavy Boiler Plate Cylinders

A number of very heavy boiler plate cylinders have been manufactured recently by the Titusville Iron Company, of Titusville, Pa. The cylinders are 63 feet long overall, with an inside diameter of 65 inches. The thickness of the shell plate is 7/8 inch and the thickness of the butt strap 15/16 inch. The cylinders were made up of two 20-foot and one 10-foot plates, making in all 50 feet of plate work. The extra 13 feet are accounted for by the castings attached at the ends.

Only outside butt straps were used in the construction. The longitudinal seams are designed with two rows of rivets on each side of the joint, while the circular seams have three and four rows of rivets on each side of the joint. All of the rivets were 1⅛ inches diameter, driven flat inside.



Heavy Plate Cylinder, 63 Feet Long, 65 Inches Inside Diameter

Each cylinder weighs about 28½ tons and an inspection of the accompanying photograph shows that the plates were rolled the 20-foot way, a piece of work which required very powerful bending rolls. That very little difficulty, however, arose in forming such wide plates speaks well for the equipment of the manufacturer's plant for doing such work.

New Boiler Tubes in Old Heads

Failure of an Attempt to Economize by Retubing an Old Boiler With Old Tubes

BY JAMES FRANCIS

"Joe! Have your yard man get that little second-hand 42-inch locomotive boiler into the shop; strip off the engine and fix up the boiler. It has been sold to go out in first-class condition. Do you get it all right, Mr. Foreman?"

"Yes, Mr. Manager. You mean that little 42-inch locomotive type boiler, No. 3018, on skids, with the engine bolted to the shell and the crankshaft carried on extensions to the forward boiler supporting castings?"

"Yes, that's the one. Pretty good boiler, isn't it?"

"I can't tell without looking it over, Mr. Manager, but I presume it will need a set of new tubes—they nearly all do, you know."

"Yes, that's so. But, Joe, why not take some of the tubes which came out of those Doe boilers which we were going to send to Small? You remember that we condemned one of those boilers because it had been in a fire, evidently, and had a crack 18 inches long in one of the upper sheets?"

"Yes, I remember those boilers. We scrapped the shells but the tubes are out in the yard. We were intending to weld on new ends, you know, and use them in some second-hand job."

"Yes, those are the tubes I mean. Now they will be cut in two, and each piece be long enough for two of the short tubes required in this little boiler, won't they?"

"Yes, Mr. Manager, those long tubes will make two short ones each, all right, for the little boiler; but I would suggest that we put new tubes in that boiler. To begin with, the heads may be pretty tender, and old tubes are never any too soft. They get hard and brittle, you know, and I am afraid that we will have trouble in expanding those old tubes into the old heads of the little boiler."

"But, Mr. Foreman, what's the difference? Why is it any better to put those old tubes into some other old boiler, rather than to cut them in half and use a few of them in this short boiler?"

"I'll tell you, Mr. Manager, it's just like this: When we use the old tubes in another boiler the ends of the tubes will have been cut off and new ends welded on. This makes the tubes as good as new, as far as the stock for expanding and beading is concerned, but when we cut the old tubes we have all old metal to work in the heads, and, as I said, I am very much afraid that the old tubes will give a lot of trouble and never come tight."

"Oh, I don't think so, Joe! We will try it, anyway. It will save the price of a set of new tubes for the little boiler."

"All right, Mr. Manager, I'll try it; but I am afraid the extra labor required to work the old tubes will come to more than the difference in cost between old tubes and new ones. But I'll try it, as you say, sir—Bill, you and two men jack up No. 3018, and get it into the shop to space No. 22, then call me when the boiler is placed so I can look it over."

"All right, Mr. Foreman, here's the little locomotive boiler, No. 3018."

"That will do, Bill. As you go along tell Tom Sikes to come over to space 22 right away. That's all, Bill."

"Did you want to see me, Mr. Foreman?"

"Yes, Tom; let's us look over this little boiler, No. 3018, and see what must be done to put it into 'first-class condition.' Now find out just what is wanted. The engine is to be pulled off, the extension supports cut off and the boiler fitted with pop valves, steam gage and all the usual fittings. Look it over and then I will go over it with you."

"All right, Mr. Foreman; I find that new tubes will be required, also that there is a whole lot of scale inside on the shell and on the tubes which must be knocked off. But the shell seems pretty fair. No signs of weakness; but I don't like the looks of the back head. I haven't got all the rust and deposit off, but there seems to be places where the metal has gone pretty thin."

"All right, Tom, get your helpers busy and strip the shell and heads, then we can see what we have to handle. And, by-the-way, get in twenty of those old 3-inch tubes which came out of the Doe boilers. Go to the yard yourself and pick out twenty of the best looking tubes and have them sent into the shop. We will clean them up and cut them in two. Each of those old long tubes will make two short ones for this boiler."

"Hadn't I better send in a half dozen extra tubes? Sometimes, you know, second-hand tubes don't show up very well when they come from the tumbler."

"Oh! Send in two or three extra ones. That will be a plenty."

"Here are those old tubes, Mr. Foreman. I had twenty-three sent into the shop, and I picked the best I could find at that; but I could only get thirty-two fair tubes out of the forty-six pieces. The others, as you may see, are all to the bad. Some of them are too brittle, some are pitted almost through, and they don't show up at all well."

"I was afraid of that, Bill; but the orders are that those tubes be used, and we will have to make them go. But, Bill, be sure to put both ends of each tube in the fire; heat 'em to a red, and let them cool as slowly as possible, so as to anneal the tube ends as much as possible. Say, Bill, there is a box of air-slaked lime in the storehouse; bring that in, and as fast as the tubes are heated stand them on end as close together as you can right in that lime and let them cool there."

"That ought to fix them, Mr. Foreman. The blacksmith says that lime softens iron and steel a whole lot."

"Not that way, Bill. All the lime does is to keep the air from the hot tubes and permit them to cool very slowly. The lime has no chemical effect on the tubes whatever. Why, some fine sand would do exactly as well as the lime."

"Why, I supposed the lime did something to the steel of the tubes!"

"Not a thing, Bill. At least not until the steel is hot enough to melt. Then lime might get hold of it. Why, Bill! this lime on steel business is about like putting linament on your body when you have a sprain or a bruise. You think the liniment heals the sprain; but really the liniment does not have the least effect upon your body. It is the rubbing and the heat which does the business and assists nature to do the healing. Hot water is just as good as the very best liniment in the world. Hot water and good rubbing—that's what does the business. But we will cool the tube ends in lime to make them cool as slowly as possible, then they will come out quite soft; and we will need every bit of ductility in those tubes that we can get."

"Wish you would come over and look at those tubes in No. 3018, Mr. Foreman, I've fixed 'em up the best I can, but it don't make a very good job. Four of the tubes went to pieces in beading the front end, and six more failed while I was rolling the back and front ends, so that's ten out of the twenty 'old new' tubes that have failed. And, Mr. Foreman, three of those tubes have gone bad in the same hole one after the other. I am afraid the tube in that and in some of the other holes can never be made tight, for the head is in very bad condition indeed, the back head especially. There is only ⅜ inch of metal between some of the tubes in the rear head, and as the metal has wasted some there really is not sufficient metal to withstand the strain of rolling. Therefore the head metal springs, the tube walls bend back and forth, and I can't get the brittle old tubes tight before they break, or before the head will let go altogether."

"I am afraid we will have to put a new head in that boiler, Bill. I'll put it up to the manager, as he has the deciding voice regarding this boiler. You have set thirty tubes already and haven't got a tight job yet?"

"No, I can't get but 20 pounds' pressure on the shell. The tubes leak it out as fact as the test pump can work the pressure up, and the tubes don't seem to tighten a bit more than they have done."

"You put in copper ferrules, did you, Bill?"

"Yes, I put them in the front head, not in the rear head. There were no ferrules in that head when I took the old tubes out, and the rear head is not reamed large enough for ferrules, anyway."

"How about the front head?"

"Oh! that is reamed for ferrules all right, but there is so very little space between the tubes that they only left a little more than 1/32 inch for ferrule thickness, and stock ferrules wouldn't go in. Why, I had to drive each one of those new copper ferrules on a mandrel, one at a time, and let the boy take a cut in the lathe over half the length of the ferrule before I could get them into the front head."

"You didn't turn the whole length of the ferrule?"

"No; just a little more than half the length; then I pushed 'em in, right up to the shoulder left by the tool, and those ferrules didn't give a bit of trouble by pushing out of place when the tubes were pushed through the head."

"All right, Bill; but the manager says he must have that boiler, anyway, and have it pretty quick, too. We will have to cut out all those tubes again, put in a new head, and then I am just going to put in a set of brand new tubes, for I am quite sure that we can't make the old ones tight, even if the front head will stand the heavy expanding and rolling that must be done on old tubes."

"Pity we didn't put in new tubes to begin with, Mr. Foreman. I could have saved that rear head by using new tubes."

"You are not the only man who is aware of that fact, Bill, but 'orders are orders,' and we will follow them for a while yet. Now, then, cut out that back head. It's flanged outward, as you see; and as there is no manhole in the shell, it being of the locomotive type, there cannot be any braces on the rear head, which is probably stiffened by angle or tee-irons riveted across it."

"Oh, say! Mr. Foreman, if I had known the head was coming out I would have waited to drive those rivets in the shell, where the engine came off; and I wouldn't have monkeyed around, putting the rivets through tube holes. It was a job, I tell you!"

"Lots of things could be done to better advantage, Bill, if we could only see twice as far ahead as we do now. Some men see farther than others, and when the far-sighted ones are not handicapped by short-sighted superiors, then work goes along pretty well. But look here, Bill, what are you doing with that square-toed, handled cutter?"

"Why, I am going to hold it against the rivets and let my helper strike it with the sledge when we cut out that rear head."

"Oh, no, Bill; that will never do, not with this very thin and tender old shell. Don't you see that the rivets are very large for the thickness of the shell plates?"

"Yes, I had noticed that."

Well, then, if you knock the heads off those rivets with a sledge you will start somethin' that will cause trouble. The shell plates are outside the heads, aren't they? Well, then, hasn't the shell got to stand all the strain of acting as wire-cutter for those rivets when you sledge off their heads?"

"I don't hit the rivets with a sledge. I have my man hit the square cutter, and that slips off the heads as slick as you please."

"That makes no difference, Bill. The shell plate must stand all the strain of the rivet shearing, and you will find each and every hole badly distorted when the rivet is cut out in that manner. Here! Just try it on one rivet. There! See how that hole is elongated in the direction of the hammer blows?"

"By Chimminy, it is so! I didn't think of that. How had we better get the old rivets out?"

"Just rig up a regular handled cutter, Bill, then get another helper; fit him out with a holding-on tool shaped like a common crowbar—and a crowbar will answer if you have it well drawn out and sharpened just like a cold chisel. Then let the other helper hold on with that tool, in the direction against which you are driving, with the handled cold chisel. That will take off the rivet heads in a hurry, and will save the holes in the shell."

"Say! I'll try that way; it looks good to me!"

"Just one thing more, Bill. You will drive those rivets from the inside, won't you? It will be hard to drive them overhead in the end of that small shell, but it won't be nearly as hard as to drive those which are underneath the shell. So just bear in mind to drive the cold heads of those rivets extra well just as soon as you get the hot heads formed down. Plug the outer heads right solid, otherwise there will be all kinds of leaks around the outer ends of those rivets which hold the head. And don't wait until the rivets are cold before plugging them from the outside. Be sure to hold on inside when you are hittin' 'em down on the outside of the shell. If you take a bit of care with the cold heads of those rivets, Bill, you will have no trouble in getting the new head tight; but you will never do the trick unless you watch the cold ends of the rivets mighty close, and plug 'em right down while they are pretty warm. Why, only last week I saw a man from another shop cutting out a lot of new rivets which he had driven in a boiler head. He just couldn't get the cold ends of those rivets tight, for he hadn't held on against the inside ends of the rivets while he drove the cold ends. In fact, the cold ends didn't look as if they had been driven at all to amount to anything."

"How did he make the job tight?"

"Why, he just had to cut out all those rivets, one by one, and put in new and properly driven rivets in their places."

"Well, Mr. Foreman, you can bet that I'll drive these head rivets so they will be tight! I won't let one of 'em get away from me!"

DEMONSTRATION OF THE OXY-ACETYLENE WELDING AND CUTTING ART.—On December 4, a large number of engineers attending the annual meeting of the Mechanical Engineers' Society in New York, visited the plant of the Davis-Bournonville Company, Jersey City, to witness a practical exhibition of recent developments in the oxy-acetylene and oxyhydric processes of welding and cutting metals. The commercial methods of producing oxygen, acetylene and hydrogen gases and the various methods of welding and cutting cast iron, steel, copper, brass and aluminum, both by hand and by special automatic machines, were demonstrated. Of particular interest were special automatic machines for welding and cutting.

The Elimination of Smoke in Large Cities

Overloaded Boilers Main Cause of Excessive Smoke—Only Small Proportion Due to Locomotives—Mechanical Stoker Best Means of Reducing Smoke on Railroads

The largest proportion of the smoke emitted in any locality where bituminous, or soft coal, is generally used may be attributed to one source, that is, the stationary boiler, which supplies the steam power for so many purposes. From a point of vantage in almost any city on a cool morning a glance around the horizon will disclose the vapor of steam arising from many buildings, including, with those used for strictly manufacturing purposes, many hotels, office buildings, stores and apartments. At practically every point where this vapor is observed there is a possible source of smoke emission.

Where any considerable quantity of smoke arises from sources such as mentioned, it may generally be attributed to one cause, namely, the capacity of the boiler plant is insufficient for the work imposed upon it. To illustrate, if a boiler having a capacity of, say, 100 horsepower, is not loaded beyond 75 horsepower, there is little probability of smoke, unless very carelessly handled. If loaded to its rated capacity, with careful handling, but little, if any, objectionable smoke will be produced. However, if the boiler be loaded beyond its capacity it is difficult, if not impossible, so to handle it as to prevent objectionable smoke. The majority of the smoke emitted in any of the larger cities may be eliminated by insisting that the owners of manufacturing plants and other classes of buildings mentioned provide boilers of adequate capacity.

Next in importance as smoke producers are the many fires used in a city for domestic purposes. Each individual fire produces only a small quantity of smoke, but in the aggregate their contribution to the smoke annoyance is very large indeed; in some cities the smoke and gases from this source exceed that from all others. It is a matter of record that the heaviest black fogs in London occur on Sundays and Christmas day, or other holidays when the manufacturing plants are closed. While the smoke from fires used for domestic purposes does not attract the attention as much as that from a large plant the effect on objects with which it comes in contact is greater, on account of the fact that the smoke from small slow fires contains considerably more tarry matter than that from large fires burning at high temperatures. The soot contained in this tarry matter adheres more firmly to the buildings, people, clothing, etc., than does the soot, which consists principally of carbon coming from fires of greater intensity.

In the cities which are adjacent to rivers, lakes or harbors a considerable proportion of the annoying smoke comes from the water craft, where the problem of producing a large amount of power with limited space tends to make the boiler plants small in comparison with the work required.

While it is true that locomotives produce a certain proportion of the smoke in localities where they are used it is a fact that if all of the locomotives in use were to cease making smoke, but 20 to 40 percent of the smoke in cities such as Philadelphia, Chicago, Cleveland and Pittsburg would be eliminated, leaving from 60 to 80 percent of the smoke now existing to trouble us.

The railways of America produce transportation of passengers and freight at the lowest cost of any in the world, and to obtain this result large locomotives, and consequently large coal consumption, is necessary; and large coal consumption with comparatively small boilers means smoke, as before explained. The dimensions of the locomotive boiler must be confined to the permissible limits of one width and high clearance; its length made to conform to the limit of practicability, and for these reasons it is impossible to increase the capacity of the boilers. The further reason that the public demands rapid and luxurious transportation makes it impracticable to reduce the work required of each unit.

The railways are most vitally interested in the elimination of smoke for economic reasons, namely, while smokeless combustion does not always mean economy, combustion with heavy smoke always indicates loss; and as many millions of dollars are spent annually for coal, even a small saving per locomotive would make a large sum in the aggregate. The property of the railway adjacent to the track, such as station, bridges, signals, telegraph lines, etc., is damaged and deteriorated by smoke, requiring large expenditures for renewals, as well as for maintenance, such as painting and cleaning.

The possibility of largely reducing the expenses for the items above mentioned, without reference to the viewpoint of æsthetic or personal comfort, has been a sufficient incentive to cause the railway people to give the smoke subject a large amount of consideration. The railway officers and employees suffer the annoyance caused by locomotive smoke to the same or even a greater extent than do the patrons or others who are located near the tracks, as their occupation requires almost continuous proximity to the smoke source.

This personal interest, the interest of the community, added to the possibility of the saving mentioned above, has led to almost continuous study of the locomotive smoke problem. This study has extended over twenty-five years to my personal knowledge, and from the records many years farther back. During the last fifteen years I have examined drawings and patents of many devices which were supposed to eliminate smoke, and made personal observations of their performance. Unfortunattly, but very few of these were even promising, and if worthy of installation and trial, the results obtained were not such as to warrant using the apparatus in regular service.

The Pennsylvania Railroad system has devoted a great deal of attention and expended a large amount of money in experimenting with and developing, either on its own account or in co-operation with representatives of other railways, or the technical societies, devices which gave promise of reducing the smoke from locomotives, and in 1910 the management sent a committee of three to Europe to study conditions and results obtained with the various devices and methods in use there, for comparison with the practice in this country. For many years devices designed to admit steam or air into the locomotive firebox have been used as a means for reducing smoke, with generally unsatisfactory results.

During the past year, however, a device for supplying air to the firebox was developed and subjected to rigid and painstaking scientific study. Tests were made at the locomotive testing plant of the Pennsylvania Railroad, and the results were confirmed by carefully watching the performance of the locomotives in regular service. This device considerably reduces the amount of smoke under some conditions, and the results obtained so far are sufficiently promising to permit extending its use, especially for the smaller locomotives.

During the past nine years there has been developed on the Pennsylvania Lines West of Pittsburg a device which, up to the present time, is the most promising yet produced for the

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* From an address by Mr. D. F. Crawford, general superintendent of motive power of the Pennsylvania Lines West of Pittsburg, before the New Century Club, Philadelphia, Pa., May 15, 1913.

reduction of smoke, and in fact under favorable conditions the practical elimination of locomotive smoke. I refer to the locomotive stoker, with which 154 locomotives have been equipped and 140 more are under construction.

With this stoker we have succeeded in greatly reducing the amount of smoke emitted by locomotives in heavy passenger train, freight and switching service. Repeated comparisons of the smoke made by locomotives with and without the stoker show that those equipped with the stoker may be operated with from one-tenth to one-fourth of the smoke made by similar locomotives in the same service without the stoker. As stated above this is the result of nine years' experimentation and development, but now, while the apparatus is sufficiently developed to warrant the trial of a large number, the problem of maintaining and satisfactorily operating them with various kinds of coal is still before us.

In addition to the study and development of mechanical devices for the elimination of smoke, the railways, by additional supervisors and instructors, are causing reduction in the amount of smoke emitted, by having more careful firing and handling of locomotives by the enginemen, and are making a comprehensive study of the problem of reducing the amount of smoke about engine houses, where fresh fires are made, the smoke from which is the most difficult to control.

All of this shows that the railways are keenly interested in this subject, and in addition thereto the American Railway Master Mechanics' Association has a committee studying the problem, and the railways are also co-operating with the various other associations, and city officials interested.

Of course, one way to eliminate locomotive smoke would be to eliminate the steam locomotive by substituting electric motors. No doubt from time to time the use of electricity will be extended, but it must be borne in mind that to do so will require tremendous outlay of capital for the installation, and it does not yet appear, except under the most favorable circumstances, that the expenditure will be warranted by the returns. Further, if the railways are electrified there will still remain from 60 to 80 percent of the existing smoke to be dealt with.

A STEEL smokestack, 13 feet 2½ inches diameter and 204 feet 5⅝ inches high, has been erected for the Kentucky Electric Company by the Kennicott Company, of Chicago.

Proposed Method of Supporting the Front Ends of Crown Sheets

BY C. E. LESTER

Some years ago the writer had as an assistant a very clever young mechanic with clever ideas and an inventive turn of mind. This man was employed as an assistant foreman boiler maker in charge of boiler repairs in the erecting shop of a large railroad system, and as such came in daily contact with the many defects caused by the rigid staying of the front end of crown sheets in locomotive boilers.

At that time there were warm discussions in technical papers and at the Master Boiler Makers' conventions as to the relative merits and demerits of the different methods of staying the front ends of crown sheets. Since that time, however, the Wood and the Jacobs-Shupert fireboxes and the Tate flexible stays have proved so very successful that the troubles then experienced have been considerably lessened.

Nevertheless, there are probably thousands of boilers with the front end of the crown sheet supported by the common rigid radial stay, although the greater percentage of the boilers were and are equipped with the so-called sling or expansion stay. The title, expansion stay, is a misnomer, however, as it is deceptive. Taken as a whole, its expansive value may be confined to the first time that the boiler is under strain.

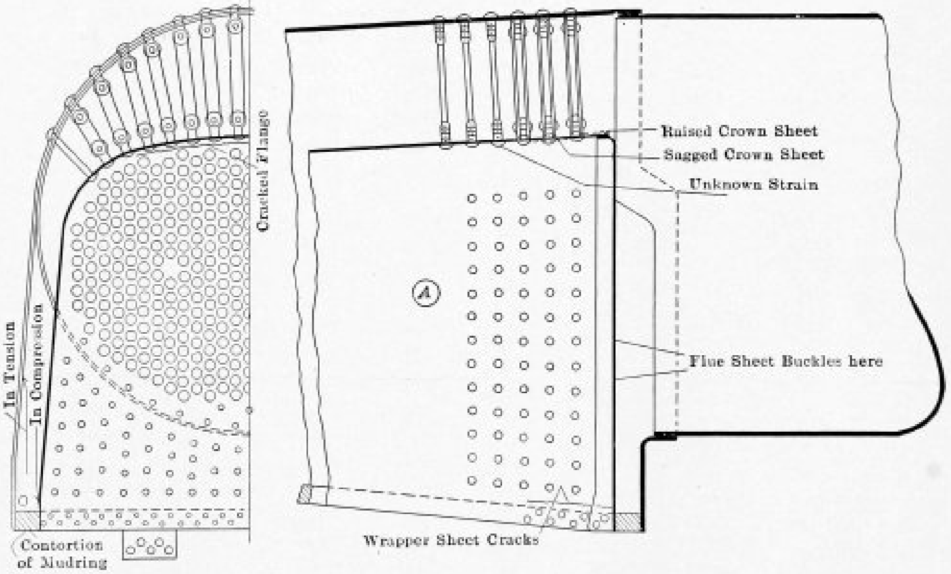

Fig. 1.—Defects Caused by Sling Stays

The most common as well as the most efficient type of these expansion stays (so-called) are those with a tee-bar supported on thimbles about 2 inches long and secured to the crown sheet with button-head taper shank fitted bolts and another tee-iron riveted to the wagon top or casing sheet, these two bars being joined with boiler plate straps with oblong holes in one end to provide for expansion. It is a well-known fact among boiler makers that this method is far from being desirable but has been used in lieu of something better. The man above mentioned gave this staying problem considerable thought and finally evolved the device illustrated.

In going over some old files the writer found the blue prints and the inventor's or designer's paper to me setting forth the defective conditions that would be overcome by the use of the device. The writer sees some merit in the device, and also features that, from the writer's viewpoint, while not making it prohibitive, at least make it unpractical. The designer is quoted verbatim:

"I herewith present for your consideration a method of supporting the front end of a crown sheet where the same is at present supported by sling stays, or more properly known as expansion stays.

"Referring to card 'A' I will show from a practical standpoint that the present method of supporting this particular part of the firebox with sling stays does not serve the purpose for which it is intended.

"According to my observations, it is obvious that the expansion stays are not in tension when the boiler is first fired. I believe that the following defects are traceable in a greater or less degree to the effect that this unsupported area has on the flue sheet, viz.: Cracked flanges, elongated flue holes, buckled flue sheets, checked flue holes, leaky mud-ring corners, broken mud-ring corners and leaky flues.

"For an illustration, take a new firebox with the stays applied under the best conditions and in the best manner possible and all being in tension even after the flues are set. When the boiler is hot the flue sheet expands, say 3/32 inch. This will relieve the sling stays of all tension and place the first row of crown stays under compression. This may be placing a compressive strain of 80,000 pounds on the flue sheet of a large boiler, the flue sheet being supported in a vertical direction by the mud-ring and the staybolts transversely.

"Removing old flue sheets on practically all wide firebox boilers, shows the crown sheet to be flared up where it comes in contact with the flue sheet. The sling stays instead of being loose are in nearly all cases under compression.

"I have removed mud-rings that have been twisted down at the front end on the firebox side and upon the outside. This coincides with the action of the flue sheet when the engine is working, due to the pressure on the unsupported area of the crown sheet.

"The method described, by a series of levers governed by the pressure in the boiler acting on the piston head in the cylinder, will support the surface and will also take care of the expansion and contraction at the flue sheet.

"Furthermore, it will relieve the crown sheet at this vital point of the severe shocks caused by the sudden operation of the locomotive, etc. To guard against the failure of the apparatus supporting the crown sheet, should the cylinder fail to do its work, the retaining lever arm 'D' is depended on the same and will have the same bearing value when the boiler is cold.

"The illustration is based on the support of a surface 20 inches by 20 inches at a steam pressure of 200 pounds, and supported by a cylinder which has a pressure of 7,650 on the piston head."

The writer will be glad to read comments on this device.

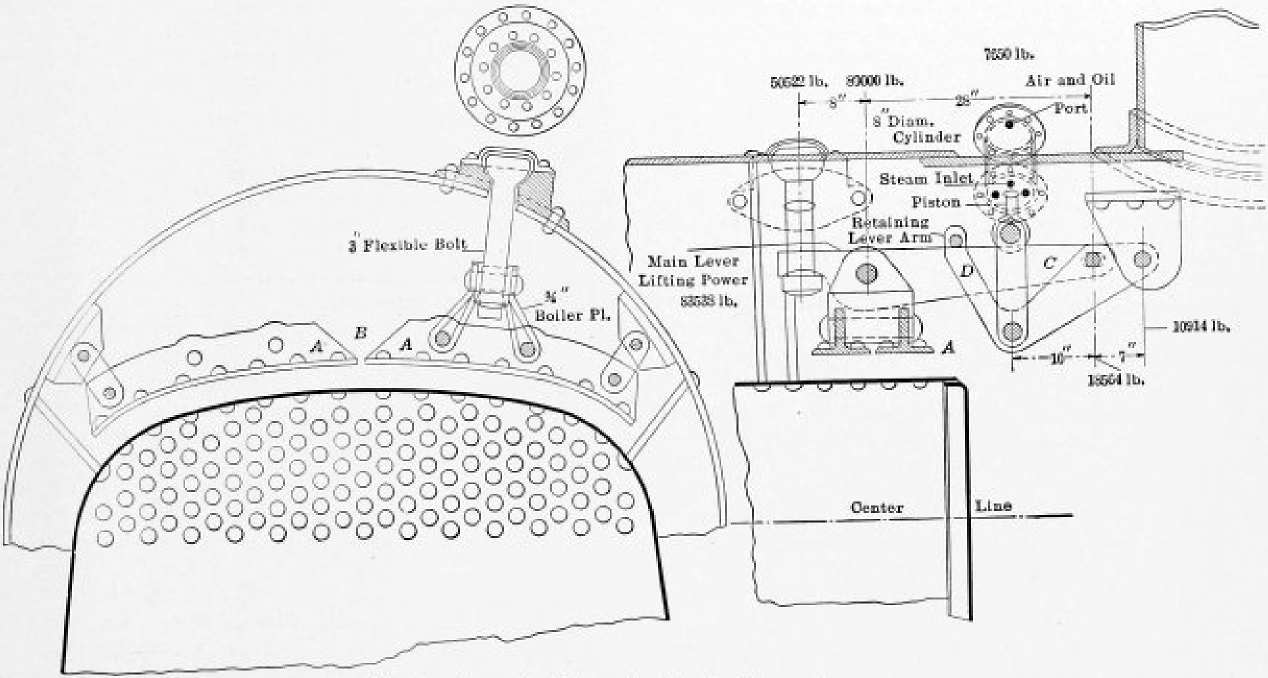

Fig. 2.—Proposed Scheme for Staying Crown Sheet

On Fusible Plugs

Fusible plugs are ordinarily made of brass with a hexagonal head at one end to permit of their being screwed in with a wrench and threaded with a standard tapered pipe thread. They are either inside plugs or outside plugs depending upon whether they are designed to be screwed in from the water or fire side of the sheet or tube they are to protect. A tapered hole is drilled through the center of the plug from end to end, with the large end toward the water side of the sheet when the plug is in place. The tapered hole is then filled with a fusible metal, which will be crowded tightly into it by the boiler pressure. The operation of the plug when in good condition is about as follows: As long as the inner end of the plug is covered by water it will remain at a temperature essentially the same as the water, or about at the boiling point corresponding to the pressure carried. The exact temperature will depend, of course, upon the cleanliness of the boiler, for there will be a much greater temperature difference between the metal and the water in a badly scaled boiler than in a perfectly clean one. When the water level falls low enough to expose the plug, the steam can no longer take heat away from the metal as fast as it is supplied by the hot gases, with the result that the temperature rises, and when the melting point of the fusible material is reached it softens and is promptly blown out by the steam pressure. Steam issuing from the orifice will tend to lower the boiler pressure somewhat, and will perhaps effect a slight deadening of the fire if the plug is located so that the jet can blow back into the furnace, but the principal effect, as we mentioned above, is to warn the boiler attendants that something is wrong in time for remedial measures to be adopted.

It will be seen that for prompt and certain action a fusible plug must be filled with a material whose melting point is but slightly above the temperature of the water in the boiler at its working pressure, allowing leeway enough for a moderate and quite safe rise in temperature of the metal above the water temperature when the boiler is somewhat scaled. Many different alloys are available for such a use, and nearly any desired melting point may be obtained by a proper mixture of metals. These alloys have been very carefully studied by the manufacturers of automatic sprinkler heads for fire protection, so that sprinklers may be had to fuse at almost any temperature which is thought desirable as a protection against incipient fires. There is one important difference, however, between the action of an alloy in a sprinkler head and in a fusible plug, namely, that in the plug the metal is constantly exposed to the chemical action of the flue gases on the one hand and the scale-forming and corroding properties of the boiler water on the other. The result is that almost all metals when used as fusible plug fillers undergo a slow change. On this account most of the fusible alloys soon become worthless in service and reach a state of decomposition where it is practically impossible to melt them at all. This being true, and because a pure metal is much more stable and dependable under such conditions than any alloy, it has become the custom to fill all plugs with pure Banca tin. This metal will remain in serviceable condition longer than any other material whose melting point is at all suitable. It may be depended upon to melt promptly at about 449 degrees F., which corresponds to a pressure of about 365 pounds gage. Since tin will melt long before steel will be injured, but will remain solid at temperatures well above those corresponding to any ordinary steam pressure, it will serve in practice as a universal filling material, and it is required by law in many States, as well as by the United States Steamboat Inspectors. One must not rest under the impression, however, that a tin-filled plug will undergo no deterioration in service, for we frequently find cases in which the metal has become hard and crystalline with a thick coating of oxide at the ends, and in this condition the melting point may be very high indeed. Because of this fact, it is important that the plug be so placed that it is accessible both from the steam and fire side of the boiler at inspection, so that the boiler inspector or the engineer in charge may frequently observe if the metal is changing. So long as the metal is clean, and seems soft and malleable when struck with a light hammer, no serious trouble need be anticipated.

There is another reason, quite as important as the first, why a fusible plug should be placed in an accessible location. It is the inborn tendency of some men to neglect or actually dispense with any attachment which is hard to replace. We have found fusible plugs with wrought nails driven in to take the place of the metal which had run out rather frequently, and many instances have been brought to our attention in which an ordinary pipe plug was found by the boiler force to be a ready substitute for the more useful trouble maker. A case in point is the location of the plug in a vertical tubular boiler. In all such boilers except the submerged head type the plug, if it is to be of service, must be located in a tube. A hand hole is usually place in the shell opposite the plug, which must be screwed into one of the tubes in the outer row. With the tubes commonly used a very small plug is required, and the boiler must be quite cold and empty to below the hand-hole level before a plug can be replaced. We do not wish to reflect upon those laws in force in many States which require a plug in this type of boiler, but we do desire to show that its use is at least a debatable question.

As to the location which we would recommend with various types of boilers, we must first state definitely that, wherever legal requirements have been adopted bearing on this important question, they should be accurately followed, as a failure to do so may involve the boiler owner in serious difficulty. This is especially true in the event of an accident occurring to a boiler which is not equipped in strict compliance with the law. A general rule would be to place the plug at that level below which the waterline should never be allowed to fall, even in an emergency, when there is a fire on the grate. Place it in the most accessible location which will satisfy the first requirement—and by accessible we mean easily reached from both the fire and water sides if possible. The third and last requirement is that the plug be as near the furnace as it may, so that it may be heated to the fusing point in the shortest possible time after being uncovered. Perhaps it may be well to illustrate this rule with a few typical plug locations in familiar types of boilers. In internally-fired boilers of the locomotive, Cornish or Lancashire type, the plug is usually located in the furnace crown at the highest point, and it ordinarily projects through the crown about an inch, so that it will be uncovered before the crown sheet is entirely dry. In Scotch marine boilers of the wet-back type, the plug would be located in the top of the combustion chamber, while in the dry-back type of Scotch boiler the plug is placed in the back tube sheet 2 inches above the top row of tubes. In the horizontal tubular type, the plug is placed in the rear tube sheet or head 2 inches above the tube tops. In watertube boilers the plug is placed, if possible, in the steam drum at the lowest permissible water level, and if possible in the first pass of the gases. An access door in the setting opposite the plug is of great assistance in this case. With those watertube boilers in which vertical, or nearly vertical, tubes terminate in an upper drum, the fusible plug is usually placed in the lower head of this upper drum. Special cases, of course, require special treatment, but we believe that by intelligently applying the general rule which we have given a satisfactory location may be arrived at for nearly every boiler type. One additional caution is necessary in the case of watertube boilers with regard to the level at which the plug should stand. In many of these vessels the tubes terminate in the upper drum, and are secured to it by a rolled or expanded joint. In such cases the fusible plug should be high enough so that the tube ends will still be covered when the plug operates, for if these tube ends are overheated all the tubes in the boiler may be ruined.—*The Locomotive of the Hartford Steam Boiler Inspection and Insurance Company.*

Talks to Young Boiler Makers*

"Here! that list has everything that we want for the shop. The office truck we can leave, but I bet a big red apple Mr. Walter cannot show me where anything should be added."

Alex, who said this, was very proud of the list. All the main tools had been selected and located on the drawing, and it turned out that the building would be 55 feet wide by 120 feet long, and the back end was to be so built that the length could be added to at any time, should work come in to warrant it.

Mr. Walter came around one evening and Alex handed him the list and made the above wild bet, feeling sure he would win out. Walter looked over the list in a few minutes, and said:

"Go after that red apple right now."

"Why, what have I left out?"

"Nothing perhaps of any account."

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* Continuation of a series of articles, the last of which appeared in the August issue, telling of the plans of two young boiler makers who propose to start a boiler shop of their own.

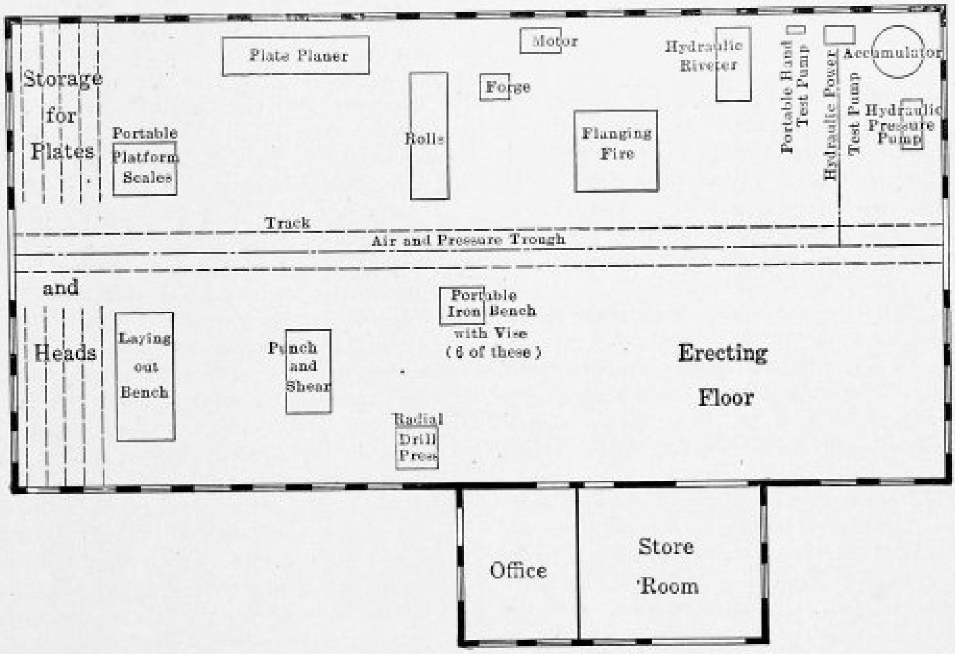
"I bet two red apples," broke in Alex.

You forgot something you can't keep house without," was Walter's answer.

"Not on your life," and so it went until Alex was, what they say in the country, "all het up," and he was disgusted when Walter pointed out that he had nothing to weigh his material with; he had forgotten a scale. He got the apples and then looked over the plan here shown.

Now we all know that men vary in their ideas, and no doubt there are lots of boiler makers who will think this layout all wrong and the selection of tools not sufficient or too many. Well, then let them speak up and give the readers of THE BOILER MAKER the benefit of their opinions.

The entire idea of the plan is to have all material keep going from one end of the shop to the other and come out complete with no unnecessary movements, as moving a weight costs just as much per pound or ton and it doesn't show in the work, although the expense is there. In fact, a lot of people do not seem to understand anything they cannot see. A rivet driven is work all right, so is a punched hole as they can be seen, but when a boiler is done, the amount of labor required to move the plates around or the taking of material to the shears and punch is not visible, and even the best of bosses sometimes jumps all over a fellow for not having more work done because he can't see the result.



Tentative Plan of the New Boiler Shop

This is so with many people besides boiler makers. It is the great reason why so many consider electricity something they cannot understand. Water in a pipe is simple enough, as when you turn the cock water runs out, and it is easy enough to understand that a 1-inch pipe will hold so much water per running foot. It is also easy to understand that in either size of pipe you can have 1 pound pressure or 100 pounds pressure, but when electricity comes along there is nothing to see, and many people get mixed up with volts and amperes. It is all easy enough if it is remembered that volts mean pressure and amperes mean volume.

On this very subject of electricity the boys almost got caught in buying an electric-driven tool. The makers told them that it would cost only 22 cents per hour to drive it. That seemed very small, as when it was not in use, the salesman said, there was no expense. But Ben kind of kicked the pail of milk over when he asked the salesman if he expected the tool would make money standing still, and how much it would cost to start the tool, and did he mean that 22 cents would pay for the running of the machine when doing no work or when doing its average work, its maximum or minimum work?

Afterwards the salesman told the boys that old Ben was an old crank and not up to date.

Now, no one has so far found a way to apply electricity gradually to a tool without wasting energy. It is mighty quick acting stuff, and the way it is applied now is to sidetrack some of the entire energy, and in so doing, waste it, but they manage to control it that way, although it is only an expensive makeshift at best. It was quite a question for the boys to settle as to whether they would put in a boiler and engine, get a generator and produce their own current, or get it from the local company.

The agent of the Economic Light & Power Company had no end of figures to show that their own plant would cost them a lot of money and be a source of trouble all the time and the up-keep would make 'em sick in a month. The only thing to do, he told them, was to take current from the Economic Light & Power Company. The sliding scale was all down hill, and the more you used the less you would have to pay (per kilowatt); but upon this point he did not dwell. Mr. Walter said it put him in mind of the boarding-house where the boy who ate the most soup could have all the meat he wanted, but after four plates of soup the desire for meat seemed to fade.

On the other hand, the agent for the Independent Electric Lighting Company said you could make the electric juice so cheap that it was not worth while to consider the power company, as they had a big overhead cost to look after, a lot of bonds and stock to pay interest on and the meters were never in order, and you could get no satisfaction if you kicked. The company would take off 16 cents or something like that and stick it on the next bill to even it up. On the other hand, an electric set could be put in a corner close to the boiler, which they would have to have for heating, anyway, so the only thing to charge against the plant was its first cost at 6 percent per year, and that divided by 300 working days would make the overhead so little that it could not be noticed. As the oil was used over and over again, the plant being enclosed, the steam was really the only thing that cost and the exhaust would heat the shop.

Of course, they would have to have a switchboard and do the wiring and buy some lamps, but then they would own the entire outfit and be independent. Oh, yes, sometimes the armature would burn out, and you had to turn up the commutator now and then.

Mr. Walter wanted to know what the boys would do if a bad snowstorm came on and they could not get coal to run the boiler, and if they would not have to shut down while they were waiting to get the commutator turned up. Although the agent seemed to think Mr. Walter's brain a feeble one, nevertheless it was determined to buy juice for the first.

New London, Conn. W. D. FORBES.

(To be continued.)

Layout of Irregular Patterns

In answer to the inquiry of Y. W. in the September issue of THE BOILER MAKER for an explanation of a laying-out problem which he presents, the following sketches may be of some guidance:

In Fig. 1 draw the center lines *A B* and *C D*. Section (*d*) is 12 inches by 24 inches inside diameter. Set off on each side of the central line *A B* the distance 6⅝ inches, which will locate the neutral line for ¼-inch plate. Draw lines to the points, and draw the lines *E F*, *F G* and *F H*. Point *F* will be the center of the elbow. With the trams set at the points *F* and *G*, scribe the circle shown by the dotted line. Do the same on points *I L*. Divide the distance *E G* into two equal parts, and draw the line *F J*. By setting off the same spaces from *E* to *K*, we will have the line *K F*, which will give the upper base for what we may call an irregular cone, which will be part of the elbow. Where the distance lines intersect line *J F*, mark off ¼ inch inside at *J M*. Draw lines *J K* and *L M*, which will complete the profile for the middle section of the elbow.

The next step will be to lay out the plan and elevation from which the pattern for this section may be developed. Draw the elevation in Fig. 2 exactly as shown at (*b*) in Fig. 1. Strike a half-circle on both the small and large ends, dividing them into an equal number of spaces. (The more spaces used the better will be the results.) From these points draw lines at right angles to the base line 1′ 9′. On the large end draw lines through points on the circle intersecting the base line 1 9, and extend down as shown.

We will now construct the plan, using *O* as the center. Strike a circle with the same radius as on the large end in the elevation, and divide one-half of this into the same manner of spaces as on the large end. From the upper base line project lines from 1′, 2′, 3′, 4′, 5′, 6′, 7′, 8′ and 9′ to the plan on the center line 1′9′. Beginning from the point *O* on the center line, lay off the distance 5′ 5′ on the small end in the elevation, also lay off the distances 6′ 6, 7′ 7′ and 8′ 8′. To these points draw the oval line shown, and connect the points 1 1′, 2 2′, etc., to 9 9′ with solid and dotted lines, as shown.

This preliminary work leads to the construction of the triangles, from which the true lengths of the lines shown in the above plan and elevation can be determined for the development of the pattern. Extend the base line in the elevation as shown; erect two perpendiculars for the diagram of triangles, Fig. 3, and project the points 1′, 2′, 3′, 4′, 9′ on the upper base line 1′ 9′ over to these two lines. This will give the height of the triangles. Now take the lengths of the solid lines in the plan, from 2 2′, 3 3′, 4 4′, 5 5′, 6 6′, 7 7′ and 8 8′, and set them off on the base line, numbering the points to correspond with the distances measured off. Proceed in the same manner for the dotted lines, from 1 to 2, 2 to 3, etc. Then draw the solid and dotted lines from the respective numbers on the perpendiculars to the corresponding numbers on the base line.

Having finished the diagrams of triangles we are now ready to proceed with the development. As the slant line 1 1′ in the elevation is the true length of the line indicated by these numbers, set this down in the pattern as the line 1 1′. On the half-pattern (*b*) take the dotted line 1, Fig. 3, and with one leg of the dividers on point 1 strike an arc at 2′. With the dividers already set to one of the divisions on the small end, set one point of the dividers on 1′, and strike an arc intersecting the arc just drawn at 2′ from the point 1. Next with the trams set to the length of the solid line 2 on Fig. 3, place one point on 2′ and draw an arc at 2. Then with the dividers set to one of the divisions of the half-circle at the large end, set one point of the dividers on 1 and strike an arc intersecting the arc previously drawn, locating point 2. Proceed in this manner first with one solid and then with one dotted line. After the dotted line 8 has been laid out in its proper position, take the throat line 9 9′ from the elevation, where the true length of this line is shown, and from point 9′ scribe an arc at 9, laying out the circular part. Now add the flat at each end. By taking the distance 1′ 0′ from the plan, in Fig. 2, set off the distance from 1′ to 0′ and 1 to 0″. From 9′ to *X*′, and from 9 to *X* draw lines at right angles to each other, completing half of the pattern of section (*b*).

Turning now to Fig. 1, the first step is to lay out the required height of this section. From the slant line *K L* to the line 1 9, the lower base line is to be 30 inches inside diameter, and the material will be 3/16 inch thick. The best way to lay this out is to mark down the outside diameter on the base line, draw both slanting lines and lay off 3/32 inch inside, measuring from the slanting line and not on the base line. Set the trams on the point 5, and on the point found on the base line for the neutral line of the plate. Scribe the circle as shown in Fig. 2, which will be used as a plan, and divide one-half of this circle into as many equal spaces as there are in the upper base. From these points project lines to the base line, as from 1 9, and then to 1′, 2′, 3′, 9′ on the top line *K L*. From the same points, 1′ 9′, project lines as shown by the dash and dotted lines over the plan. Now take the distance 5′ 5′ on the half-circle at the top; set one point of the dividers on the pont 5, and scribe a small circle at *d*. Draw the line 1′ *d* 9′ out to *N*, as this line will be used later on. Take the distance 4′ 4′ with the dividers, and from the point *c* scribe the point 4′. Step over to *e* and scribe the point 6′. The distance 3′ 3′ should be laid off on *b* to 3′ and *f* to 7′. Lay off the distance 2′ 2′ from *a* to 2′, *g* to 8′. Draw the connecting lines from the large circle 1, 1′, 2, 2′, 3, 3′ to 9, 9′, and also the dotted lines shown, as lines of this character serve as guides throughout the layout.

The diagrams of the triangles may be erected on each side of the profile, or on any of the other figures of this drawing, whichever is most convenient. Lay a straight edge on the base line and draw a line to the right and left. The center line 5 5′ is shown at its true length, therefore this height can be taken direct from the figure to the pattern, and it is, of course, unnecessary to construct a triangle for this line. In the plan, Fig. 2, take the solid line 4 4′, and with the dividers on *P* scribe an arc at 4 back to the plan. In a similar manner transfer the lines 3 3′, 2 2′ and 1 1′. Transfer the dotted lines in the same way. Transfer the lines 2′ 3, 3′ 4, 4′ 5 from 3 4 and *P*. It will be found that these lengths laid down on the line *P* 1 are the same as those from 5 5′ to 9 9′ in the plan, and we can therefore set off two lengths with the same setting of the dividers; that is, when taking the distance *P* 4 step over to *R* and scribe the point 6. Now 6 7 equals 4 3, 7 8 equals 3 2 and 8 9 equals 2 1. To get the height of the triangles, project points 1′, 2′, 3′, 4′ on line *K*, *L* and points 6′, 7′, 8′, 9′ parallel to the base line. Draw perpendiculars 2, 3, 4, *P* and *R*, 6, 7, 8, and connect as indicated, drawing the slant lines, solid and dotted, in their respective positions.

To develop the pattern take the slant line 1 1′, in Fig. 1, and lay off the line 1 0′ Take the distance 1′ 0′ on the plan of the flat part of the figure and scribe an arc at 1′. Next take the length of the solid line 1 in the triangle, set one leg of the dividers on point 1 and scribe another arc at 1′. Take the dotted lines 1′ 2, and from 1 scribe to point 2. With the dividers set to the same spacing as that of the large circle in the plan, with one point on 1, strike an arc to 2. Take the solid line 2 in the triangle on the trams, and from 2 scribe an arc 2′. Then with the dividers set on the same spacing as in the half circle at the top of the elevation, Fig. 1, from the point 1′ strike the arc 2′. Proceed in this way until the dotted line 4′ 5 is reached; then take the line 5 5′ in the elevation and set it off at 5 5′ in the pattern. It will be seen that the dotted lines start from the large end on point 5. When the last line 9 9′ has been laid off add the flat part of the pattern, as was done at the other end. This completes the half pattern.

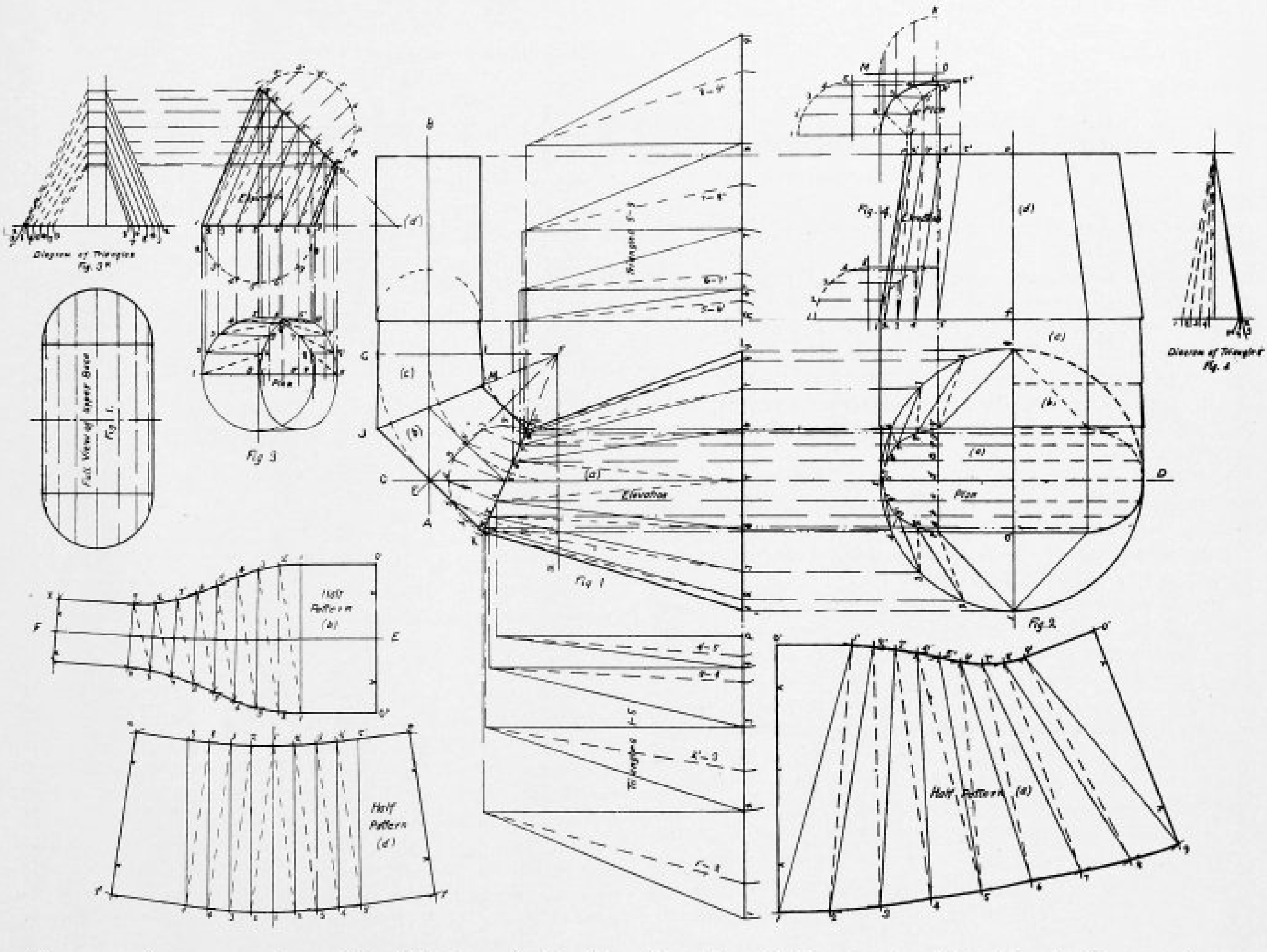
Proceeding further in the study of the drawing of the elbow, a pattern for section (*c*) must be laid out. This section is extended out on the drawing in order to avoid too many lines crossing the plan in Fig. 2. On the half pattern (*b*) find the center line *F E* by dividing each line in half, the lower half forming a flat piece in the elbow, line *F E* being the small end *G I*.

In Fig. 4 the circular part is 12 inches inside diameter and 12¼ inches to the neutral line. We have been using the distance 1′ 9′ on the line *K L* as the diameter, which is more than 12¼ inches, and it will be noticed that the distance 1 5, line 1 5 *f*, Fig. 4, is longer than the distance 1′ 5′, line 1′ 5′ *e*. If we examine the circular end in the plan, Fig. 2, containing 1′ 5′ 9′, we will find this to be an oval, with the distance 1′ *b* shorter than *b* 5′. It will be necessary to apply triangulation to lay down the plan.

Draw the right angle 1′ 0 5′ with 0 as the center and 6⅛ inches radius; scribe the quarter-circle with the same radius; strike the quarter-circle at the left on the base line, and divide into an equal number of spaces. At the bottom draw lines from these divisions to the right. Over the figure at the top draw lines to the left. With the dividers set to the radius on the large end at the elbow section in Fig. 3, scribe the quarter-circle *M N*, and divide into the proper number of spaces. Draw lines intersecting lines from the smaller quadrant and also project lines drawn at the lower base line. Through these intersections draw the oval, as indicated. These two oval figures will be divided again, and these divisions will be used to develop the pattern.

At right angles to the base line 1 5 of the large end drop lines from the points in the oval. Do the same at the smaller circle. Draw lines from base to base. Connect the solid and dotted lines in the plan, and erect the diagram of triangles, Fig. 4, in the same manner as in the previous problems.

To develop the pattern take the slant line 1 1′ on the elevation, set off 1 1′ on the center line of the pattern. Take the dotted line 1 on the diagram of triangles and set it off from 1′ to 2. Bear in mind, that the dividers are to be set to the divisions on the heavy line in the plan. Further explana-



tion is unnecessary for this development, except that flanges and laps must be added to all of these patterns.

Regarding the laying out of rivet holes in section (*a*) before rolling the plate, if this should be flanged (which is not really necessary, for it will be seen that the flange is very uneven, as at 9' it will be turned over more than at 1', while at 5 it is straight), simply punch the holes in the plate as it is, without adding anything. Add enough for the flange on (*b*); lay out the holes on the flat part and punch. When flanged bolt together and mark off the holes in the round from section (*a*), and we have a good job.

For the stack base lay out all holes in section (*d*) on the flat in stock plate. Lay off the required length for the round part, dividing it into the same number of spaces as there are in the corresponding part in section (*d*), and we have a good piece of work all around. C. F. AXELSON.

Rutland, Vt.

Locomotive Boiler Inspection*

The tabulated data contained in this report show a marked decrease in the number of casualities due to failure of locomotive boilers and their appurtenances and a substantial improvement in the condition of such equipment, when compared with the report for the preceding fiscal year.

Knowing that it would be impossible to correct at once all defective and improper conditions existing, and that improvement must come as the result of a process of evolution rather than revolution, attention was first concentrated on the more serious accidents in an effort to reduce the number of fatalities, although no minor defect that could be remedied was neglected.

The result of this policy is shown by a reduction of over 60 percent in the number of killed and 10 percent in the number injured by failures of locomotive boilers and their appurtenances during the fiscal year ending June 30, 1913, as compared with the preceding year.

In accordance with the provisions of Section 8 of the law, 592 accidents resulting from failure of locomotive boilers and their appurtenances were investigated by this division during the year; 228 accidents, most of which were of a minor character, were not properly reported to this division by the carriers, therefore a proper investigation could not be made. In such cases the cause assigned by the carriers in the reports to the accident division has been used in our compilation. Failure to make a proper report has usually been found to be due to the fact that the requirements of the locomotive boiler inspection law were not fully understood by all carriers. It is believed that all are now fully conversant with these requirements, as practically all accidents are now properly reported and investigated.

The practice of conducting a rigid, searching investigation of all accidents sufficiently serious to justify a report, with the sole object in view of determining the exact cause and having the proper remedy applied, has done much to reduce the list of casualities. The knowledge that such an investigation will follow every accident is an incentive to the railroad companies to maintain their equipment so that its condition cannot be shown to have caused the accident, and is also an incentive to the employees to perform their work in the most efficient and careful manner. Therefore, we have followed the policy of investigating every accident reported to this division. The investigation of accidents by Government inspectors, whose only object is to promote safety, and who are therefore impartial, has directed attention to conditions which previously have been overlooked or ignored.

The period since the law became effective has been too brief to permit a comparison to be made which will accurately show its value. It is believed, however, that the following comparison of some of the most serious as well as some of the most frequent accidents during the first and last quarters of the fiscal year ending June 30, 1913, fairly represents the benefits which result from Government supervision over the condition of locomotive boilers and their appurtenances:

	Accidents During Firs Quarter 1913.	Accidents During Last Quarter, 1913.
Crown-sheet failures	18	9
Water glasses bursting	36	16
Lubricator glasses bursting	11	6
Squirt-hose failures	161	64
Flue failures	15	11

A summary of the inspection work performed during the year shows the following:

Number of locomotives inspected	90,346
Number found defective	54,522
Number ordered out of service	4,676
Number having pressure reduced to insure proper factor of safety	472
Number having seams reinforced by welt plates to insure proper factor of safety	561
Number having the lowest reading of the water-glass raised to comply with the law	381
Number having the lowest gage cock raised to comply with the law	172
Number strengthened by having braces of greater sectional area applied	281
Number requiring additional support of crown sheet	147

It will thus be seen that during the year 6,690 locomotives were either held out of service for repairs or ordered changed and strengthened to conform to the requirements of the law.

The number of locomotives found defective, as shown above, viz., 54,522, does not indicate that this number of locomotives were found to be in violation of the law, but they were found to contain defects which should be remedied before the locomotives were again placed in service. The number found in direct violation of the law is represented by the number ordered out of service in accordance with Section 6 of the law, which requires the district inspectors to issue a written order holding the locomotive for repairs when one is found that does not meet the requirements of the law or rules. No formal appeal from the action of any district inspector has been filed during the year. This, in view of the vast amount of work performed and the number of locomotives on which repairs were ordered, shows that while the inspectors have been diligent they have also used discretion and good judgment in the enforcement of the law. It is believed that it also shows the existence of a spirit of co-operation and an earnest effort to comply with the requirements of the law on the part of a large majority of railroad officials.

Specifications for practically all locomotive boilers in service were filed within the time prescribed by the law, but the variation in design and the widely different methods of calculation followed by the various railroads have delayed the work of checking them. Very satisfactory progress is being made in this important work, and it will soon be possible to show accurately the stresses on each part of every locomotive boiler in service.

The results obtained indicate that when the checking is complete it will be necessary in some instances to compare the data shown on the specification cards with actual measurements in order to insure the accuracy of the information furnished.

Specifications are filed for all new locomotive boilers before they are put in service, and when repairs are made on boilers now in service which in any way affect their strength, the changes are reported on a suitable form, therefore our records are kept up to date.

Extract from annual report of the Chief Inspector of Locomotive Boilers to the Inter-State Commerce Commission, Division of Locomotive Boiler Inspection.

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Arbors, lathe
Arbors, saw
Arches, corrugated
Bands in scrolls
Bar cutters and benders
Bars, cylinder boring
Bars, iron and steel
Bars, round, square, etc.
Bars, concrete reinforcing
Beams
Benders, angle
Benders, bar
Benders, sheet metal
Billets
Blades, stone, saw
Blocks, chain
Blowers, forge
Blowers, hand
Boilers
Bolt ends
Bolts, boiler patch
Bolts, boiler stay
Bolts, bridge
Bolts, carriage
Bolts, expansion
Bolts, eye and hook
Bolts, iron
Bolts, machine
Bolts, patch
Bolts, tap
Bolts, tire
Bolts, track
Braces, boiler
Braces, McGregor
Brackets, boiler
Burrs, riveting
Cement, steam joint
Chain
Chain block machinery
Channels
Chisels, caulking
Chisels, cape and round nose
Chisels, cold
Chisels, diamond point
Chucks, drill
Chucks, lathe
Circles, flat
Clamps, flange
Cleaners, boiler, flue and tube
Compressors, air
Crabs, pressed steel
Cranes
Crayons
Cutters, angle iron
Cutters, bar
Dies, split
Dies, adjustable
Dies, boilermaker
Dies, cutting and forming
Dies, pipe threading
Dies, screw cutting
Dies, sheet metal working
Dogs, lathe
Drills, bench
Drills, blacksmiths
Drills, boilermakers
Drills, electrically driven
Drills, flat
Drills, multiple spindle
Drills, portable
Drills, post
Drills, radial
Drills, Ryerson
Drills, sensitive
Drills, track flat and twist
Drills, universal
Drills, upright
Ends, safe machine
Engines, gas
Expanders, flue and tube
Ferrules, boiler tube
Ferrules, copper
Ferrules, iron
Files and rasps
Fittings, boiler
Flanges, boiler
Flanges, cast iron
Flanges, cast steel
Flanges, forged steel
Forges
Forges, portable
Forges, rivet heating
Forging bars
Furnaces, Morison
Gaskets, boiler
Gaskets, metallic
Gaskets, manhole
Glyco metal
Grinders, drill
Grinders, emery
Grinders, tool
Hammers, drop
Hammers, steam
Hammers, power
Hammers, hydraulic
Hangers and lugs, boiler
Heads, dished, flanged, etc.
Hoists, chain
Hoists, hand power
Hoops
Iron, ingot
Iron, planished
Iron, refined bar
Iron, staybolt
Iron, angle
Iron, sheets
Iron, Ulster
Iron, wagon box
Lathes
Lathes, engine
Lathes, turret
Lock nuts
Lugs and hangers, boiler
Machine tools
Machine boring and turning
Machines, cutting off
Machines, drilling
Machines, valve seat facing
Machines, crank pin trying
Machines, flanging
Machines, flue cleaners
Machines, flue welding
Machines, grinding
Machines, keyseating
Machines, milling
Machines, pipe cutting
Machines, planers
Machines, polishing
Machines, shaping
Machines, riveting
Machines, shearing
Machinery, sheet and metal working
Machines, spring making
Machines, swaging
Machines, hydraulic
Machines, flue cutting
Machines, turret
Machines, saw
Manholes
Metal, babbitt
Mills, boring and turning
Motors, electric
Nails and lead washers
Nozzles, boiler
Nuts, case hardened
Nuts, cold punched
Nuts, hot pressed
Nuts, iron
Planers, metal
Planers
Plates, American ingot iron
Plates, flange and tank
Plates, floor
Plates, sheared
Plates, universal
Plates, Universal rolled
Plugs, boiler flue
Plugs, fusible
Presses, drill
Press, hydraulic
Presses, punching
Punches
Punches, boilermakers
Punches, hand
Punches, power
Punches, screw
Punches and dies
Reamers, track
Rests, slide
Rivets, boiler
Rivets, iron and steel
Rivets, structural
Rivets, tank and sheet
Rivet sets, pneumatic and hand
Riveters, hydraulic
Rods, reinforcing
Rolls, bending and straighteneing
Roofing, corrugated
Roofing, galvanized
Rounds, mild steel
Saws, circular
Saws, hack
Saws, swing
Saws, Ryerson high speed friction
Saws, cap
Screws, coach
Screws, machine
Screws, lag
Screws, steel
Screws, top
Sets, rivet
Shafting, cold rolled
Shafting, steel
Shapers, metal
Shears, hand
Shears, metal bench
Shears, metal cutting power
Shears, rotary bevel
Sheets, black
Sheets, galvanized
Sheets, roofing
Sheets, iron and steel
Siding, brick and stone
Spikes, railroad
Staybolts, iron
Staybolts,
Sheets, steel
Steel, flange and tank
Steel, Hartford firebox
Steel, special sheet
Steel, strip
Steel, structural
Steel, tool
Taps, machinists, hand
Taps, machine nut
Taps, patch bolt
Taps, pipe
Taps, staybolt
Tees,cast iron extra heavy
Tees, cast iron flanged
Tool steel
Tools, blacksmiths
Tools, boilermaker
Tools, boring
Tools, calking
Tools, cutting off
Tools, hydraulic
Tools, milling
Tools, threading
Tools, planer
Tools, shaper
Tools, structural iron workers
Tools, valve facing
Tread, stair
Trimmings, boiler
Trolleys
Tubes, boiler
Tubes, locomotive boiler
Tubing, mechanical
Turnbolts
Turnbuckles
Twisted bars
Ulster iron
Washers, wrought iron
Washers, lead
Washers, O. G.
Wheels, Emery
Wire, flat cold rolled
Wire, round in coils
Wire strand, galvanized
Etc., etc., etc.

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Shortly after our inspectors were placed in the field they frequently advised that they were finding locomotives in service with serious defects, such as sharp or badly worn flanges, flat wheels, cracked or broken wheels, loose wheels or tires, thin or badly worn tires, excessive lateral motion in engine trucks, drivers and trailers, broken frames, broken arch bars, broken springs, and other defects, all of which are a fruitful source of accidents and derailments, but which are not covered by the locomotive boiler inspection law, or any other law. In fact, it was found to be a common practice on some railroads to continue in service on their own line equipment which if offered in interchange by a connecting line would be refused on account of its defective condition.

Although this division has no legal authority to act in such cases, we believe that travelers and employees on railroads are entitled to all the protection against accidents that can be provided. Therefore our inspectors were instructed while making their regular inspections to note any defective conditions on locomotives which were apt to cause accidents, and when any were found to advise the railroad official in charge, and if proper repairs were not promptly made to wire the chief inspector, who would bring it to the attention of higher officials. During the past year 1,568 locomotives having defects of the above-mentioned character, 1,052 of which were defective wheels, have been reported to this division and to the railroad officials. These defects have been discovered by such casual inspection of the different parts of the locomotives as could be made while our inspectors were engaged in their regular work of inspecting locomotive boilers and their appurtenances as required by law. There can be no doubt, therefore, that many more would have been found had a more thorough inspection been made. It is extremely gratifying to be able to state that a large percentage of the railroad officials appreciate this action on the part of our inspectors, and take prompt action to remedy the defects to which their attention has been thus directed.

ACCIDENTS AND CASUALTIES RESULTING FROM FAILURES OF LOCOMOTIVE BOILERS AND THEIR APPURTENANCES.

Nature of Failure or Defect.	Year Ended June 30—					
	1913.			1912.		
	Accidents.	Killed.	Injured.	Accidents.	Killed.	Injured.
Arch-tube failures	20	3	27	18	..	23
Arch-tube plugs defective	..	..	..	2	..	4
Ash-pan blowers defective	14	1	14	3	..	3
Blowers defective	13	..	13	11	..	12
Blow-off cocks defective	16	..	18	23	2	22
Boiler checks defective	11	..	12	11	1	11
Boiler explosions:						
A—Shell explosion	..	..	..	3	27	41
B—Crown-sheet failures due to low water where no contributory causes were found	44	23	67	69	35	129
C—Crown-sheet failures due to low water where contributory causes or defects were found	28	6	50	23	15	38
D—Fire-box failures due to defective stay bolts, crown stays, or sheets	5	..	8	1	1	1
E—Fire-box failures due to water foaming	1	2	..	1	3	..
Cross stay defective	1	..	3	..	..	..
Crown stays defective	1	..	1	..	..	..
Dome caps defective	2	..	2	2	..	2
Draft appliances defective	4	..	4	3	..	4
Exhaust nozzle breaking	1	..	1	..	..	..
Fire doors defective	2	..	2	..	..	..
Flue failures	54	1	63	56	1	62
Flue-plug failures	..	..	..	7	..	8
Flue pockets defective	2	..	2	3	..	4
Flue sheets defective	1	..	1	2	..	2
Gage cocks defective	2	..	2	4	..	4
Grates defective	1	..	1	..	..	..
Handhole plate defective	..	..	..	1	..	1
Injectors and connections defective (not including injector steam pipes)	28	..	28	47	..	48
Injector steam pipe failures	36	..	47	31	..	38
Lubricators defective	11	..	12	11	..	12
Lubricator glasses bursting	45	..	45	49	..	49
Lubricator piping defective	4	..	5	..	..	..
Mud ring defective	..	..	..	1	..	1
Patch bolts defective	..	..	..	1	..	1
Plugs in fire-box sheets defective	5	..	6	1	..	1
Plugs (fusible) defective	1	..	1	1	..	1
Plug in steam chest defective	1	..	1	..	..	..
Plugs (washout) defective	20	..	23	11	2	14
Rivets defective	2	..	2	..	..	..
Safety valves defective	1	..	1	..	..	..
Squirt hose failures	266	..	267	243	..	245
Stay bolts defective	2	..	3	9	..	11
Steam-heat hose defective	1	..	1	..	..	..
Steam leaks obscuring view of enginemen	..	..	..	1	1	..
Studs defective	20	..	21	14	..	16
Steam piping defective	5	..	6	11	2	11
Superheater-tube failures	1	..	2	1	..	1
Tank hose defective	3	..	3	..	..	..
Throttle glands defective	3	..	4	..	..	..
Valves defective (not including safety valves)	6	..	6	5	..	5
Water-bar failures	1	..	1	3	..	4
Water glasses bursting	128	..	128	165	1	168
Water-glass fittings defective	7	..	7	8	..	8
Total	820	36	911	856	91	1,005

In some instances, however, railroad officials have objected to this division requesting repairs to defects not covered by the law, have advised us that we have no authority over such matters, and have failed to make the repairs, even though the defects were of a nature that might cause serious accidents. For this reason the provisions of Section 6 of the Locomotive Boiler Inspection Law should be made to apply to every part of locomotives and tenders, as well as to locomotive boilers and their appurtenances, so that our inspectors would have legal authority to require proper repairs to be made to any part of the locomotive or tender when it is found to be in an unsafe or improper condition for service.

It is respectfully recommended, therefore, that Congress be requested to enact necessary legislation to confer upon this division the authority to require repairs to be made to any part of a locomotive or tender when it is found to be in an unsafe or improper condition to operate in the service to which the same is put.

Such an inspection would to a certain extent increase the work and responsibility of this division, but it would be a safeguard to travelers and employees upon railroads that would amply repay the effort, and as this division already has an organization of mechanical experts fully qualified to perform such work, a small increase in this force would enable us to conduct a very efficient locomotive inspection without increasing the cost beyond the maximum fixed by Section 10 of the Locomotive Boiler Inspection Law.

Standard Specifications for Horizontal Return Tubular Boilers*

The dimensions and rating of standard stationary tubular boilers, together with the sizes of the parts and usual fittings, will be found tabulated on pages 19 and 20. Boilers to conform to these specifications shall be made and equipped as there indicated and as described herein. All boilers shall be of such strength that the factor of safety shall be not less than five.

MATERIALS

The shell, heads and covering strips of the standard boiler shall be of flange steel as described in the standard specifications of the Association of American Steel Manufacturers. All such plates shall be marked 60,000 pounds tensile strength, and in building the boiler the plates shall be so placed that these stamps are plainly visible on the outside. These plates shall have the full specified thickness at the edges and shall meet the tensile, quenching and bend tests described.

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* These specifications have been adopted by the members of the National Tubular Boiler Manufacturers' Association, Chicago, Ill.

SPECIFICATIONS—STANDARD RETURN TUBULAR BOILERS

Longitudinal Seams, All Butt Jointed—Double Riveted.

100 Pounds Working Pressure

Horse Power of Boiler as rated	15	20	25	30	35	40	45	50	60	70	80	90	100	110	125	150	165	180	200
Diameter of Boiler ... inches	36	36	36	44	44	44	48	48	54	54	60	60	66	66	72	72	72	78	78
Length of Tubes ... feet	8	10	12	10	12	14	12	14	14	16	16	18	16	18	16	18	20	18	20
Number of 3-inch tubes	24	24	24	36	36	36	46	46											
Number of 3½-inch tubes				28	28	28	34	34	44	44	54	54	66	66	86	86	86	110	110
Number of 4-inch tubes							28	28	36	36	44	44	54	54	70	70	70	88	88
Tube Heating Surface with 3-inch tubes ... square feet	150.8	188.5	226.2	282.7	339.2	395.8	433.5	505.8											
Tube Heating Surface with 3½-inch tubes ... square feet				256.6	307.9	359.2	373.9	436.2	564.4	645.1	791.7	890.6	967.6	1088.6	1260.8	1418.4	1576.0	1814.0	2015.9
Tube Heating Surface with 4-inch tubes ... square feet							351.9	410.5	527.8	603.2	737.2	829.4	904.8	1017.9	1172.9	1319.5	1466.0	1658.8	1843.1
Shell Heating Surface ... square feet	50.3	62.8	75.4	76.8	92.2	107.5	100.5	117.3	131.9	150.8	167.6	188.5	184.3	207.4	201.1	226.2	251.3	245.2	272.4
Thickness of Shell ... inches	¼	¼	¼	¼	¼	¼	5/16	5/16	5/16	5/16	5/16	5/16	11/32	11/32	⅜	⅜	⅜	13/32	13/32
Thickness of Heads ... inches	⅜	⅜	⅜	⅜	⅜	⅜	7/16	7/16	7/16	7/16	7/16	7/16	7/16	7/16	½	½	½	½	½
Width of Grates ... inches	36	36	36	42	42	42	48	48	54	54	60	60	66	66	72	72	72	78	78
Length of Grates ... inches	36	36	42	36	42	48	42	48	48	54	54	60	54	60	54	60	66	60	66
Area of Grates ... square feet	9.0	9.0	10.5	10.5	12.25	14.0	14.0	16.0	18.0	20.25	22.5	25.0	24.75	27.5	27.0	30.0	33.0	32.5	35.75
Diameter of Stack ... inches	16	16	16	22	22	22	24	24	26	26	28	28	30	30	34	34	34	38	38
Length of Stack ... feet	30	35	40	35	40	50	40	50	50	60	60	60	60	60	60	60	70	60	70
Gauge of Stack	16	16	16	16	16	16	16	16	16	16	14	14	14	14	14	14	14	12	12
Length of Guys ... feet	180	210	240	210	240	300	240	300	300	600	600	600	600	600	600	600	700	600	700
Diameter of Guys ... inches	3/16	3/16	3/16	¼	¼	¼	¼	¼	¼	¼	5/16	5/16	5/16	5/16	5/16	5/16	5/16	⅜	⅜

SIZE OF TRIMMINGS

Size of Steam Opening ... inches	2½	2½	2½	2½	3	3	3	3	3½	3½	4	5	5	5	5	6	6	6	6
Size of Pop Safety Valve ... inches	1¼	1¼	1½	1½	1½	2	2	2	2½	2½	2½	3	3	3	4	4	4	4	4
Size of Water Gauge Glass ... inches	⅝	⅝	⅝	⅝	⅝	⅝	⅝	⅝	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾
Size of Water Column Connections ... inches	¾	¾	¾	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼
Size of Gauge Cocks ... inches	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾
Size of Blow-off ... inches	1½	1½	1½	1½	1½	1½	1½	1½	2	2	2	2	2	2	2	2½	2½	2½	2½
Size of Feed and Check Valves ... inches	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	2	2
Size of Steam Gauge Dial ... inches	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

SPECIFICATIONS—STANDARD RETURN TUBULAR BOILERS

Longitudinal Seams, All Butt Jointed—Triple Riveted.

125 Pounds Working Pressure

Horse Power of Boiler as rated	45	50	60	70	80	90	100	110	125	150	165	180	200
Diameter of Boiler ... inches	48	48	54	54	60	60	66	66	72	72	72	78	78
Length of Tubes ... feet	12	14	14	16	16	18	16	18	16	18	20	18	20
Number of 3-inch Tubes	46	46											
Number of 3½-inch Tubes	34	34	44	44	54	54	66	66	86	86	86	110	110
Number of 4-inch Tubes	28	28	36	36	44	44	54	54	70	70	70	88	88
Tube Heating Surface with 3-inch Tubes ... square feet	433.5	505.8											
Tube Heating Surface with 3½-inch Tubes ... square feet	373.9	436.2	564.4	645.1	791.7	890.6	967.6	1088.6	1260.8	1418.4	1576.0	1814.0	2015.9
Tube Heating Surface with 4-inch Tubes ... square feet	351.9	410.5	527.8	603.2	737.2	829.4	904.8	1017.9	1172.9	1319.5	1466.0	1658.8	1843.1
Shell Heating Surface ... square feet	100.5	117.3	131.9	150.8	167.6	188.5	184.3	207.4	201.1	226.2	251.3	245.2	272.4
Thickness of Shell ... inches	5/16	5/16	11/32	11/32	⅜	⅜	13/32	13/32	7/16	7/16	7/16	½	½
Thickness of Heads ... inches	7/16	7/16	7/16	7/16	7/16	7/16	7/16	7/16	½	½	½	9/16	9/16
Width of Grates ... inches	48	48	54	54	60	60	66	66	72	72	72	78	78
Length of Grates ... inches	42	48	48	54	54	60	54	60	54	60	66	60	66
Area of Grates ... square feet	14.0	16.0	18.0	20.25	22.5	25.0	24.75	27.5	27.0	30.0	33.0	32.5	35.75
Diameter of Stack ... inches	24	24	26	26	28	28	30	30	34	34	34	38	38
Length of Stack ... feet	40	50	50	60	60	60	60	60	60	60	70	60	70
Gauge of Stack	16	16	16	16	14	14	14	14	14	14	14	12	12
Length of Guys ... feet	240	300	300	600	600	600	600	600	600	600	700	600	700
Diameter of Guys ... inches	¼	¼	¼	¼	5/16	5/16	5/16	5/16	5/16	5/16	5/16	⅜	⅜

SIZE OF TRIMMINGS

Size of Steam Opening ... inches	3	3	3½	3½	4	5	5	5	5	6	6	6	6
Size of Pop Safety Valve ... inches	2	2	2½	2½	2½	3	3	3	4	4	4	4	4
Size of Water Gauge Glass ... inches	⅝	⅝	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾
Size of Water Column Connections ... inches	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼
Size of Gauge Cocks ... inches	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾
Size of Blow-off ... inches	1½	1½	2	2	2	2	2	2	2	2½	2½	2½	2½
Size of Feed and Check Valves ... inches	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	2	2
Size of Steam Gauge Dial ... inches	5	5	5	5	5	5	5	5	5	5	5	5	5

SPECIFICATIONS—STANDARD RETURN TUBULAR BOILERS

Longitudinal Seams, all Butt Jointed—Quadruple Riveted.

150 Pounds Working Pressure

Horse Power of Boiler as rated	45	50	60	70	80	90	100	110	125	150	165	180	200
Diameter of Boiler ... inches	48	48	54	54	60	60	66	66	72	72	72	78	78
Length of Tubes ... feet	12	14	14	16	16	18	16	18	16	18	20	18	20
Number of 3-inch Tubes	46	46	...	...	...	...	...	...	...	...	...	...	...
Number of 3½-inch Tubes	34	34	44	44	54	54	66	66	86	86	86	110	110
Number of 4-inch Tubes	28	28	36	36	44	44	54	54	70	70	70	88	88
Tube Heating Surface with 3-inch Tubes ... square feet	433.5	505.8	...	...	...	...	...	...	...	...	...	...	...
Tube Heating Surface with 3½-inch Tubes square feet	373.9	436.2	564.4	645.1	791.7	890.6	967.6	1088.6	1260.8	1418.4	1576.0	1814.0	2015.9
Tube Heating Surface with 4-inch Tubes ... square feet	351.9	410.5	527.8	603.2	737.2	829.4	904.8	1017.9	1172.9	1319.5	1466.0	1658.8	1843.1
Shell Heating Surface ... square feet	100.5	117.3	131.9	150.8	167.6	188.5	184.3	207.4	201.1	226.2	251.3	245.2	272.4
Thickness of Shell ... inches	11/32	11/32	3/8	3/8	13/32	13/32	13/32	13/32	½	½	½	17/32	17/32
Thickness of Head ... inches	7/16	7/16	7/16	7/16	½	½	½	½	9/16	9/16	9/16	9/16	9/16
Width of Grates ... inches	48	48	54	54	60	60	66	66	72	72	72	78	78
Length of Grates ... inches	42	48	48	54	54	60	54	60	54	60	66	60	66
Area of Grates ... square feet	14.0	16.0	18.0	20.25	22.5	25.0	24.75	27.5	27.0	30.0	33.0	32.5	35.75
Diameter of Stack ... inches	24	24	26	26	28	28	30	30	34	34	34	38	38
Length of Stack ... feet	40	50	50	60	60	60	60	60	60	60	70	60	70
Gauge of Stack	16	16	16	16	14	14	14	14	14	14	14	12	12
Length of Guys ... feet	240	300	300	600	600	900	600	600	600	600	700	600	700
Diameter of Guys ... inches	¼	¼	¼	¼	5/16	5/16	5/16	5/16	5/16	5/16	5/16	⅜	⅜

SIZE OF TRIMMINGS

Size of Steam Opening ... inches	3	3	3½	3½	4	5	5	5	5	6	6	6	6
Size of Pop Safety Valve ... inches	2	2	2½	2½	2½	3	3	3	4	4	4	4	4
Size of Water Gauge Glass ... inches	⅝	⅝	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾
Size of Water Column Connections ... inches	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼
Size of Gauge Cocks ... inches	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾
Size of Blow-off ... inches	1½	1½	2	2	2	2	2	2	2	2½	2½	2½	2½
Size of Feed and Check Valves ... inches	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	2	2
Size of Steam Gauge Dial ... inches	5	5	5	5	5	5	5	5	5	5	5	5	5

The tubes shall be standard quality lap-welded mild steel of standard manufacture. The thickness of the metal shall be 12 B. W. G. for 3-inch tubes, 11 B. W. G. for 3½-inch tubes and 10 B. W. G for 4-inch tubes.

The rivets shall be of boiler rivet steel, as described in the Standard Specifications of the Association of American Steel Manufacturers, and of proper size to suit the size of the hole and the thickness of the plates and to form up heads equal in strength to the pressed heads of same.

The diagonal braces shall be weldless, of the same quality as the flange steel previously described and pressed from the solid plate, or else forged from steel bars. The number of braces to be used shall be computed on an allowance of not more than 7,500 pounds of load per square inch of section of brace neglecting, in this, the inherent strength of the heads and the slight angularity of the braces.

Suitable through rods and braces shall be installed below the tubes when necessary to sustain the pressure. These shall be of steel and shall be computed with the same allowance as diagonal braces.

Braces as above described shall be carefully placed so that the pressure on the flat surfaces, both above and below the tubes, shall be as nearly equally distributed as possible.

For any boiler head the area to be supported by braces shall be the surface included within lines drawn 2 inches from the outside of the tubes and 3 inches from the inside of the shell.

DESIGN

The longitudinal seam of the shell shall be of the butt-joint type, having inside and outside covering strips, and either double, triple or quadruple riveted, as indicated on pages 19 and 20.†

The circumferential seams shall be of the lap type of joint and single riveted.

In all joints the size, number and spacing of the rivets shall be such as to provide the strength necessary to maintain the factor of safety of five.

The tubes shall be placed in vertical and horizontal rows, with ample space between the adjacent tubes and also between tubes and shell for the circulation of water and also with a large steam space above the waterline.

Boilers 44 inches or less in diameter shall have a manhole above the tubes and a handhole below the tubes. These may both be in the front head or the handhole may be in the front head and the manhole in the back head. Boilers 48 inches in diameter shall have two manholes, both in the heads, one above the tubes and one below the tubes. They may both be in the front head or one manhole may be in the front head below the tubes and the other in the back head above the tubes. Boilers larger than 48 inches shall have two manholes, one of which shall be in the front end below the tubes, the other shall be above the tubes in either head or preferably may be placed in the shell.

The opening in the manhole shall not be less than 10 by 15 inches. Each manhole shall be equipped with a heavy plate, bale, bolt, nut and gasket.

Manholes placed in the shell shall be properly reinforced with a suitable steel saddle.

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† The butt type of joint is specified because the lap joint has been proved dangerous when used for the longitudinal seams. Defects in the lap seam usually develop where the parts are hidden. Inspection cannot reveal them. Domes are not specified because they are mechanically bad and are not necessary. The fixed, or "plug hat" type of dome is awkward at best, it tends to weaken the boiler and frequently makes the use of the lap type of joint necessary on the longitudinal seam. The independent type of dome can be used on any boiler, but it will probably be found to be better engineering to apply it in the form of a steam separator near the engine throttle instead of as a dome near the boiler. The manufacturers who have adopted these specifications do not recommend domes or lap joints when used on longitudinal seams.

(*Concluded on page* 30)

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NOTICE TO ADVERTISERS.
Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

In the last annual report of the Chief Inspector of the Division of Locomotive Boiler Inspection, Inter-State Commerce Commission, the need for further legislation is pointed out so that the locomotive boiler inspection law will apply to every part of the locomotives and tenders, as well as to the boilers and their appurtenances. It is maintained that the boiler inspector should have legal authority to require proper repairs to be made on any part of the locomotive or tender which is found to be in an unsafe or improper condition for service. This recommendation for additional authority on the part of the locomotive boiler inspection department is the result of findings by the inspectors in the performance of their regular duties. Locomotives are commonly found in service with serious defects, such as badly worn flanges, flat wheels, cracked or broken wheels, broken frames, broken arch bars and a number of other defects, any of which might be the cause of serious disaster, although not at present subject to any inspection law.

It is quite apparent that some provision should be made to enforce the repair of such defects, although the desirability of placing this authority in the hands of boiler inspectors will perhaps be questioned. Such action, however, would add very little to the present cost of locomotive boiler inspection service.

The summary of the inspection work for the fiscal year ending June 30, 1913, shows that during the year 6,690 locomotives, out of over 90,000 inspected, were either held out of service for repairs or changed and strengthened to conform to the regulations of the law. A comparison of the number of accidents due to crown sheet failures, water glasses bursting, lubricating glasses bursting, squirt hose failures and flue failures during the first and last quarters in 1913 give some idea of the benefits of the inspection service, as during the first quarter 241 such accidents occurred, while during the last quarter only 106 accidents of this nature were reported.

We are authorized by Mr. David J. Champion, vice-president and general manager of the Champion Rivet Company, Cleveland, Ohio, to announce a prize competition for the best essays on "How to Heat Rivets Satisfactorily."

Three prizes are offered by the Champion Rivet Company, the first of $50, the second of $35, and the third of $25. The awards will be made at the next annual convention of the Master Boiler Makers' Association, which will be held in Philadelphia May 25 to 28, after the papers have been submitted to a committee of three members of the association, chosen for the purpose by the chairman of the association.

The competition is open to all, and the papers should cover thoroughly the subject of heating rivets, taking up the construction of furnaces, the best kind of fuel to be used in the furnaces, the most desirable degree of heat for the rivets, the proper methods of heating and every detail that in any way affects the satisfactory heating of rivets. Photographs, sketches or drawings may, of course, be submitted with the articles, if they will serve to explain the ideas expressed in the paper.

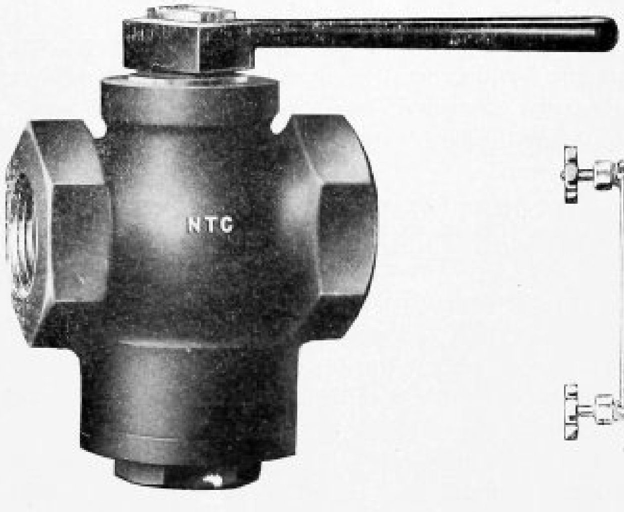
Papers for this competition should be sent to THE BOILER MAKER, 17 Battery Place, New York City, and should reach this office not later than 12 o'clock on Wednesday, May 20. The papers should not be signed by the author, but they should bear some distinguishing mark, and the name of the author should be inclosed in a sealed envelope bearing a duplicate of this identification mark. In this way the identity of the author will not be disclosed until after the papers have been judged, so that the prizes will be awarded with strict impartiality, upon the merits of the papers alone.

This competition brings out a very important question for boiler makers to discuss. A great many people do not seem to realize that even the best rivets when improperly or carelessly heated will fail. Boiler making concerns having poorly constructed furnaces and employing improper methods of heating too often blame the rivets when failure occurs, whereas the fault lies entirely in the treatment which the rivets receive when they are being heated and driven. There are right ways and wrong ways of heating rivets, and the subject should be carefully studied by all users of rivets so that the right ways and the wrong ways may be distinguished.

Engineering Specialties for Boiler Making

National Spring Plug Cock

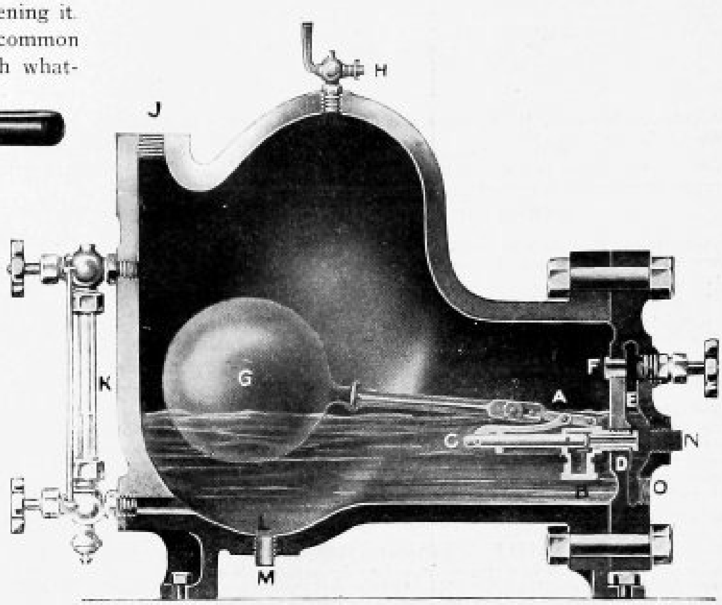
The National spring plug cock, manufactured by the National Tube Company, Pittsburg, Pa., was designed to overcome the disadvantages of the ordinary style or through-plug cock. When the plug becomes loose in the ordinary type of cock, the workmen frequently injure the plug in tightening it. Also, if the plug becomes cemented to the body, it is common practice to loosen the nut and drive up the plug with whatever tools are at hand, no special care being taken to properly adjust the plug afterwards. The National spring plug cock on the other hand has an inverted plug with a spring at the bottom, which constantly presses the plug firmly against the seat. While the plug usually turns easily, if for any reason it should stick it may be loosened by a blow on the top, after which it is immediately reseated by the spring. The cap at the bottom is screwed secure into the body and cannot be tampered with by the workman. These cocks are tested to 250 pounds cold-water pressure and to 125 pounds compressed air pressure under water, and are recommended for 125 pounds working pressure.



American Ideal Steam Trap

The American "Ideal" steam trap, manufactured by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass., is of the ball-float type, but differs from other steam traps of this type in that its operation is not materially affected by the motion of the ship. The construction is such that the trap may tilt to an angle of 35 degrees either way without affecting its operation. A horizontal valve guided true to its seat by two bearings is fitted with an adjustable seat which can be regulated to give the valve a sufficient amount of water seal so that the valve will not be exposed to the steam at any angle of the ship. This is accomplished by the use of a specially designed shell large enough to maintain enough water in the trap to keep the valve sealed at all angles, and by the use of a heavy float which is not so easily affected by motion as a lighter float. This construction, it is claimed, overcomes the faults in other types of steam traps, whose successful operation depends almost wholly upon being in a horizontal position at all times, on account of the use of centrally and vertically guided valves or balance weights.

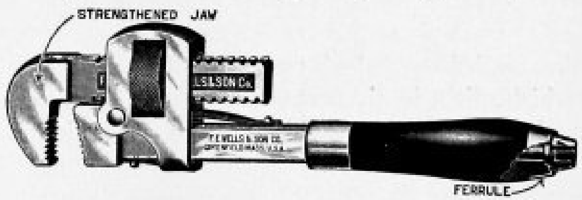
Practically all steam traps are constructed with a system of leverage which determines the capacity of the trap and the weight of the float which can be used to operate the valve. Where the leverage is insufficient, pilot valves and balance weights are used to aid in operating the valve proper. Such conditions, however, are eliminated in the American "Ideal" trap on account of a specially designed system of leverage which is exceptionally powerful, and which with the use of heavy floats makes possible the construction of a steam trap of great capacity. There is an emergency by-pass in the cover which does not affect the water seal, and also a water gage which is the "watchman" for all steam traps.



The actual capacity of any steam trap is obviously limited to the size of the opening in the valve seat. The American "Ideal" traps have standard size orifices in the valve seats equal to the pipe size connections, therefore giving assurance that the valve is large enough to handle all the condensation coming to it through the inlet pipe. By specifying the size of orifice in the valve seat and the maximum pressure under which the trap must operate, the manufacturers claim that all guesswork in determining the proper size of trap is eliminated, as the American "Ideal" trap is built to meet these specifications.

"Wells" Pipe Wrenches

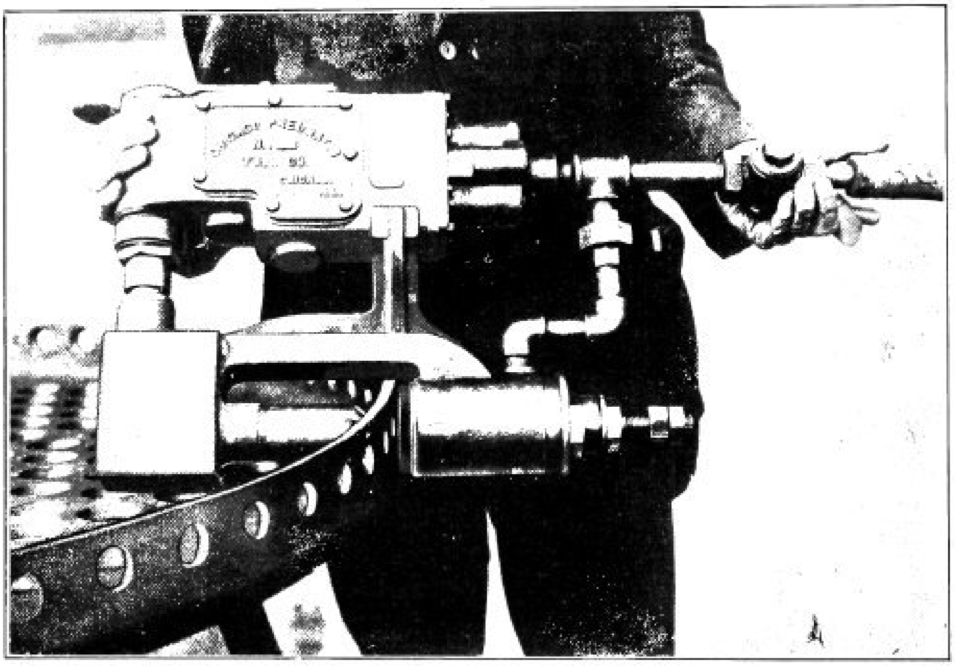
F. E. Wells & Son Company, Greenfield, Mass., has on the market pipe wrenches with especially strengthened jaws and fitted with double ferrules to protect the wood handles from breaking. The construction of the wrench is shown in the illustration.



Testing of Lubricants

Rough-and-ready methods of testing lubricating oils to ascertain their suitability for various purposes are frequently misleading, and lacking a standard of comparison are of little practical value to the engineer. The Stern Sonneborn Oil

Company, Ltd., London, E. C., has produced a comparatively simple and reliable apparatus, known as the Sternol oil testing machine, to be used for determining the value of lubricating materials under actual working conditions, with means of standardizing the results obtained. This machine, it is claimed, is capable of reproducing the exact working conditions of any machinery, steam, gas and oil engines, covering such items as load, speed, cylinder pressure, temperature, etc. By means of this apparatus the engineer is able to determine with certainty the suitability of an oil or grease for any given purpose and also to prepare charts showing the comparative efficiency of various qualities.



Chicago Countersinking Machine

The Chicago Pneumatic Tool Company, Chicago, Ill., has placed on the market a combined drilling and countersinking device to operate in connection with a "Little Giant" drill for drilling and countersinking flanges on flue sheets, door sheets, channel iron, I-beams, etc., doing away with all rigging, backstop and feed screws. It is said that with this device the rivet holes in the flanges of flue sheets can be countersunk at the rate of two holes per minute, as compared with the old rate of one hole for two minutes.

The device is fitted with a No. 4 Morse taper spindle and is kept from turning by means of lugs which fit around the housing. Ball bearings are fitted throughout and bevel gears are inclosed in an oiltight chamber. The feed is automatic, being regulated by means of an air chamber or push-up device which forces the drill against the work with constant pressure.

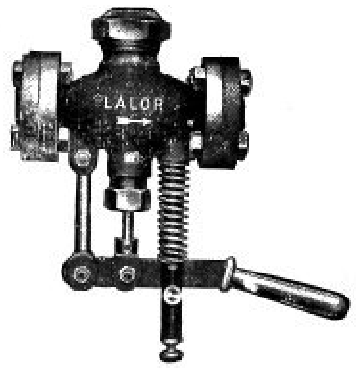
The weight of the machine complete is 35 pounds; the shortest distance from the drill to the side of the flange is 1½ inches. The machine is equipped with a drill 1 1/16 inches in diameter.

Lalor Automatic Stop Valve

The Lalor automatic stop valve, manufactured by the Lalor Fuel Oil System Company, Philadelphia, Pa., was designed to prevent fire and loss of life in connection with the use of any burning liquids. It minimizes the danger which has hitherto attended the use of fuel oil by providing the equipment with positive valve control. The valve can be used in connection with various oil-burning systems, such as steam boilers, heating and tempering furnaces, rivet forges, portable torches and gas retorts. The valve has been placed on the approved list of the Underwriters' Laboratories and has also been approved by the United States navy.

This automatic stop valve has a distinct feature, in that all the working parts are submerged, and they are therefore not subject to the action of the air, and, consequently, corrosion is prevented. Furthermore, the general design of the valve is such that the controlling forces acting on the plunger are greatly in excess of any friction that might possibly occur, so that the valve cannot fail to operate. The reliability of the valve and absence of failure are shown by a series of tests made on a number of these valves, where out of forty-six hundred fractures of various sizes the valves never had a single failure.

The complete Lalor system for safeguarding the use of fuel oil is composed of a master valve situated at the tanks or pressure means, group control valves for the pipe system and individual control valves which control the burner operation on each furnace. A test of a ½-inch individual control valve, made on a bolt-heating furnace, prevented the operator of that furnace from drawing more oil than the furnace could properly consume, and when the operator attempted to throw open the ½-inch needle valve, the flow of oil was checked with a loss of only 2 ounces, and the fire was thrown not more than 12 inches beyond the furnace doors. A similar test, made on the same furnace but without the use of the automatic stop valve, showed that the fire was thrown for a radius of 35 feet.



Lunkenheimer Pop Safety Valve

The Lunkenheimer "Sentinel" pop safety valve, manufactured by the Lunkenheimer Company, Cincinnati, Ohio, is made either entirely of bronze (Fig. 1) or with iron body and bronze mounted (Fig. 3), and as the working parts are identical a description of one will suffice for both. Reference is therefore had to Fig. 1, which illustrates the bronze construction.

When a pop valve is ordered, the purchaser, as a rule, stipulates the pressure at which he desires the valve to relieve, but after the valve is connected certain conditions may arise that require a resetting of the valve. With the Lunkenheimer construction it is not necessary that the entire valve be taken apart for this purpose, it being only necessary to remove the lever *U*, then the bonnet *C*, when access can be had to the regulating screw *L*. Should it be desired to have the valve relieve at a higher pressure than that for which it was set, the regulating screw *L* is turned down, placing a greater load on the spring, and for a lower pressure it is turned up, which relieves the load.

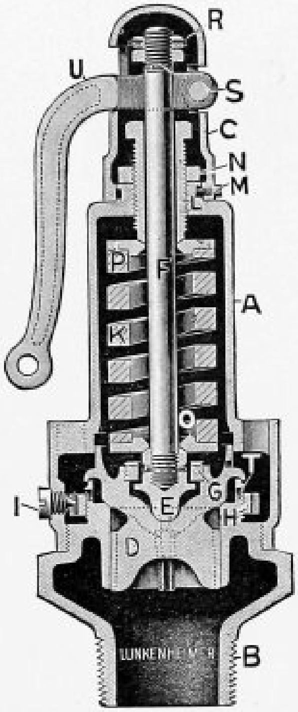


Fig. 1

Fig. 2

It is usually found that after a valve has been reset it will either relieve too much or not enough pressure. This is rectified, in the Lunkenheimer improved construction, by a regulating ring *H*, located in the base of the valve, and which screws over an extension of the seat. The object of this ring is to cover or uncover, as the case may require, a series of holes *T* drilled around the extension of the seat, and by removing the set screw *I* and inserting a wire the regulating ring *H* can be turned up or down as desired. By turning the ring *H* up, covering the holes, only a small quantity of steam can escape through these holes, which places a large amount of pressure on the bottom of the disk flange or lip, giving it a higher lift and holding it longer off its seat, thereby allowing considerable steam to escape and a proportionate amount of pressure. Turning the ring *H* down uncovers the holes, allowing the free escape of steam through them, but inasmuch as the pressure on the bottom of the disk flange is decreased, the disk will not rise very far off its seat, closes quicker, permits but a small amount of steam to escape, and therefore a small reduction in pressure. This improved construction, it is claimed, enables a very wide range in reduction of pressure—from as low as 1 pound to as high as 15 pounds, depending, of course, on the pressure carried in the boiler.

It will be noticed, by reference to Fig. 1, that an extension on the top of the disk *G* fits within the bottom of the bell *A*. The object of this is to thoroughly encase the spring *K*, thereby protecting it from the corrosive action of the steam.

The valve shown in Fig. 1 is of the top outlet pattern, but where it is desired to have the escaping steam exhaust at a distance from the valve, the angle pattern (Fig. 2) should be used, which permits of the connection of a pipe at the side.

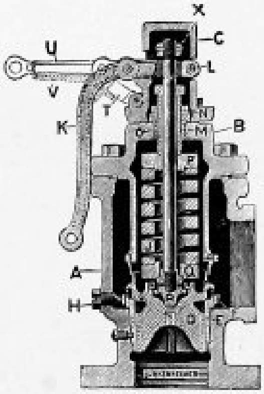


Fig. 3

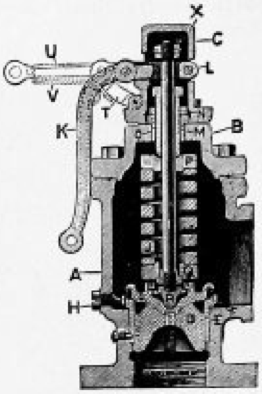
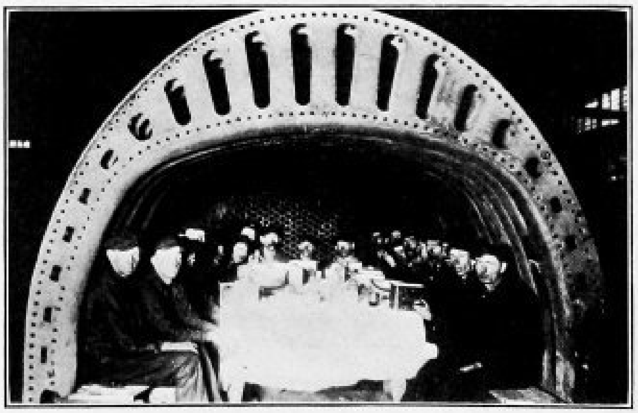


Fig. 4

A comparison of Figs. 3 and 4, which illustrate iron body types, will show that the working parts are practically the same, but that the spring casing has been omitted in Fig. 4, and the spring is consequently not protected from the steam. In some cases, however, it is not considered essential that the spring be encased, hence the necessity of a design like Fig. 4, which is known as the "Plain Pattern."

Large Jacobs-Shubert Sectional Firebox

The largest Jacobs-Shupert sectional fireboxes yet built are under construction for the Philadelphia and Reading Railway, to be applied to their 1-8-A consolidation locomotives. These locomotives are designed to burn anthracite coal, and hence a large grate area is requisite. A Gaines arch or bridge wall is installed so as to form a combustion chamber between the bridge wall and the back flue sheet. Each firebox consists of 15 channel-shaped sections, each section being 10 inches wide overall. The firebox is 13 feet 2 inches long and 8 feet 8 inches wide inside dimensions. The distance from the bottom of the mud ring to the center of the crown on the inside is 5 feet 1 inch.



Letters from Practical Boiler Makers

As to Efficiency in the Boiler Shop

Much is being written in regard to efficiency and as to its adaptability to boiler shops. That there are many shops in which efficiency is giving good results cannot be denied. That it will be of any material value in a shop doing a general line of plate work, the writer seriously doubts. Such shops are termed contract shops, boiler shops being a misnomer.

To be of sufficient value to be a paying proposition the following conditions must prevail:

The work must be standardized.

The machinery must be designed to handle this particular kind of work.

A large number of units of each part must be put through the shop at one time.

These conditions are obtainable in a shop making a specialty of some certain machine or a general line of boiler work.

Let us consider a moment the modern contract shop. Here we find that each contract is especially designed to meet the fancy of the customer. No two contracts are similar in construction, and while the shop may contain numerous rectangular tanks, for instance, investigation will prove that there are not more than, say, two of the same design.

What are the principal defects of the present method of operating such plants?

1. Delays in making delivery of contracts.
2. Poor workmanship.
3. Errors in construction.

Of the above, the first condition is the only one that the efficiency system would affect. Would it be possible to remedy the above conditions without the aid of an elaborate system? Yes. A well-organized shop would perfect systems of their own with but very little expense. Let us analyze the above defects and see what would be necessary to make a marked improvement in conditions.

As to the delays in making delivery. This is due perhaps to several reasons: 1. The order clerk or sales department do not keep a proper record of the several contracts in the shop, or do not have an intelligent idea of how long it will take to complete a contract after receipt of material. 2. The job may be held up in the shop after being partly finished owing to the fact that parts or material required to finish are not on hand. 3. Errors in construction. Is it necessary to install an elaborate system to correct these conditions? No. The first two causes should be up to the engineering department to rectify, the third to the superintendent. As to poor workmanship, efficiency will not furnish a boiler maker with gray matter and enable him to overcome errors of judgment. This must be taken care of by the shop organization. Several methods could be followed along educational lines to make those responsible for the poor workmanship, or departments where errors of judgment are liable to occur, more efficient: by errors here we mean principally poor workmanship.

As to errors in construction. This is perhaps the most grievous defect in the above list. It costs annually thousands of dollars, and an efficiency system offers no solution. Here, again, the shop organization can eliminate a large majority of the trouble.

By making these few comments I do not desire to be understood as being opposed to the efficiency methods as outlined in the articles in THE BOILER MAKER. What I do believe is, that certain conditions must prevail to make it a paying proposition. That these conditions are not present in a contract (boiler?) shop is my firm belief. The solution of all the evils of a contract shop can be solved by the proper organization of the executive force. Satisfy your customers by prompt delivery and good work, and have an executive force capable of eliminating the sore spots, and it will be unnecessary to saddle the shop with the cost of an elaborate system.

ERNEST PATRICK.

Surface-Combustion

In the December issue of THE BOILER MAKER, Mr. Jashky contributes an article relating to surface combustion and its discovery by Prof. Bone and Dr. Schnabel. The writer wishes to mention that as early as 1882 Fletcher called attention to this flameless combustion, and in 1883 the same was investigated by Prof. F. Fischer, Germany. In Northwestern Pennsylvania, where natural gas has been used for many years for domestic purposes, it is well known that when one ignites a mixture of gas and air in a bed of refractory material ("doughnuts" made of fire-clay), and by proper regulation of the gas-supply valve, he can obtain a continuously glowing mass of this refractory material without having a noticeable flame. Many gas stoves are supplied with these small pieces of formed firebrick.

There is no doubt that this flameless surface combustion will materially change furnace designs in the future, specially in many branches of the metallurgical and similar industries, also for domestic use, but in regard to its application to boiler operation we should wait for the results from further experiments and investigations.

Prof. Bone has made his first experiments with illuminating gas in the laboratory. The results mentioned by Mr. Jashky in THE BOILER MAKER were obtained with coke-oven gases. At present experiments are being made with blast-furnace gases, which have a very low heat value. Lucke gives for coke-oven gas a heat value of 524-620 British thermal units, blast-furnace gas a heat value of 99-100 British thermal units.

There might be a promising future of this flameless combustion in connection with such furnaces where the wash gases can be utilized for steam generation in boilers, or where gas is manufactured for other heating purposes, as gas works, blast furnaces, smelting works, coke ovens, glass works.

It might be of great value to manufacture gas near the mines from inferior grades of fuel, coal dust and other refuse. But this requires costly installations, and it is more economical to transform the heat energy directly into useful work by installing gas engines and electrical equipment. In large iron and steel plants the gas is used at present to a great extent in such gas engines to transform mechanical into electrical energy. There is no need for boilers in such places.

The gas-firing of boilers in direct connection with gas producers has not, in spite of the perfect and smokeless combustion, found much favor. The generator has to be built near the boiler to prevent heat losses as much as possible. This requires much valuable room. The many repairs on brickwork, caused by the extreme heat in the producer and furnace, the necessary blast installation and many explosions have prevented the extensive use of such furnaces in connection with boiler operation. In fact, most of such installations have ended in the return to the direct-fired furnace.

Nevertheless, the high evaporation obtained per square foot of heating surface and the high efficiency in the experiment mentioned by Mr. Jashky, should encourage further investigation and study, and this might finally lead into a boiler and furnace construction entirely different from what is offered at present.

Prof. Bone mentions in his lecture held in St. Louis that the principles of this surface combustion apply also to liquid fuels. These fuels have to be transformed into gaseous state, and what has been said in regard to other gaseous fuels applies to liquid fuel just as well. C. W. R. EICKHOFF.

Chicago, Ill.

Further Light on Examination Questions for Boiler Inspectors

With reference to Mr. Mason's answers to Inspectors' Examination Questions on pages 406-7 of the December issue, I beg to state that reading between the lines of question 27 gives every indication that it is a catch question.

The Massachusetts boiler rules do not allow more than 100 pounds pressure on lap seam boilers up to 36 inches diameter, and drums of greater diameters must be of butt-strap construction.

The joint efficiency given in the question is either a lap seam longitudinal joint or a very poorly designed butt-strap joint.

The patch shown as an answer to question 38 would be improved by having been of the half-circle shape, thereby eliminating the square corners and the short longitudinal seam. The ends at the girth seam should be drawn out, tapered the same as the patch described, and otherwise put on in the same manner; but it would require less material, less rivets and less labor, and therefore should cost less.

O. B. SERVER.

No Combustion Chamber for Him

Here are the contents of some letters that passed between a prospective buyer and a manufacturer of boilers:

Gentlemen:—How much would a 30-horsepower tube boiler cost, including setting and grate arranged so that coal will touch the boiler shell to get highest heat and most steam. Please send some of the designs you advertise in ———.

The boiler builder was amused, of course, yet he feared that some advance in the fine art of boiler making of which he was unaware might have been made by his competitors. He therefore spent considerable time studying the latest types on the market, but failing to find any prominent manufacturer who recommended the elimination of the combustion chamber, he replied in about this way:

Dear Sir:—We have your favor of the 18th inst., and are pleased to send herewith blue prints of our 30-horsepower horizontal tubular boiler and three blue prints showing methods we follow in arranging settings and grates.

We are sorry to advise that we have no prints showing the grates so close to the boiler that the coal would touch the shell. Such is not considered good design, because combustion would be incomplete and the shell would soot badly. However, if you insist, we could no doubt alter the setting to conform to your requirements, although we would then be obliged to withdraw our regular performance guarantee.

In this connection we would like to ask just how you expect to stoke the boiler. It would be a difficult matter to shovel coal into such restricted space by hand. Do you expect to use a mechanical stoker?

We will be glad to have you give us as many details as possible and we will do what we can for you.

To this the correspondent hotly retorted:

Gentlemen:—I don't see why you can't guarantee your boiler if it will give more steam and save a lot of coal, and that is just what my invention will do. I have studied heat of coal for a long time, and know that the hottest place is right in the fire, where anybody with sense would expect it to be. When a blacksmith heats his horseshoe or plowshare, or makes a weld, he doesn't put the iron 3 or 4 feet away from the fire. That is why I want the live coals to touch the boiler shell. I will get more steam and it won't take much coal. If you will send me $1,000 I will sell this invention and my secret invention for feeding coal, to you, and if you won't take my offer I will sell it to ——— & Company.

The manufacturers, still wishing to make a sale, wrote the inventor at greater length, trying to show him wherein he was mistaken, but the correspondent refused to respond. Perhaps he is disgusted with the theories of common man.

New York. N. G. NEAR.

How to Calculate the Heating Surfaces of Boilers

The area of heating surface of a boiler is calculated from the surfaces of the boiler shell, tubes, furnaces, flues and fireboxes having water backing and in contact with the fire or the hot gases resulting therefrom. All boiler surfaces below the mean waterline which have water on one side and fire or the products of combustion on the other are considered as heating surface. All surfaces above the waterline having one side exposed to the products of combustion and the other to steam are regarded as superheating surfaces.

In the case of a horizontal tubular boiler the amount of heating surface will vary materially with the form of setting, as with some forms of setting little more than one-half of the lower circumference is exposed to the fire, while in others considerably more than one-half is exposed. The only correct method to follow in computing the heating surface of any boiler is to measure the amount of the circumference of the shell exposed as well as the other dimensions.

As an example, the heating surface of a horizontal tubular boiler, 60 inches diameter and 16 feet long, containing eighty-four 3-inch tubes, will be calculated. Such a boiler would have a nominal rating of about 90 horsepower.

If, upon measuring the circumference of the shell exposed to the fire and products of combustion, it is found to be 8 feet 6 inches, the total heating surface of the shell will be $16 \times 8\frac{1}{2} = 136$ square feet. The internal diameter of a 3-inch tube is 2.78 inches, so that the internal circumference is $2.78 \times 3.1416 = 8.733$ inches. The internal area of a 1-foot length of the tube is therefore $12 \times 8.733 = 104.796$ square inches. Dividing this by the number of square inches in one square foot (144) gives the internal area of one tube for 1 foot of length, or .728 square foot. Since the length of the tubes is 16 feet, each tube will have a total internal area of $16 \times .728 = 11.648$ square feet. Multiplying this by the number of tubes gives the total tube-heating surface as $11.648 \times 84 = 978.432$ square feet. Adding together the total tube heating surface and the total shell heating surface gives the total heating surface of the boiler, exclusive of the tube sheets, as 1114.43 square feet.

Some rules for the heating surface of horizontal tubular boilers direct that the area of the tube sheets between the tubes should be calculated as heating surface. In the ordinary horizontal tubular boiler, however, it is doubtful if these surfaces are of much value. It is evident that at the up-take end of the boiler the gases do not circulate over the tube sheet in a manner conducive to heat convection, and the same holds true to a lesser extent at the other end. The hot gases upon entering the tubes impinge somewhat upon the tube sheet, but the heating surface is probably not as effective as that of the shell or the interior of the tubes. If, then, the heating surface between the tubes on one tube sheet is included, the total will be practically all of the effective heating surface of such a boiler.

The average submerged area of the tube sheets on a horizontal boiler is about three-fourths the total area. To find the area of a circle, multiply the square of the diameter by the constant .7854, hence $5 \times 5 \times .7854 = 19.637$ square feet.

Three-fourths of 19.637 is 14.728 square feet. If, now, from three-fourths the area of the back tube sheet the combined area of eighty-four tube ends be subtracted, the remainder will be the effective heating surface of the back tube sheet. The area of one tube end is 3 × 3 × .7854 = 7.0686 square inches. Reducing it to square feet by dividing it by 144 gives the area of one tube end as .0491 square feet. The area of eighty-four tube ends is therefore 4.124 square feet. Subtracting this result from 14.728 leaves a remainder of 10.604 square feet to be added to the heating surface of the shell and tubes, giving a total heating surface of the boiler of 1125.03 square feet.

It will be seen that the greatest amount of heating surface is in the tubes and after that comes the shell. The amount of heating surface on the back tube sheet is relatively small, and can be safely omitted in any but an exact calculation.

Albany, N. Y. CHAS. MILLER.

Questions and Answers

QUESTIONS

(1) Give a general rule for finding the thickness of outside roof sheets for the firebox of a locomotive boiler.

(2) Give a rule to determine the size of injectors for a locomotive boiler having 48 square feet of grate surface and 3,250 square feet of heating surface.

(3) Give rule to determine size of safety valves for same boiler.

(4) Give a rule to find the working pressure allowed on a boiler flue 5/16 inch thick, 20 inches inside diameter and 12 feet long, the flue to be in two 6-foot sections with longitudinal seams single riveted.

(5) Give a rule to find the number and size of staybolts to apply in a circular firebox 5/16 inch thick, 36 inches inside diameter and 36 inches high to carry 125 pounds pressure.

(6) Give a rule to determine the size of pump to supply a boiler rated at 250 horsepower, assuming that 30 pounds of water is evaporated per horsepower per hour. Speed of pump 47½ feet per minute.

ANSWERS

(1) The outside roof sheets of a locomotive boiler are of the same thickness of metal as are the side sheets. The roof sheets are sometimes curved, and, again, they may be flat. As the curved sheets are connected to the crown sheet of the firebox with stays, in a similar manner to flat roof sheets, they may be considered as flat surfaces, and the thickness of the plate calculated accordingly.

The formula for safe working pressure on flat, stayed surfaces is this:

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

in which the values of the letters are: P = safe pressure in pounds per square inch, C = a constant, 112 for plates up to and including 7/16 inch thickness, and 120 for plates over 7/16 inch thickness, t = the thickness of plate in sixteenths of an inch, and p = the greatest pitch of stays in inches. Having the safe pressure, the greatest pitch of stays and one of the constants given, the formula may be transposed to find the required thickness of plate, like this:

$$\frac{P \times p^2}{C} = t^2, \text{ or}$$

$$\sqrt{\frac{P \times p^2}{C}} = t.$$

For example, let us assume that in a given case the safe pressure required is 200 pounds per square inch, the greatest pitch of stays is 6 inches, and that the constant to be used is 120. Then to find the thickness of plate for those conditions, the statement becomes

$$\sqrt{\frac{200 \times 6^2}{120}} = 7.74, \frac{7.74}{16}, \text{ or } 8/16 \text{ inch, nearly.}$$

In practice 8/16 or ½-inch plate would be used.

The side sheets may be figured on this basis and by the foregoing method, and if safe for them the same method may be employed for the roof sheets.

(2) The size of injector required depends upon the quantity of water evaporated, and that in turn depends upon the quantity of fuel consumed in a given time. For example, assume that a quantity of 65 pounds of coal is consumed per square foot of grate surface per hour. Then

$$48 \times 65 = 3{,}120 \text{ pounds}$$

of coal per hour consumed. Assume that each pound of coal will evaporate 1 gallon, or 8.3 pounds of water, so that 3,120 × 8.3 = 25,896 pounds of water per hour required, or

$$\frac{25{,}896}{8.3} = 3{,}120 \text{ gallons.}$$

An injector that can handle that quantity per hour will be required. A No. 9 Chicago locomotive injector will suit the conditions of the question and those assumed.

Figuring on the basis of heating surface we find this:

Heating surface per pound of coal burned per hour = 0.9 to 1.5, say as an average 1.0 square foot. This means that 3,250 pounds of coal will be consumed per hour. And, further, that as each pound of coal will evaporate 1 gallon of water, then there will be 3,250 gallons of water per hour required. This differs from the former method by 3,250 − 3,120 = 130 gallons per hour, or a difference of about 4 percent, which checks up sufficiently close, when it is considered that in any case an injector more than just sufficient for the needs would be installed.

The foregoing shows that the size of injector will depend upon the rate of combustion of fuel, and also the rate of evaporation, and a margin allowed in the choice of injector as to capacity.

(3) For locomotive boilers the following formula determines the proper size and number of safety valves to use:

$$D = .055 \times \frac{H}{L \times P},$$

in which D = the nominal diameter of the valve in inches.
H = the heating surface in square feet.
L = the lift of the valve in inches.
P = boiler pressure in pounds absolute.

In the question, let us assume that the boiler pressure is 185 pounds, or 185 + 15 = 200 pounds *absolute*, as required in the formula. Let it further be assumed that it is desired to use 3-inch valves, the lift of which is .13 inch. The heating surface is 3,250 square feet. The statement becomes:

$$D = .055 \times \frac{3{,}250}{.13 \times 200} = \frac{178.75}{26} = 6.87 \text{ inches.}$$

Therefore two (2) 3½-inch valves would be required.

(4) The formula to use for this problem is this:

$$P = \frac{51.5}{D} \left[(18.75 \times t) - (L \times 1.03) \right],$$

P = safe working pressure per square inch.
D = outside diameter of flue in inches.
t = thickness of wall in *sixteenths* of an inch.
51.5, 18.75 and 1.03 are constants.

Applying this formula to the values given in the question, we have

$$P = \frac{51.5}{20.625} \times [(18.75 \times 5) - (72 \times 1.03)] = 48.9,$$

say 49 pounds per square inch safe pressure to carry (United States Marine Rule).

(5) In this problem, as the external diameter of the furnace does not exceed 38 inches, and the plate is 5/16 inch thick, the longitudinal pitch of the staybolts should not exceed 5⅜ inches, and the diameter of the staybolts over the thread must not be less than ⅞ inch, according to Massachusetts rules.

Then 36 × 3.1416 = 113.0976 inches circumference. As the height is 36 inches then 113.0976 × 36 = 4071.5136 square inches area to support, making no deductions for the area of the stays themselves. As the allowable pitch is 5⅜ inches, this means that each bolt supports an area of 5⅜ × 5⅜ = 28.89 square inches. So that

$$\frac{4071.51}{28.89} = 140.9,$$

say 141 ⅞-inch bolts will be required.

The formula from which the longitudinal pitch of staybolts is found, according to the Massachusetts rules, is this:

in which $L = \left(\frac{c \times t^2}{P \times d}\right)^2$

L = longitudinal pitch of staybolts in inches.
c = a constant = 110.
t = thickness of furnace sheet in *thirty-seconds* of an inch.
P = working pressure in pounds per square inch.
d = external diameter of the furnace in inches.

Applying this to our problem as a check up on the figures found, we have

$$L = \left(\frac{110 \times 10^2}{125 \times 36\tfrac{5}{8}}\right)^2 = 2.4^2 = 5.76$$

inches as the *maximum* allowable pitch; but a pitch of 5⅜-inches with ⅞-inch bolts and 125 pounds pressure is desired. Variations in the values in the formula, and certain allowances in the table (Board of Boiler Rules State of Massachusetts) from which the 5⅜-inch pitch is obtained, make the difference between it and the 5.76 value found by the formula. It cannot always be expected that these things will check up *exactly*. Of course, some other engineer may figure out a different number of stays, and probably get less than 141 for the given problem, and still be within the limits of safety.

(6) The total quantity of water required will be 250 × 30 = 7,500 pounds per hour. Assume 150 pounds pressure in the boiler.

The area of the water piston or plunger equals

$$\frac{\text{discharge in cubic feet per minute} \times 144}{\text{piston speed in feet per minute}},$$

and to find the corresponding diameter,

$$\sqrt{\frac{\text{discharge} \times 144}{.7854 \times \text{piston speed}}}.$$

For leakage, possible losses, etc., allow 25 percent in excess of the actual quantity. Then the statement becomes

$$\sqrt{\frac{\text{discharge} \times 1.25 \times 144}{.7854 \times \text{piston speed}}} =$$

diameter of plunger or piston in inches. This reduces to

$$\sqrt{\frac{229 \times \text{discharge}}{\text{piston speed}}} = \text{diameter.}$$

Now, 7,500 pounds water per hour $= \frac{1}{60} \times 7{,}500 = 125$ pounds per minute, and as 1 cubic foot is usually estimated at 62.4 pounds, then $\frac{125}{62.4} = 2.0$ cubic feet per minute required. So that

$\sqrt{\frac{229 \times 2}{47.5}} = 3.1$ inches diameter required for water end as calculated.

To find the *number of strokes*, or to find the *length of stroke*, we use these formulas:

$$N = \frac{P}{L}, \text{ or } L = \frac{P}{N},$$

in which P = piston speed,
N = number of delivery strokes,
L = length of stroke in feet.

In our problem it is

$$N = \frac{47.5}{.5} = 95 \text{ strokes per minute, or}$$

$$L = \frac{47.5}{95} = .5 \text{ foot, or 6 inches stroke.}$$

For the *steam* end of the pump the area of the piston is found from this formula:

$$\frac{1.4 \times \text{area of water piston} \times \text{pressure per square inch}}{\text{steam pressure per square inch}}$$

To find the corresponding diameter the formula becomes

$$\sqrt{\frac{1.4 \times \text{area of water piston} \times \text{pressure}}{.7854 \times \text{steam pressure}}} = \text{diameter in ins.}$$

When simplified the formula becomes

$$\sqrt{\frac{1.8 \times \text{area of water piston} \times \text{pressure}}{\text{steam pressure}}} = \text{diameter.}$$

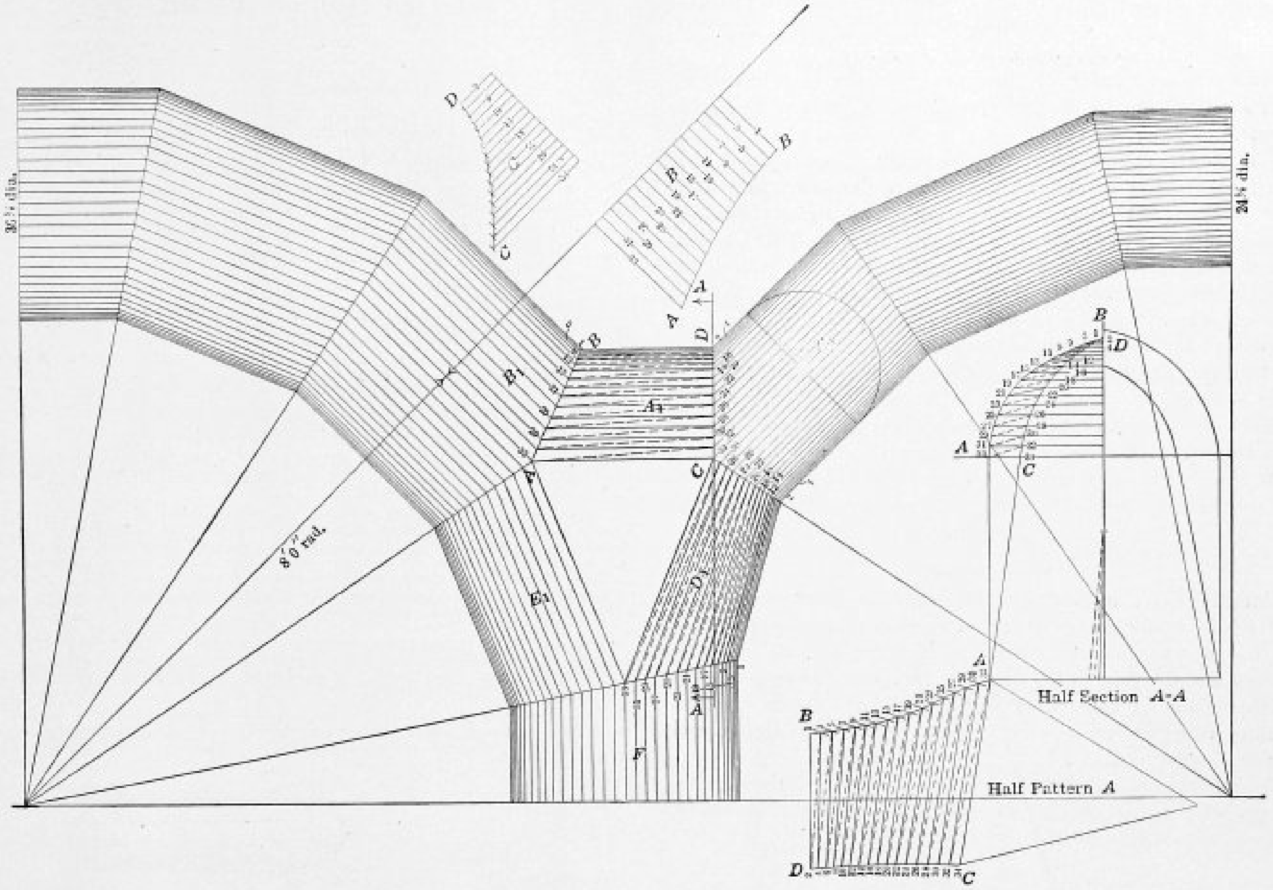
Applying the values in our problem:

$\sqrt{\frac{1.8 \times 3.1^2 \times .7854 \times 155}{145}} = 3.8$ inches (the pressure values 155 and 145 are arbitrarily chosen to show the method only), *minimum* diameter of steam piston, under the conditions taken.

Now, in looking through various manufacturers' pump catalogues, we find that the nearest commercial size pump to suit the requirements of the question is a 5-inch by 3-inch by 6-inch feed pump, which is listed to deliver about 15 gallons per minute at 75 strokes. That is the size pump that would probably be chosen to comply with the terms of the question.

Scranton, Pa. CHARLES J. MASON.

JOHN WALTERS, boiler inspector of the P. C. C. & St. L. Railway, died recently of pneumonia at Carnegie, Pa. Mr. Walters was 58 years old and had worked for the Pennsylvania Lines west of Pittsburg for the last twenty-five years. For twenty years he had been inspector in charge of repairs. He previously served his time with the Dowlais Steel, Iron & Coal Company, Dawlais, Wales. He was a member of the Order of Moose, K. of P., B. P. O. E., and Heptasophs.



Layout of Branch Pipe

The Layout of a Branch Pipe

In the October issue the layout of a branch pipe is asked for. In the accompanying sketch such a branch pipe is shown together with the development of part of it. The remaining parts require only ordinary methods for their layout.

Comparing this sketch with the sketch in the October issue, it will be noted that a small change has been made on the part marked *A*, at the point where *A* connects with *F*. By bringing the part *A* down to a point, it is much easier to lay out the parts *E* and *D*.

The development of parts *C* and *B* will give the length of spaces to lay out *A*. Part *E* will be the throat part of an elbow piece. JOHN L. E. RIEDY.

Bowmanstown, Pa.

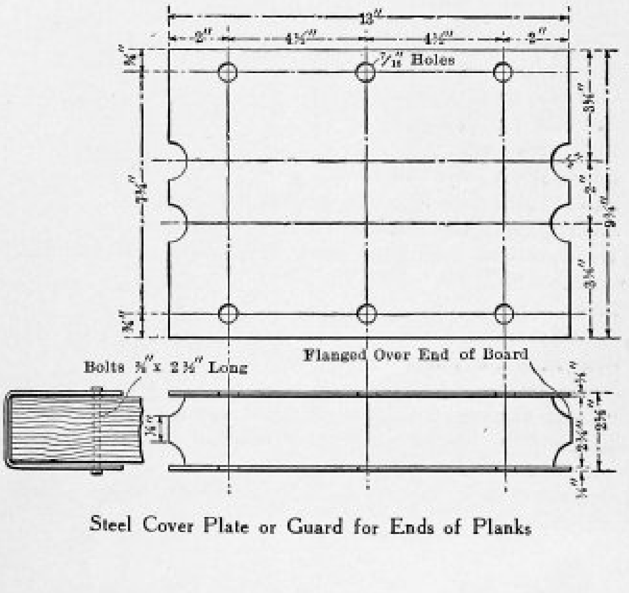
Another Safety Device

In visiting many of the boiler shops one cannot help noticing the condition of the planks used for staging around different classes of work. Many of these planks are split up at both ends and some of them are split the entire length. Furthermore, instead of being of a uniform length, the planks are usually of a great variety of lengths, a fact which is due many times to the sawing off of bad ends of the planks due to their splitting.

The illustration shows a light steel guard made of No. 12 or No. 14 steel, to be bolted on each end of a plank when it is being used for staging. This is to overcome the splitting of the planks in handling them or when they are dropped from the support to the floor. The guards also tend to prevent injury to the workmen by preventing the use of defective planks. At the present time planks from 10 to 16 feet long cost a great deal, and as these guards increase the life of the planks very materially, they are useful in bettering the economy of the shop. Fitting these guards to the planks insures a good platform at all times, and by adopting standard lengths of 10 and 16 feet there will be no uneven ends, so that the men working on the staging will be much less likely to make a misstep and fall from the staging.

The writer believes that this device is along the lines of "Safety First," and that it would be of benefit if used in any shop. A. N. LUCAS.

General Foreman Boiler Maker, Chicago, Milwaukee and St. Paul Railroad Company, Milwaukee, Wis.



Steel Cover Plate or Guard for Ends of Planks

Standard Specifications for Horizontal Return Tubular Boilers

(*Concluded from page 20*)

All openings 2 inches in diameter or larger shall have suitable steel reinforcing flanges riveted on. Cast iron flanges or nozzles shall not be used.

Boilers for 125 or 150 pounds working pressure shall have the feed opening in the front head over the tubes, and same shall be provided with a brass bushing and an internal feed pipe extending from the front end of the boiler to within about 3 feet of the rear head, thence across to the side of the shell, terminating in an elbow for discharge below the top row of tubes.

Boilers for 100 pounds working pressure shall be arranged to feed through the blow-off connection and the internal feed pipe be omitted.

Each boiler shall be provided with four steel lugs or brackets, two on each side, for supporting the boiler, except that boilers 78 inches in diameter, or boilers 20 feet long, shall be provided with eight such lugs, four on each side of the boiler and all of them arranged in pairs.

WORKMANSHIP

All rivet holes and all tube holes shall be either drilled from the solid or punched small and reamed to size. After drilling or reaming the plates shall be taken apart and all burrs removed and the tube holes shamfered with a rose reamer.

The edges of the plates shall be beveled to an accurate calking edge, and after being riveted shall be calked tight with a round-nose tool.

The tubes shall be carefully placed, expanded tight in the heads with a roller expander, and the ends carefully beaded over against the head at both ends.

WATER COLUMN

The water column shall be provided with three gage cocks, and shall be so placed that the lowest gage cock shall be 2 inches above the tops of the uppermost row of tubes. The middle gage cocks shall be 3 inches and the uppermost gage cock 6 inches above the lowest gage cock measured vertically.

TESTS

All material used in the construction of the boiler shall be rigidly tested as called for in the above specifications, and the completed boiler shall be subjected to a steady water pressure 50 percent above its proposed working pressure and made tight.

When specially requested the boiler manufacturer will furnish copies of the record of tests of the plates as made by the steel manufacturers. These reports shall be deemed sufficient indication of the quality of steel used.

EQUIPMENT

A complete standard boiler equipment includes:

The bare boiler with lugs.

Cast iron front with anchors.

Grate bars with bearers.

Rear arch bars.

Rear ash-pit door and frame.

Safety valve with nipple to connect it to boiler.

Steam gage with siphon.

Water column with gage glass, three gage cocks and pipe connections to boiler.

Blow-off valve.

Check valve.

Stop valve for water-feed line.

Smokestack and guys. (Stacks less than 60 feet long shall have four guy eyes and guys six times as long as the stacks. Stacks 60 feet long or longer have six guy eyes, two sets of three, and guys ten times as long as the stack.)

A stack plate or nozzle shall be included with each full-front boiler.

Selected Boiler Patents

Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,

LOAN AND TRUST BUILDING,

Washington, D. C.

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

1,073,795. FUEL-ECONOMIZING APPARATUS. EDWARD FUHRMANN CLARKE, OF BIRMINGHAM, ENGLAND.

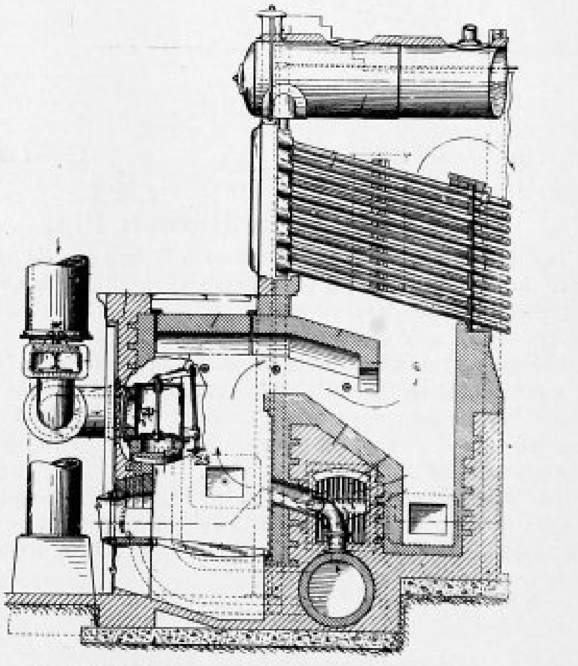
Claim 2.—The combination with a clock work mechanism for automatically closing a damper; of a governor for such mechanism operably connected thereto and comprising a fan, a volute casing surrounding said fan and having an inlet opening at one side, and a movable closure plate to open and close said inlet opening. Four claims.

1,076,342. LIQUID FUEL FURNACE. GUSTAV AYRES, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO JOHN C. CALHOUN, OF NEW YORK, N. Y.

Claim 1.—In a liquid fuel furnace, the combination of a pan burner having a longitudinal vertical partition to provide two independent fuel chambers, means for supplying a liquid fuel to said chambers, a conduit for directing air across the surface of the liquid fuel in set chambers, shiftable means for varying the extent of such liquid fuel surface exposed to the air, and means for independently controlling the fuel supply to either of said chambers. Eleven claims.

1,076,344. GAS-BURNING FURNACE. JOHN E. BELL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 4.—In a gas furnace, a combustion chamber having a hollow bridge wall extending the full length thereof, means for supplying air to each end of the bridge wall chamber, said chamber having openings leading forwardly into the combustion chamber, gas nozzles extending through the bridge wall chamber and projecting into said openings, and a refractory arch extending rearwardly from the furnace chamber over the bridge wall. Six claims.



1,074,300. STEAM SUPERHEATER. PETER THOMSEN, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, OF CASSEL, GERMANY, A CORPORATION OF GERMANY.

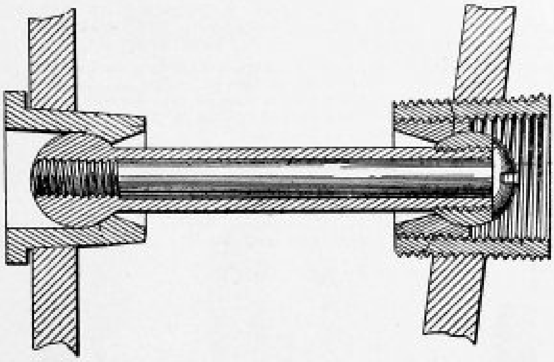
Claim 1.—In a smoke tube boiler, superheater pipes in some of the smoke tubes, steam supply means connecting the boiler to the superheater pipes, and a valve in said steam supply means adapted to be opened or closed as to the atmosphere. Seven claims.

1,074,536. SAFETY FEED-WATER CONTROLLER FOR BOILERS. FRED WALLACE AND FRED ERNST, OF EDEN, NEW YORK.

Claim 1.—A feed-water controller for steam boilers comprising a water-containing casing in communication with the boiler, a valve for controlling the feed of water to the boiler, a rod connected with the valve and movable vertically in the casing, said rod being adapted to drop by gravity to valve opening position, spaced contacts upon the rod, a main float slidable on the rod between said contacts and co-operating with the upper contact to lift the rod to valve closing position, locking means adapted to engage the lower contact to hold the valve rod in valve closing position and to be retracted to release the rod by the main float when the latter descends to a predetermined position, a second float mounted on the rod below the level of the main float, an electric circuit containing an alarm, and contacts included in said circuit and adapted to be connected by said second float to close the circuit when said second float descends to a predetermined degree.

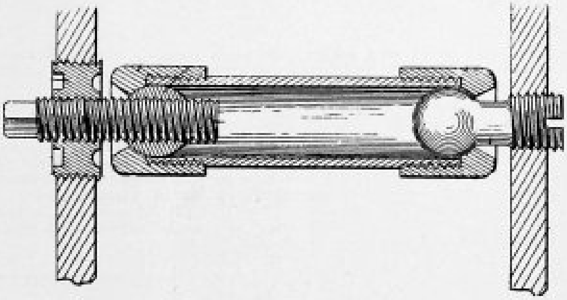
1,077,045. STAY-BOLT. ETHAN I. DODDS, OF CENTRAL VALLEY, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

Claim 1.—A stay-bolt comprising an outer section having an integral head, and an inner section provided at one end with a head and threaded at its opposite end, the threaded end of the inner section engaging female threads on the outer section. Five claims.



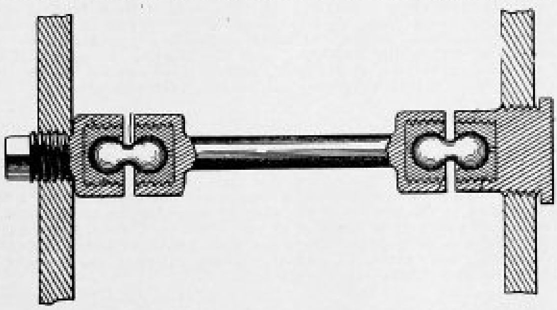
1,077,046. STAY-BOLT. ETHAN I. DODDS, OF CENTRAL VALLEY, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

Claim 1.—A stay-bolt consisting of a hollow shank having a concave seat at each end, the seats being made separate from the shank, and connectors having spherical heads, the latter being within the hollow shank and resting against the concave seats. Three claims.



1,077,054. STAY-BOLT. ETHAN I. DODDS, OF CENTRAL VALLEY, NEW YORK, ASSIGNOR, TO MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

Claim 1.—A stay-bolt, a connector for the same, and dumbbell-shaped link connecting one end of said stay-bolt with said connector, whereby a universal joint is provided between the connector and the link and between the link and the bolt. Three claims.



1,076,142. DRAFT APPLIANCE FOR LOCOMOTIVES. CARL J. MELLIN, OF SCHENECTADY, NEW YORK.

Claim 3.—The combination, with a locomotive boiler, of a fan shaft journaled in the smoke box door and having an air passage from the atmosphere to its inner end, a centrifugal fan secured thereon, a shield fixed to and spaced apart from the inner side of said fan, and means for rotating said fan. Eleven claims.

1,076,289. JOINT FOR LOCOMOTIVE EXHAUST PIPES. JOSHUA J. JONES, OF SCHENECTADY, NEW YORK.

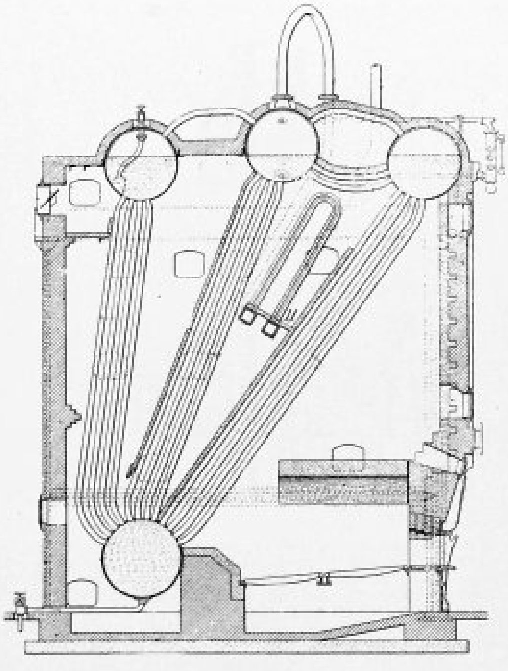
Claim 1.—The combination of a cylindrical thimble casing, which is open throughout the diameter of its bore at each end, and is adapted to be secured at its bottom to the inside of a locomotive smoke box, a lower exhaust pipe section fitting in said casing, with the provision of surrounding space for the reception of packing, and an upper exhaust pipe section secured detachably to, and constituting the entire upper closure of, the top of said casing. Seven claims.

1,076,315. SUPERHEATER. JOHN PRIMROSE, OF NEW YORK, N. Y.

Claim 4.—A superheater comprising separate inlet and outlet headers at the upper end thereof, a plurality of distributing headers at the lower end thereof, superheating elements for connecting the inlet header with one of said distributing headers and for connecting the outlet header with another of said distributing headers, and superheating elements connecting said distributing headers. Six claims.

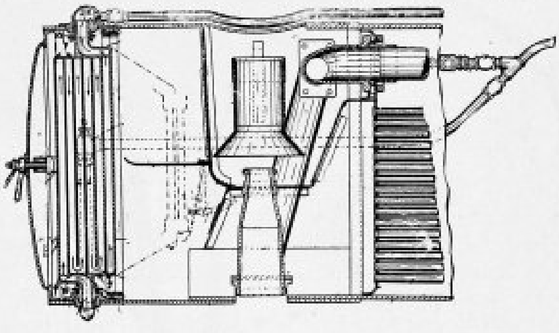
1,077,117. SUPERHEATER BOILER. JOHN E. BELL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 5.—The combination with a water tube boiler of the general Stirling type having a triangular space between the first and second banks, of an inverted U-tube superheater located in the upper portion of said triangular space, and having headers extending across from side wall to side wall and exposed to the products of combustion. Seven claims.



1,078,026. FEED-WATER HEATER. DAVID T. WILLIAMS, OF PATERSON, N. J., ASSIGNOR OF ONE-HALF TO FRANK L. CONNABLE, OF WILMINGTON, DEL.

Claim 1.—In combination, with a smoke-box having an opening in the outer end thereof, a feed-water heater pivotally arranged in the smoke-box and having its pivoting axis extending transversely of the smoke-box and substantially coincident with a line extending centrally through the heater. Nine claims.



1,078,187. STEAM BOILER. ALFRED CATCHPOLE, OF GENEVA, N. Y.

Claim 2.—In a steam boiler, the combination of a shell having heads on the opposite end thereof, a smoke box at each end of the boiler, a partition of water tubes extending horizontally across the smoke box at the rear end of the boiler, and a damper at one end of said partition. Eight claims.

1,077,047. STAY-BOLT. ETHAN I. DODDS, OF CENTRAL VALLEY, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

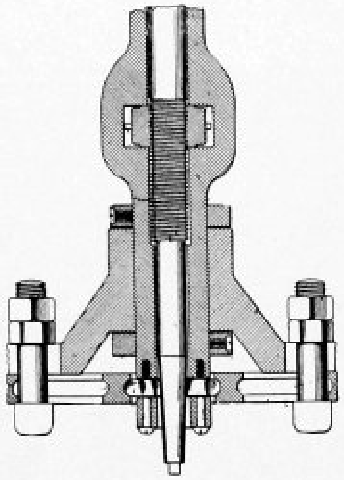
Claim 1.—A stay-bolt consisting of a bolt shank having a spherical head at each end thereof, threaded bushings on said shank, each bushing having a concave seat for a head, and connectors having threaded angagements with said bushings, one of said connectors having a closed outer end and a threaded shank integral with said closed end. Three claims.

1,077,975. FIREBOX STAY BOLT FOR LOCOMOTIVE AND OTHER BOILERS. ETHAN I. DODDS, OF CENTRAL VALLEY, N. Y., ASSIGNOR TO KERNER MANUFACTURING COMPANY, OF PITTSBURG, PA., A CORPORATION OF PENNSYLVANIA.

Claim 1.—A stay bolt having a body portion, a screw threaded connected member at each end, and a cast metal portion between each connecting member and the body portion for connecting the body portion to the connecting members. Four claims.

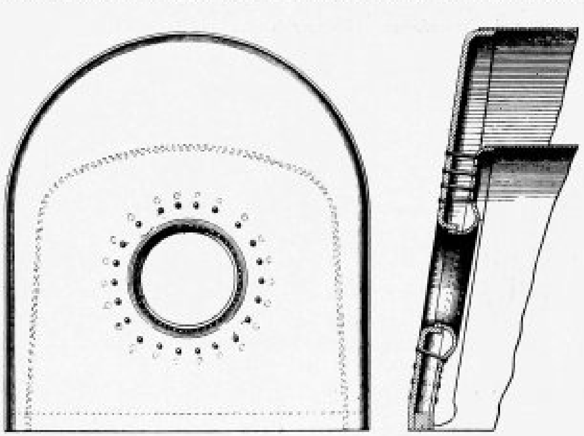
1,078,615. JOINING APPARATUS FOR BOILER TUBES. SAMUEL AUSTIN DUGAN, OF GORGONA, CANAL ZONE.

Claim 1.—Joining apparatus for boiler tubes, comprising a hollow shaft, radially extensible cutters carried by said shaft, a spindle mounted in said hollow shaft and having a tapered section to engage the inner ends of said cutters and move the same outward, said spindle having screw threads thereon, an adjusting nut carried by said spindle and engaging said threads and located in a recess in said hollow shaft to control the position of said spindle with respect to the said shaft to move the cutters outward, and means for mounting said shaft in operative relation with respect to a perforated tube sheet, whereby when the shaft is turned a groove can be cut in the walls of the perforations of said tube sheet. Three claims.



1,078,216. STEAM BOILER. EDWARD W. PRATT, OF CHICAGO, ILL., ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO HIMSELF, AND TO MICHAEL O'CONNOR, OF MISSOURI VALLEY, IOWA, TRUSTEES.

Claim.—In a boiler, a firebox comprising spaced sheets having a door opening therethrough, each of said sheets having a flange formed around its door opening, said flanges being fastened together, the inner or door sheet being swelled around its door opening, and stay bolts connecting said sheets, said stay bolts being connected to the outer sheet nearer the door opening than they are to the inner sheet, and being connected to the inner sheet approximately at the base of said swelling, and whereby they spread apart in a direction considered toward the inner sheet. One claim.



1,077,203. FURNACE FOR STEAM GENERATORS. JACOB RAMACHER, OF DELLBRUCK, BEZ., COLOGNE, GERMANY, ASSIGNOR TO WALTER GARTNER, OF HAMBURG, GERMANY.

Claim.—In a furnace for steam generators, the combination of a fire grate, a combustion chamber, fuel supply passages at opposite sides of the grate, a refractory partition forming one wall of each fuel passage and having therein two chambers, one situated close to the outer face of the partition and extending through the end wall of the furnace and the other situated between and communicating with both said air inlet chamber and the combustion chamber, whereby excessive heating of the wall of the fuel passage formed by said partition will be prevented by the cool air within the inlet chamber and heated air will be supplied to the combustion chamber, and additional air supply conduits arranged to supply air to the fuel on either side of the grate. One claim.

1,078,583. PROCESS OF HARDENING COPPER BOILER TUBES. PHILIP D. JOHNSON, OF CHICAGO, ILL.

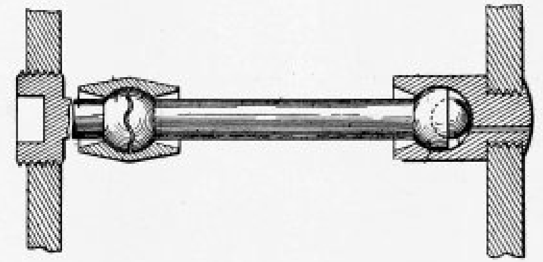
Claim 1.—The process of restoring burned boiler tubes which consists in expanding the ends of the burned tubes to make tight joints in the heads of the boiler, collapsing the burned tubes by the application of pressure in the boiler, and restoring the tubes to circular cross-section and hardening them by means of a rotating spinning tool passing through them. Two claims.

1,079,224. STAY BOLT. ETHAN I. DODDS, OF CENTRAL VALLEY, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 3.—The combination of a member having a ball-shaped head, a recess in said head to one side of the long axis of the member, a second member having a socket with a curved seat for the head and a key carried by said second member and resting in the recess in the ball-shaped head. Five claims.

1,079,223. STAY BOLT. ETHAN I. DODDS, OF CENTRAL VALLEY, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

Claim 1.—The combination of a member having a ball-shaped socket therein, a member loose within said socket and a third member having an enlarged end to fit said socket, the loose member closely fitting a recess in said enlarged end and bearing against said socket. Two claims.



1,078,803. BOILER FURNACE. AUGUSTIN NORMAND, OF LE HAVRE, FRANCE.

Claim.—An oil burner adapted to be used in connection with furnaces, comprising an atomizer, a sleeve-like air supplying nipple cooperating with said atomizer adapted to communicate with the interior of a furnace, adjustable shutters at the point of communication, a casing inclosing the nipple and the ejector end of the atomizer, adjustable means in said casing for admitting air to the nipple, and means for operating the said shutters. One claim.

1,078,935. FIREBOX. JAMES M. M'CLELLON, OF EVERETT, MASS.

Claim 3.—In a firebox, the combination of a series of upright wall sections comprising outer and inner channels having flanges secured together, the flanges of said inner channels being extended to provide flattened contacting walls for the sections, said flattened walls being apertured and nippled together to permit circulation from one section to another. Twenty-two claims.

1,076,362. FLUE CLEANER FOR STEAM BOILERS. CHARLES W. HAMILTON, OF BAKERSFIELD, CALIFORNIA.

Claim 1.—A flue cleaner for boilers comprising a fluid feeding conduit, a nozzle adjustable angularly thereon and arranged in open communication therewith, a controlling lever at the intake end of the conduit and a rod connecting the lever with the nozzle, the said conduit having an opening therein at one side, and a valve carried by the rod and movable over the said opening on longitudinal adjustments of the rod. Three claims.

1,076,410. COMBINED CONDENSER AND FEED WATER HEATER. MARTIN L. DUNNAM, OF MERIDIAN, MISSISSIPPI.

Claim 1.—A combined condenser and feed water heater, comprising a casing closed at each end, a heating chamber thereunder having a flue passing one end of the casing, a plurality of pipes in the casing leading from the air at one end to the flue at the other end, drip plates below the pipe, troughs at each side to catch the drip, means to admit the water to be vaporized, and means to lead the condensation in the troughs to the boilers. Four claims.

1,076,428. FURNACE FRONT. JAMES HOWDEN HUME, OF GLASGOW, SCOTLAND.

Claim 1.—In a furnace front, in combination, a furnace door hinged on a horizontal axis, a lever provideed with an extension adapted to be moved toward and from the door, air supply valves, connections between said valves and said lever for imparting closing movement to the valves on movement of said lever in one direction, a balance weight tending to open the door and means operable by said lever serving in one position of the lever to lock the balance weight and thereby also lock the door. Nine claims.

1,076,869. FLUE CLEANER. JOHN PERCIVAL CULLON, OF TORONTO, CANADA.

Claim 1.—In a flue cleaner a series of cutting blades arranged end to end in circumferentially and curved eccentric form, said blades being wider at one end and tapering to V-shape at the opposite end thereof and a support for said blades. Two claims.

THE BOILER MAKER

FEBRUARY, 1914

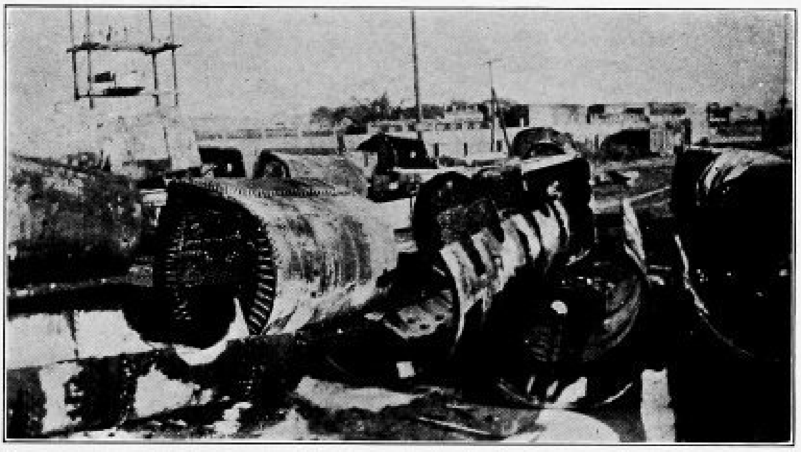
Oxy-Acetylene Cutting in Boiler Work

Eighty-six Boilers, Aggregating Nearly Two Thousand Tons of Metal, Cut into Scrap in a Single Shop—The Cost of the Work

BY C. E. LESTER

The rapidity with which the oxy-acetylene process has gained foothold in boiler work is barely short of marvelous, yet the merits of the process fully justify the esteem in which it is held for all sorts of welding and cutting.

It is but about five years ago that the writer first ventured into the field and was one of the first to successfully weld firebox patches. In the very short space of time between then and now the progress has been rapid and sure. In fact, at that time, while patches with one or two free ends were generally welded successfully, barely 20 percent of the enclosed patches, or patches that required welding on all sides, were successfully welded. At the present time, however, technical papers devoted to the several branches of mechanics publish many articles describing difficult jobs. The jobs that five years ago were deemed impossible are now performed without much difficulty.



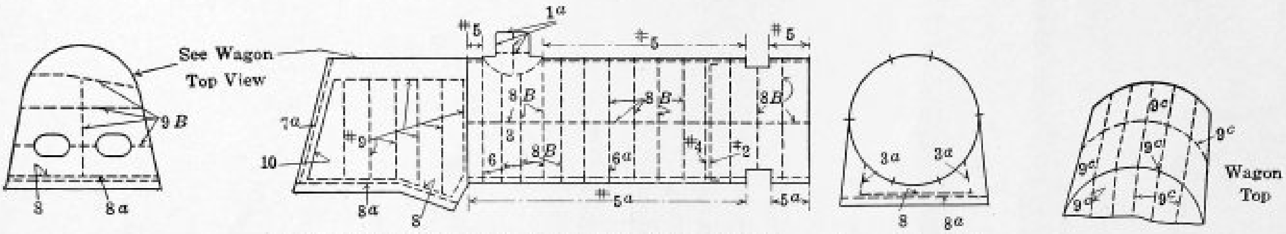
Collection of Old Boilers Stripped for the Scrap Heap

This paper is merely to illustrate one of the commonest uses of the blow-pipe, yet the job is rather unique, in the fact that 86 boilers with an aggregate weight of about 1,950 tons are being cut up into pieces 18 inches by 56 inches, to enable them to be placed into a charging furnace preparatory to being reconverted into new steel. The writer believes this job to be the largest job of cutting up boilers ever undertaken.

The boilers were taken from locomotives that are being converted into the Mikado type with Schmidt superheaters. While the boilers are 84 inches in diameter, and have 460 flues and are comparatively of modern construction, the recent strides in the economic use of steam prohibit their use from an economic standpoint, and they give way to boilers of more modern construction. The work was started about the middle of October, and due to the lack of storage room and due to the fact that winters start early and are severe, and that an oxy-acetylene generator freezes up easily, it was necessary that no great amount of time be lost.

The outfit consists of a 100-pound carbide feed oxy-acetylene generator, using ⅜-inch by 1¼-inch lump carbide; this carbide gives a better yield of gas than smaller sizes, averaging better than 4½ square feet of gas to 1 pound of carbide. Pure carbide gives 5½ cubic feet per pound at atmospheric pressure. The generator is not of the "portable type," yet to hurry the work and to increase the facility with which it could be handled the generator was mounted on a four-wheel track truck. This can easily be shoved from place to place in the yard. A tool box has been mounted on it, and racks made that will carry six tubes of oxygen. There are three cutting torches in the outfit, yet, due to the delicacy of some of the apparatus and the regularity with which the regulators and indicators get out of order, one torch has been out of commission most of the time.

It might be added here that the cleverness of the manufacturers in adopting mongrel threads and unusual methods in the manufacture of the several parts gives them a good source of revenue and prohibits users from manufacturing



Figures Showing Length of Time and Cost of Cutting up Locomotive Boiler

(Location of Cuts Shown on Drawing)

Cut No.	Location.	Oxygen.	Time.	Cost† Acetylene.	Cost‡ Oxygen.	Cost* Time on Cut.	Total Cost of Cut
1	Cut Out Dome	48	18	.0960	$0.840	.18	$1.1160
1A	Cut Dome in 4 quarters and around body	144	62	.2880	2.520	.62	3.4280
6	Shell around Throat, 6-1⅛" braces; Sheet, etc., including 8-1¼" Stays	88	52	.1760	1.540	.52	2.2360
5	Cut Shell on Top-Longitudinal	54	25	.1080	.945	.25	1.3030
5A	Cut Shell on Bottom-Longitudinal	84	29	.1680	1.470	.29	1.9280
2	Cut Out Front Flue Sheet	40	26	.0800	.700	.26	1.0400
3	Cut Out Back Flue Sheet	40	20	.0800	.700	.20	.9800
3A	Cut Throat Sheet in and out	44	36	.0880	.770	.36	1.2180
6A	Cut around Shell	40	20	.0800	.700	.20	.9800
4	Cut around Shell Front	52	27	.1040	.910	.27	1.2840
	Cut out 18 Braces 1⅛" diam., front	22	9	.040	.385	.09	.5150
8	Cut around Mud Ring—inside	76"	36	.152	1.330	.36	1.8420
8A	Cut around Mud Ring—out side	48"	30	.096	.840	.30	1.2360
8B	Cut Shell into Charg. Box sizes, 18"x56"	1,024	6 hr. 32 min.	2.048	17.920	3.63	23.5980
7A	Around outside of Back Head	24	18	.064	.420	.18	.6640
9	Cutting Side Sheets into Charg. box sizes	218	3 hrs. 14 min.	.4360	3.815	1.94	6.1910
9B	Inside and outside Back Head, Charg. box sizes	157					
9C	Wagon Top, into Ch. box sizes, 13-1¼" Cross		1 hr. 57 min.	.3136	2.747	1.17	4.2306
	Braces	211	2 hrs. 30 min.	.4220	3.692	1.50	5.6140
10	Around inside Back Head	20	10 min.	.0400	.350	.10	.4900
	Total	2,434 cu. ft.	20 hrs. 42 min.	$4.8796	42.594	$12.42	$59.8936

* Time is figured sixty cents an hour for operator. † @ .008 a cubic foot. ‡ @ .0175 a cubic foot.

repair parts without going to the trouble and expense of making special lathe gears and other expensive changes.

After cutting up several boilers completely in the yard, it was decided in order to let the work progress on through the winter that the boilers be cut in as few parts as possible to let the locomotive crane pick the pieces up and place them inside the shop. These cuts consist of cutting out the dome, separating the shell from the firebox end, cutting off the mud-ring, cutting out the front flue sheet and splitting the shell from end to end. None of these pieces exceeds 8 tons in weight, so that the crane can handle them readily after they are wedged apart.

The cutting amounts to about 160 lineal feet through plates varying from ⅜ inch to 2½ inches in thickness. The 2½ inches is through the smoke-box rings and through the dome flange shell and reinforcement plate. The hardest cutting is through the smoke-box liner and sheet, which are never well laid up and have scale between them, often calling for high-pressure cutting or cutting from both sides.

To those who follow written instructions literally, it may be said that there is frequently, if not generally, no economy in trying to use just the pressures that the manufacturers' prescribe. The pressures advocated are the lowest pressure at which clean plate can be cut, and with conditions, if not ideal, very nearly so. As a rule such cutting is not often encountered. If the manufacturers advocate, say, 30 pounds for ¾-inch plate, it is safe to say that the operator will find 40 or 45 pounds makes a cleaner "Kerf," and cutting can be done enough faster to compensate for the increase in oxygen, and the cut will not require wedging apart.

The above-mentioned cutting includes, quite naturally, the belly and front flue sheet braces, and such of the back-head braces as extend beyond the casing sheet out into the shell.

The entire operation can be done in about three hours by two cutters of ordinary ability at a cost of about $12.50 for labor and gases. This includes the cost of helpers who scale the boiler, charge the generator tanks, etc.

It may be well to mention that it is simply a waste of time and valuable gases to try to cut dirty materials. Heavy scale and dirt should be broken loose with a sledge, and the surface, when both sides of it can be reached, be thoroughly scrubbed with a wire brush. The fact that the heating flame has a temperature of about 6,300 degrees F. does not signify that it will cut or burn scale, for it will not. Boiler scale contains, as a rule, quite an amount of magnesium carbonate ($MgCO_3$). This mineral salt is the basis of boiler lagging being a non-conductor of heat, and quite naturally the oxy-acetylene flame cannot do much with it.

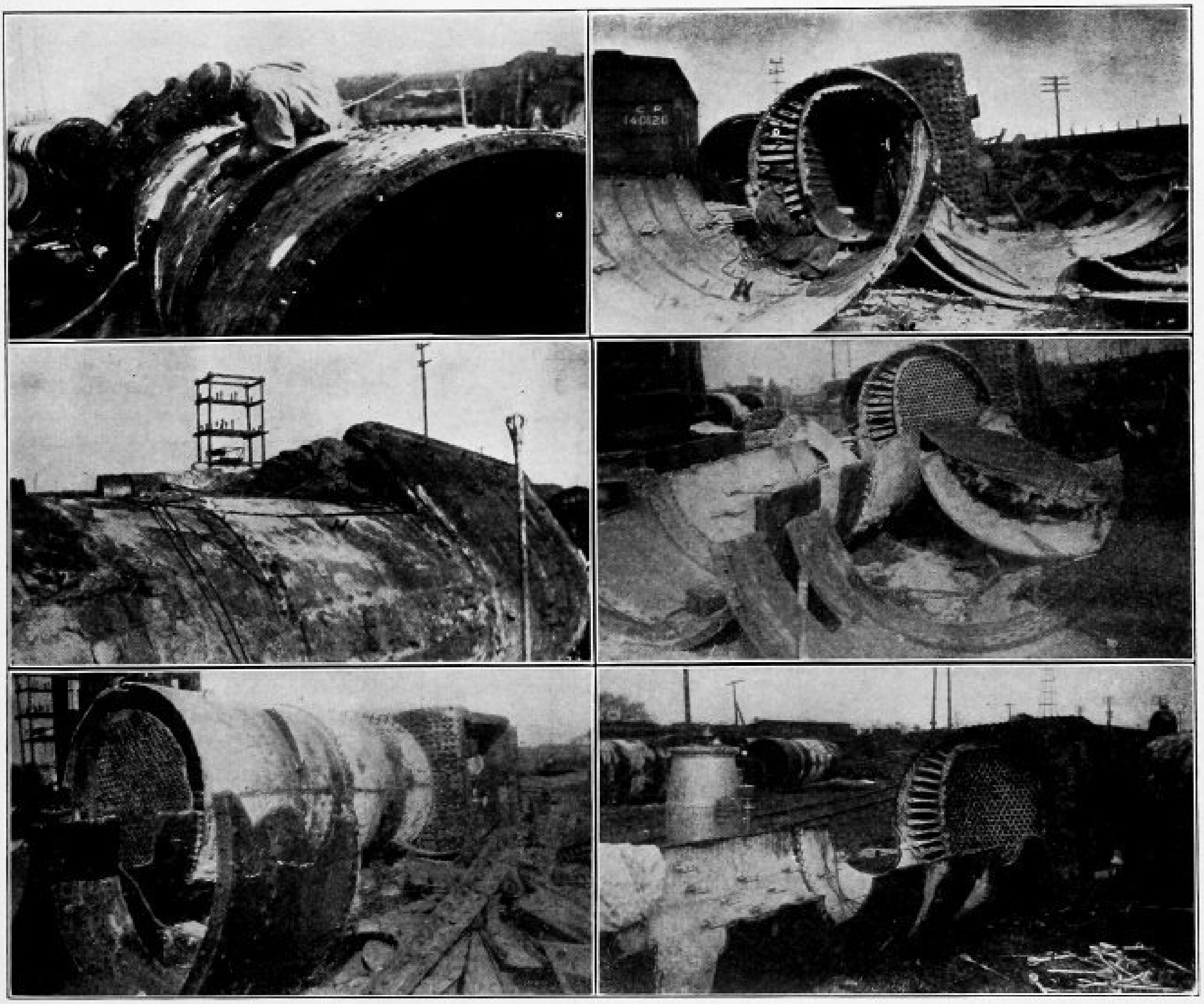
It has been the rule on this work so far to use two helpers. One of these is kept busy on the interior of the shell, shoveling out loose scale, cleaning the surface to be cut and getting pins and keys out of braces wherever possible.

The diagram showing all cuts in detail was worked up from data obtained in timing an expert cutter. It is hardly to be expected that ordinary workmen can do as well as this, although the leading operator now on the job, with only six weeks' experience, is using but about 5 percent more oxygen and 8 percent greater time.

It will be noted that the time given on the diagram shows "actual cutting time," and not the total time the operator was on the job. In fact, the "actual cutting time" was spread over a period of about three and one-half days. This does not signify that the operator was idle when not cutting. There are many other things to do. The generator requires recharging, tips have to be changed, oxygen tanks have to be changed, moving about from cut to cut and boiler to boiler. Other than these there are the innumerable little necessary and unnecessary things that happen in a day's work.

The entire cost of cutting up a boiler complete into charging furnace sizes (18 inches by 56 inches) will average between $80 and $90. The position the boiler lies in and the amount of scale adhering to inaccessible portions of the plates have a definite relationship to the cost. The cost may be divided approximately as follows: Oxygen, 55 percent; acetylene, 6 percent; operator's time, 8 percent; helper's, 5 percent, and the remainder may be charged to the locomotive crane that picks the pieces apart, turns sections over, etc., at a cost of about $0.75 per hour. The illustrations show the work in different stages of progress.

As a point of information to users and prospective users of oxygen, it may be said that it is good policy to check tanks of oxygen for shortage. While the manufacturers no doubt intend that all tanks shall contain the amount agreed upon by the contracting parties, carelessness on the part of employees allows tanks to go out leaking or some few pounds short of the prescribed amount. The writer recalls distinctly a time when he checked seventy tanks after shortage had been claimed with a representative of the company supplying the oxygen, and found but three full tanks in the entire number, the shortage aggregating some 420 feet, or four and one-fifth tanks, with a monetary value of about $7.35. This is enough oxygen to cut 240 feet of ⅜-inch plate. A very good plan is to have a hydrostatic gage, of any standard make, with a capacity of about 2,500 pounds, for checking tanks for shortage and for regulating gages. The gage should be fitted with three or four checks in the inlet to retard the flow of oxygen, so that the mechanism of the gage may not be injured by taking high-pressure too rapidly. Impure oxygen is a prolific source of trouble, and it is something that usually has to be borne in silence, as it can hardly be tested outside of the laboratory, although moisture is easily detected, and the tank should be rejected, for it is but a waste of time and money trying to use it.



Various Stages in Cutting Apart a Locomotive Boiler

AIR BRAKE TESTS, PENNSYLVANIA RAILROAD.—Important improvements in the braking of heavy passenger cars were described in a paper read before the American Society of Mechanical Engineers, New York, Feb. 10, by Mr. S. W. Dudley, of Pittsburg. These tests were conducted jointly by the Pennsylvania Railroad and the Westinghouse Air Brake Company. The results are considered the most important recent contribution to the subject of air brakes.

A train of twelve steel cars at 60 miles per hour stores up 224,000,000-foot pounds of energy. This is sufficient to raise the entire train 120 feet. With prevailing brake equipment such a train would be stopped by an emergency application in a distance of 1,600 to 2,200 feet, according to the truck rigging and brake-shoe design. These tests showed that this distance has actually been reduced to 1,000 feet, or to within the length of the train. This was the result of improvements in the truck-brake design, involving the clasp brake, having two shoes per wheel, and the location of the brake-shoes with reference to the horizontal center line of the wheels, in addition to improved methods of applying the air brakes quickly and simultaneously and at a high pressure. This concerns safety.

These tests emphasized, as has never been done before, the possibilities of improvement in efficiency and economy in regular service operation by proper attention to design and installation in order to permit the realization of the flexibility of improved air-brake apparatus.

Oxy-Acetylene Welding of Boilers

Extent to Which Oxy-Acetylene Welding can be Used With Safety on Steam Boilers—Welds Allowed by Boiler Inspectors

BY HENRY CAVE*

In the August, 1913, number of THE BOILER MAKER, on page 265, the writer contributed an article entitled "The Repair and Manufacture of Steam Boilers by Autogenous Welding," in which was emphasized the necessity for care in carrying out welds on boilers, particularly on vital parts (generally considered to be those under tension strains). In this article it was recommended that both the equipment, the operator and the concern carrying out the welding should be licensed for work of this nature, after being thoroughly examined as to their capabilities, under what was termed the "three-license system," which the writer considers would allow for the development of the oxy-acetylene process to its limit of usefulness, by doing away with the restrictions imposed at the present time by inspection authorities, but at the same time protecting all concerned.

The present article is a discussion of the class of work that can be carried out at the present time on boilers subject to the control of inspection authorities, and as such the work described therein should also be considered to be the limit of work that it is safe to carry out at the present time on boilers not subject to such inspection control, on the grounds that the inspection authorities have thoroughly studied the matter under present conditions at the present time, and their ruling is undoubtedly a safe one.

The slogan of the majority of industrial concerns at the present time is "Safety First." It should be borne in mind that even though the inspection authorities allow such work as is listed below to be carried out, it should be insisted that the best welding that can be carried out—with the equipment that can make the strongest welds, by the concern that knows the most about that class of work—is by far the cheapest in the end. Although it may not be a question of safety, there is always the possibility of the work carried out with the inefficient equipment breaking out, due to the breathing of the boiler or other causes, within a short time. There is also the possibility that the unskilled operator, even with the best equipment, may not be able to make a successful job, and may damage the boiler to such an extent as to make its repair by other means, if possible, a very expensive proposition. Furthermore, even though the equipment can make a strong weld, and the operator is skilled in the operation of the torch, either the operator or some one connected with the welding concern should have a sufficient knowledge of the structure of boilers to determine the best method of carrying out the work, and where the opinion of the inspector is not available, whether the job is one that should be carried out by welding or not.

Owing to the conditions under which locomotives are operated, the repairs to boilers of this nature do not come within the scope of this article, which is therefore confined to marine and stationary boilers.

It is not necessary to enumerate here the regulations of the inspection authorities, as these can readily be obtained by reference to books of rules and regulations published by them. It is sufficient to say that all these regulations, in a general way, prohibit the oxy-acetylene welding of any part of a boiler not in compression or not stayed, except such work as the reinforcing and correcting of defects on riveted seams, providing the weld does not in any way take the place of the rivets, therefore allowing the welding of parts in compression, parts stayed and such welds as are neither in tension nor compression, but merely to make a tight joint, frequently with the proviso that flexure should not come on the weld. In some cases restrictions are placed on the amount and extent of the work that can be carried out.

To illustrate the different welds that come under this heading, Fig. 1 shows a small vertical multitubular boiler on which representative welds are made, the boiler then being cut in half by means of the oxygen-cutting torch, so as to show these welds in the best possible manner.

The welds are framed with an outline of white paint, leaving the metal in the neighborhood of the weld in the condition it was in after the work was completed, so that the effect on the metal can be observed. Wire rings were welded on close to the weld, to which were attached ribbons running to cards describing the work. Commencing at the upper right-hand card: (1) This ribbon indicates the welding of a vertical crack in the firebox sheet; the next ribbon (2) shows a defective spot in the plate of the firebox, which was entirely removed and a new piece inserted, the sectional cut of the boiler passing right through the center of this piece, thus giving a section of the weld; (3) a circumferential crack in the firebox is also welded, this also being divided by the section of the boiler.

Commencing at the bottom card on the left-hand side and reading up, the first ribbon (4) indicates the removing of the heavy cast iron or steel door frame, which in the case of cast iron frequently cracks and are difficult to repair in any other way than the one shown. The steel frames, owing to the unequal heat conditions, cause considerable trouble at the calking edge and rivets. In this case a plate frame is welded in, thus doing away entirely with the calked seams and rivets, and owing to the fact that the water is in contact with all parts of the plate, it eliminates the numerous troubles which result from the heavy frame.

The next card (5) indicates the thickening up of a thin section of the firebox where corroded away. A very large amount of this work has been carried out successfully, having been in constant use and carefully observed for several years in boilers where 8 or 10 square feet have been built up from ¼ to ⅜ inch. This method of repair costs less than putting in patches by ordinary boiler makers' methods, and as patches of this sort in the neighborhood of the fire are liable to give constant trouble, and assuredly must increase the troubles of the boiler owing to the increase in length of riveted and calked seams, it is generally more satisfactory in a general way to build up the plate sooner than weld in a patch, which frequently is complicated by the necessity of riveting to the mud-ring or the vertical seam.

The next ribbon (6) shows the welding of cracks between rivet holes in the vertical seam of the firebox. This work, together with welding of cracks from the rivet holes (8) in the seam, and also in the girth seam of horizontal return tubular boilers, probably being the most extensive work that is carried out on stationary boilers, and proves exceptionally satisfactory, particularly as there is really no satisfactory boiler makers' method of taking care of this trouble. Different authorities recommend various methods of carrying out this work, in some cases removing the rivets entirely and

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* President of the Cave Welding Company, Springfield, Mass.

welding up the holes, which are then redrilled and a new rivet put in, and in other cases welding up the head of the rivet.

The next card (7) shows the welding up of a handhole by inserting a plate through the handhole and building on metal in the angle produced by the thickness of the plate, together with the patch, so as to make a tight joint. This work can obviously be carried out on surfaces that are in tension, providing the section of metal of the plate in the neighborhood is sufficient to carry the strain, as the pressure would then hold the patch in place, the welding merely being a means of making it tight and withstanding such slight strains as are imposed by the "breathing" of the plate and by expansion and contraction.

Handholes which are cut with the object of tightening up rivets or for other work can be closed in this way instead of using the usual handhole cover and yoke, thus insuring against any possible leakage of the packing and improving the appearance of the boiler, as this handhole would then not show through the boiler covering.

The next card (8) indicates the welding of fire cracks in the vertical seam of the firebox from the rivet hole to the edge. This has been already described.

The next ribbon (9) indicates the safe ending of the flue tubes, a new piece of tube having been welded to the end of the old one, the weld being hammered, so there is no projection on the outside that would interfere with inserting the tube through the tube plate. This oxy-acetylene process is particularly well adapted to this work owing to the fact that it can be carried out at the point where the boiler is located, the tubes being put right back into service, as the equipment is so readily portable as to bear very favorable comparison with any other methods of tube welding.

The next card (10) indicates the reducing of the size of a handhole where, due to corrosion, it has become necessary to enlarge it to the limit, and further corrosion has taken place. It should be understood that the repairs shown on this illustration are not necessarily in their correct places, being made in these positions for convenience of illustration. This repair generally takes place on the back end of a horizontal return tubular boiler at the handhole below the tubes. This hole frequently has to be enlarged, due to corrosion caused by leakage of the handhole cover, and the extent to which the hole can be enlarged is very limited, owing to the fact that in one direction the tube plate flange and the shell of the boiler will be approached and in other directions tube holes will prevent the enlargement. Owing to the small amount of metal it is absolutely impossible to rivet in a patch, and therefore in cases where the hole has been enlarged to the limit of safety, and still further corrosion has taken place, the most feasible method of repair is the insertion of a plate described above, the original size handhole being cut in the plate before welding in. This repair, at small cost, does away with the necessity of putting a new tube plate into the boiler, and is frequently the cause of the saving of the boiler, as in a large nnumber of cases when this occurs the rest of the boiler would hardly be in the condition to warrant the large expenditure for a new tube plate.

This defect is sometimes accompanied by the welding of cracks in the sheet, in which case immediate steps have to be taken, and with this means of repair a very large saving is frequently made, as the shutting down of the boiler, due to this crack, for the time necessary to repair it by other means is attended with great loss to the user whether the boiler is used to supply steam for power or heating purposes.

The next repair (11) is that of a tube plate bridge. This probably represents the largest possible saving that can be made in the shortest possible time by the process, as the welding of two[*] sections less than an inch in length and the thickness of the tube plate by this means may result in doing away with the necessity of replacing the boiler, removing the boiler and replacing the tube plate and tubes with its attending delay and expense, and with the possibility that the boiler may not be worth this expenditure, thus necessitating the installing of a new boiler, which, owing to the progress in boiler design, generally necessitates other changes, as it is very seldom that the same type of boiler is purchased to replace the one thrown out.

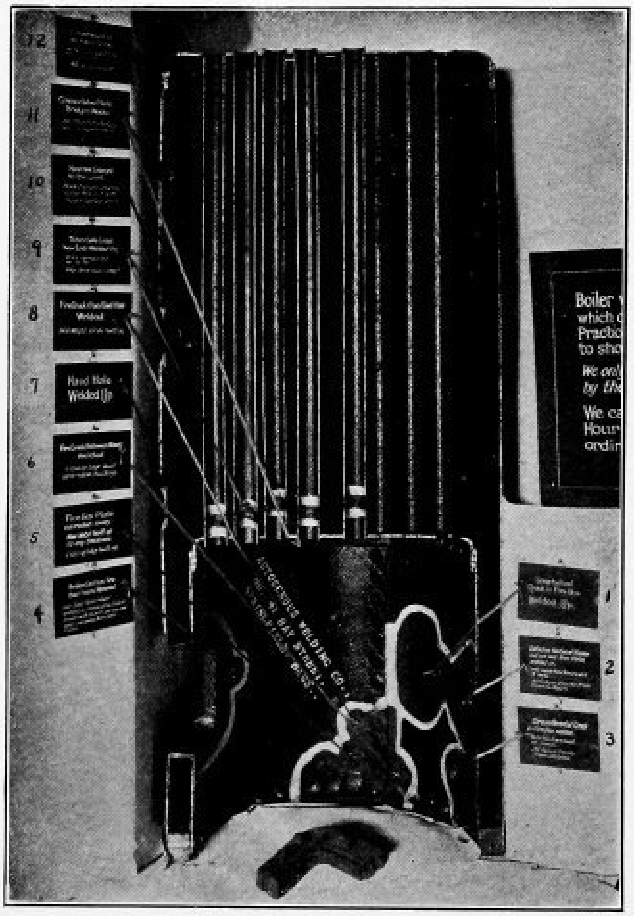

Fig. 1.—Typical Oxy-Acetylene Welds on a Boiler

The carrying out of this work, though the section is so small, should not be looked on too lightly, however, as, owing to the strains set up by the expanded tubes, and due to the construction of the plate, there is frequently considerable difficulty in making these welds owing to contraction strains drawing the weld apart again. The experienced operator, however, will be familiar with several methods of insuring success in this direction.

The upper ribbon (12) indicates a radial crack at the bend of the upper tube plate which has been welded. This repair not, however, being of very frequent occurrence. The welding of a circumferential crack in this same location is one that should be taken up with the inspector, as the advisability of welding it depends upon the reason for the crack, which, if from flexure, should not be welded.

The process can also be used in a number of places in connection with the manufacture of boilers, one of which is the welding together of a few inches at the end of the plate of the boiler shell where a butt-strap is used, thus insuring a tight joint at this point.

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[*] In speaking of the weld taking place in two of these ligaments or bridges, the writer had in mind the fact that the inspection authorities generally allow only one bridge to be repaired by boiler makers' methods of stitching, therefore if two are broken it becomes essential that they be taken care of in this way.

If desirable, tubes can be welded into the tube plate either in the course of manufacture or repair. This work can be done quite satisfactorily with this process if the proper methods are used, though, due to incorrect methods being attempted, the job has frequently fallen down.

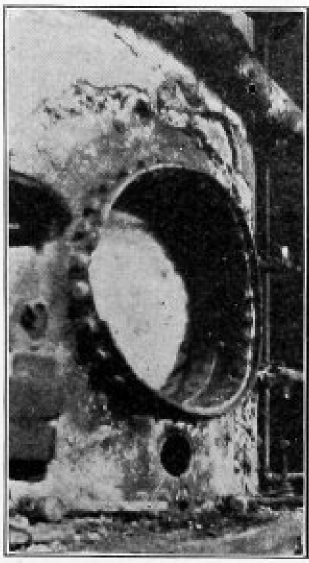

Fig. 2

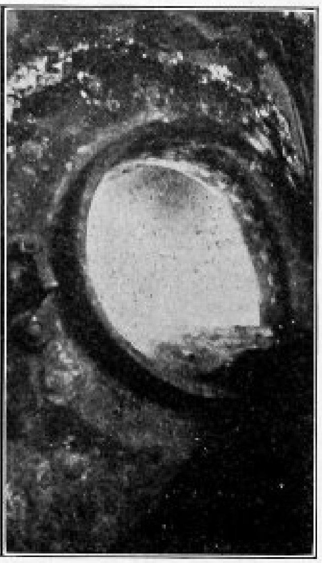

Fig. 3

It is advisable in all cases to obtain the sanction of the boiler inspectors to any work that it is desired to carry out, irrespective of its type. This is particularly necessary where the operator and those connected with the welding concern are not experienced boiler men.

A repair that very frequently comes up in connection with the fire-door frame, and differing somewhat from that already illustrated and described, is shown in Figs. 2 and 3. It will be seen that in Fig. 2 the flange of the fire-door frame is corroded away so that some of the rivets are exposed. Fig. 3 shows these welded up, the conditions of the flange being as good, if not better, than when the boiler was new. The work shown was carried out by the Cave Welding Company, of Boston and Springfield, with the Davis-Bournonville "Positive Mixture" torch.

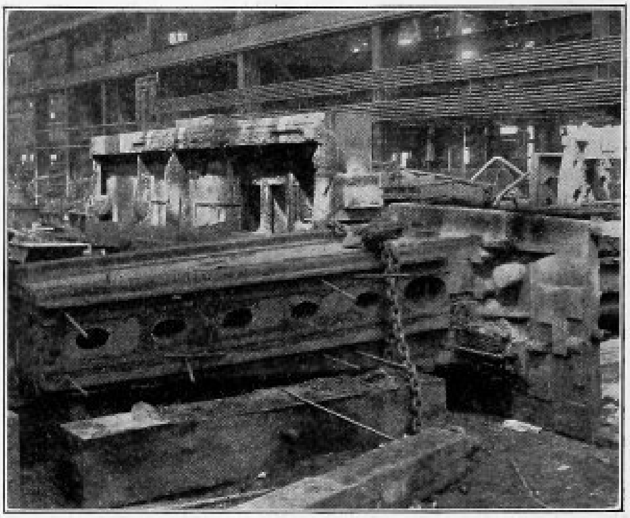

Fig. 1.—Welded Casting

The welding of riveted seams along the calking edge so as to make the plates solid is questioned by some authorities, as it is claimed there is some flexure in rivets, and this throws welds of this description into "shear," which is frequently increased by the rivets loosening with the heat of welding, this depending on the skill of the operator.

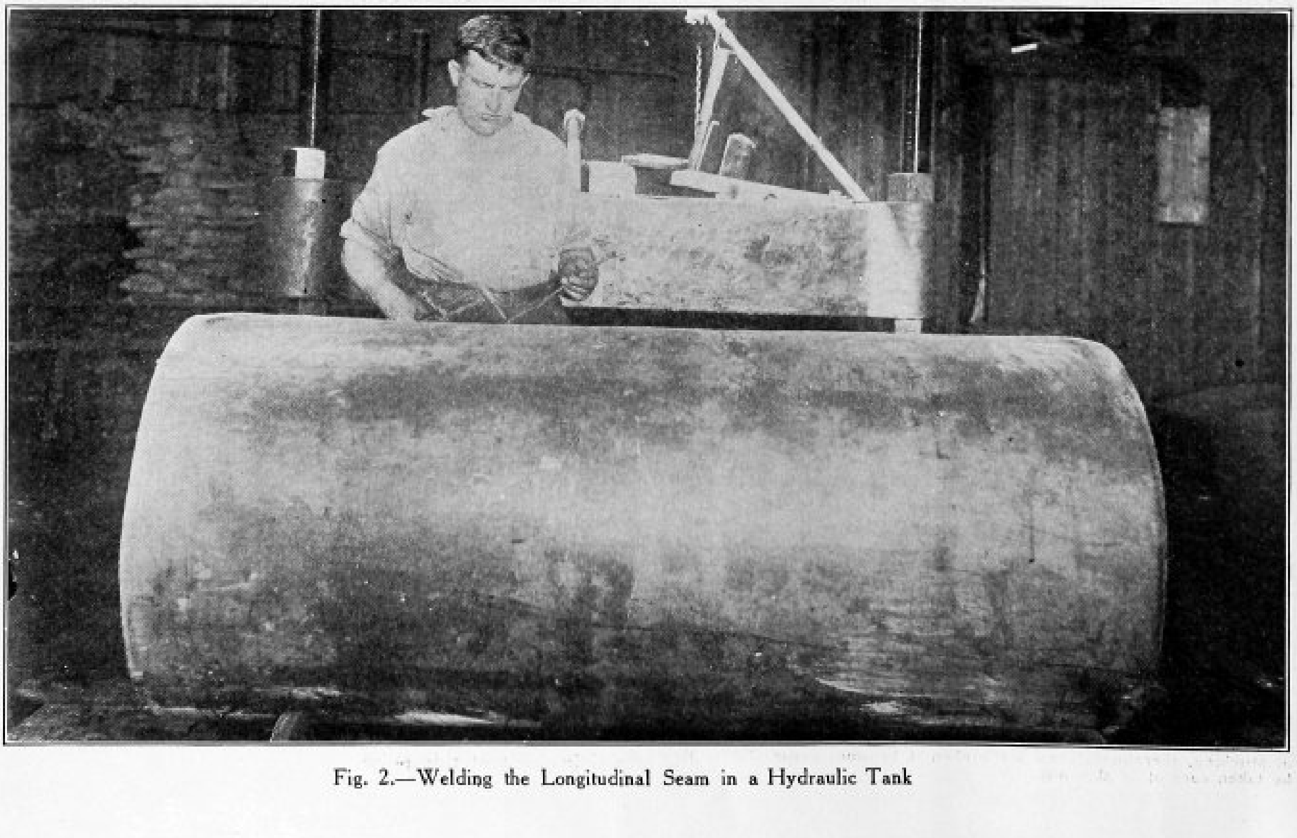

Fig. 2.—Welding the Longitudinal Seam in a Hydraulic Tank

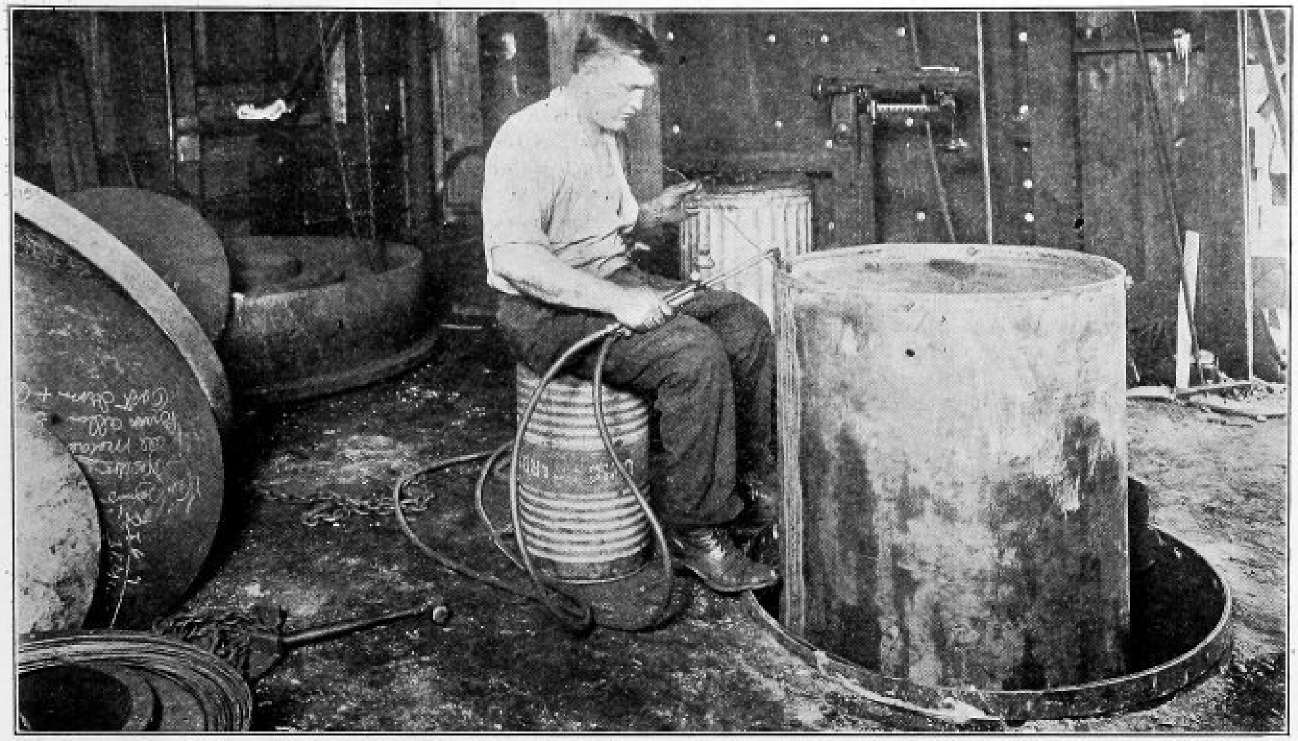

Fig. 3.—Welding Head of Tank to Shell

Some Results Obtained with Buckeye Oxy-Acetylene Apparatus

Fig. 1 shows a casting for a radial drill press which was welded in the shops of the Niles Tool Works, Hamilton, Ohio. This casting weighed 22,000 pounds, and on taking it out of the sand it was found that a part was missing, and that there was a shrinkage crack extending half the length of the base. The casting was pre-heated for about twelve hours, using charcoal and coke in a furnace built up of firebrick piled loosely around the casting, and the defective parts of the casting were welded by an operator and helper in thirteen hours. The cost of the work, including gas and labor, was $38.50. As the value of the casting was about $500, the saving due to the use of the welding apparatus is apparent, although the greatest saving effected was in the time saved. The work was done with a No. 3 Buckeye welding plant, manufactured by Walter Macleod & Company, Cincinnati, Ohio. Generators for making both oxygen and acetylene gases were carried from the repair shop and set up in the foundry where the welding was done.

Figs. 2 and 3 show the work of making up hydraulic tanks in the shops of the Tudor Boiler Works, Cincinnati, Ohio. The tanks are 72 inches long, 38 inches diameter, made of

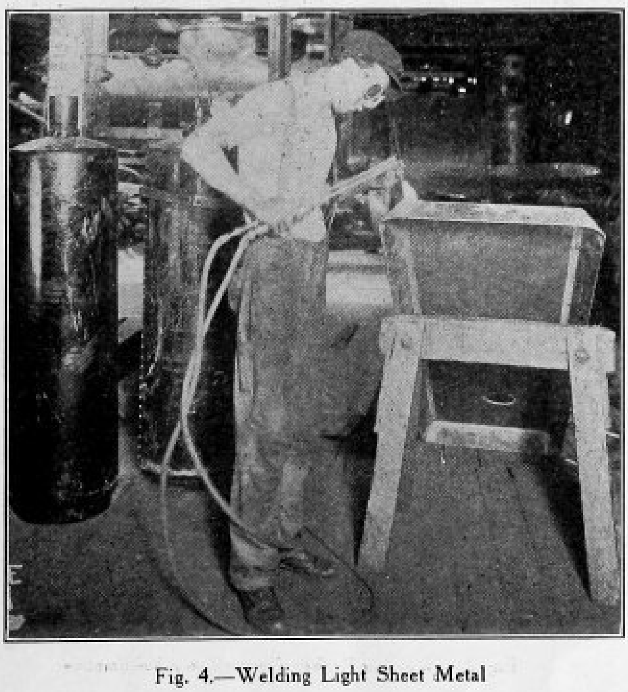

Fig. 4.—Welding Light Sheet Metal

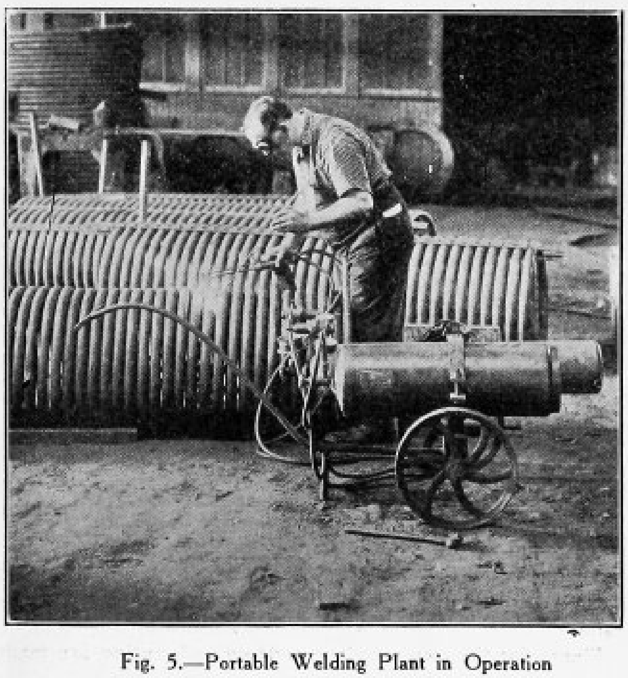

Fig. 5.—Portable Welding Plant in Operation

3/16-inch shell and 5/16 heads. They are used for water supply, and carry a working pressure of about 100 pounds, being tested at the time of manufacture to a pressure of 275 pounds per square inch. These welded tanks have been found more economical than riveted tanks, as no trouble is experienced with them on account of leaking after they have been shipped some distance by rail, while it has been found that with riveted tanks, owing to rough handling in shipment, the tanks were found in a leaky condition upon arrival at their destination.

The oxy-acetylene plant can be applied equally well to very light sheet metal work, as is shown in Fig. 4, where an operator is welding up steel lathe pans. The pans are made in two pieces, shaped and cut to size. The corners are welded first and then the two parts are welded across the bottom and finally up each flange. It is claimed that these welded sheet metal pans are more substantial than cast pans, and that they are much cheaper to construct.

In the work described above, stationary welding plants were employed, but many times it is advisable to use a portable plant in which either both of the gases are supplied compressed in cylinders, or one gas is supplied in this way and the other by means of a generator. Fig. 5 shows such a plant in use in the shops of the Columbus Iron Works, Columbus, Ga., making up worms for stills. Practically all of the pipe-bending companies have resorted to the use of the oxy-acetylene welding process for making up joints in coils, etc., as it has been proved to be of particular advantage for such work. Where the work is done nearby a station where compressed gas can be obtained, the use of a portable plant where both gases are supplied compressed in cylinders is very convenient, but it is usually much cheaper to use gas generated in the user's own generator.

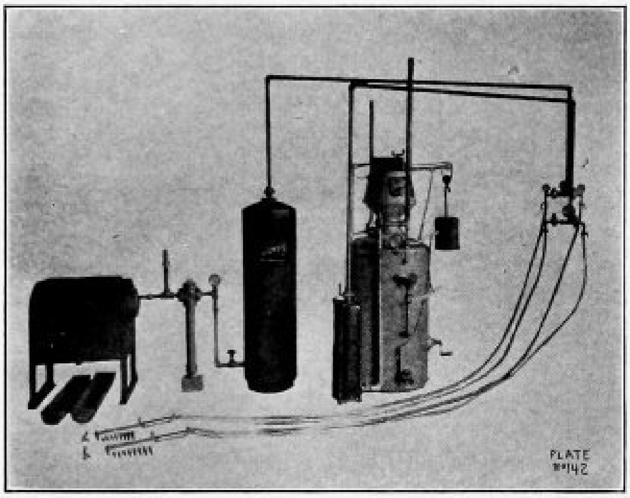

Fig. 6.—Buckeye Welding Outfit

In addition to the great number of uses the oxy-acetylene process has been put to in repairing and manufacturing, the cutting of iron and steel by this means has proved one of the greatest money savers in mechanical lines. One concern, for instance, estimates that a single oxy-acetylene-cutting torch does as much work as four saws at a considerably lower cost in cutting gates and risers from steel castings. The torch may be used without guides where only a rough cut is required, but it is supplied with adjustable guides for straight cutting and compass attachment for cutting circles. These attachments are so arranged that they can be set to cut directly through the metal or on a bevel, either right or left-hand.

Plants for the oxy-acetylene welding and cutting are made by Walter Macleod & Company, Cincinnati, Ohio, in all styles and sizes, using compressed gases or having generators for making the gases. Fig. 6 shows a Buckeye plant with both oxygen and acetylene generator and two welding torches. This is a type of self-contained plant which requires no power, as the acetylene is generated under pressure and the oxygen is forced into the tanks or receivers at any pressure that may be desired up to 300 pounds by the force of generation, no compressor being required.

Welded Locomotive Castings

With the aid of small portable oxy-acetylene welding plants serious fractures in castings on locomotives have frequently been repaired with a considerable saving in time. In Fig. 1 is shown a 4-ton cylinder from a locomotive belonging to the Kansas City Southern Railway Company, which fractured

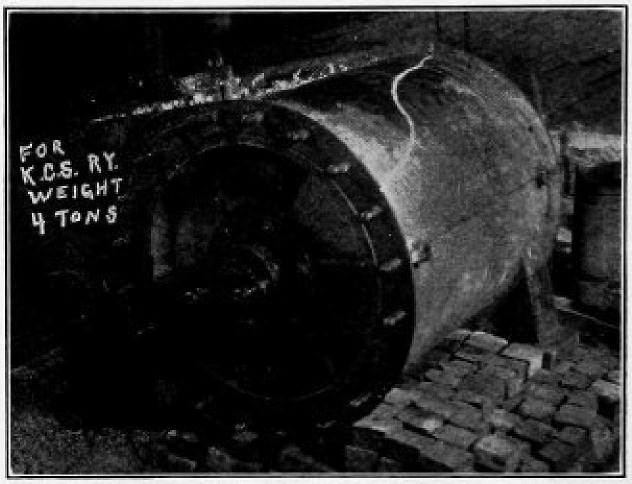

Fig. 1.—Fractured Cylinder Welded

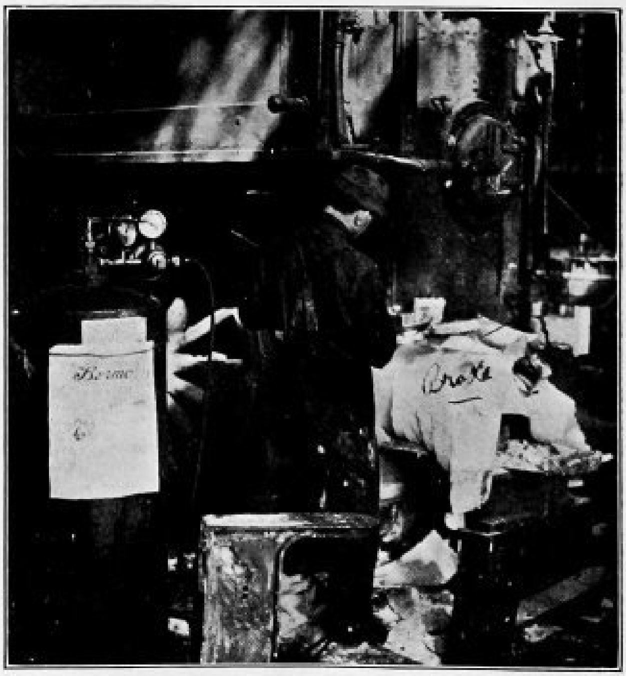

Fig. 2.—Welding Broken Castings on a Locomotive

along the line shown in the photograph. This break was welded in four hours, 100 cubic feet of oxygen and 100 cubic feet of acetylene being used to make the weld. The work was done by the Autogenous Welding Devices Company, Kansas City, Mo., and proved satisfactory in every respect.

At another time this company spent about four days welding various castings on one of the locomotives used by the Wyandotte Construction Company, which was building the Kansas City, Clay County & St. Joseph Electric Line. The locomotive was a 75-ton engine, and was used for hauling crushed rock for the road bed. The locomotive was going down a rather steep grade and then started up a grade at the bottom of the hill. When it started up the grade the heavy cars took up the slack so fast that the end of the frame was broken off, and the cross bars and couplers were partially fractured. The frame, which was 4 inches by 10 inches, was also broken in the middle on the opposite side. In welding these fractured castings 800 cubic feet of oxygen was consumed, and the work was completed in four days. The locomotive is at present in good running order, and has been in continuous operation for months since the welds were made. The draw-bar pull on the end of the castings is a little over 1,000,000 pounds, which tends to prove that oxy-acetylene welding, when properly done, will leave the castings in as good condition as they were before they were fractured.

Seamless Lap Welded Tanks

The American Welding Company, Carbondale, Pa., constructs a variety of tanks and other sheet metal articles in which all the seams are heated with fuel gas and are lap-welded by hydraulic power. Fig. 1 shows a tank 20 feet long and 60 inches in diameter, which was made in this manner and tested to 600 pounds per square inch hydrostatic pressure. The shell and heads are ⅝ inch thick with a manhole-plate 11/16 inch thick.

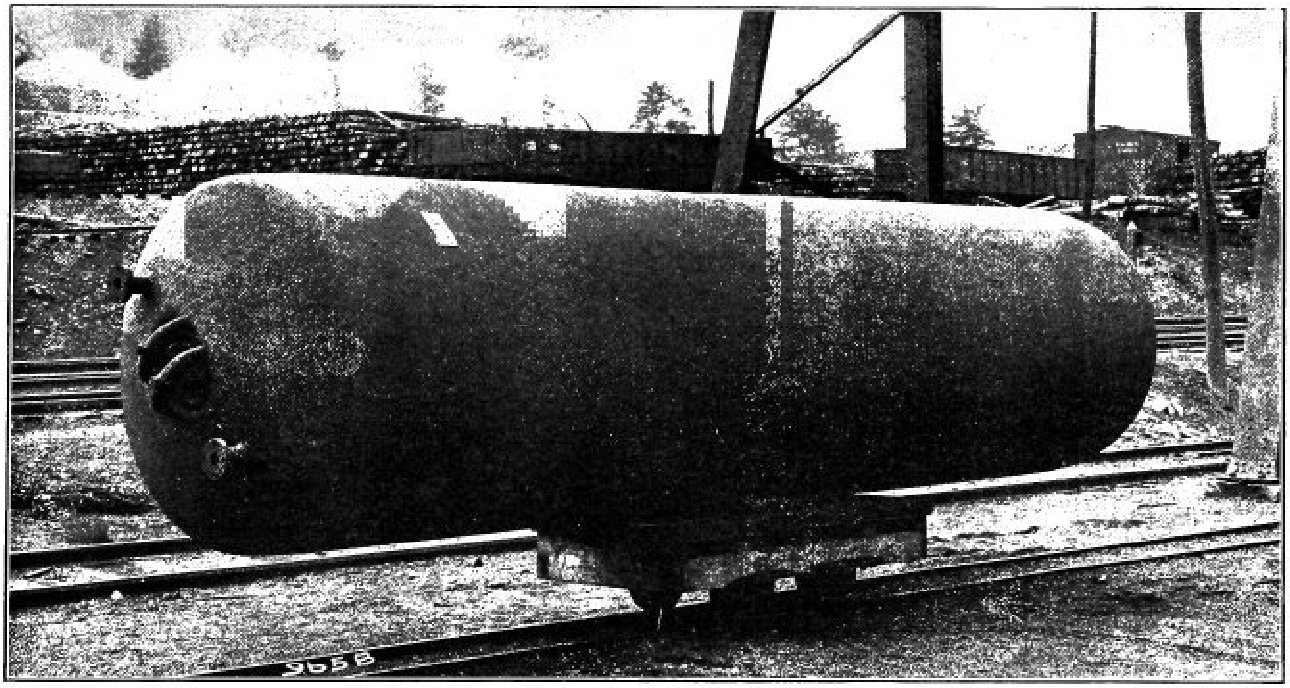

Fig. 1.—Seamless Lap Welded Tanks, 60 Inches in Diameter, Tested to 600 Pounds per Square-Inch Pressure

Fig. 2 shows a 3,000-gallon kettle, weighing 9,500 pounds, which was also made in this manner. The inside dimensions of the kettle are: Diameter, 8 feet; depth, 8 feet 6 inches. The shell and convex bottom are ¾-inch steel plate, while the flange at the top is 4½ inches wide.

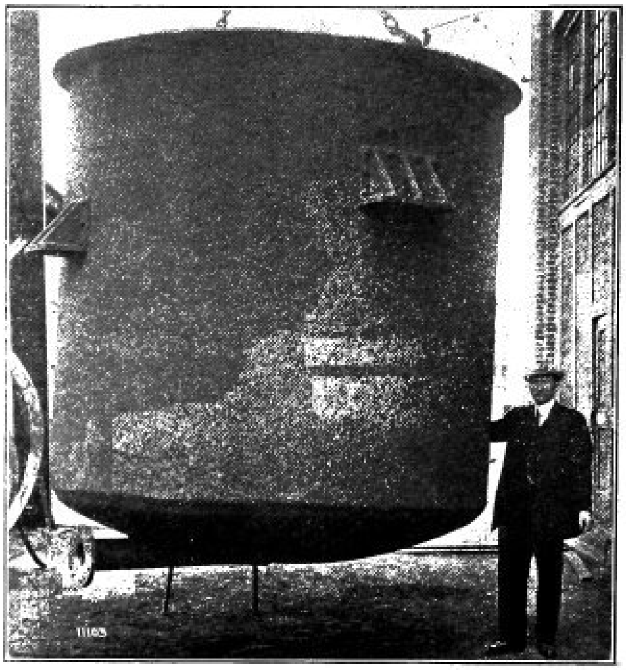

Fig. 2.—Seamless Kettle; Capacity, 3,000 Gallons; Weight 9,500 Pounds

BOILER HORSEPOWER.—Formerly it was the custom to rate certain types of boilers as capable of developing 1 horsepower for each 10 square feet of heating surface. In modern boiler practice, however, this rating is entirely inadequate, as much depends upon the kind of fuel used and the condition of the furnace. In many cases a boiler may develop a horsepower from 5 or 6 square feet of heating surface as economically as from 10 square feet.

Autogenous Welds for Boiler Work

Autogenous Welding for Boiler Repairs Discouraged Where the Safety of the Boiler is Directly Affected—Failures Cited

We are constantly requested to approve boiler repairs of various forms that have been accomplished by means of autogenous welding of the parts, and while we feel that there are many kinds of repair to which this process is admirably adapted, we have consistently refused to approve such repairs where the strength of the repaired part is of vital necessity to the safety of the boiler. We are not alone in our distrust of this method of joining metals for the purpose of boiler repairs or manufacture under the present condition of the art of autogenous welding.

Prof. Theodore Kautny, of Nürnberg, who is considered one of the leading authorities of the world on this subject, is using his influence to prevent the autogenous welding of boiler shells until some reliable method can be devised for ascertaining the probable strength of a weld without destroying it. We also understand that the United States Government does not approve of acetylene welding for boiler repairs where the parts welded are subjected to tensile strain.

One of the most important companies doing general autogenous welding in this country advocates the licensing of equipment, operator and company where engaged in boiler repairing, to the end that greater skill may be brought to bear in making such repairs. There are so many conditions surrounding the making of a safe weld by this process that it hardly seems possible that all the improper ones can be guarded against except possibly in a few cases presenting difficulties of a fixed nature. In the oxy-acetylene process it is first necessary to obtain the right mixture of gas. If too much oxygen is present the material is oxidized and the weld is left brittle and weak. Impurities in the oxygen used may also have a bad effect on the strength of the weld. If storage tanks are used as a means of supplying acetylene, and the draft of gas from these tanks is too rapid, some of the absorbent liquid may be drawn through the connections to the burner and produce defects. A flame too rich in acetylene may also cause injury to the steel. The expansion of the parts adjacent to the weld, due to the heat necessary to make it, may leave tremendous internal stresses in the plate or other part that is welded which cannot even be estimated. This is such a variable factor that only the nicest judgment could be of any value in determining whether a given repair may be made with safety or not.

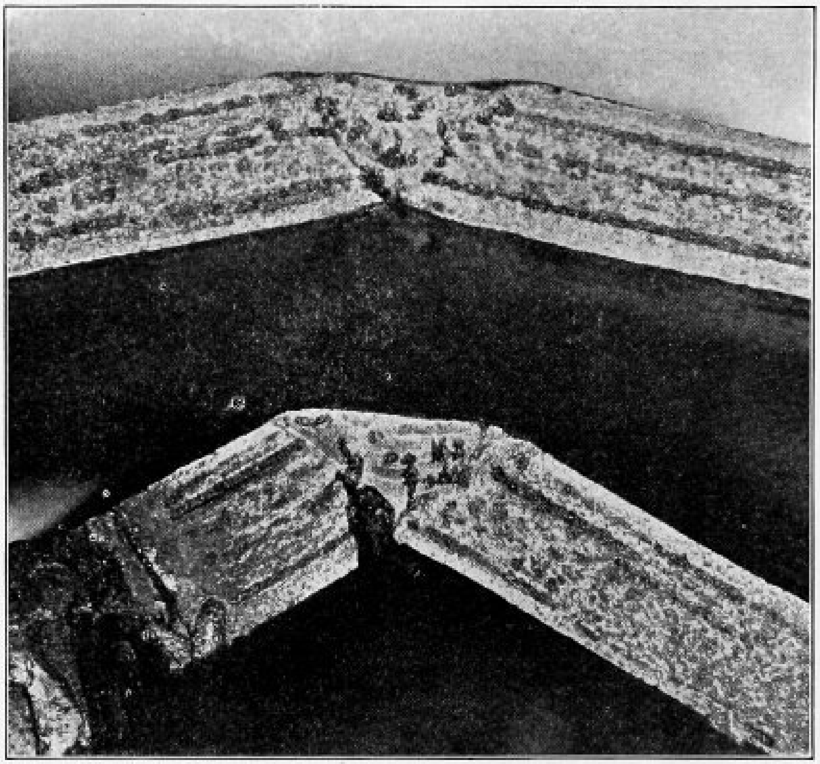

Fig. 1.—(Upper). Etched Section of Longitudinal Seam
Fig. 2.—(Lower). Etched Section of Weld Between Head and Shell

In a few instances we have sanctioned the autogenous repair of cast iron sectional boilers, used for very low pressures, where the nature of the structure surrounding the defective part would seem to indicate that no severe local strains might be set up in the act of welding. However, our experience with this kind of repair has been very discouraging, for while the welding has held in most cases, subsequent breaks have developed which were produced by shrinkage strains at the weld.

One of the worst specimens of autogenous welding that has come to our notice was through the failure of a receiver separator connected to a turbine. While this cannot be taken

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as a fair sample of welded work, still it shows how poorly such work can be done, and aside from the poor design of this vessel there was nothing to definitely show that the welding was not what it should be. For while the welds were roughly made, this does not always indicate that the surfaces are not properly joined. This receiver had been formed entirely by means of the autogenous welding process, the longitudinal seam, head seams and nozzles all being welded. The general dimensions of the vessel were 30 inches in diameter by 5 feet long, with ⅜-inch shell and heads. The accident was due to the lower head of this receiver blowing out, the receiver operating in a vertical position, and after an examination of the parts the only wonder that it had ever remained together.

Fig. 1 shows a section across the longitudinal seam which has been etched. By examining this section it will be seen that there is a line of holes at each side of the V representing the surfaces of the plate, and there was very little sound metal bonded together along this seam. It will be seen from Fig. 1 how poorly the contour of the cylinder was maintained at the joint, for by placing a rule on the cut the shell will be seen to be perfectly straight; and while the cut only extends 2 inches across the seam, this flat space was 5 inches each side of the weld. With this misshapen seam and lack of bond

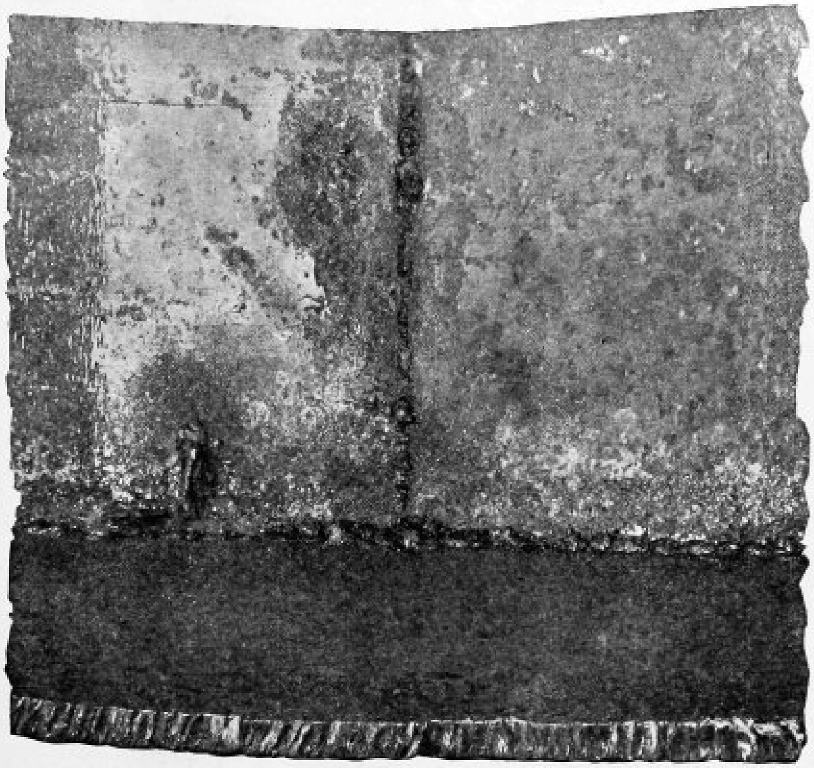

Fig. 3.—Welding of Head to Shell. Note the Rough Character of the Work

Fig. 4.—The Wrecked Separator

between the parts, the only explanation that can be advanced to show why it held together at all (which it did for two years) is that the draft of steam was steady.

Fig. 2 shows an etched cross section of the connection between the upper head and the shell of the receiver, the head being on the left-hand side of the figure. A close inspection of the weld at this point will show that there was almost no sound contact between the welding material and head at this point. It is evident from Fig. 2 that the head was only dished and that no attempt was made to flange down the edges so as to bring the points of maximum bending stress away from the weld.

Fig. 1.—2½-Inch Plate, Welded Solid

Fig. 3 is a view of the inside of the separator showing a portion of the top head (at the bottom of the figure) and the longitudinal seam. Some idea of the roughness of the welding can be gained from this view, but the parts themselves looked much worse than the cut shows.

Fig. 4 shows a general view of the receiver, with the top head lying towards the observer. On the ground at the left is seen the bottom head which was blown out. This head was dished outwards the same as the upper one, but when it failed the force of the pressure forced it down over a pipe standard that supported it from the floor. The nozzle on the left-hand side of the receiver, which was stripped off by the explosion, was of 10-inch size. This nozzle was made up of a flange butt-welded to a short section of 10-inch pipe, and instead of flanging the opposite end of the pipe in order to attach it to the shell, a sheet steel collar was welded on, which in turn was welded to the shell of the receiver. The head and longitudinal seams on this vessel were bad, but the nozzle seams were worse. The welded-on collars did not fit the contour of the shell, and numberless shims and nails were used in filling the voids between the shell and collar on the nozzle. If Fig. 4 is examined carefully, some of these shims may be seen around the opening on the left-hand side.

Such work as this is more likely than anything else to retard the progress of autogenous welding, which we believe has a real field of usefulness even in boiler work, but we are not yet ready to approve it for repairs where the safety of the boiler is directly affected.

Welded Plate Work

In connection with a general line of plate construction, the Knox Pressed & Welded Steel Company, Pittsburg, Pa., has made a specialty of welded construction, the extent of which can be gaged by an inspection of Fig. 1, which shows a 2½-inch plate rolled into a cylinder and welded. A construction of this kind is also shown in Fig. 2, where a shipment of welded steel oil filters is loaded on a railway car. These welded filters are claimed to be far superior to riveted filters. One particular product of this firm is the Knox patented O. H. furnace doors, frames and ports, in which the plates are bent and welded together. An example of this work is shown in Fig. 3.

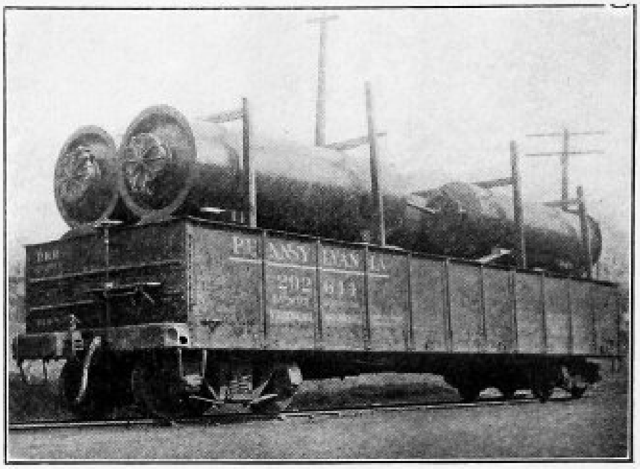

Fig. 2.—A Shipment of Welded Filters

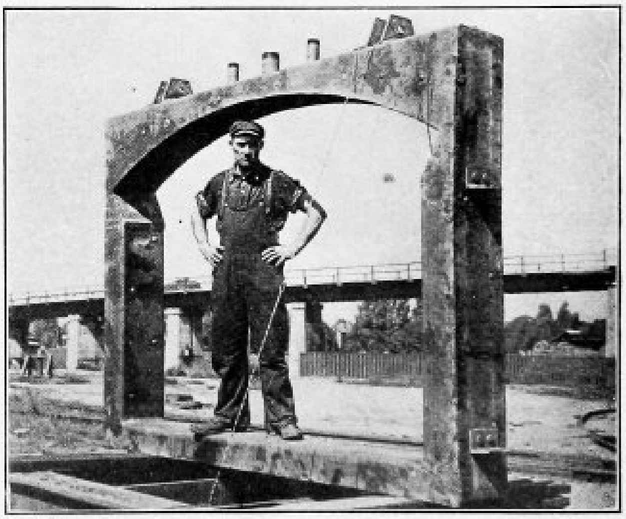

Fig. 3

The Champion Prize Competition

Readers of The Boiler Maker should not forget the prize competition for the best essays on "How to Heat Rivets Satisfactorily," which was announced in our last issue. This competition was instituted by Mr. David J. Champion, vice-president and general manager of the Champion Rivet Company, Cleveland, Ohio, who offers three prizes—the first of $50, the second of $45 and the third of $25—for the three best essays on this subject. All papers entered in this contest should be sent to The Boiler Maker, 17 Battery Place, New York City, and should reach this office not later than 12 o'clock on Wednesday, May 20. The prize will be awarded by a special committee at the annual convention of Master Boiler Makers' Association in Philadelphia May 25 to 28. Papers submitted in this contest should not be signed by the author but should bear some distinguishing mark, the name of the author being enclosed in a sealed envelope, bearing a duplicate of this identification mark and forwarded with the paper to The Boiler Maker.

Saving in Piping Installation on Board Ship by Use of Oxy-Acetylene Welding

Fig. 2 shows how a piping installation on board a naval vessel was simplified and the cost greatly reduced by the use of oxy-acetylene welding. Fig. 1 shows the installation as required in the original plan. Upon comparison, it will be noted that there resulted a saving of nineteen castings and thirty joints. An elliptical flange was used, as an elliptical hole in the inner bottom of the vessel would permit the standard flange on the bottom of the piping being passed through the inner bottom, thus requiring a smaller hole than if it were perfectly round. A. H. NOURSE.

Navy Yard, Brooklyn, N. Y.

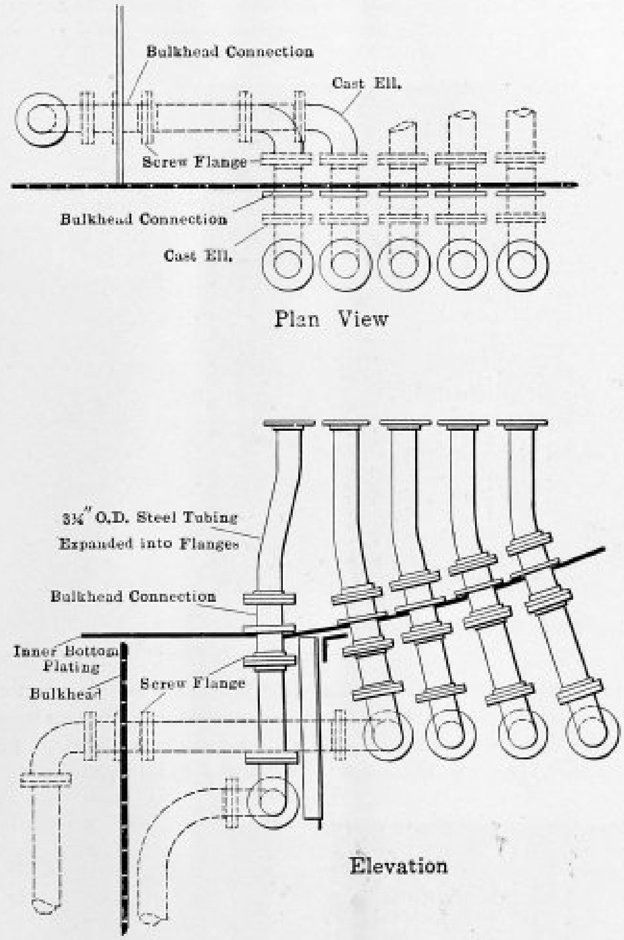

Fig. 1.—Original Plan for Piping Installation

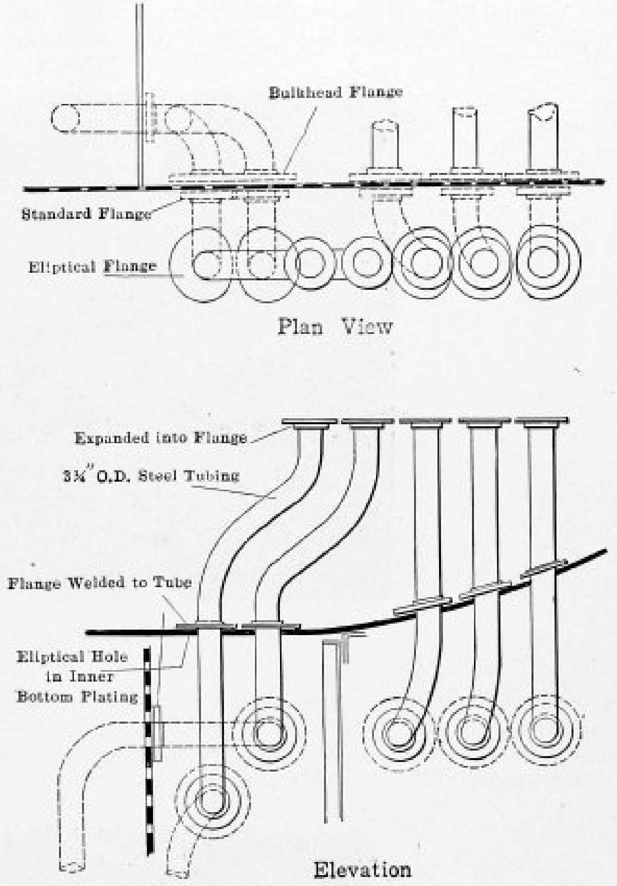

Fig. 2.—Simplified Arrangement of Piping

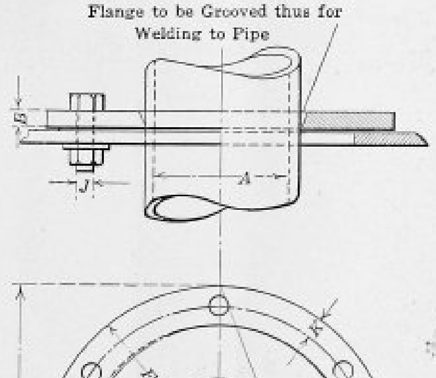

Fig. 3.—Elliptical Bulkhead Flange

ELIPTICAL BULKHEAD FLANGE—WROUGHT STEEL.

Size of Pipe.	Flange. Thickness.	Flange. Long Width.	Flange. Short Width.	Flange. Radius. Bottom.	Flange. Radius. Top.	Flange. Radius. Side.	Bolt. Number.	Bolt. Diameter.	Bolt. Outside of Flange to P. C.	Outside of Flange to Hole in Bulkhead.
A	B	C	D	E	F	G	H	J	K	L
1½	½	7 9/16	6 5/16	6 1/16	3 25/32	2 1/32	6	½	9/16	1 1/8
2	½	8 1/16	6 11/16	6 11/16	4 1/32	2 29/32	6	½	9/16	1 1/8
2½	½	8 5/8	7¼	7¼	4 5/16	2 9/16	6	½	9/16	1 1/8
3	½	9 1/8	7¾	7¾	4 9/16	2 7/8	8	½	9/16	1 1/8
3½	½	9 11/16	8 3/16	8 5/16	4 27/32	3 5/32	8	½	9/16	1 1/8
4	½	10 3/16	8 11/16	8 13/16	5 3/32	4 15/32	8	½	9/16	1 1/8
4½	½	10 11/16	9 5/16	9 5/16	5 11/32	3 27/32	10	½	9/16	1 1/8
5	5/8	11 13/16	10 5/16	10 7/16	5 29/32	4 5/32	10	5/8	⅝	1¼
5½	5/8	12 5/16	10 13/16	10 13/16	6 5/32	4 13/32	10	5/8	⅝	1¼
6	5/8	12 7/8	11 5/8	11 3/8	6 7/16	4 13/16	12	5/8	⅝	1¼

IMMUNITY FROM BOILER EXPLOSIONS IN MONTANA.—During the year ending Nov. 30, 1913, 2,260 boilers were inspected by the State Boiler Inspection Department in Montana, and of these, twenty-one were condemned as unfit for use. No boiler explosion or accident or injury to persons in charge of the boilers occurred in that State during the year. Traction engines constitute a large proportion of the boilers used in the State, and these are widely scattered throughout the State.

Oxy-Acetylene Apparatus Applied to Heavy Sheet Metal and Boiler Shop Work

The use of oxy-acetylene apparatus in heavy sheet metal and boiler shop work is a natural development of its earlier application to light sheet metal work, and is accompanied with increasingly important advantages as regards reductions in factory costs and gains in quality and quantity of output. The rapidly increasing field of its application, however, has been brought about only by the gradual improvement of the apparatus itself and of the methods employed in its use. Some idea of the wide range of application which this apparatus now enjoys in general boiler shop work can be gained from a few of the instances reported by the Oxweld Acetylene Company, of Chicago, whose process is extensively used for both welding and cutting where heavy sheet metal is employed.

In Fig. 1 is shown a number of boiler shells at the works of a large locomotive manufacturing plant ready to be welded by the oxy-acetylene method. Fig. 2 shows the welding operation, while Fig. 3 shows the finished work. In this case the plate varies in thickness from ¾ to 15/16 inch. The seam is clamped in place with bolts and a jig, and is welded for a distance of about 1 foot from each end. The work is done at the rate of 1 foot in 25 minutes per operator, at a cost of about 81 cents per foot. The shell is welded in this manner in order to prevent leakage underneath the overlapping portions of the smoke-box shell and the dome section of the boiler. Over the balance of the seam a saddle plate is set, riveted and calked. The former method of doing this was by a running forge weld made by hand. The oxy-acetylene weld, it is said, is more quickly made and results in much less leakage than welds made by the older method. This same concern also uses this apparatus extensively in cutting heavy plate and welding vertical seams in steam domes.

Fig. 4 shows a welded tank that carries a working pressure of 200 pounds to the square inch, and is tested to 300 pounds.

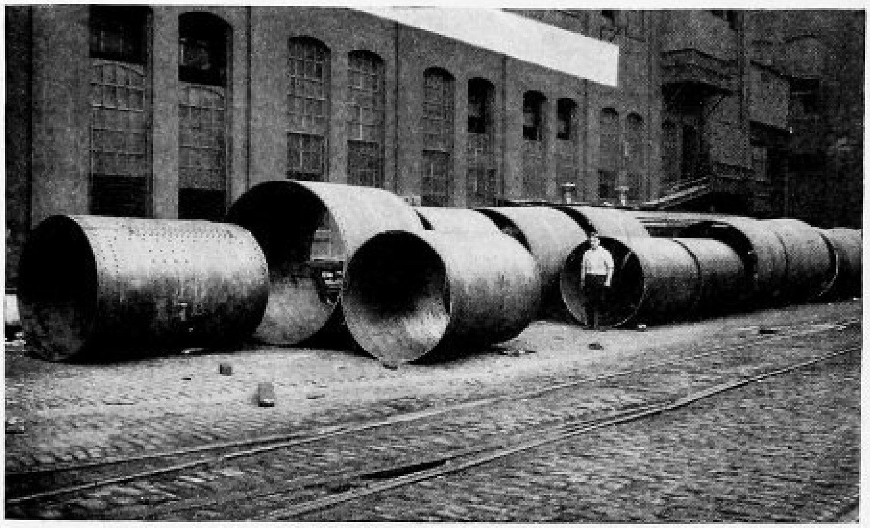

Fig. 1.—Boiler Shells at Locomotive Works Ready for Welding

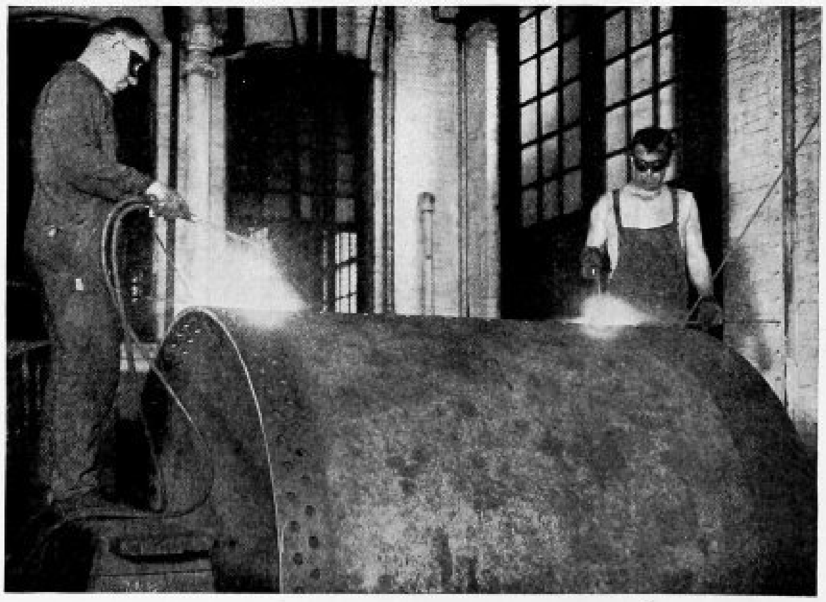

Fig. 2.—Operators Welding Part of Shell of Locomotive Boiler

The shell of the tank is made of ⅝-inch plate and the dished bottom of ¾-inch plate. Its diameter is 4 feet and its length 5 feet. The longitudinal seam is welded, and the bottom is welded to the body in six hours at one-third the cost of riveting. This construction requires no calking, either for testing or after subsequent use.

Manufacturers of plate metal products have applied oxy-acetylene welding to a varied assortment of articles, including tanks of all shapes, power and heating boilers, receivers, kettles, condensers, filters, agitators, evaporators, dryers, stills, pen stocks, gas producers, etc. The thickness of plate welded in these products varies from ⅛ to 1 inch, and the joints are subjected to various strains and deteriorating agents, such as intermittent pressures, corrosion, heat, cold, etc. The tanks are made from 5 to 9 feet in diameter, and in any length required. Welding gives the advantage of a smooth joint, with no rivets and no laps to cause leakage.

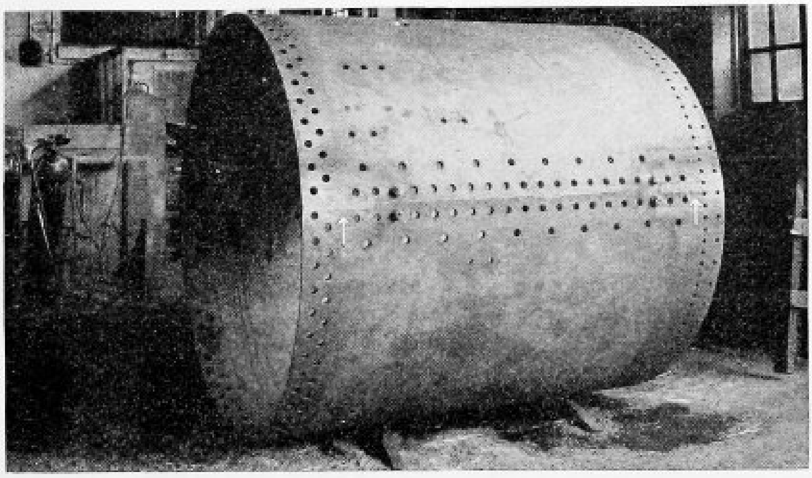

Fig. 3.—Welded Section of Locomotive Boiler

A comparison between the cost of welding and riveting, as carried out with the apparatus furnished by the Oxweld Acetylene Company, shows that up to certain thicknesses of plate, notably ⅜ inch, welding is cheaper per lineal foot than riveting. On heavier material than this, however, the cost is about the same as good riveting practice. The speed of welding in lineal feet per hour, as given by this company, varies from 20 for ⅛-inch plate to 2 for 1-inch plate. The cost per foot varies from $0.04 for ⅛-inch plate to $1.20 for 1-inch plate. In these figures the price of oxygen is placed at 2 cents per cubic foot, acetylene at 1 cent and labor at 30 cents per hour. For cutting, the speed in lineal feet per hour varies from 100 in ¼-inch plate to 31 in 2-inch plate, while the cost per foot varies from $.0251 in ¼-inch plate to $.1351 in 2-inch plate. Extensive tests have been made by the Department of Commerce and Labor on the strength of welds made by the oxweld process, showing an average efficiency of 79 percent for the weld on specimens tested.

Fig. 4.—Welded Tank

The Upkeep and Management of Boilers on a Tramp Steamer

At a meeting of Institute of Marine Engineers on Dec. 1 a paper on "The Upkeep and Management of Boilers on a Tramp Steamer," by Mr. G. A. O'Neill, was read. In dealing with the question of internal corrosion the author stated that sufficient care was not always taken, when fitting zinc plates in the boiler, to clean away the dirt and scale from around the necks of the stays so as to form a metallic contact. Soda was often used without any consideration as to the amount required. This could easily be ascertained by the use of litmus paper. The pitting frequently found along, and a little above, the line of the firebars on the water side of a furnace, could be arrested by making it a practice to clean thoroughly and remove the black scale, afterwards coating with a mixture of metallic zinc powder and clean fresh water. He did not agree with the practice of scaling furnaces only to the line of the firebars, and leaving the bottoms untouched. In modern ships a great many of the difficulties were eliminated by the use of independent feed pumps and efficient feed heaters.

It was quite a common rule in raising steam to light the fire in the center low furnace of a three-furnace boiler four or five hours before the others, but with the modern appliances for artificial circulation this practice was entirely unnecessary. It was also harmful by setting up undue strains on the front end plate. The bottoms of the combustion chamber on the fire side were liable to corrosion if not carefuly watched. Salt from leaky tubes and joints, when mixed with wet ashes, set up corrosion, and it was essential that any leaks noticeable should be stopped at the first opportunity. Corrosion at the bottom front end plates could be eliminated to some extent when at sea, if the ashes were removed from the furnace fronts immediately after the fires were cleaned, and not allowed to remain there until the end of the watch, as was often the case.

Hydraulic Pressing

BY C. W. R. EICHHOFF

In large modern plate shops in which the operations of flanging, forging and bending plates are carried out, hand work has become a thing of the past. One of the most important machines found nowadays in such shops is the hydraulic press, on which many of the above-mentioned operations can be performed in the shortest possible time. In fact, there is no limit to the possibilities for the application of this machine if the formers are properly designed. Of course, there are many forging operations which can be fabricated more economically and rapidly by steam, helve or drop hammers, but the advantages of hydraulic forming or pressing are so many that this method is preferable in many cases.

Hammering

Let us consider what happens when we form a piece of steel or iron by either hammering or pressing. In the hammer process we find that the effect on the molecules of the material is a local one, and these molecules are crowded together where the hammer strikes the forging. In hammer forging the zone nearest the surface is affected and the effect is a superficial one. The interior of the piece being worked is influenced to a less extent, so we have a heterogeneous product. This condition is aggravated by the variations in the force of the hammer blows, as it is practically impossible to have uniformity in the intensity of the blows, and it takes a very skillful hand to operate a hammer so as to bring about that result.

Pressing

With the application of hydraulic pressure the situation becomes quite different. The whole mass of iron or steel is influenced by a uniform pressure. This pressure is applied slowly, proportionately, and the molecules have time to take their new position through the whole mass and the material will be of a more homogeneous character. Some people claim that hammer forging is better than hydraulic pressing, as the blows can be directed wherever they are wanted to place the material. However, with properly designed forming dies, and with a proper heat, the same result is effected by hydraulic pressure. With the hammer superficial cracks and other defects can be covered up and hidden, but this cannot be done with the former. For this reason hydraulic forming is preferable.

The stresses set up in the material are less with pressing than with hammering, and to remove the effect of the stresses it is necessary to anneal the forging or pressed work before it is used.

Effect on the Structure of the Material

In hydraulic-forming operations, such as flanging, bending plates, bending shapes and bars, it is very essential that the material to be used is of uniform structure. The material also has to have great tenacity and ductility. In ordering such material it is advisable to specify to the supply house the particular operations to which the material is to be subjected. In bending a piece of steel or iron we have a tension on one side and a compression on the other. If the material is not of good quality it might, after bending, show cracks. It happens, too, that bad material cracks in cooling off. The application of heat very often shows defects in forgings and plates which probably would not have been detected if the heat had not been applied. This is particularly true with laminated and blistered sheets, where heat opens up the cracks and makes them more visible.

Heating Iron or Steel

The heating of plates which are to be subjected to pressing operations is one of the most important factors for a successful result. It is here where the flanger or operator of the press has to show great skill and judgment. If a proper heat is applied to the work, well-designed forming blocks have little influence on the material, and the forming blocks suffer little by wear and tear.

The heating should take place gradually and uniformly. A piece of steel that is to be subjected to a bending operation should be heated slowly, at least at the beginning, say up to a temperature of 600 degrees F., when afterwards the heating can be accelerated. Too hasty heating, or heat not uniformly applied to the work, produces minute cracks in the interior which are not visible on the outside. The effects of unequal expansion and contraction when a piece is not heated uniformly are noticeable in a marked way when the piece is cooling off. The product is also a heterogeneous one.

The Dangerous Blue Heat

It should be mentioned here that steel should not be worked unless at a red-hot heat, or in the cold state. There is a state between these two extremes which is called the blue heat. In this warm condition the material has a blue appearance and is very brittle. The writer has found many boiler makers who were unaware of this fact. The flanger frequently has to use the sledge or maul to make small corrections in the shape of the piece which he is flanging; as, for instance, on the heads of Scotch marine boilers with their flanged furnace mouths and hand and manholes. If the operator is not careful, and strikes the work while it is at this blue heat, very frequently annoying cracks will be the result. Many good steel plates have been rendered useless by not heeding this precaution, and very often the blame was laid on the material instead of placing it where it belonged, namely, on the careless or ignorant operator. Work on steel should never be continued after the steel becomes dark.

Scale

If a piece of iron or steel is heated in contact with air it will absorb oxygen from the air and scale will be formed on the surface. The hotter the iron the more readily the scale will form. This scale is very annoying in all operations performed on the press, but it can be prevented by thoroughly lubricating the forming blocks and keeping them thoroughly lubricated.

The best way to remove scale from the material which is being worked is by using compressed air, but the operator should be careful not to cool off the material. A stream of compressed air is more effective than brooms or wire brushes.

The formation of scale must be absolutely prevented in welding operations. This will be taken up again in discussing welding operations performed on the hydraulic press.

(*To be continued.*)

Labor Saving Flanges

Labor saved and breakage prevented by Ryerson forged steel flanges as compared with ordinary cast and pressed flanges, make their use a decided economy.

Quality of steel used not only imparts strength to flanges but permits punching of Rivet Holes; this alone justifies any difference in first cost.

Metal thickest where strain is greatest is assured by forging flanges whereas in pressing flanges from boiler plate the drawing of the metal to form the head leaves the metal thinnest at this point.

Extra high head has full deep threads shown in above illustration which run flush with the bottom of the flange, always insuring safe connections.

Lathe finished to a beveled edge for calking, a great advantage appreciated by every boiler maker.

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Talks to Young Boiler Makers

Alex and Carl made up their minds that it was not fair to the boss not to tell him that they were going to give up their jobs and start in business. When, with many misgivings, they went in to see him they were more than surprised to have the old man say to them that he thought they had made a very good selection for the site of their new boiler shop, and that they were wise in deciding to take new work as well as making repairs.

He said: "You boys are practical, ambitious and young; you have a good reputation for being good workmen, and deserve it. You will have one of the best shops in the country and you should do well. You have got to remember that a good kit of tools needs a skilled pair of hands to use it, or it is not worth much. On the practical side you are all right, but you want to look out for snags on the business side.

"You are ready to work hard, but hard work does not mean success by any means. If you get into a tight place, come and see me; but just remember this one thing: that it is a great deal easier to steer a person around a hole than it is to pull him out of it, so do not wait too long before asking advice. I wish you both well."

When this conversation was repeated to Mr. Walter, he said: "It's just like the old man, and you want to remember what he said."

Mr. Walter got the boys together one evening, and said: "Here is how I have got the financial matter fixed up.

"You fellows have paid $3,000 in cash for the property; my friend has put in $32,000 in cash, or a total amount of $35,000. Now this is represented by building, tools and land. You want to protect your cash, and so does my friend, as much as possible, so the company will issue $35,000 worth of bonds, and bonds are really a sort of mortgage; that is, they are the first lien against the assets. Now, as an inducement for you to put your money in, you are to have $50 worth of stock for every $100 cash you put in, my friend, of course, having the same. This stock is called common stock.

"You two young men have got up this idea and are going to do the work of running the business, and you are going to accept journeymen's wages instead of a big salary, but, of course, you have a right to expect something more, so there will be issued to each of you $20,000 worth of common stock.

"Remember, you have half as much common stock as you have bonds, so you will each of you have $750, plus your $20,000, or you will each have $20,750 worth of stock in the company besides your $3,000 of bonds. To set it down in another way we have:

Bonds	$35,000
Bonus on bonds in stock	17,500
Common stock to Alex and Carl	40,000
	$92,500

"Now, boys, on this you have to pay, first, 6 percent on the bonds. If you do not the bondholders can close you up. The bondholders have no votes. 'But what is the good of common stock?' you will ask. It's just this: If you make more money than 6 percent on your $35,000, whatever this surplus is, whether it is $1 or $10, the common stockholders are entitled to receive it. You want to understand that it really makes no difference to you how much common stock is issued, as you have a rated proportion of whatever it is. The advantage of having the bond is that there is something of real value behind it. The disadvantage of the bond is that no matter how much money the company makes the bondholder can only get 6 percent. The advantage of the common stock is that if the company is prosperous, 10, 15 or 20 percent may be earned on it, and the disadvantage of the common stock is that it has no intrinsic (or actual value) behind it except the earning capacity of the company.

"Many times the common stock is far more valuable than the bonds as an income maker; but it can hardly be said that stock is ever a gilt-edged security. It's right up to you fellows to make the common stock worth something. If you do you will reap the benefits, as you have such a large amount of the stock.

"Now the money is all paid in, and we will have to form the company, elect officers and get busy. I have got an application made out for a State charter. and we have got all through with the legal proceedings. Alex should be the president, I the secretary and treasurer, Carl the vice-president and general manager."

After a little discussion this was agreed to, and all the legal steps being taken the Eureka Boiler Works came into existence. Contracts were let for the buildings, tools ordered, a lot of details looked after, some half dozen estimates made on new boilers, and at the end of ninety days the shop was completed, and the boys found to their delight that they had been successful in two bids, and that they would open their shop with four new boilers to build.

Mr. Walter got the bills of material for the boilers, sending them to several concerns for bids. The boys gave him a pretty close estimate of the cost of labor and other expenses, but after the material was ordered the boys got a shock. They had bought their rivets and other small supplies locally, and the agent for the plate mill from whom the boss had always bought it had come to them and solicited their business. It so happened that he was the lowest bidder. The material amounted to quite a tidy sum, as the boilers were good size, and in the morning's mail Carl had found the bill for material with a very polite letter saying that the Eureka Boiler Works, not being rated in either of the commercial rating books, the mill was taking the liberty of making a sight draft for the amount of the purchase, as was their invariable custom under the circumstances. They would make shipment immediately on receipt of their (the Eureka Boiler Works) acceptance of the terms.

Carl was entirely upset by this, as was Alex, because the amount of the draft would make a tremendous hole in their bank balance. The boys had supposed that everybody knew they were honest, and the question of credits had never entered their heads before. What were they to do for weekly wages?

When Mr. Walter arrived they both tried to tell him about the matter at once, and to their surprise he did not seem to be upset at all. He said, "I should have given some attention to the matter of how we were to be paid for the boilers, and I thought that you, Carl, would make some arrangements to get money as the work progressed, but evidently you did not think of this, so it is my fault. We will have enough cash to carry us for two or three payrolls, anyway, and if I can't get Adams & Adams, who have ordered the boilers, to pay us something on account, we will go to the bank and borrow some money."

This was a great relief, and a letter was written to the mill accepting the terms. In about a week the material turned up, during which time Alex, who was back as sort of foreman, engaged his boiler makers, and he and Carl started in on laying out the work. Very soon the clatter and bang of boiler making sounded and it was like music to their ears. Of course, some things did not run as smoothly as might have been expected. There were mistakes made in punching and a couple of sheets were spoiled. Some plates that should have been half-right and half-left were all made one-handed, and it was a matter of profound astonishment to the boys that so many things were wanted which were absolutely necessary, but which, with all their thought and study, had been overlooked, as, for instance, lumber for staging and horses.

Although the boilers were taking shape, Alex and Carl looked worried. Alex remembered how the size of the boss's payroll never worried him, but now his own payroll became a nightmare. Mr. Walter got after them both to push the work, although they said they could not work any harder. His answer to this was that they were "working too hard—worrying too much." He gave them to understand that worry never calked a seam or drove a rivet; that it was their business to plan and direct, not personally to do the work. He said, "You fellows have got to remember that directing work will not allow you to do it. Another thing, your payroll is too small."

At this Alex almost fainted. "Why!" he gasped, "I've been cutting it down all I can; it's hard enough to raise the money we want each week without having to make the sum larger."

"Now, there you are," said Mr. Walter. "I am the treasurer of this company, and I will look after getting the payroll. You two fellows 'shinny' on your own side and I'll 'shinny' on mine. Just stop worrying about my department; put on all the men you can work to advantage. The bigger your payroll for men well employed the sooner you will get on easy street."

After this very mild flare-up things went better.

After Mr. Walter had paid off and gone home, the boys sat in the office and began discussing how to figure out the important matter of profits. They had understood pretty clearly Mr. Walter's idea of a large payroll, and saw the advantage of pushing work through so that it could be billed out.

"I remember a story," said Alex, "that a feller told about profits, which was that an old lady up-country made a lot of doughnuts on circus day, and she told a friend next day that she had made four dollars. The friend asked how much the flour, sugar and fat cost her to make these doughnuts. 'Oh,' said the old lady, 'they did not cost me anything, I had them in the house!'

"Now, we have got to be careful not to figure that way. I am getting a little anxious about the cost of our electric current, as it seems to be going up all the time, and in figuring out what it costs us to run every item must be correct or we are guessing at results. This 'constant factor,' or overhead cost, is getting on my nerves. I thought we had made money the first month because we had taken in a good deal more than we had paid out, but my mind acted like the old lady's. I forgot that the shop, the tools and all that, although we had them, were costing us so much a day."

"Well," said Carl, "how are you going to figure this? On Tuesday the check valves in the accumulator pump went out of business, and we had to overhaul them. Altogether I figure that we had to pay two men for three hours' work on the pump, and for three hours all the riveting and other work had to be done by hand. The men worked very much harder than usual, yet there was very little work done.

"Now, that accumulator pump was a new one, and should not have gone out of business; but it was not the fault of the pump but the result of the scale and dirt that had not been blown out of the new pipe. We cannot charge this loss up to anybody, so far as I can see."

"Mr. Walter has a heading here of 'Maintenance of Tools,'" said Alex, "and in a case like this we have to enter the money paid to the men for repairs, and I should think that the difference between what we got done and what we should have done should be charged to maintenance too, but how are we to get at it? And now, here's another thing that has just come up. The Legislature has passed a law holding a company or individual responsible for all accidents to workmen, no matter how they occur or where, so long as the workmen are doing work for either a company or individual."

"What!" broke in Carl. "Suppose it is the workman's own fault?"

"That," replied Alex, "makes no difference according to the law. The way I dope it out from what I read and hear is that no excuse goes, even if a workman disobeys you and runs a machine you have told him not to, and gets hurt, it is up to you to pay, and what's more, three commissioners, as they are called, have the full power of settling and you can't go back of them. If they are not satisfied that you are able to pay for any accident you have got to take out a wolloping big insurance in some company or go out of business."

New London, Conn. W. D. FORBES.

(To be continued)

Standards for Horizontal Tubular Boilers

A vigorous campaign is under way, backed by members of the National Tubular Boiler Manufacturers' Association, with the object of securing the enactment in various States of uniform laws covering the specifications for horizontal tubular boilers. This campaign is in charge of a National Committee of Standard Specifications for Horizontal Tubular Boilers, which met in Pittsburg on Oct. 30 and 31, 1913, to discuss in detail recommendations for the standardization of tubular boilers.

At this meeting twenty-five men were present, representing boiler manufacturers, boiler inspection and insurance companies, and the executive heads of industrial commissions and boiler rules' commissions of the various States and localities where boiler laws are already in force. This meeting was, therefore, distinctly a national meeting, and a thoroughly representative one, the recommendations of which constitute the best judgment of men best qualified to represent the most important interests which are concerned with the manufacture and operation of steam boilers.

The meeting was called with the hope of being able to make recommendations that would be acceptable to all localities that now have boiler laws, and that would be considered as the best possible laws for every community and State to adopt when legislation of this character came up in the future. The complete minutes of this meeting have been published in pamphlet form, covering 65 pages of printed matter, a digest of which containing the recommendations unanimously adopted follows:

As the Massachusetts laws had been in existence longer than any others, and had been found to be very good and efficient laws, they were rather taken as the basis of all the argument. The Massachusetts law, mainly, is concurred in by the Ohio law, the Chicago Rules, the Detroit Rules and the Memphis Rules, and as they are pioneers in this class of legislation from a State viewpoint, it is fair to assume that their laws will probably be the basis for the concurrent legislation throughout the United States.

1. Factor of safety of five.

2. Fusible plugs in all boilers.

3. All rivet holes to be reamed. Plates up to and including 5/16 inch to be reamed 1/8 inch. From 5/16 inch to 5/8 inch, inclusive, 1/4 inch. Above 5/8 inch drilled from the solid.

4. Tube holes to be cut from the solid, or punched 1/2 inch small, and reamed to size.

5. The pitch of diagonal braces to be the pitch of staybolts, plus 2 inches to be the allowable pitch for diagonal braces in a boiler. Pitch to be taken from center to center of rivets.

6. Through rods to be pitched the same as diagonal braces.

7. When boiler has a manhole, the front head or rear head can be braced with crowfoot braces, and can be triangular if properly distributed, but the bridge type of brace for rear head is preferred.

8. Longitudinal seams of shell to be butt-strapped in all cases except boilers under 36 inches in diameter, not exceed-

ing 100 pounds working pressure. Thickness of butt-straps as recommended by Massachusetts Board of Boiler Rules.

9. Manholes and Handholes: Boilers 40 inches in diameter shall have a manhole above the tubes. Boilers above 48 inches diameter, below the tubes. Boilers 48 inches and larger in diameter shall have two manholes, one above and one below the tubes. All boilers that do not have a manhole shall have a handhole in the front head.

10. Perforated dry pipes to be prohibited. The slotted or channel dry pipe to take its place.

11. Boilers above 72 inches in diameter shall have gallows frame suspension; 72 inches diameter and less shall be supported by brackets.

12. Internal feed pipes as per Massachusetts laws.

13. All plates to be beveled on a regular plate planer where possible, and no process to be used in beveling plate that causes distortion at the edge.

14. Inspectors to be authorized to replace obliterated stamps.

15. Blow-off tanks to be made of boiler plate to stand boiler pressure with two flanges for inlet and outlet. Outlet to be equivalent to twice the diameter of the blow-off inlet.

16. Fitting of butt-straps per Massachusetts law.

17. Minimum size of water column pipe, 1½ inches.

In regard to the stamping of the plate, a further conference is to be held between the plate makers and the committee. The desire of the assemblage was that plates be stamped giving the tensile strength that was developed in the test, and not the minimum, and that the heat number and the specimen number be given, and that a record of the test and both the chemical and physical properties be provided by the mill, and a certificate of such test and analysis be provided the State inspectors and the customer, and a record of same kept, together with the specimen number of the boiler at the factory where the boiler is made, so that at any time, by giving the number, a certified copy of such test could be furnished. To such people as desire it, a verbatim report of all the arguments by all people who discussed it may be obtained.

This committee is now in correspondence with the proper authorities in every State of the Union, and copies of these recommendations, as well as copies of the complete minutes of the committee meeting, are being placed in the hands of the proper authorities in each State in the endeavor to secure the necessary legislation for their adoption as a standard throughout the country.

The following were present at the committee meeting:

John C. McCabe, Chief Inspector of Boilers, Detroit, Mich.

John M. Lukens, Chief Inspector of Boilers, Philadelphia, Pa.

R. B. Wilcox, Chief Inspector of Boilers, Chicago, Ill.

J. J. Graham, manager Hartford Insurance Company, Pittsburg, Pa.

H. A. Baumhart, representing Ohio Board of Boiler Rules, Century building, Cleveland, Ohio.

R. M. Pennock, Department of Labor and Industry, Harrisburg, Pa.

I. E. Jones, secretary and general sales manager, Brownell Company, Dayton, Ohio.

W. M. Taylor, president, Chandler & Taylor Company, Indianapolis, Ind.

Robert Joy, Kingsford Foundry & Machine Works, Oswego, N. Y.

C. Ferrari, mechanical engineer, Erie City Iron Works, Erie, Pa.

Theodore O. Vilter, president, Vilter Manufacturing Company, Milwaukee, Wis.

William Murray, Chief Boiler Inspector, Seattle, Wash.

C. V. Kellogg, president, National Association Tubular Boiler Manufacturers, Chicago, Ill.

Charles S. Hooper, secretary, Union Iron Works, Erie, Pa.

J. D. Farasey, representing Teachout Boiler Works and secretary Boiler Manufacturers' Association, Cleveland, Ohio.

L. E. Connelly, president D. Connelly Boiler Company. Cleveland, Ohio.

George A. Luck, representing Commonwealth of Massachusetts, Room 3, State House, Boston, Mass.

C. H. Wirmel, chief inspector of Boilers, State House, Columbus, Ohio.

M. F. Moore, assistant to president, Kewanee Boiler Company, Kewanee, Ill.

T. E. Durban, general manager, Erie City Iron Works, Erie, Pa.

J. D. Beck, Industrial Commission of Wisconsin, Madison, Wis.

T. J. Scanlon, inspector, Pittsburg Inspection Division, Maryland Casualty Company, Park building, Pittsburg, Pa.

Henry Wilkinson, engineer, Travelers' Indemnity Company, Hartford, Conn.

George N. Riley, National Tube Company, Pittsburg, Pa.

D. L. McLean, inspector, Travelers' Insurance Company, Travelers' Indemnity Company, of Hartford, Commonwealth building, Pittsburg, Pa.

Master Boiler Makers' Eighth Aunual Convention

As previously announced, the eighth annual convention of the Master Boiler Makers' Association will be held at the Hotel Walton, Philadelphia, Pa., May 25, 26, 27 and 28. Attention is directed by the secretary to the fact that chairmen and members of committees appointed for the convention should have their reports in the hands of the secretary on or before March 1, in order that the reports can be printed and distributed in advance of the convention. Any reports which are not forthcoming at this time will be sent to the executive board, which will decide whether they may go before the convention. Reports of the individual members of the committees should now be in the hands of the chairmen of the committees, as the time limit for individual reports was up Jan. 1.

The special rates made by hotels in Philadelphia for this convention are as follows:

Hotel Walton—Single room, without bath, one person, $2 and $2.50 per day; single room, with bath, one person, $2.50, $3 and $3.50 per day; double room, without bath, two persons, $3 and $4 per day; double room, with bath, two persons, $4 and $5 per day.

Hotel Adelphia—$4 to $6 per day, one or two persons in a room, as members see fit to room themselves.

Bellevue-Stratford Hotel—Single room, without bath, $2, $3 and $4 per day; single room, with bath, $3.50 to $5.00 per day; large room, with bath and outlook, $6 to $8 per day; large room, with bath and twin beds, $4.50 to $6 per day; additional charge of $1 per day for each additional person in a room.

BOILER MANUFACTURERS' CONVENTION.—The American Boiler Manufacturers' Association will hold its next annual convention at the Waldorf-Astoria Hotel, in New York City, Sept. 1, 2, 3 and 4.

The Boiler Maker

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CIRCULATION STATEMENT.

Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

It is not surprising that the leading article in our last issue, which explained the application of useful formulas to laying out work, should occasion some complaints from those of our readers who are easily frightened by the appearance of a formula. The objection has been raised that such formulas cannot be understood by the average boiler maker or apprentice, and requests have been made that such subjects be presented in a simpler manner. As a matter of fact, a formula is one of the simplest means of expressing relations between factors in mathematics which otherwise would require long and involved explanations. Practically all of the formulas used in laying out boiler work are based on the most elementary propositions in geometry and involve a minimum of calculation, once the symbols employed are understood. In order to help out those of our readers who are mystified by the appearance of formulas in these pages, a series of articles will be published, beginning with the next issue, explaining just what the most common formulas mean and how they are derived. As formulas are a great aid in the rather complicated work of laying out, all beginners should make a special study of this subject.

The recommendations for standard specifications for horizontal tubular boilers, made recently by a special committee of the National Tubular Boiler Manufacturers' Association, mark an important step toward the realization of a hope long cherished by practically all boiler manufacturers in the United States that uniform laws governing the construction of steam boilers should prevail in every State in the Union. Of course it is a long step from recommendations to legislation, but the way in which this matter has been taken up by the National Tubular Boiler Manufacturers' Association gives us some confidence in believing that definite results will soon be forthcoming. As outlined elsewhere in this issue, the recommendations are brief, but they cover the essential points and represent the judgment of the class of men best qualified to make such recommendations. They were adopted only after the most thorough discussion by men representing boiler manufacturers, boiler insurance companies, and the heads of State and industrial commissions having boiler legislation in charge. Considering the fact that these recommendations were unanimously concurred in by these various interests, they can be looked upon as an eminently suitable basis for any legislation of this character which may be enacted in future. This campaign once started should be pushed with vigor in every community, and we urge readers of THE BOILER MAKER to take a hand in the matter and use their influence for furthering any attempt which may be made in the State or community in which they are located.

In devoting the greater part of this issue to the subject of oxy-acetylene welding and cutting, no attempt has been made to describe the types of apparatus used, but simply to show in a general way some of the results which have been obtained with such apparatus. Notwithstanding the fact that the use of welded seams in steam boilers is discouraged by insurance companies and boiler manufacturers, nevertheless this process has found a wide application in the construction of various articles made of both light and heavy sheet metal plates, and many of these articles, such as tanks, are subject to comparatively high pressures and other conditions which require reliability and strength in such work. It is not to be expected that welded seams will be accepted in cases where failure would involve a disastrous explosion, as in steam boilers, until some means is provided so that the actual strength of the weld can be determined and guaranteed without the necessity of destroying the weld with an actual breaking test. It is generally recognized that the oxy-acetylene process is but one of several successful methods of autogenous welding, each of which has its field of application distinct from the others, but it is a method that has an exceptionally wide range of application, both in the form of stationary and portable plants and in connection with special machines. To insure success in oxy-acetylene welding, however, it is essential that only the very best apparatus should be used, and that the welding should be done under the supervision of men who are thoroughly experienced in handling the apparatus on the particular kind of work that is being attempted.

Engineering Specialties for Boiler Makers

Special Types of Lunkenheimer Pop Safety Valves

The use of large-size pop-valves is in a number of cases not only objectionable, but in some cases a pop-valve above five inches is prohibited. It is therefore necessary to use two smaller valves having a combined area equal to that of the required large-size valve, and for this reason the constructions shown in Figs. 1 and 2 were designed by the Lunkenheimer Company, Cincinnati, Ohio. Fig. 1 illustrates the "Twin" pop-valve, which merely consists of two separate valves attached to a suitable base or Y, while Fig. 2 shows the "Duplex," in which two independently operating valves are encased in one body. Both have their advantages. With the "Twin," should one of the valves become damaged beyond repair it can be replaced with a new valve at a less cost than the "Duplex." On the other hand, space may not permit of the use of the "Twin," and, consequently, the "Duplex" must be resorted to. In some cases no objection is had to the escaping steam within the boiler room, and, therefore, no pipe connection is made to the outlet. Should it be desired to have the steam exhaust at a distance from the valve, the "Duplex" would then have the advantage, inasmuch as only one pipe connection is necessary, whereas the "Twin" would require two.

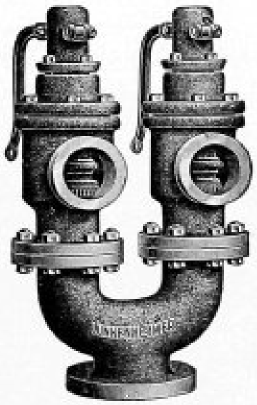


Fig. 1

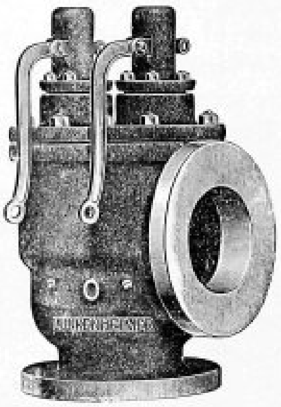


Fig. 2

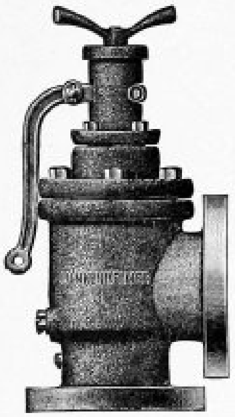


Fig. 3

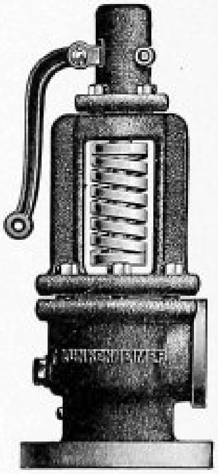


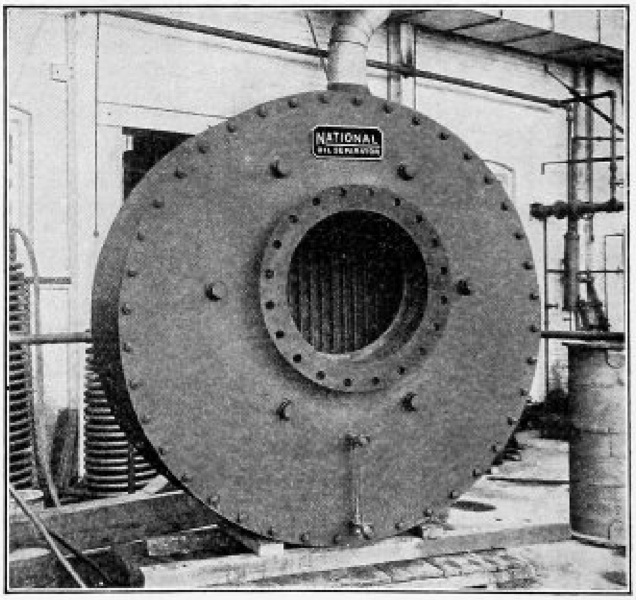
Fig. 4

Fig. 3 illustrates a type of valve generally known as the "Marine" pattern. It differs from the "Sentinel" pop-valve described in the January issue only in the addition of a wing handle at the top of the valve, the object of which is to conveniently enable the turning of the disk on its seat for regrinding purposes, or while the valve is under pressure to remove slight incrustations that may lodge on the seating surfaces.

An improved form of valve that is very popular is that shown in Fig. 4. In this construction the spring is exposed, the principal advantages being that the spring is positively protected from the steam and that it is at all times accessible for inspection. This valve is particularly well adapted for use where superheated steam is used, as the extremely high temperatures cause the springs to rapidly lose their tension. The construction of the working parts is practically the same as the "Sentinel" valve, shown in the January issue.

National Oil Separator for Portsmouth Navy Yard

A 24-inch National oil separator was recently delivered to the Portsmouth navy yard by the National Pipe Bending Company, New Haven, Conn. The outside diameter of the separator is 72 inches and it weighs 5,300 pounds. The internal area is unusually large, so that the incoming steam expands, and is so reduced in velocity that anything heavier than steam, such as oil or water, will fall out of the current by gravity. Any minute particles which may be carried in the current are thrown out, it is claimed, when the current impinges on the main baffle, which extends the full width of the separator and has vertical ribs to prevent side travel. The distinctive feature lies in the arrangement of ports and the independent baffles, which so oppose the current of steam that there is no chance of oil being carried by into the outlet chamber. There can be no drop in pressure because there is no friction; the area of the outlets is one and one-half times greater than that of the inlet pipe. The separator is made in two parts, which allows for inspection and testing of baffle plates, and it is claimed insures a perfect casting, a condition which cannot be guaranteed in separators cast in one piece.



The Blonck Boiler Efficiency Meter

W. A. Blonck, consulting engineer of Chicago, Ill., has invented what is termed a boiler efficiency meter, which consists of a convenient combination of gages giving the fireman definite information of furnace and load conditions.

As will be noted by the illustration the Blonck meter is a combination of two sensitive draft gages, one connected between the atmosphere and the furnace and one connected between the furnace and breeching on the boiler side of the damper. The lower one, filled with red oil, gives a relative indication of the pressure with which the air rushes into the furnace or the resistance of the fuel bed, while the upper gage, filled with blue oil, gives a relative measure of the amount of combustion gases passing the boiler proper.

In addition to the two gages the meter is provided with two sliding scales (see Fig. 1), which are to be adjusted to the best and most efficient operating condition of the particular boiler; the instrument should be mounted on the boiler front, so that firemen, chief engineer and owner can see at a glance the working conditions of each boiler.

It is known that a draft gage indicates a difference in static pressure. As gases in the chimney are lighter in weight, volume for volume, than the air outside the chimney, there is a tendency for the gases to rise, being pushed up by the air beneath. If there were no resistance to the air through the ash pit door, grate and fuel bed, the pressure in the furnace would be the same as the atmosphere, so far as we are capable of measuring it.

As a matter of fact, however, these do offer a resistance, and the greater their resistance the greater will be the difference in pressure between the furnace and atmosphere and the higher will be the gage reading; in other words, the thicker the fuel bed or the more the grate is clogged with clinkers the higher will be the draft gage reading; or if the resistance is reduced by holes developed in the fuel more air will pass into the furnace and the draft gage will read lower.

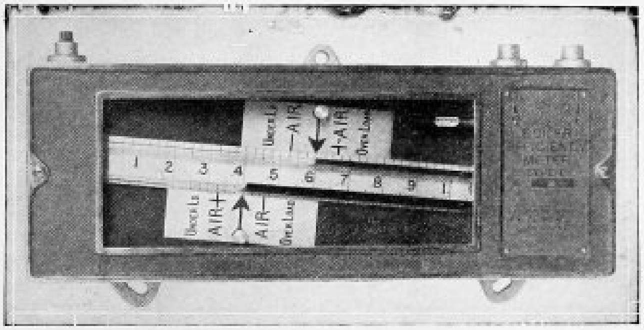


Fig. 1

Suppose that the draft gage gives a low reading, it would naturally be expected that a great amount of air is passing through the furnace, this excess of air may produce complete combustion, but at the same time reduce the temperature, and since there is more oxygen in the air than can be taken up by the carbon in the fuel, the percentage of CO_2 in the gases will be low. Going to the other extreme, if the furnace gage reads high this indicates that the resistance through the fuel bed is great and little air is passing. The result is a lack of air supply, and sufficient oxygen does not reach the coal to cause complete combustion, and an analysis of the flue gases shows carbon monoxide. Between these two extremes is the point where just enough air passes through the fuel to cause complete combustion without reducing the temperature of the gases; so, for normal operation, this medium gage reading should be carried.

Should a load greater than normal come upon the boiler, it would be necessary to carry a little thicker fire, and at the same time a little more air, in order to secure complete combustion; therefore the gage would read a little higher than normal. An underload would have the opposite effect.

From the above it will be seen that any slight change in the fuel bed will be indicated by a change in the reading of the furnace draft gage.

Taking up a similar discussion of the differential draft gage, *i. e.*, the gage showing the difference in pressure between the furnace and the damper, we find that changes in the amount of air furnished the fuel affect it oppositely to that of the furnace draft. For instance, too much air causes greater resistance through the tubes and a higher differential gage reading, too little air passing offers little resistance and a low gage reading; for normal operation there is, therefore, as in the other case, a medium gage reading, which should be maintained.

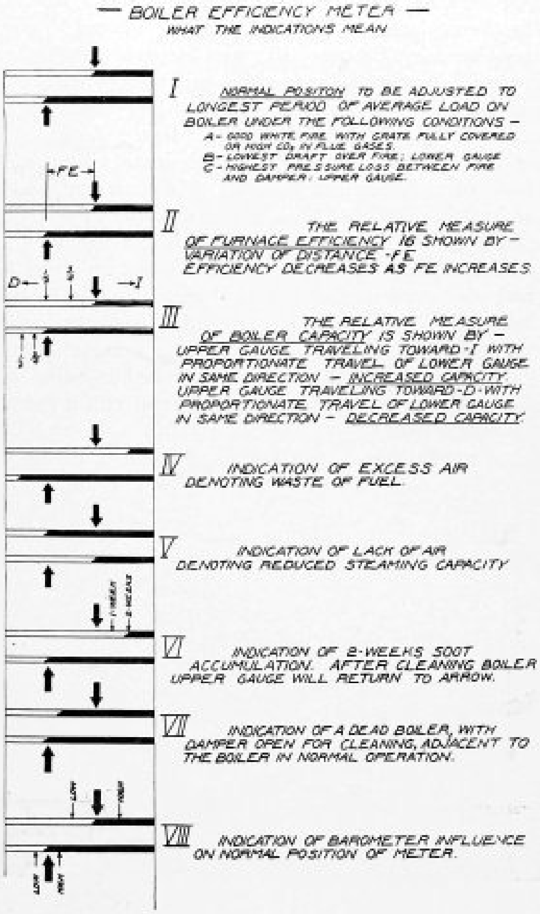


Fig. 2

Taking abnormal conditions, an overload on the boiler requires more gases to go through the tubes, with consequent higher resistance and higher differential gage readings. An underload will have the reverse effect on the gage.

By placing the gages together, as is done in the Blonck meter, the relation between the readings can easily be observed, and a slight change in the operating conditions of the boiler can instantly be noted and normal conditions restored before serious waste can take place. The five positions shown in Fig. 2 are those most commonly noted, though others, such as dirty flues or a fallen baffle plate, are just as readily and instantly shown by the meter.

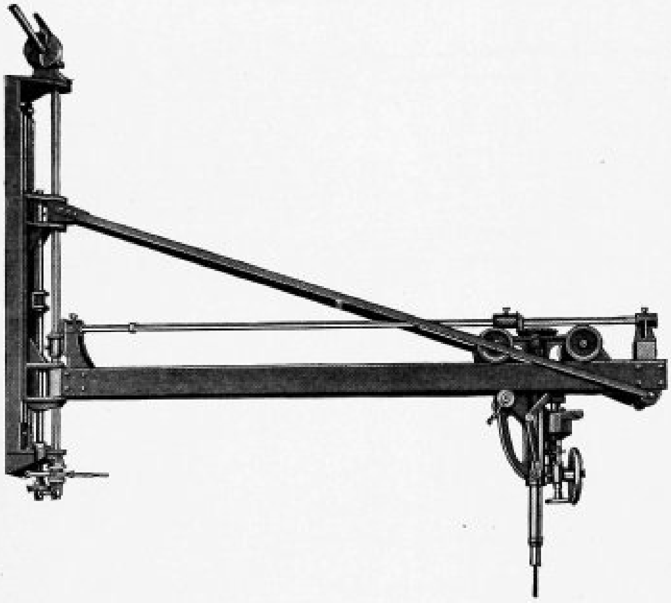
When installed on boilers in batteries the meter is of further value in keeping the boilers evenly loaded. The connections between the instrument, furnace and boiler side of damper consist of standard ⅛-inch steel piping.

The procedure for adjusting the instrument to the most efficient operation of the boiler should take place while the boiler runs with a steaming capacity equivalent to the longest period of average load, then the following three conditions taking place simultaneously will give the best economical results: A. White fire with fully-covered grate giving high CO_2 in flue gases. B. Low draft over the fire, or low red gage. C. Large pressure drop between fire and damper, showing maximum amount of combustion gases or high, blue gage. In order to prove the adjustment a number of tests should be made by taking simultaneous observations of the Blonck boiler efficiency meter and flue gas samples.

The Milwaukee Wall Radial Drill and Reamer

The Milwaukee wall radial drill and reamer illustrated, which has been placed on the market by the Vulcan Engineering Sales Company, Chicago, Ill., was designed to fill the requirements of structural iron works, boiler shops, ship yards, bridge shops, and in fact any plant where large surfaces have to be covered for drilling and reaming. In the design of this machine every effort was made to eliminate vibration, the great fault of previous machines of this character, and the fact was kept in mind that the average machine in such shops receives a great deal of abuse and little or no attention. All parts are strong and rugged, designed to stand up under hard usage and give good service under all conditions. The levers and hand wheels have been brought within easy reach of the operator, making it a one-man tool. The gears are all cut from solid blanks and the bearings are bronze bushed throughout, thereby reducing friction to a minimum with a resultant saving in power and wear of parts.

The drill can be bolted to a building column or to the wall, or it can be carried on a car, making a portable machine that can be moved to any position in the shop. This, it is claimed, is a valuable adaptation in any plant where long lines of holes are to be reamed, as in bridge or hull work. A stud is furnished in the boom end casting to provide a means of anchoring the boom to the floor when drilling holes of large diameter.



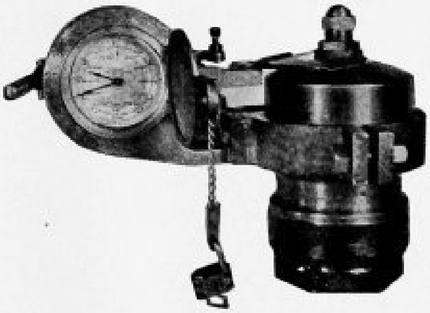
Power connection is made by coupling a countershaft (belt or gear driven) to the upper horizontal friction clutch shaft. The wall plate is a heavy casting with machined ways to guide the elevating carriage, which in turn supports the boom and sway bars. This carriage is provided with large bronze bushed lugs, through which passes the vertical shaft. Cupped brass frictions, engaging with spur gears, operate the screw shaft for raising and lowering the carriage, hardened steel ball bearings taking the vertical load. The spindle carriage is a heavy ribbed casting with truck wheels roller bushed. Provision is made for locking the carriage in position when drilling and reaming, and it is so arranged as to take the direct thrust of the spindle. The spindle is assembled with ball bearings for end thrusts in a large and substantial sleeve having a ground fit to the bore of the carriage frame. The large bevel gear guides and drives the upper end of the spindle.

The power feed consists of four changes of gears in connection with a worm gear and friction clutch device. The hand feed is direct, and is operated by the large hand-wheel, which also constitutes a quick return when power feed is disengaged. A counterweight automatically raises the spindle on release of the hand feed.

The height of the machine over all is 11 feet 4 inches, the length over all 15 feet 7 inches, and the weight is approximately 5,000 pounds. Five horsepower is required at the countershaft to operate the machine, the countershaft speed recommended being 250 revolutions per minute. The spindle speed is one-half the countershaft speed. The boom has a swing of 180 degrees and a vertical travel of 3 feet 6 inches. The horizontal travel of the carriage is 10 feet 9 inches.

The Zerbee Safety Valve Discharge Register

The Chicago Pneumatic Tool Company, Chicago, Ill., has brought out an ingenious device invented by a railroad master mechanic in response to a call from the general manager and superintendent of motive power to stop the popping of safety valves. The device, known as the Zerbee Safety Valve Discharge Register, consists of a timing arrangement or clockwork which, when clamped around a safety valve, starts running when the safety valve opens and stops when the valve seats, thus recording the time the valve was open. In an effort to make the device fool-proof it is so arranged that by a simple adjustment the register will operate continuously except when the pops are blowing. In this case the register clock is set at the current time on leaving the terminal; then any difference in the time of the register clock and the current time on arrival of the engine at the opposite terminal represents the time the valve was open on the trip. Having this information and the rate of discharge through any given valve at any given boiler pressure and the fuel required to evaporate any given quantity of water, the loss in both fuel and water is readily calculated. The dial of the register is so arranged as to automatically calculate the loss in fuel and water for a 3-inch valve on a boiler carrying 200 pounds pressure.



The manufacturers of this device have ascertained by accurate estimates obtained on several of the largest railroads that over 15 percent of the fuel that goes into the firebox goes out through the safety valves without doing an ounce of work. This new device, therefore, furnishes a means of making a remarkable saving in fuel on railroads, while of scarcely less importance is the saving of water, for not only is less water required but also the evaporation of less water means a reduction of labor on the part of the firemen and it prolongs the life of the flues. There are also the further advantages of prolonging the life and reducing the repairs to safety valves and injectors and the reduction of the noise of popping around stations and terminals.

Letters from Practical Boiler Makers

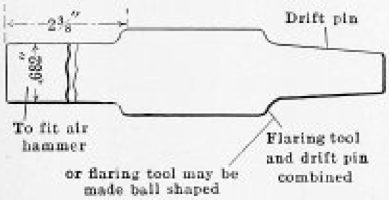
Setting Small Brass Tubes

In response to an inquiry from a reader of The Boiler Maker asking for the best methods and tools required to secure ⅝-inch outside diameter ½-inch inside diameter brass tubes in a ½-inch tube sheet, the following methods have been suggested:

Drift Pin Method

Insert the tubes in the back sheet with the end projecting about ⅛ inch through the sheet. Have a man at the opposite end hold the tubes tightly with a pair of tongs to keep the tubes from driving back in the hole.

To expand the tubes, use a drift pin made to fit the calking hammer. If the tubes are to be flared they should be flared with a light calking hammer and flaring tool. The drift pin should have nearly 3/16-inch taper in 2 inches, so that it can be withdrawn easily. If the drift pin sticks in the tube, however, it should be hit on the side to withdraw it. If the tubes are not too long, a piece of ⅜-inch steel rod may be inserted from the other end of the tubes and a blow with a hammer will knock the pin out of the tube.



Combined Flaring Tool and Drift Pin

The man using the tongs to hold the tube should let go as soon as he feels that the tube is tight, and insert the rod, so that as soon as his mate, who is expanding the tubes at the other end, stops hammering he is ready to hit the rod and knock out the pin, thus leaving the rod in that tube until the next tube is tight. In this manner the work is carried along quickly from one tube to the next.

The sketch shows a flaring tool and drift pin combined which is suitable for this work. James Crombie.

Setting Small Tubes to Withstand Pressures Up to 400 Pounds

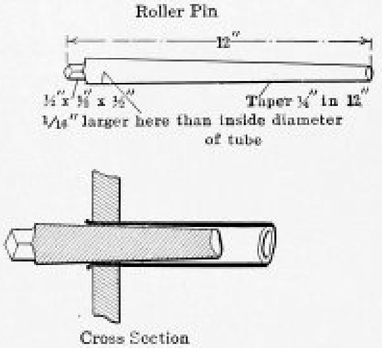
An intelligent answer to this question cannot be given until the correspondent gives further information, telling just what the apparatus is in which the tubes are to be used. If it is a case of securing a piece of brass tubing to one sheet, the best method would be to thread the tube about 14 threads to the inch and screw the tube into the sheet; but if it is a case of securing the tube in two sheets, the best method would be to thread the tube for one sheet and expand it in the other.

If, however, as is very likely the case, it is required to fasten a number of tubes at both ends in some receptacle that must withstand pressure, the best method to be used with tubes of such small diameter for pressures up to 400 pounds per square inch is first to drill the tube holes not over 1/32 inch larger than the normal diameter, or to punch the holes ⅛ inch small and ream to size. The sharp edge of the plate around the hole should be slightly filleted on both sides to prevent cutting the tubes when expanding. The tubes should be thoroughly annealed at the ends, and the rough-cut ends should be cleaned and slightly rounded out with a file. This will lessen the liability to fracture when working the tubes.

Cut the tubes ⅛ inch longer than the outside distance between the tube sheets, and when setting the tubes allow them to project through the sheets 1/16 inch at each end. When the tubes are in position, clinch them by peaning over a small section of the tube which projects through the sheet. This will prevent the tube from moving while it is being worked.

If the tubes are so small that the roller or prosser expander cannot be used, they can best be expanded by the use of a pin roller, or, in other words, a plain, round, slightly tapered pin that fits the interior of the tube and made with one end squared so that it can be turned with a wrench. The pin should be about 12 inches long, with a square ½ by ½ by ½ inch at the large end. The round part of the large end should be about ⅛ inch larger than the inside diameter of the tubes, and the pin should be tapered ¼ inch to the foot. An old flue roller pin that has a slight taper is often used successfully for this work.

The pin should be driven in with light blows with a 2-pound hammer and then turned with a wrench, the leverage of which is not over 14 inches. It is impossible to explain just how much a tube should be rolled, as this can best be determined by the sense of feeling. An experienced mechanic will be able to judge when the rolling is sufficient.



Roller Pin

After rolling, the ends of the tubes should be slightly flanged, which will serve to stiffen them. This part of the operation, however, should be done carefully in order to avoid fractures.

If only a few tubes are placed in heads with wide bridges, the oxy-acetylene process could be used, if an expert welder is available. When it is remembered that the fusing point of brass is 1,650 degrees F., and the fusing point of soft steel about 2,350 degrees F., it is easily understood that considerable skill is required to weld the two metals.

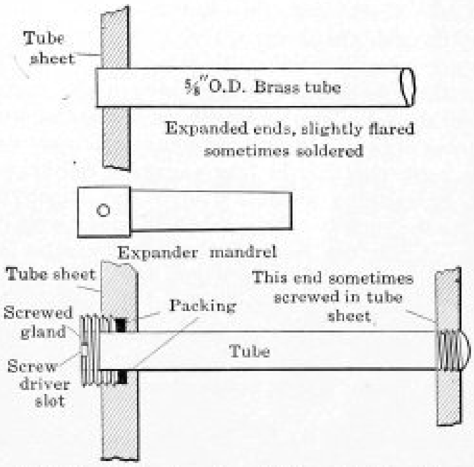
C. E. Lester.

Alternative Methods

There are several ways of securing tubes in tube sheets, according as to the purpose for which the apparatus as a whole is used. It is not stated in the inquiry as to whether the brass tubes referred to are to be used in a flash boiler, a feed heater or a condenser. If the tubes are for a so-called flash boiler, the tubes are simply expanded in the tube sheets, and in some instances they are slightly flared. The expander is a tapered mandrel, which is driven in the tube end by hand only, as such small tubes of brass do not require any greater force than that to make them tight in the tube sheets.

In some cases the tubes have been secured by soldering the ends in the holes in the tube sheets. This method also applies equally well to small feed heaters.

If the tubes are to be used in a surface condenser then the following methods may be applied: The tube sheets are recessed to admit of small packing being wound around the tube ends with a screwed gland to keep it in place, as shown in the sketch. This may be done at both ends of the tube or one end may be screwed into the tube sheet and the other packed as described. The packing generally used is cotton tape or ordinary corset lacing, either of which is satisfactory for that purpose.



Method of Securing Brass Tubes in Tube Sheet

Still another method is to secure the tube ends with vulcanite paper ferrules, which are driven into recesses surrounding the tubes.

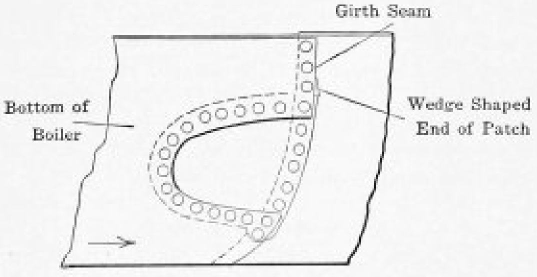
It would seem from the inquiry and the thickness of tube sheets given that the most suitable way to do this work is with the tapered mandrel, which will also slightly flare the tube ends. This, it is believed, will make a good job at a minimum cost.

Charles J. Mason.

Jim to Jack

"Hello, Jack; what's got you to-day? One would think by the look on your face that some one had sneaked your dinner pail."

"Everything is fine and dandy, Jim, but I was looking over the December Boiler Maker. I don't know much about these examination questions for the boiler inspector, but there is one that interests me. That is the one about the patch necessary to repair a shell plate that's got fire cracks at the girth seam over the fire. I see that they always scarf the corners and slip the patch between the shell plates. Why don't they slam it on the outside? That would be much easier, Jim."



Proper Shape of Patch

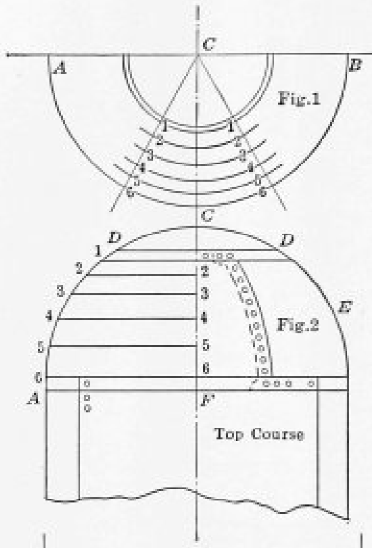
"There is a reason, Jack, and if you will stir up the cork dust you call your brain, we might have a little talk. Suppose, as you express it, we did slam it on the outside and made a good, tight job of it, do you believe it would be as good as the one in the illustration?"

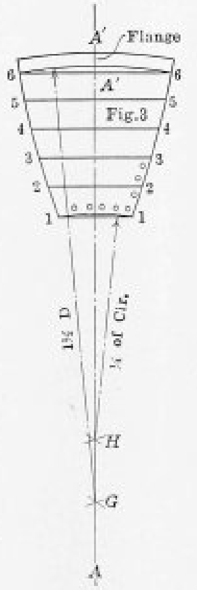
"Why, sure it would!"

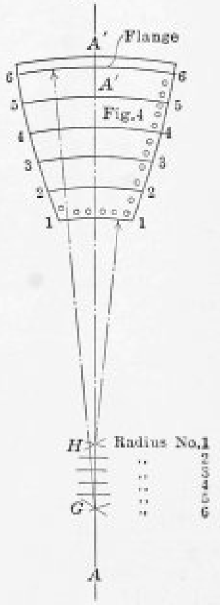
"No, it would not. The hot gases and flames are traveling in the direction of the arrow shown, and they would soon hit the edge of your patch and cause trouble. But worse than that, the scale and dirt would soon fill up the hollow where the piece of shell plate was cut out, and the dirt could not get out of that hollow when the fireman opened the blow-off. The result would be that your patch would soon be burned and bagged, and a larger patch necessary, if the bottom did not come down altogether."

"Why, Jim, I never thought of these things."

"Bah! You don't think. Now that patch should be rounded instead of being cut square, at least I have always put them on that way. This will increase their value, as we then have the longitudinal seam taking the form of a diagonal seam. It is easier to keep tight, too, for a square-cut corner is hard to calk and keep tight, and would soon develop fire cracks."







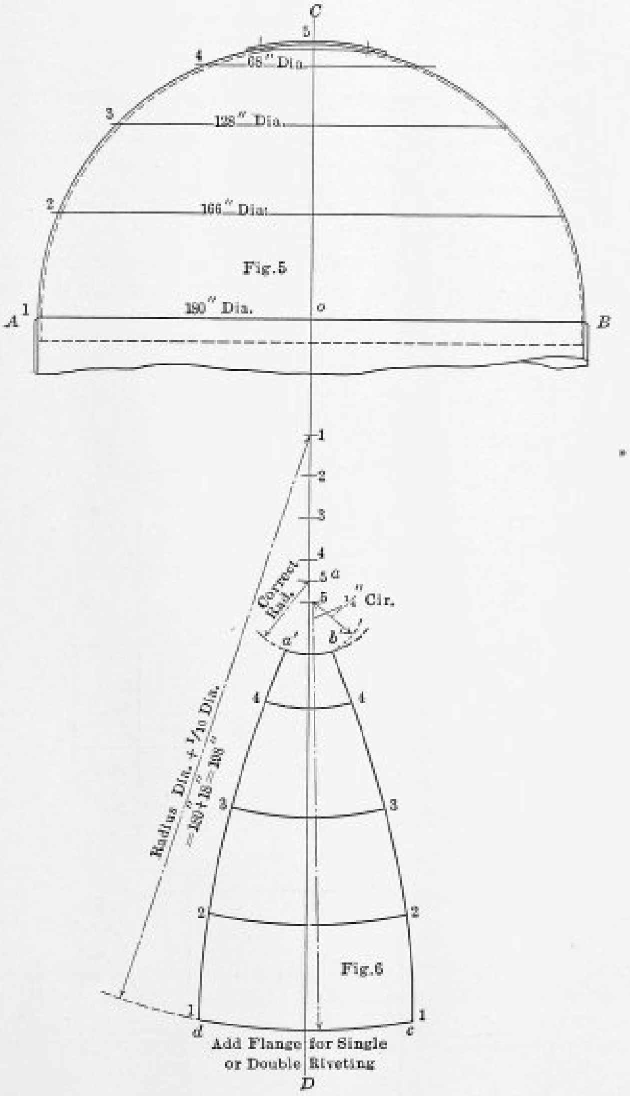
"There is another thing that is worrying me, Jim. Take that layout of a round-top tank. I don't know a great lot about it, but that layout does not look right."

"I do not think it is right, Jack. Take the length of that curved line 5-5, Fig. 1, and transfer it to the straight line 5-5, Fig. 3. That would be away out. The segment would be the correct size, top and bottom, but 5-5, 4-4, 3-3, 2-2 should be curved to a certain radius and the lengths from Fig. 1 transferred to the curved lines in Fig. 3."

"Those 15-foot diameter heads we had were dandy fine holes and a fit like a glove."

"Yes, Jack, and these heads would have been all out if we had taken the length, say, of segment 5-5, Fig. 1, and transferred it to the straight line 5-5, Fig. 3. They would have been 5/8 inch too long. That would have made our pattern 5/8 inch too long at 5-5, and with eight plates that would have been 5 inches too large in circumference, and all the other lines would be large in proportion.

"Now we will draw in Fig. 4 just alongside Fig. 3, and you will see at a glance what I mean. Then to get the radius for each different diameter we have to divide the major and minor radii, or the distance *G-H*, Fig. 4, into as many sections as we have on Fig. 1, in this case 6; we then have radii 1, 2, 3, 4, 5 and 6 on Fig. 4.



"Now let us draw a 15-foot diameter head on the line *A B*, Fig. 5, and with *o* as a center and the radius *o*-1 lay out our head 180 inches diameter. We then divide one-quarter of this circle into as many pieces as possible; the more we have the more correct will be the development of the pattern. To save confusion we will only divide it into four pieces. This will give us points 1, 2, 3, 4 on the circle, Fig. 5. Then we draw lines parallel to the center line *A B* from the points 1, 2, 3, 4 on the circle to the center line *C D*. This will give us each diameter of the head. At 1 it is 180 inches, at 2, 166 inches, and so on. We have eight plates; that would be one-eighth of these diameters for our pattern.

"We now extend the center line *C D*, and with the point 1, Fig. 6, as a center, and the radius equal to the diameter plus 1/10 diameter; that is, 180 inches + 18 inches = 198 inches radius, we lay out the bottom line of the required segment. For the radius at the top use one-quarter circumference for a start, as at 5, Fig. 6. Then divide the distance between these two into as many parts as required; in this case four. These points will be the correct ones for each radius, as 1 to 1-1, 2 to 2-2, 3 to 3-3, 4 to 4-4, and then we come to the top. The hole and cover plate may be any odd size; in this case it comes midway between the points 4 and 5, Fig. 5, and for the radius we locate the point midway between 4 and 5, as 5a, Fig. 6.

"We now figure out each circumference; take 180 inches diameter, and mark 1/16 the circumference on a piece of hoop. Do the same with each diameter 166 inches, 128 inches, 68 inches, 36 inches, or whatever sizes we have. We then locate these lengths that we have marked on the hoop, on Fig. 6; working from the center we thus locate the points 1-1, 2-2, 3-3, and so on, on the curved lines already drawn on Fig. 6. Then using the points so found we draw in the shape of the figure, and this will be the required segment as at *a'*, *b'*, *c'*, *d'*, Fig. 6. These points should then be checked up with the trammels from the center line to see that both sides are exact. Add the flange and the laps.

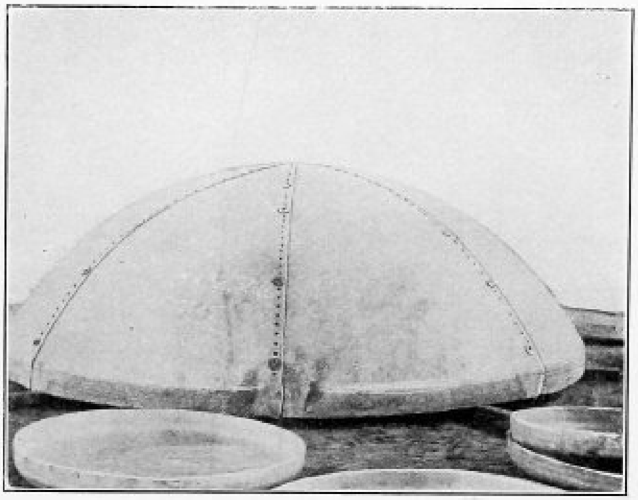


Fig. 7

If the segments are to be of lap-joint construction the outside plate will have to be longer. Suppose the heads are ½ inch thick, the outside plate will be nearly 7/8 inches longer, and two-thirds of this is added at *c'* and one-third at *b'*. These plates are scarfed at *b'*, *c'*, and then pressed into dies, flanging and dishing at one operation.

"The photograph, Fig. 7, shows a head laid out this way. It is 8 feet 3 inches radius. When flanged the edges of the plate lay straight with the sides of the dies, thus proving the accuracy of the layout, and when the heads were erected they came right in place without any drifting."

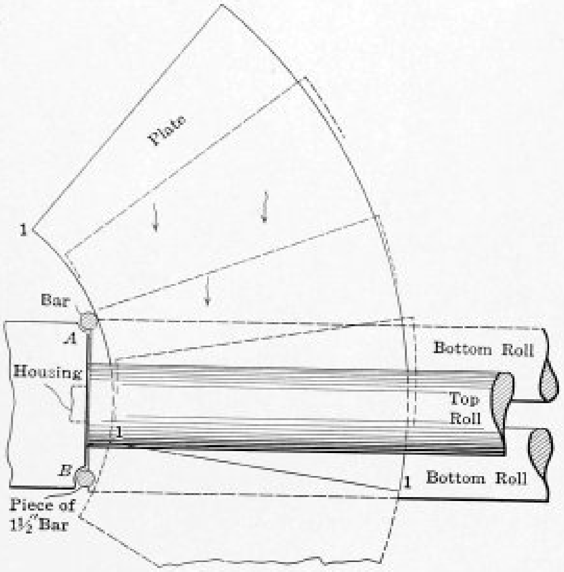
"You bet they did!" said Jack. "Every hole fair, and we had only to heave it up with the crane and punch around the bottom. Well, good bye, Jim." CRAGLUG.

How to Roll Cones or Cone-Shaped Plates

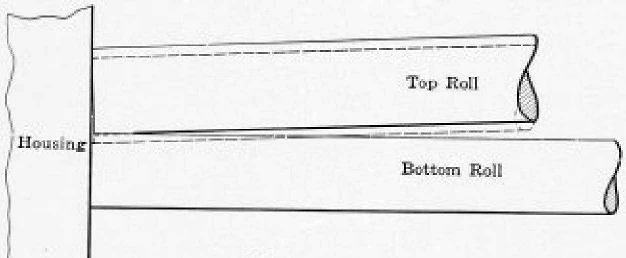
The rolling, or shaping, of tapered plates that go to make up cones or tapered cylinders seem to many boiler makers to be a very formidable-looking job, yet it is not so difficult a matter.

Plates forming complete cones in one piece, if not of too heavy material, may be rolled right up without any lining up or shifting of the plates. Take, for instance, a cone of 5/16-inch plate, 48 inches diameter at the bottom and 40 inches diameter at the top, and about 36 inches high, such as are used for reducers from the wagon top to shell of "oil country" boilers. A one-piece cone of this description takes about half an hour to roll.

The plate is entered in the rolls and run right through; the narrow end of the plate is kept close up to the housings of the rolls, and a piece of round bar is placed between the housings and the plate for the plate to swing around on. It will readily be understood that when the plate starts to travel in the direction of the arrows in the illustration it will hit and jam on the bar *A*, and this will retard the narrow end, and the wide end of the plate will keep traveling through the rolls and gradually swinging around, while the narrow end travels more slowly. The plate will require possibly four or five passes through the rolls to come out right.



Plan View of Rolls



Side View of Rolls

Arrangement of Bending Rolls for Rolling Cones

If these bars are not used at *A* and *B*, the sharp edge of the plate will soon cut a groove in the housing of the rolls. The makers of these tools might take a hint from this and have tool steel rolls inserted in their new machines. Having rolled some hundreds of these cone-shaped plates in a year, the writer knows whereof he speaks.

With heavy plates it is usual to put lines on them radiating from the center to the circumference; and to keep these lines which we have put on the plate as nearly as possible parallel with the rolls, and to roll a short piece at a time, then move the plate around a little at the bottom so as to avoid flat spots. The bottom may have to be hammered out a little if the cone is very short and has a sharp taper. The rolls should be lowered only from the one end, but like the rolling of any shell plate good judgment will be required. The illustrations will show more clearly what is required.

Cone sections of heavy plate are sometimes set up under the sectional flanges with formers, and in one shop the writer saw them forming cones of ½-inch plate under the punch press with a pair of forming dies. Where a number of plates are required to make up a very large cone it is sometimes cheaper to roll one plate to correct shape, and lay it on a sand bed, or bed it in the ground in front of the furnace; then heat the plates and set them hot into the plate already formed, using wooden mauls to beat them into shape. We recently made some 25-foot diameter cone bottoms in this way with butt joints and cone straps; they were for 1,500-barrel agitators. James Crombie.

Oil City, Pa.

Two Easy Lessons for the Apprentice

Fig. 1 shows a side view and elevation of a wheelbarrow body which may be constructed out of light material. Fig. 2 shows a half plan of same.

Layout of Wheelbarrow Body

To lay out this article begin by dividing the quarter circles into equal parts. These quarter circles constitute the top corners of the body.

To produce the pattern, lay off the rectangle as shown by *A-A-C-C* in Fig. 3. Extend the side lines, as shown, to *B-B* and *D-D*. With dividers set to the slant line *A-B* in Fig. 1,

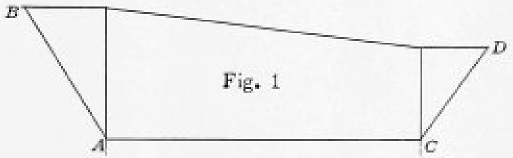


Fig. 1

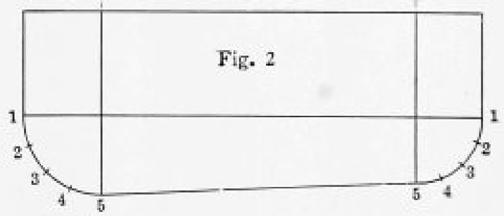


Fig. 2

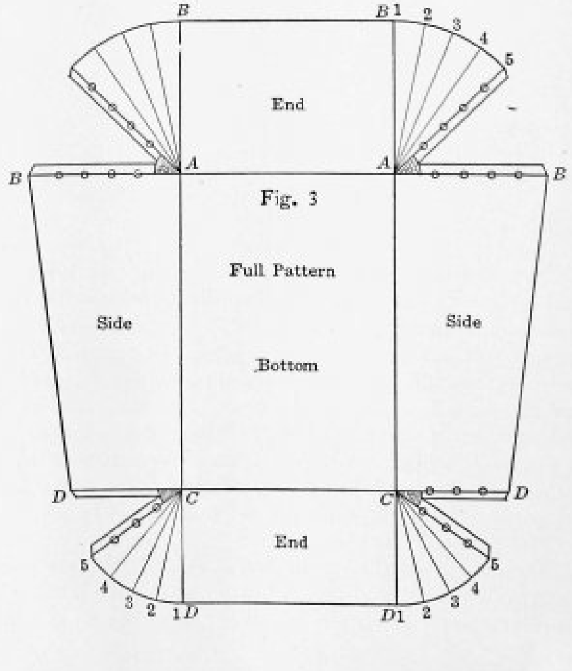


Fig. 3

strike arcs from *A-A*, Fig. 3. Set the dividers to one of the spaces on the quarter circle, Fig. 2, and step off four points as shown, and connecting to the corners *A-A* and *B-B*. This completes the large end of the pattern.

For the small end, set the dividers to the slant line *C-D*, Fig. 1, and strike arcs from the corners *C-C*, Fig. 3. Set the dividers to spaces on the quarter circles at the small end and step off the spaces as shown.

The dimensions for the sides are taken from the slant lines *A-B* and *C-D*, Fig. 1. Connect up the outline, as shown to the rivet lines. The shaded portions can be cut out, as it will then be easier to work the corners together. A light reinforcing band can be applied around the top edges, adding to the durability of the body.

Layout of Square Tapering Article.

Fig. 4 shows the elevation of a square tapering article. To secure the pattern, set a square to the line *C-D*, and mark off lines *D-G* and *C-E*, which make a length equal to one-half of the width of the desired article. Through points *E* and *G* strike lines intersecting at right angles at *F*. This will give the radius from which the pattern can be struck.

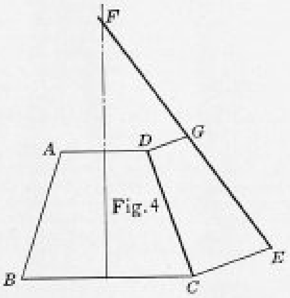


Fig. 4

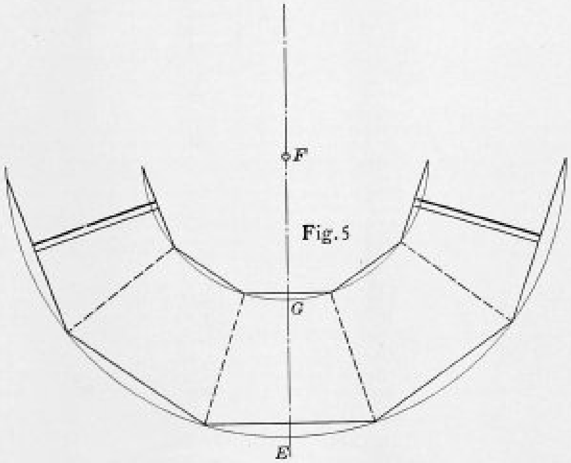


Fig. 5

Set out the line *F-E*, Fig. 5, and with the radius *F-E* draw up part of the circle as shown. With radius *F-G* draw the top circle. From the point *E* on the radius, Fig. 5, step off on each side of line *F-E* the half width of the bottom. From these points step off two full widths of the bottom and connect with lines as shown. The same procedure should be carried out at the top with half widths of the top from point *G*, and then two full widths on each side, as shown. The last widths on each side are to be halved and lines drawn for the rivet line, bringing the same at the center of one side of the article. Bending lines are shown dotted.

These two problems are submitted with the idea that they will be interesting to many of the younger boys in the shops, and that they may perhaps lead some of them to utilize their spare time in efforts that eventually will lead up to better positions.

Joseph Smith.

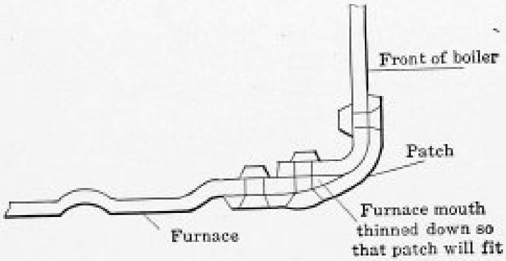
Lorain, Ohio.

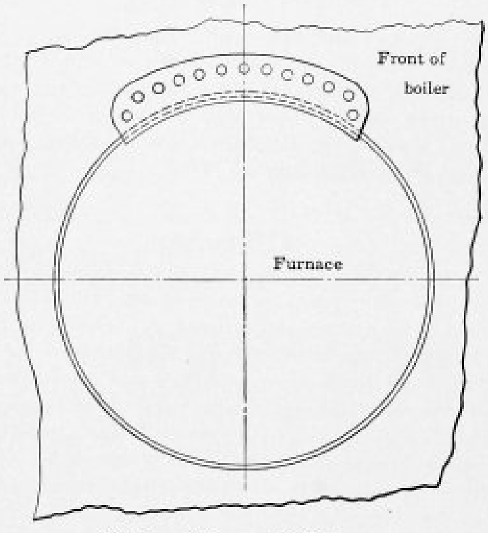
Applying a Patch to a Corrugated Furnace in a Scotch Marine Boiler

Patches are rarely used on a corrugated furnace in these days. The insurance company usually specifies repairs of this kind to be made by the oxy-acetylene welding process.

If the crack is only at one rivet hole, or in several widely scattered places, the rivet should be cut out, and the hole well countersunk, then a long rivet, well driven, will keep this tight for a long time, and will be better than a patch.

If there are a number of cracks close together, the rivets around the damaged part of the furnace mouth should be cut out and the furnace mouth chipped so that a patch will fit close to it, as shown in the illustration. Then a patch should be made to take a row of rivets on the front of the boiler, and a new row of rivets back of the old row of rivets in the furnace mouth. There should be room enough for this extra row of rivets without interfering with the first corrugation.





Patch on Corrugated Furnace

The cast iron baffle-plates on the furnace front will protect this patch from the flames. If the baffle does not extend inwards far enough it may be a wise plan to have new baffle-plates made with a flange projecting inwards.

Oil City, Pa.

James Crombie.

A Problem in Laying Out

The following is a problem in laying out I should like to have readers of The Boiler Maker explain in the next issue:

The problem is to lay out a pattern for a helicoid conveyor with an outside diameter of 12 inches and a pitch of 12 inches, made of No. 24 U. S. standard gage iron wound around a 2-inch bar. The writer found it necessary to make two cuttings for one complete pitch for this job, but would be glad to see other methods of doing this.

H. H. S.

Philadelphia, Pa.

Personal

L. E. Boline has been appointed foreman boiler maker of the Rock Island lines at Pratt, Kan., vice J. W. Greenly.

Albert Lodor has been appointed foreman boiler maker of the Rock Island lines at Biddle, Ark., vice P. J. Donohue.

William J. Hess, formerly of Manitowoc, Wis., has established a new boiler shop, to be known as the Hess Iron Works, Inc., at Green Bay, Wis. The plant is fully equipped for the manufacture of stationary and marine boilers.

John Cook, Springfield, Ill., recently established a small boiler shop equipped for doing general sheet iron work and boiler repairs. Mr. Cook has been actively engaged in boiler making for sixty years, and has been a frequent and valued contributor to The Boiler Maker.

James H. Sheridan, formerly foreman boiler maker for the Pioneer Iron Works, and at present foreman boiler maker of the McNeil Iron Works, Brooklyn, N. Y., has been appointed instructor in a course for boiler makers at the Murray Hill Evening Trade School, Thirty-eighth street and Second avenue, New York City. The hours for this school are from 7:45 to 9:45, Monday, Tuesday, Wednesday and Thursday evenings each week. Instruction in these courses is free, and the first class in laying-out will be graduated this year.

The Central Boiler & Sheet Iron Works, Indianapolis, Ind., was recently incorporated under the name Central Boiler & Sheet Iron Works, Inc. The change in the company is accompanied with a considerable increase in the equipment of the plant, which is designed for a general line of boiler, tank, stack and sheet metal work.

Obituary

Herman Charles Meinholtz, vice-president of the Heine Safety Boiler Company, died at St. Louis, Mo., Dec. 24, at the age of 45. Mr. Meinholtz entered the employ of the Heine Safety Boiler Company at the age of nineteen as a draftsman, and was continuously connected with that company up to the time of his death. He was made superintendent in 1895 and vice-president in 1907. He had entire charge of the company's shop when it was established in 1899, and under his general direction the company's new factory was designed and built in 1909, and since that time it has been under his direct supervision. Mr. Meinholtz was a member of the Engineers' Club of St. Louis and of the American Society of Mechanical Engineers.

Pacific Locomotives for the Chicago-Great Western.—During the month of December, 1913, the Baldwin Locomotive Works completed for the Chicago-Great Western Railroad five Pacific type locomotives which are notable because of their general design and the details of their construction. The cylinder volume is 15.9 cubic feet and the total equivalent heating surface of the boiler is 4,293 square feet. There are thus provided 310 square feet of equivalent heating surface per cubic foot of cylinder volume—a liberal allowance even for a fast passenger locomotive. The boiler is of the extended wagon-top type, equipped with the Gaines locomotive furnace. The firebox has a deep, sloping throat, and is placed entirely back of the driving wheels. The length of the combustion chamber, measured from the vertical face of the tube sheet to the front of the bridge wall, is 30 inches. Air is conducted to the top of the wall through five wrought iron pipes, each 3 inches in diameter, set vertically in the brick work. The air as it leaves the pipes is in a heated condition, and is deflected in a downward direction under a brick arch. This arch is supported on four watertubes, and extends backward a distance of approximately 40 inches from the top of the bridge.

Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
Millertown, N. Y.

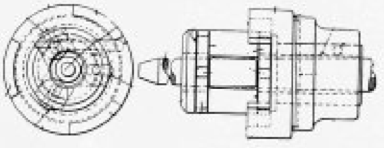
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,071,787. STEAM-BOILER FURNACE. ORLAND D. ORVIS, OF NEW YORK, N. Y.

Claim 2.—In a furnace for water-tube boilers, the combination with the furnace walls forming a grate chamber and nested water tubes extending across said chamber, of baffles positioned over the grate chamber and spaced with respect to each other to produce a throat or outlet substantially centrally of said chamber, said baffles consisting of firebrick which are imposed upon, and supported directly by, the lower tier of said nested water tubes, blast pipes positioned in opposite walls of said grate chamber, means for supplying steam and air to said blast pipes, and a plurality of series of blast nozzles attached to said pipes and positioned in facing relation for discharging steam and air in a common plane with reference to the grate chamber, said blast nozzles being provided with horizontally positioned flaring outlets which operate to direct the outflowing currents of steam and air on diverging lines so that the individual streams will intersect one with the other, the two series of nozzles operating to project the steam and air in thin sheets and opposite directions and in intersecting paths so that the aggregate area of the two sheets of steam and air is equal substantially to the area of the grate chamber. Two claims.

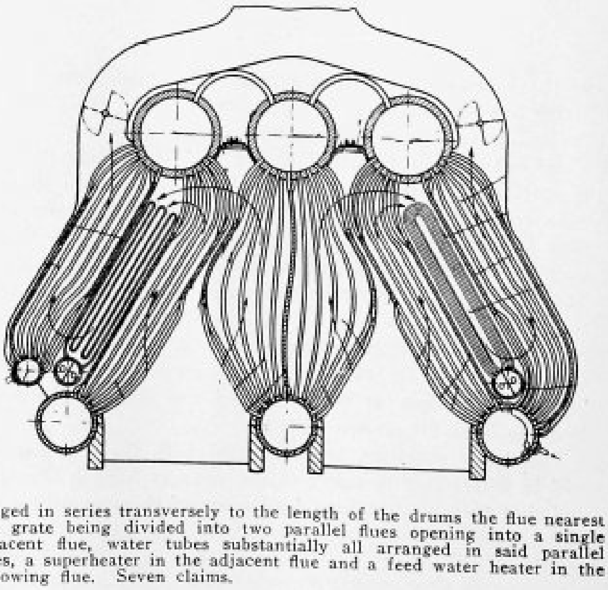
1,072,056. FLUE-EXPANDER. JOHN STRAUSER, OF ALTOONA, PA.

Claim.—A flue expander comprising a roller carrying frame having a central bore extending throughout its length, the body of which is provided with circumferential grooves whose bottoms have notches, spaced apart segmental posts formed between said grooves and parallel to the axis of the frame, a stem portion of the frame, a collar formed at the junction of the latter with the body of the frame, rollers located between the spaced apart posts and having journals bearing in said notches, spring retaining rings fitting in the grooves in the frame body to hold the rollers in position, a flue guard fitted over the stem portion and having a circular recess receiving the collar between the body and stem of the frame, a ferrule having a central opening and a circular recess on its bottom face adjacent thereto, a ring of anti-friction material fitted within said recess, said ferrule being fitted over the stem and locked thereto so that the anti-friction ring abuts against the rear face of the flue guard, and a roller bar extending through the central bore of the frame for forcing the rollers outwardly. One claim.



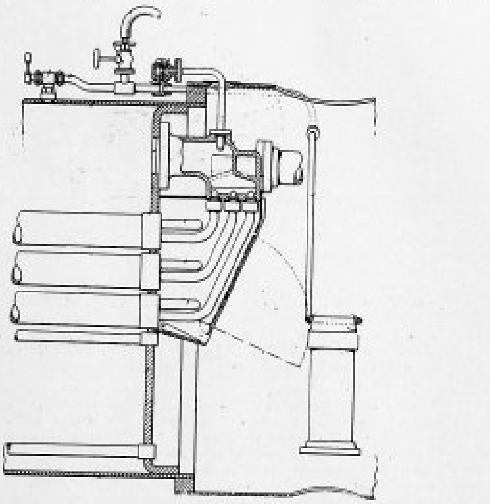
1,072,174. WATER-TUBE BOILER. WILHELM SCHMIDT, OF CASSEL-WILHELMSHOEHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF GESELLSCHAFT MIT BESCHRAENKTER HAFTUNG, OF CASSEL, GERMANY, A CORPORATION OF GERMANY.

Claim 2.—In a water-tube boiler provided with upper and lower drums, and a plurality of heating flues extending in opposite directions arranged in series transversely to the length of the drums the flue nearest the grate being divided into two parallel flues opening into a single adjacent flue, water tubes substantially all arranged in said parallel flues, a superheater in the adjacent flue and a feed water heater in the following flue. Seven claims.



1,072,149. APPARATUS FOR COOLING SUPERHEATER-PIPES. PETER THOMSEN, OF CASSEL-WILHELMSHOEHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF GESELLSCHAFT M. B. H., OF CASSEL-WILHELMSHOEHE, GERMANY, A CORPORATION OF GERMANY.

Claim 1.—In a boiler provided with fire tubes, in combination, superheater tubes in some of said fire tubes adapted to have their steam supply cut off, a blower pipe connected with the boirler by a cock and provided with a nozzle, a branch pipe opening from the blower pipe between said cock and nozzle and jointed to the saturated end of the superheater elements, and a check valve controlling said branch pipe. Three claims.

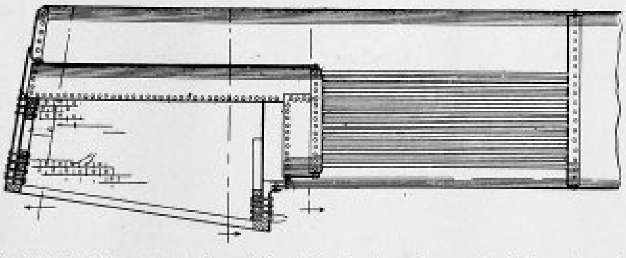


1,072,598. APPARATUS FOR SUPERHEATING STEAM. EDWARD A. GEOGHEGAN, OF ERIE, PA.

Claim 1.—In a device, the combination of a heating chamber, a furnace for supplying hot gases of combustion to said chamber, and a series of steam conveying tubes in said chamber, which tubes increase in number and decrease in diameter in the direction of the flow of steam therethrough. Four claims.

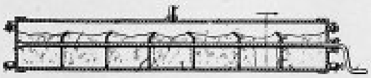
1,072,831. STEAM-BOILER. JAMES R. CUSHING, DECEASED, LATE OF COLUMBUS, OHIO, BY MARY K. CUSHING, ADMINISTRATRIX, OF COLUMBUS, OHIO.

Claim 1.—A boiler comprising a casing, a crown sheet secured thereto, a tube sheet connected to the crown sheet, a waist, and an auxiliary sheet extending rearwardly of the tube sheet and connected thereto and to the waist. Two claims.



1,075,162. AUTOMATIC MUD-DRUM FOR BOILERS. ALEXANDER FRANKLIN SHREVE, OF HOISINGTON, KANSAS, ASSIGNOR OF ONE-HALF TO GILBERT SETTE, OF HOISINGTON, KAN.

Claim 1.—A device comprising a boiler, a mud ring communicating therewith, a mud drum connected with said mud ring for receiving mud therefrom, means for venting said mud drum in order to convey into said mud drum material deposited in said mud ring, and means for opening said drum in order to discharge said material therefrom. Four claims.



1,071,689. SMOKE-CONSUMING DEVICE FOR FIRE-BOXES. WILLIAM D. BOYCE, OF NEW YORK, N. Y.

Claim 4.—In combination with a fire-box baffled to deflect the combustion products in a direction opposed to the normal direction of flow of said products, means for conducting currents of air in subbstantially vertical sheets to said deflected products, and means for projecting independent jets of steam at an oblique angle to intersect the air currents, and in a direction opposed to the general direction of initial flow of said deflected products. Seven claims.

1,072,865. FIRE-BOX FOR BOILERS. JAMES M. McCLELLON, OF EVERETT, MASS.

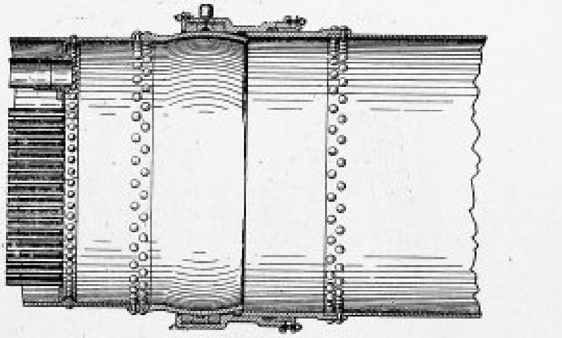
Claim 1.—In a fire-box the combination of a wall comprising flanged sections, the flanges whereof at their lower ends have portions removed, a connecting plate crossing the lower ends of said sections and secured to the unflanged faces thereof, and a mud-ring to which the lower edge of said plate is secured. Nineteen claims.

1,075,043. AUTOMATIC BOILER-FEED REGULATOR. WILLIAM F. KRICHBAUM, OF NEWARK, N. J., ASSIGNOR TO FOSTER ENGINEERING COMPANY, A CORPORATION OF NEW JERSEY.

Claim 4.—In a boiler-feed regulator, the combination of a base, and expansion tube projecting upward from said base, guide rods at opposite sides of said expansion tube, a cap for the expansion tube slidably engaging said guide rods, a bell-crank lever pivotally connected to said guide rods with one arm extending transversely of the end of the expansion tube adjacent thereto and the other arm projecting downward longitudinally of the expansion tube, and means for connecting said last-mentioned arm of the lever to the boiler feed valve to open and close the same as the expansion tube varies in length. Nine claims.

1,074,877. BOILER FOR ARTICULATED LOCOMOTIVES. WILLIAM J. LEIGHTY, OF TOPEKA, KAN.

Claim 3.—A boiler made in two sections, a coupling member secured to each of said sections, said coupling members being articulated by a movable joint. Thirty-six claims.

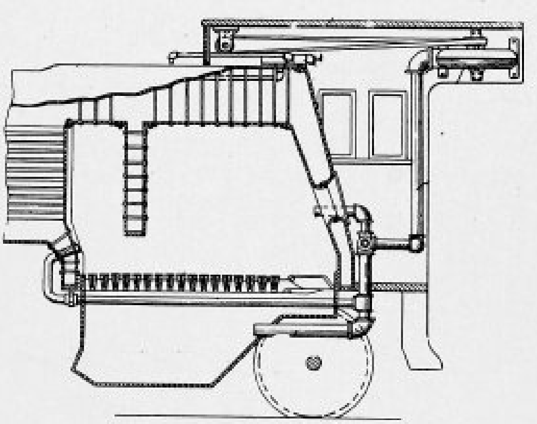


1,075,728. STEAM GENERATOR FOR OIL BURNERS. PETER ROOT, OF EUREKA, CAL.

Claim 4.—A steam generator coil, having a plurality of superposed U-shaped members, and four vertical pipes, each pipe having the upper end connected to and in communication with the lowest member of the coil to provide a sediment receptacle for the generator. Five claims.

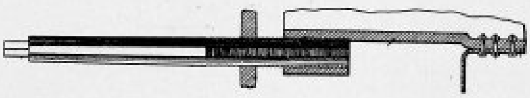
1,080,103. LOCOMOTIVE. FRANCIS J. DOYLE, OF CHICAGO, ILL.

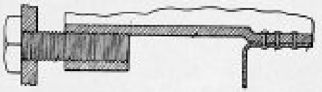
Claim.—In a locomotive, the combination with a fire chamber a grate at the lower end of said chamber and a closed ash pit below said grate, flues extending from the front end of said fire chamber, a wall depending from the roof of said fire chamber and terminating within a short distance of the grate and disposed in front of but spaced only a short distance from the inlet ends of said flues, adjustable means for restricting the outlets of said flues, means for positively forcing air into said closed ash pit and into said fire chamber and into the restricted throat between said depending wall and grate. One claim.



1,080,686. METHOD OF SECURING THROAT-BRACES. JOHN FRANCIS GERO, OF NEWARK, OHIO.

Claim 1.—The method of securing throat braces to boilers consisting of primarily threading a throat brace and leaving the tap therein, temporarily attaching the brace to the boiler with the operating end of the tap disposed through the aperture of the flue sheet, and then withdrawing the tap from the brace through the sheet aperture and threading the aperture during the withdrawal of the tap. Two claims.



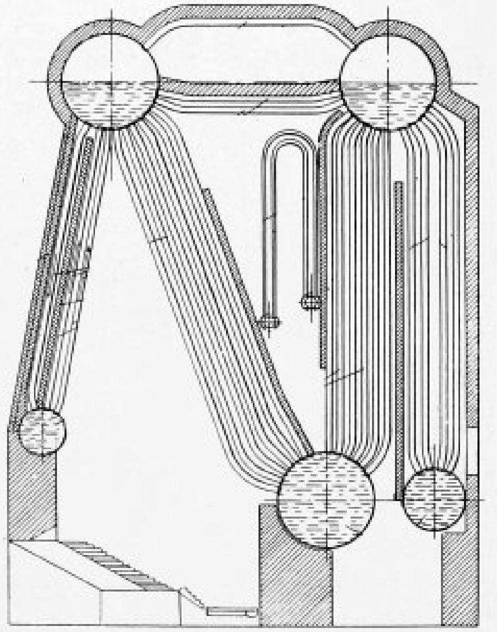


1,081,132. STEAM-REGENERATIVE ACCUMULATOR AND WATER-HEATER. DONALD BARNS MORISON, OF HARTLEPOOL, ENGLAND.

Claim 1.—A steam regenerative accumulator having submerged steam condensing and water circulating devices, consisting of circulating tubes, steam discharge outlets disposed within said circulating tubes for directing a surface flow of water toward one end of the accumulator, water outlets in said circulating tubes arranged at one side thereof adapted to co-operate with said discharge outlets for establishing a surface flow in one direction. Four claims.

1,082,597. WATER-TUBE STEAM BOILER. GEORGE M. KOHLER, OF SYRACUSE, NEW YORK.

Claim 3.—A water-tube boiler comprising a wall, a lower front water drum, an upper front steam and water drum, a bank of tubes longitudinally positioned adjacent said wall and connecting said drums, a baffle plate placed transversely between said tubes and extending logitudinally thereof substantially the entire length of said bank of tubes with a row of said tubes positioned between said baffle plate and wall. Four claims.

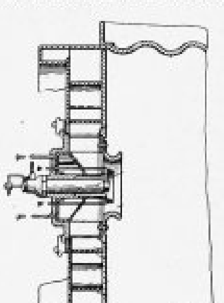


1,080,368. STEAM-BOILER FURNACE. JAMES REAGAN, OF PHILADELPHIA, PA.

Claim 1.—In a boiler furnace, the combination with the combustion-chamber thereof, of a baffle or retarder wall constructed of interlocked tiles, laid loosely one upon the other, said tiles being of substantially rectangular shape provided with longitudinal, circular passages therethrough, and with grooved corners to provide circular passages at the intersection of the adjacent tiles. Three claims.

1,082,835. FURNACE FRONT. WILLIAM ALBERT WHITE, OF NEW YORK, N. Y.

Claim 1.—A furnace front, a burner tube entered therein, a perforated cooling jacket spaced from and surrounding said burner tube, and main air supply means surrounding said jacket, said perforated cooling jacket receiving air from said main air supply for impingement upon the burner tube, and for issue about the burner nozzle. Eight claims.

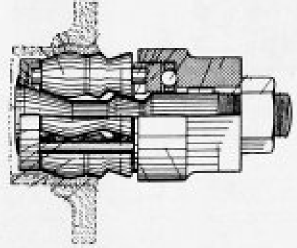


1,080,613. WATER-TUBE BOILER. EDWARD H. WELLS, OF MONTCLAIR, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 2.—A water-tube boiler having two banks of inclined generating tubes one above the other, uptake and downtake headers into which the tubes of said banks are expanded, tubes connecting the downtake headers of said banks, a transverse baffle extending across the tubes of the upper bank to the lower bank, a longitudinal baffle extending from the downtake headers of the lower bank to said transverse baffle, a plate resting against said connecting tubes, said longitudinal baffle and plate forming with the side walls of the setting a dust-collecting chamber between the two banks of tubes, and means for removing the dust from said chamber. Five claims.

1,081,496. EXPANDER FOR PIPES, TUBES, ETC. HORATIO G. GILLMOR, OF QUINCY, MASS.

Claim 1.—The combination of a plurality of rolls constructed with a plurality of parallel conical surfaces, and a mandrel having a plurality of parallel conical surfaces adapted to bear upon the parallel conical surfaces of said rollers. Eleven claims.

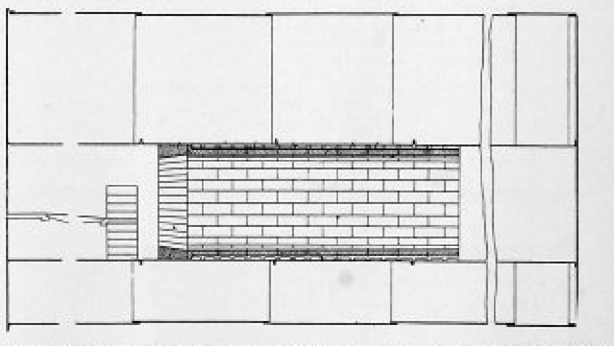


1,081,545. FURNACE. ROBERT D. McMANIGAL, OF LOGAN, OHIO, ASSIGNOR TO THE McMANIGAL GRATELESS FURNACE COMPANY, OF COLUMBUS, OHIO.

Claim.—The combination with a coking chamber and ash pit of a furnace, of a division wall separating the same and provided with a longitudinal draft passage open to the atmosphere, an arch also provided with a longitudinal draft passage leading therethrough, an upstanding bridge wall located in rear of the coking chamber and arch and separated from the rear end of the division wall, the upper end of the upstanding wall being provided with vertical and horizontally arranged passages. One claim.

1,082,829. HEAT DIFFUSER FOR BOILER FLUES. LEONARD A. SMALLWOOD, OF BIRMINGHAM, ENGLAND; ALFRED SMALLWOOD, ADMINISTRATOR OF SAID LEONARD A. SMALLWOOD, DECEASED.

Claim 2.—In combination with a boiler having a flue therein, of a refractory lining in said flue having reduced portions engaging the flue to support the lining therein, and metal heat conducting elements between the lining and said flue and out of contact with the flue. Three claims.



1,082,809. TOOL FOR SPREADING THE TUBES OF WATER-TUBE BOILERS. JOHN KEERS, OF BROOKLYN, NEW YORK.

Claim 1.—A tool for spreading the tubes of water-tube boilers, embodying a carrier comprising two main parts one of which is slidable in the other, a pair of tube-spreading members secured respectively to said carriers and disposed end to end and one of which is movable toward and from the other lengthwise of the carrier for spreading a plurality of tubes relatively to one another, and means for moving said tube-spreading members toward and from each other. Six claims.

1,082,701. EXHAUST NOZZLE. LAWRENCE C. MOONEY, OF MONTGOMERY, ALA.

Claim 1.—An exhaust nozzle comprising a hollow stand or body divided centrally by a vertical partition extending to the open bottom of the stand and forming an independent inlet from each exhaust port, said body being enlarged above the inlets to permit the expansion of steam and prevent compression within the cylinders, a contracted nozzle on the upper end of said body or stand above the partition, and a rigid deflector in the center of said nozzle in the form of two cones united at their bases, the connected bases lying in the plane of the top of said nozzle. Four claims.

1,082,312. STEAM GENERATOR WITH FORCED CIRCULATION. PIERRE FOUQUE AND GILBERT CHARPENTIER, OF LA-PLAINE-ST.-DENIS, FRANCE.

Claim.—A steam generator with forced circulation and composed of detachable separate elements comprising in combination a certain number of chests, each forming one element, a partition in the chest dividing the same into two compartments and having a hole of small diameter, U-shaped tubes terminating with one end in one of said compartments and with the other end in the other compartment, an inclined perforated top wall of the chest and an inclined perforated bottom of the chest, cross pieces supporting said chests and having holes registering with the holes in the bottom and top plates of said chests, cavities in the upper and lower surfaces of said cross pieces corresponding with the inclined top and bottom plates of said chests, ring-shaped projections surrounding said holes of the cross pieces, preforated red copper caps upon said ring-shaped projections and double uprights at the ends of the cross pieces supporting the same. One claim.

THE BOILER MAKER

MARCH, 1914

Oxy-Acetylene Torch Reclaims Scrap Metal

Cutting Up the Wreck of a Steel Ship with the Oxy-Acetylene Torch—The Metal Reduced to Mill Scrap

The tangled wreckage of the 1,800-ton steel freight steamer *Alum Chine*, which was destroyed by a dynamite explosion in the lower harbor of Baltimore on March 7, 1913, has recently been reduced to steel mill scrap with the aid of the oxy-acetylene cutting torch. This steamer was destroyed by an explosion of 300 tons of dynamite in its hold while loading a cargo for Panama. The violence of the explosion was so great that the entire forward part of the ship was blown away, the deck and upper works being reduced to bits and scattered over the harbor and adjacent shores for a radius of several miles, while the major part of the hull was thrown to the bottom in 33 feet of water. Pieces of steel 3 to 5 feet long were found at distances 2 to 3 miles from the wreck.

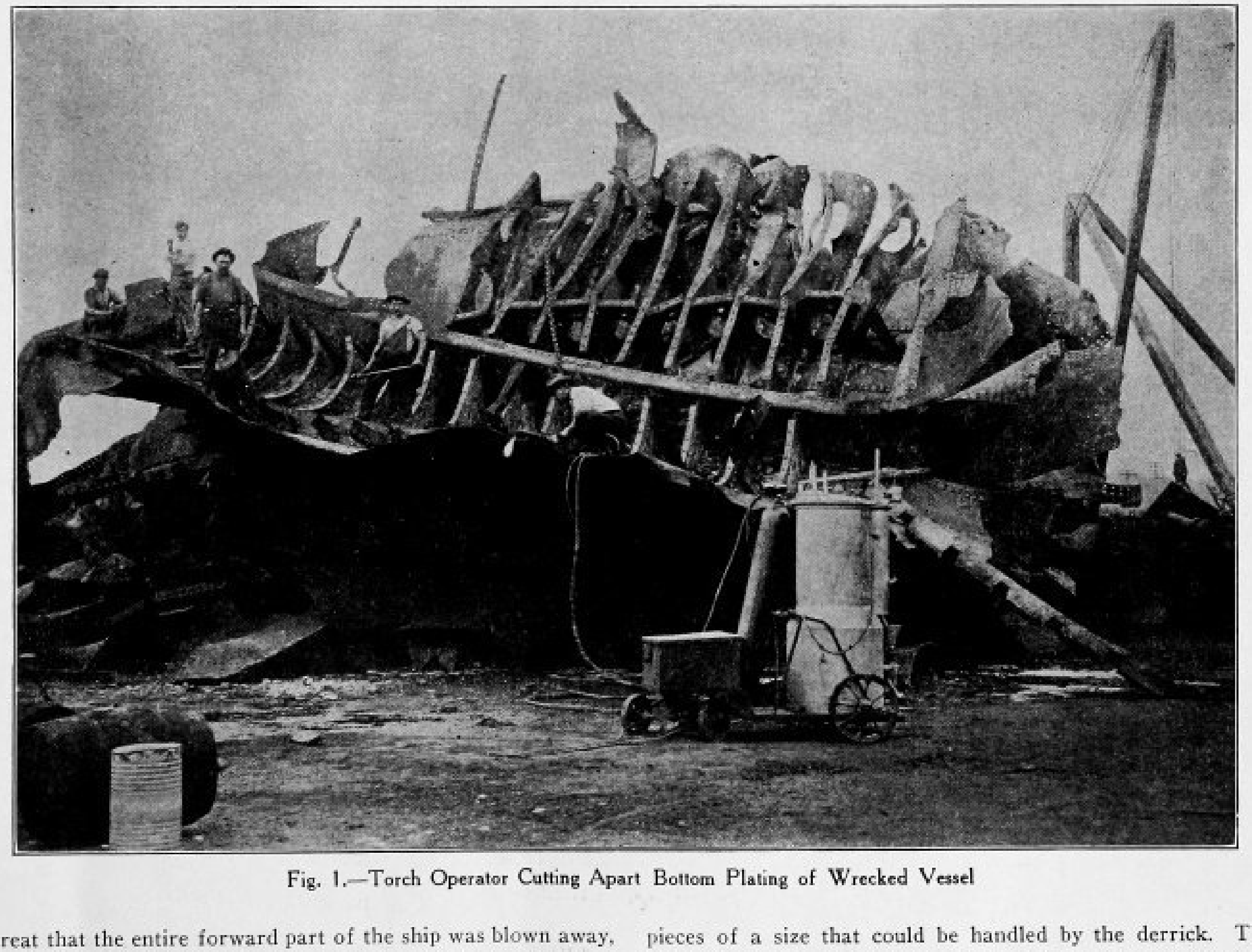


Fig. 1.—Torch Operator Cutting Apart Bottom Plating of Wrecked Vessel

A survey of the site showed that the after part of the hull, containing several hundred tons of steel, lay just outside the channel, covered by about 13 feet clear depth of water. The entire upper works, boilers and engines were gone, and the steel beams and plates were badly bent and twisted. It was necessary to remove the wreck in order to protect navigation, and a contract for this was let during the past summer to the Merritt & Chapman Derrick & Wrecking Company, of New York. An 80-ton steel floating derrick was detailed to the work. Divers were sent down to lay strings of dynamite, which were exploded under water so as to cut the hull into pieces of a size that could be handled by the derrick. The sections were then lifted onto a scow and towed to the dock and yard of the Southern Iron & Metal Company, of Baltimore, a concern which had purchased the steel from the wrecking contractors for disposal as steel furnace scrap. At the dock the floating derrick laid down the 25- to 40-ton pieces of the hull in a huge pile, as shown in the accompanying views.

Each large piece was a shapeless mass, with the plates, beams and members bent and crumpled. Rivets could not be

Fig. 2.—Pile of Wreckage before Dismantling

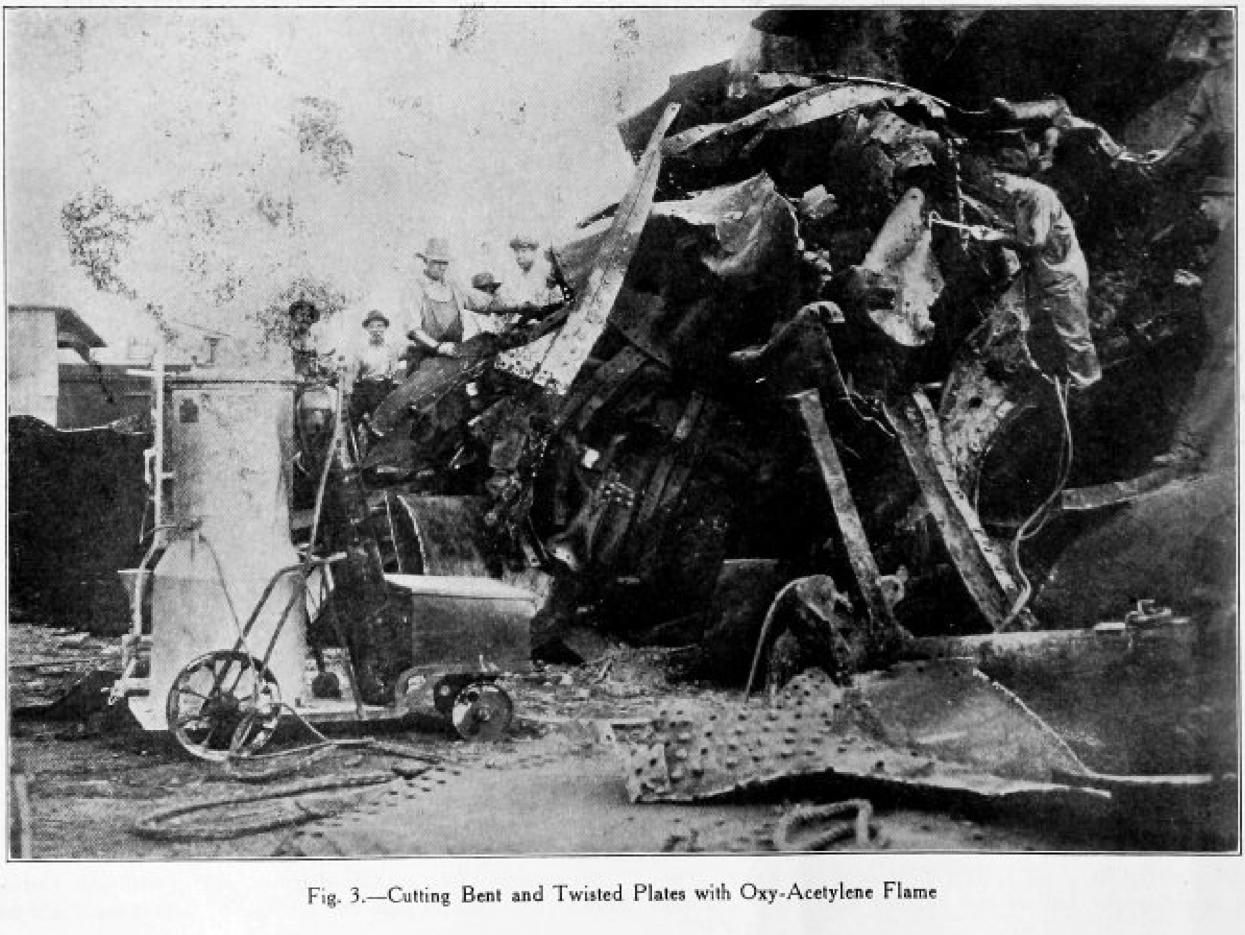


Fig. 3.—Cutting Bent and Twisted Plates with Oxy-Acetylene Flame

removed to good advantage, since in many cases the flanges of angles or pieces of plate were bent over flat against them, preventing access to their heads. Most of the skin plating of the ship was ⅝-inch steel, running to greater thicknesses in the sheer, bilge and garboard strakes. The frames and stringers were deep, built-up sections of plate and angles. The condition of the steel was such that the expense of ordinary hand cutting would have been prohibitive, and the wreckage would have been a total loss had the oxy-acetylene process not been available.

A Milburn oxy-acetylene plant, mounted on a truck for portability, was supplied by The Alexander Milburn Company, of Baltimore. One torch operator was employed, long lines of gas hose being provided to allow sufficient freedom of movement about the wreckage, in order to attack it from points of greatest convenience. As fast as the pieces of steel of suitable size for handling were cut out by the torch they were loaded on wagons and then to freight cars for transportation to the mills.

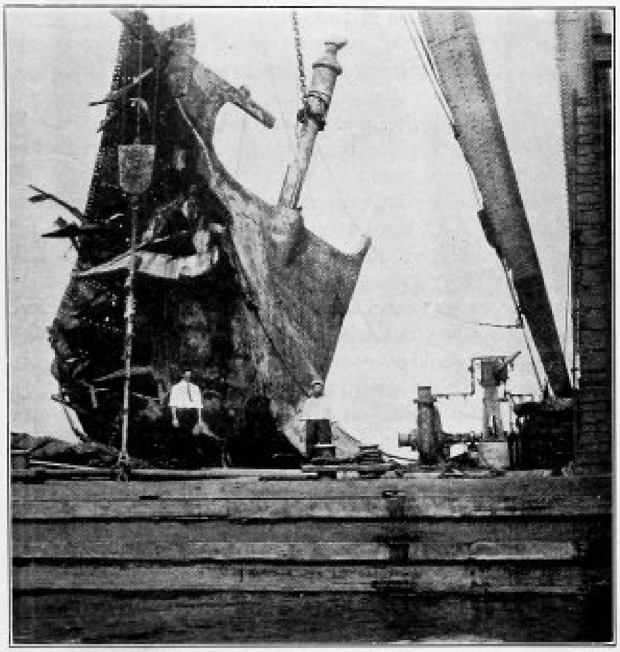


Fig. 4.—Hoisting Stern of Wrecked Vessel from Salvage Scow

It was impossible to establish a definite routine of dismantling the wreckage, both on account of the condition of the steel work and on account of inaccessibility. The work was simply started from the top or one side of the pile, and carried as far as convenient from that point, then resumed from some other point.

Owing to the irregularity of the work very little data were obtainable as to the rate of progress and other details. This was also complicated by the fact that the work was carried on only periodically, the operator being otherwise employed during a considerable part of his time.

LIST OF BOILER MANUFACTURERS.—The Supply Men's Association of the American Boiler Manufacturers' Association has recently compiled and published an authentic list of the boiler, tank and stack manufacturers and steel plate users of the United States and Canada, in neat booklet form, which is now ready for distribution. Manufacturers of boiler materials, boiler manufacturers' supplies, tools, etc., can secure copies of the book for the sum of $3 (12s. 6d.) by addressing the secretary, Mr. F. T. Slocum, West and Calyer streets, Brooklyn, N. Y.

Modern Boiler Design

BY R. CEDERBLOM

The problem of meeting the steady increase in steam pressures—an increase from atmospheric in the time of Watt to 300 pounds, or more, at the present time—with a safe, practical and efficient boiler construction, has not been an easy one to solve; as is plainly evident from the many different designs now in use, all intended for the same purpose, that of generating steam, but representing as many different ideas of what the design should be to accomplish the best results as there are different types.

Studying the evolution of the steam boiler, we learn from the constructions of the earliest types that when steam was first utilized as a means for producing power, the inventors and manufacturers of steam boilers had their hands full in wrestling with the sole problem of building a structure that would withstand a few pounds pressure, regardless of any results in the way of economy and efficiency in generating the steam; and when we remember that even wood was used as a material for building boilers in those early days, it can easily be imagined that this problem alone was not an easy one to solve, considering the poor facilities at hand in those days.

To design a boiler nowadays, no matter of what size or shape, that will withstand almost any attainable pressure, with a fair factor of safety, is a comparatively easy matter with the material and machinery as found in any well equipped boiler shop.. But to take the completed, and often complicated, structure, and partly fill it with water, and then subject different parts of the structure simultaneously to temperatures ranging from a few hundred to several thousands degrees, and still maintain the same factor of safety, is quite a different problem, the more so when, as nowadays, consideration must be given to other characteristics, such as efficiency, capacity, durability, etc., fully as much as to safety, in order to make the type a successful one.

The failure to produce a thoroughly satisfactory type of boiler after so many years of trial and experience with different designs seems to finally have led to an understanding that there is one important factor that enters into boiler design which had not previously been given the consideration which is its due, namely, the manner in which the water, and the mixture of water and steam, is made to circulate in the boiler during the steam-making process, and the means provided for keeping up the circulation when once established, not only when the boiler is new but after it has given years of hard service.

Upon the water circulation really depends the safety, the efficiency, the capacity and the life of the boiler; a fact now recognized by designers and builders, but to which the average operating engineer, even to-day, gives far too little attention. As a consequence there are thousands of boilers in operation, of good design and first-class workmanship, which nevertheless cause the owners and operators considerable trouble and expense, simply because the operative conditions are such as to hinder the circulation.

Take a piece of iron, heat it to whiteness, and plunge it into a bucket of water, and note how quickly it will cool off. The experiment will afford a good indication of the almost unlimited heat-absorbing capacity of a steam boiler; for the same performance takes place in boiler operation, excepting that the water, flowing in a constant stream over the heating surface, does not allow the metal to become any hotter than it is itself, if conditions are right. If conditions are not right, we are confronted with bagged and burnt sheets, leaking or bursted tubes, cracked headers, etc.; evils that could have been forestalled at the time the boiler was built, if due to faulty construction, or that could have been avoided by securing proper operating conditions if the defect is not inherent. As already said, if the boiler construction were such, in every case, as to create a rapid and abundant flow of water over the heating surfaces as soon as heat is applied, with no possible chance for impeding the circulation at any time, we would not have many failures.

Many engineers will contend that scale deposits account for for more of these troubles than defective circulation. This is true to a certain extent; but if we build a boiler in such a manner that we know there will be a rapid and positive circulation in a certain direction, we also know where the scale-forming matter will be carried and deposited by the circulation; and it is then a very simple task to provide means for removing the scale and mud as fast as it accumulates, either by providing suitable mud-drums or pockets in the right place, or by installing devices for catching and blowing out the impurities as fast as they are precipitated. In fact, if the circulation is rapid enough, no scale can be deposited on those heating surfaces that generally give the most trouble, as, for instance, the lower row of tubes in some types of watertube boilers, for the rush of water over these surfaces washes them as cleanly as when a hose is applied at washing-out time.

As mentioned in a preceding paragraph, some designers and manufacturers are waking up to the supreme importance of water circulation in the working of a boiler, and there are at present four or five types of boilers which are constructed so as to assure a positive flow at all times. By this is meant that no matter what the construction of the furnace may be, or the method of the firing, there is no tendency of the applied heat to retard or counteract the downflow of the water at any time, the construction being such that the passages for the downflow are of ample size, under all conditions, to keep the heating surfaces flooded, no matter how rapid the circulation.

With perfect circulation will follow perfect safety, and almost unlimited capacity; and the outlook indicates that we will have both in the near future. The most serious problem just now seems to be an improved type of furnace that will give the required amount of heat and perfect combustion and at the same time eliminate the smoke, dust and soot which now cut down the capacity and efficiency of the heating surface.—*The National Engineer.*

Superheating Steam in Locomotives*

BY HENRY FOWLER

The utilization of steam superheated, or of a higher temperature than saturated, has engaged the attention of engineers since the inception of the use of the expansive power of steam; *i. e.,* since the middle of the eighteenth century. Its application in locomotives was suggested over eighty-five years ago, and for half a century many attempts were made to employ it in this class of engine. Owing to trouble arising from the packing and the lubrication, these were not successful, and the prominent position it occupies at the present day is very largely due to the investigations of Dr. Wilhelm Schmidt, of Cassel, and to the practical trials of his apparatus made by Mr. R. Garbe, of the Prussian State Railways. Various types of superheaters were tried, but the one now in most general use is that in which the steam receives its superheat when passing through small tubes placed in large smoke tubes through which the heated gases travel on their way from the firebox to the chimney. This type is general in this country, where, in addition to the Schmidt system, the Swindon and Robinson systems, which differ from the Schmidt in detail only, are also employed. The utilization of the heat in smoke-box gases has been tried repeatedly, but without much practical success.

Under ordinary conditions, when an engine is running, the steam passing through the superheating elements carries away with it sufficient heat to keep the metal of the elements comparatively cool. When, however, a locomotive is running down an incline without steam, this does not occur, and it is necessary to prevent the gases from passing through the fire-tubes, which is effected by a damper or some other type of retarder. Arrangements are generally made for working the dampers or retarders automatically.

The connection between the superheater elements and the header from which steam is distributed is a matter of importance, and the methods by which this is done constitute one of the chief differences between the various fire-tube superheaters. Essentially, however, they consist of those in which a joint is made between the pipe and the collector and those in which the former is expanded into the latter.

The large tubes in which the superheater elements are placed give little trouble in England.

The greater volume of superheated steam, when compared with saturated, has in many cases led to the adoption of larger cylinders and lower boiler pressure. This leads to economy in boiler repairs, which should counterbalance the increase of maintenance necessary for the extra apparatus required when superheated steam is used.

The degree of superheat usually employed is 230 degrees to 260 degrees F. No figures at present seem to be available for the variation in the economy with varying degrees of superheat.

The chief advantage claimed for the use of superheated steam in locomotives is the economy in coal consumption, and on the Midland Railway a number of trials have been made to ascertain what this is with the various types of engines, the comparison being made on the consumption per ton-mile under circumstances as nearly comparable as possible. These trials show that a saving of 23 percent in the coal consumption and of 22 percent in the quantity of water used was obtained in one case, while in another, where the difference between the locomotives was solely in the superheater, the saving of coal was as high as 30 percent. This high figure was probably due to the engine which used superheated steam having more reserve of power than the one employing saturated steam. From diagrams of these two engines it can be shown very clearly how much more fluid superheated steam is than saturated.

Experiments have been carried out to ascertain the effect of superheating the steam supplied to the high-pressure cylinder of a three-cylinder compound locomotive, and it has been found that a saving of coal of 25.9 percent and of water of 22.3 percent has resulted when comparison is made with a similar engine using saturated steam. In tests carried out with freight engines, the coal saving has been from 14.3 percent to 18 percent.

NEW MIKADO LOCOMOTIVES FOR THE PHILADELPHIA & READING.—Six new locomotives of the Mikado type were recently completed by the Baldwin Locomotive Works for the Philadelphia & Reading Railway Company. The boilers are of the Wooten type. The boiler barrel is made of three rings, the smallest being 84 inches in diameter and the largest 96 inches diameter. The shell plates are ⅞ and 15/16 inch diameter, the boiler being designed for a working pressure of 225 pounds per square inch. The firebox is 144¼ inches long, 108¼ inches wide, with a depth of 69 inches at the front and 50½ inches at the back. The firebox side, back and crownsheets are ⅜ inch thick and the tube sheet ⅝ inch thick. The ordinary tubes are 2¼ inches diameter, 17 feet 8 inches long, and the superheater tubes 5½ inches diameter. The superheater is composed of 48 elements and has a total heating surface of 993 square feet. The firebox heating surface is 245 square feet, the combustion chamber heating surface 81 square feet and the tube heating surface 3,898 square feet, making a total heating surface of 4,224 square feet. The grate area is 108 square feet.

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* Abstract of a paper read before the Institution of Civil Engineers, London, England, January 13.

Patents and the Boiler Maker

A Boiler Maker Learns How to Take Out Patents Covering a New Tool Without Consulting a Lawyer

BY JAMES FRANCIS

"William, why don't you get a patent on that beading tool of yours? It's a likely looking device, and you might be able to get some one to take it up and make you some money out of it, if you had it protected by patents. Why don't you take out a patent on it?"

"Oh, pshaw! Mr. Francis, what's the use? I haven't got a lot of money to throw away on patents, and after you get a patent it don't protect; it is only a license to fight infringers in the United States courts. Anyway, I haven't got money with which to pay patent lawyers and the like!"

"You don't have to pay out good money to patent attorneys, William—not a bit of it. If you can do the work yourself there is no need of hiring a lawyer. It is only when you don't know how, or have not time to do the work yourself, that a patent attorney need be called in."

"Say, Mr. Francis, can you tell me how to go to work to get up some patent papers? If you can tell me so I can do this, and don't have to spend a hundred dollars over the matter, then I will sure take a flier in patents, and see what I can dope out with your assistance!"

"I surely can, William, and I'll do so with the greatest pleasure. You need only spend $15 to begin with, for that is the cost of filing and must accompany the application for each patent. The first thing to be done is the preparation of the necessary drawings, the description of the invention, specifications and claims, etc., together with the oath and the petition."

"The petition and the oath? What are those, and for what purpose?"

"Why, the matter of an application for a patent is really divided into four or five parts, according to the nature of the case. These parts are: Petition, specification, oath, the drawings and the model or specimen if required. But usually a model is not necessary. Models used to be the thing before draftsmen became so expert and before people became used to reading drawings, but now models are rarely necessary."

"Can you give me an idea of how the several parts should be gotten up?"

"Yes, William, I will try and give specimens of some of the parts, the others will suggest themselves to you after looking over a copy of some patent. The 'Old Man' will probably lend you one for that purpose. But, to begin with, we will give herewith a form of petition which you can use by changing the names to suit:

To the Commissioner of Patents:

Your petitioner, William Newthing, a citizen of the United States, residing at Newville, in the county of New, and State of ———, prays that letters patent be granted to him for the improvement in Tube Beading Tools set forth in the annexed specification. WILLIAM NEWTHING."

"And is that all there is to the petition?"

"Yes, that's all. Simple and to the point, and all the rest of the necessary 'dope' may be made just as plain and easy."

"But what is meant by 'the specification'? What does that look like?"

"The specification is simply a written description of the invention, and must tell how it is made, how it works, and what it is intended to do. And the only requirement is that the description be written so clearly that anybody who understands beading tools could, from the description, make and use a tool as designed or invented by you."

"Is there any set form for the specification, or can it be written in common language?"

"No, a set form is not necessary, but each specification must be gotten up in the order of the following seven sections or parts as follows:

1. Preamble.
2. General statement.
3. Brief description.
4. Detailed description.
5. Claim or claims.
6. Signature of inventor.
7. Signature of two witnesses."

"What does the preamble and general statement consist of, Mr. Francis?"

"The preamble must give the name of the applicant for a patent, same as in the petition. It must also give the title of the invention, and must tell if it has been patented in any country, giving, if so, the names thereof and the date and number of each patent. And if the patent be not numbered that fact must be so stated under oath.

"The general statement must tell the object and nature of the invention.

"The brief description merely names each of the drawings and tells what each view represents.

"The detailed description must explain the invention fully and completely. This portion may cover several sheets of the patent, if the object be a complicated machine, or perhaps a single paragraph will answer for your beading tool. The detailed description must tell fully and plainly how to make and use the invention, and must set forth every detail and particular concerning it.

"The claim (or claims) is the vital part of the patent, and must tell what the inventor desires to protect himself in. The claims are the most important part of the patent, and it is that part which causes the invention to be patented or rejected. It is in the claims that infringements originate, and the stronger and simpler the claims the better the patent and the more protection it will give to your invention. Therefore, take great care with the claims, and get the advice of a patent attorney in this section if you feel that you are not getting the claims just as you would like them.

"Signature of inventor. If you employ an attorney, you need not sign the papers yourself, the attorney can do it; but each separate sheet of drawings, as well as the specification, must be separately signed, either by the inventor or his attorney.

"Signature of two witnesses. The attorney cannot sign the papers for these people, and each sheet must be signed separately, but any friends, employees or even strangers may be used as witnesses. All Uncle Sam requires is that there be the names of two actual people on each sheet of drawings and on the specifications."

"Well, say, Mr. Francis, that seems rather simple, doesn't it. I don't see anything hard about that, or anything requiring the services of a $500 patent attorney?"

"No, William, it's all plain sailing thus far, and if you are sure that you have got the claims just right there is little more to be done."

"But how about those drawings? I don't quite understand how they want them to be made; can you tell me about that?"

"The drawings must show every feature of the invention covered by the claims. There are several things which must be looked after when making patent office drawings, and these are presented in the accompanying six paragraph sections:

"1. Drawings must be made upon clean white paper of a thickness about equal to that of three-ply bristol board.

"2. The sheet must be exactly 10 inches by 15 inches, no more and no less, and a border line must be drawn all around 1 inch from the edge, leaving the working space just 8 inches by 13 inches. All the work and the signatures must be within these border lines or the drawings will be rejected. One of the shorter sides is to be regarded as the top, no matter whether the drawing be made sidewise or crosswise the paper, and under all circumstances a space 1¼ inches wide is to be left across the top end of the paper, inside the border line, for the title, name, number and date."

"Say, Mr. Francis, will they accept pencil drawings in the Patent Office?"

"No, William, they surely will not, and that matter comes under the next paragraph of conditions, as follows:

"3. All drawings must be made with the pen only, and with jet black ink. India ink is almost the only kind which is acceptable for patent drawings, and each and every line and letter, the signature included, must be absolutely black and solid. No matter how fine the lines may be, even those representing shading, must be coal-black, and must never carry even a suspicion of a gray tint. The reason for this is, the drawings are to be photographed, and thin, gray lines will not take well in the negative, therefore there is nothing to be done but to make each and every line and letter a solid black.

"Furthermore, the lines must all be clean-cut. They must be sharp and solid and not too fine. In fact, fine lines should be avoided, not only in patent drawings but in all other mechanical drawings whenever possible. Surface shading must be open, and section lining should be done with oblique lines spaced never less than one-twentieth of an inch apart.

"4. The drawings should be made with the fewest lines possible. Never put in two lines when it is possible to show the matter equally well with one line. Never use shading unless it is impossible to show the desired effect without it; and even then never use shading except on concave or convex surfaces.

"When you make sectional views always indicate on the plan view, by means of broken lines, where the sections were taken. Also, always use heavy lines on the shade sides of objects, except when they cannot be used without making the work obscure. In using shade lines, always do so with the supposition that light comes from the left upper corner, at an angle of 45 degrees. Furthermore, never use imitation of wood or any surface-graining."

"What scale do they generally use in making Patent Office drawings, and is there any certain number of sheets—that is, any limit to the number of drawings which may be used?"

"No, there is no limit to the number of drawings which may be used, provided that they are necessary to show up the invention. Neither is there any scale which must be used. Make the drawings to the scale which is the most convenient. The work may be drawn full size, double or triple size for small parts, or it may be drawn a 'mile to the inch,' if the nature of the invention requires so small a scale. Use as many sheets as are found necessary.

"In making reference letters and figures, take great care to make them all plainly and of uniform size and character. Make them about ⅛ inch high if possible, and never place them on shaded surfaces. If possible always 'draw off' the reference letters. That is, place the letter outside the part to which the letter applies, then draw a light line from the letter to the part indicated. This makes a clean, easily observed reference, and there is never any doubt as to just what part is indicated by the letter in question.

"Never use the same letter to indicate more than one part. Place the signature of the inventor in the lower right-hand corner of the drawing, and place the names of the witnesses in the lower left corner, and put them both within the marginal or border lines. Be sure to write the title in pencil on the back of the drawing, and send them rolled—never folded—to the Patent Office. And, William, if you don't wish to make the drawings yourself the Patent Office will do it for you, and will make them at cost."

"It seems to me, Mr. Francis, that it would be pretty hard work to write up the description of the invention so as to get it all in with as few words as possible. Is there any rule for this part of the work?"

"No, William. That must be done with horse-sense and judgment. Try to say exactly what you mean, and you will not go far astray. Use legal cap paper to write upon. That with numbered lines is the best, and be sure to write in the oath. Everything you say regarding the invention is under oath, therefore stick to facts and state them plainly and fully."

"What is the oath? How is it worded?"

"The oath must follow the specifications, and may be worded as follows:

State of ...., County of ...., *ss.:*

................., the above petitioner, citizen of .... and resident of ...., in the county of .... and the State of ...., being duly sworn (or affirmed), depose and say that .... verily believe .... to be the first, original and .... inventor of the improvement in .... described and claimed in the foregoing specification; that the same has not been patented to .... or to others with ...... knowledge or consent, except in the following countries: ...., ..., ...; that the same has not to ...... knowledge been in public use, or on sale in the United States for more than two years prior to this application, and ...... do not know and do not believe that the same was ever known or used prior to .... invention thereof.

(Inventor's name in full) ....

Sworn to and subscribed before me, this .... day of ...., 19..

[L. S.] (Signature of justice or notary) ....
[L. S.] Official character ....

"There you are, William. That will give you an idea of how to work up a patent application on your beading tool. Fix it up and send it to Washington—the application—with $15.00, and the Patent Office will do the rest—or ask you to do some of it p. d. q."

"What if there are changes necessary?"

"Never you mind. The examiners will let you know of them, and just how to make 'em, too, and in no undecided language at that."

"I'm going to start on an application, Mr. Francis, right straight off!"

New Pacific Type Locomotive for Lehigh Valley.—Six heavy Pacific type locomotives have recently been placed in the passenger service of the Lehigh Valley Railroad. The boilers are of the Wooten type, designed for a steam pressure of 215 pounds per square inch. The minimum outside diameter of the boiler is 72¼ inches. The firebox is 126⅛ inches long by 104⅝ inches wide, built of ⅜-inch plates. There are 234 2-inch tubes and thirty-two 5⅜-inch flues, all 21 feet long. The tube heating surface is 3,519 square feet, the firebox heating surface 225 square feet, making a total heating surface of 3,744 square feet. Added to this is a superheater heating surface of 812 square feet, making a total equivalent heating surface of 4,962 square feet. The grate area is 87 square feet.

Methods of Stretching Boiler Tubes

BY CHARLES F. BENNETT

Reading over an article in The Boiler Maker relating to reclaiming boiler tubes found too short for a particular job, brings to mind instances of a like character wherein jobs had been worked through to the point ready for test.

In one particular case referred to, a peculiar type of boiler, the outside of which appeared to be of the locomotive firetube, firebox type, was in reality included in the watertube class. Owing to its large dimensions it was found necessary to assemble the boiler at the place of installation. Upon completion of the work on the shell and furnace in readiness for tubing, it was found that the tubes had been ordered according to length given by the drawing.

Now it happened that in the process of making and assembling this particular boiler no attention was given to prove the length of tubes required after assembling the boiler. The result was that the order of tubes at hand proved they were O. K. with the length given in the drawing, yet proved too short for the boiler. To avoid loss upon the part of the boiler manufacturer, a remedy was sought to reclaim the tubes at hand.

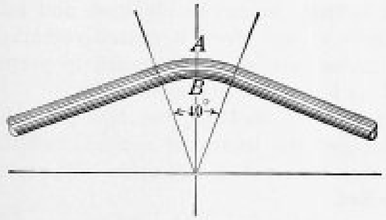

Fig. 1

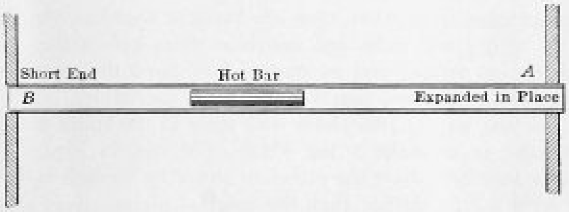

Fig. 2

As the lengthening was a matter of less than 1 inch, welding was not practical, and some other means had to be devised by the makers as more favorable in the matter of cost. It is known by the older members of the boiler making craft that tubes can be stretched, although they would not be considered by manufacturers of the honest class from the standpoint of safety. A simple method, which was not fully explained by the writer of an article in the August, 1912, number of The Boiler Maker, is as follows:

First, let us assume that the tubes are, say, 3 inches in diameter. It is desired to stretch them about ⅝ inch. Fig. 1 shows the first operation. They are heated at the center for about 15 inches, the side (*A*) to a light color, the side (*B*) to a darker heat. The tube is then placed over a block or form with (*A*) on top, and the ends forced down until the heated portion forms an arc of about 40 degrees. The tube is then allowed to cool, after which a heat is taken to bring (*B*) to the light color; the tube is then straightened, which results in stretching the tube.

There is no hard and fast rule to govern the stretch desired other than that of practice. It matters not how carefully the stretching is done, it can be detected in more ways than one. Admitting the possibility of "getting out of the rut," no man of honor would resort to such vile practice likely to result in injury and loss of life. Apparently sound tubes are none too safe, judging from the many accidents reported from day to day.

Another method of stretching one or more tubes is shown in Fig. 2, which can be used to advantage without injury to the tube, and can be applied to a case where it is desired to bring a sprung head or tube sheet back to place, particularly when entirely retubing boilers and the heads spring out of line and there are no bolts or other means at hand to do the work.

Suppose it is a case wherein it is desired to pull the head? In that case the tube is expanded at one end, a hot billet is placed at about the center, keeping the tube free at the loose end. It will be noted that the tube will move through the hole in the sheet. As soon as the desired expansion is reached remove the billet, flare out the end, and expand as quickly as possible. If the sheet is brought to the proper line you can proceed with your work.

This method may also be applied for forcing the sheets outward; in that case the tube is expanded at one end, a suitable clamp is secured to the tube close to the sheet, another tube is also placed in a hole in the vicinity of the first and also expanded at one end, and the clamped tube is then heated as in the previous case, forcing the sheet outward to the desired line. Remove the billet and expand the offset end of tube number two as soon as possible. By this method clamping and bolts are avoided.

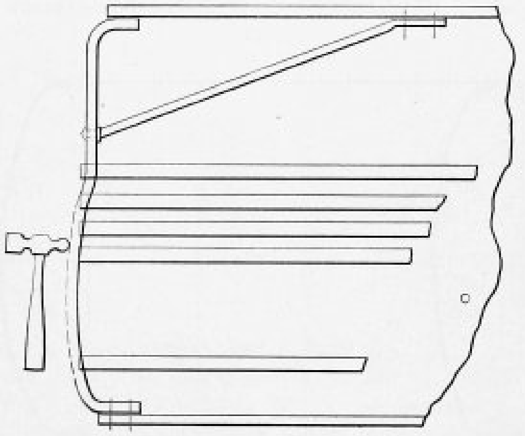

Fig. 3

Fig. 3 refers to a case where the tube sheet was forced out, due to low water in the boiler. The tubes were loose in the holes at rear, and gave every indication that the boiler required entire retubing. Yet this was not necessary, as would be recognized by an experienced mind. The "modus operandi" is as follows. Fill the boiler just over the tubes. The water will act as a lubricant, although you will find the job a wet one, therefore should provide a suitable covering. The ball hammer shown is to sound the ligaments from place to place, by which you will note the sheet gradually working back into place. Carefully expand a tube here and there to keep head in place, and then draw off the water and proceed to expand all the tubes, after which apply a moderate hydrostatic test for leaks. A horizontal tubular boiler was treated in this manner* some ten years ago, and is now in service and operating at about 75 pounds pressure with great satisfaction.

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* It is customary in laying out a boiler to a line, say a 72-inch horizontal tubular boiler 17 feet long, to allow about ⅛-inch for stretch.

Personal.—John Huyette, resident inspector at the Brooks Works of the American Locomotive Company, has been transferred to the Richmond, Va., plant in the same capacity, and John Gill, special boiler inspector at the Brooks plant, has been promoted to fill the vacancy left by Mr. Huyette.

A High-Pressure Cylinder

BY C. E. LESTER

Recently the writer was asked to design a cylinder 18 inches diameter and 24 inches long to carry 1,000 pounds pressure per square inch. The following gives the writer's views on the subject:

The common rule used later in this article for determining the true bursting or working pressure of cylindrical receptacles of small diameter and short length seems to the writer far from being correct. This has been demonstrated a number of times. One case brought to the writer's attention was of a destructive test at the plant of the Biglow Company at New Haven, Conn. The test was made on a unit of a Horsley watertube boiler. The theoretical strength to resist bursting was 1,000 pounds per square inch. Failure occurred at something over 1,200 pounds per square inch, and then it was not the drum that failed; in fact, neither the cylinder nor its seams showed any signs of being strained.

It is a recognized fact that a girth seam has a great stiffening effect and increases the strength of the receptacle in its vicinity, yet the head seams or any girth seams are never considered in calculations as being of importance. The Hartford Steam Boiler Inspection Company has pointed out from time to time that a girth seam is of considerable importance on the score of safety, and its absence is doubtless one of the causes of failure of single bottom-sheet type of tubular boilers.

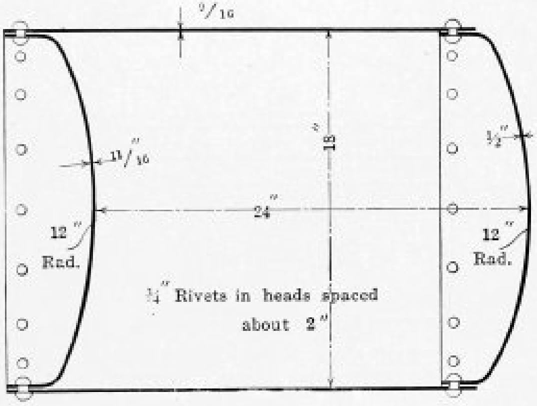


Fig. 1

There is no room for argument in saying that the girth seam undoubtedly supports the strain on the course for a considerable distance from the seam, hence the shorter the course the stronger it becomes and the less the need for a high-efficiency longitudinal seam. In many, many cases, in fact, all photographs and illustrations that the writer has ever seen of explosions from over-heating or excess pressure, the girth seams either held or were the last to give way. In fact, the writer has before him a photo-engraving of an ammonia tank with two courses bulged to nearly twice their diameter and one of the sheets ruptured, yet the girth seams retain their original size and contour.

This subject is one of considerable interest to the writer, and one which he has taken up with several of his acquaintances in the boiler making field, but with little or no satisfaction. It seems that about all of them think a different rule is desirable for small diameters and short courses, but (as is the writer) they are unable to construct the formula. The writer cannot but feel that the subject is one that could be studied with profit to the makers and users of boilers and other sheet metal receptacles. A few destructive tests could be arranged with but little cost, and the results would, it is believed, greatly change the present formulas. In the design of a cylinder of this description, or of anything else, the appearance lends to the value of it, and but few persons tolerate a rough looking piece of work when buying. In this case it was necessary to get a high efficiency joint or use plate so heavy that it could not be well rolled to such a small diameter.

A joint that would be of about 90 percent efficiensy would have to be a quadruple-riveted joint, with cover plates inside and out, or else the Baldwin diamond joint of over 90 percent efficiency. In either case the joints would be so large that they would take up a third of the circumference, increase the weight and cost materially and make a very rough looking job. The welding of domes and dome courses in locomotive boilers has become common in the past few years, so that most shops of any size have smiths that weld cylindrical shapes of boiler plate very readily. The tensile pulling test on a number of such pieces showed them to run from 90 percent up in efficiency.

The following extract from Ford's "Boiler Making" the writer believes to be about as clear and concise a description of welding a cylinder as can be obtained, and fully coincides with the writer's views. Ford is quoted verbatim:

"To weld plates care should be taken to prepare the surfaces as well as to get the proper heat.

"A perfect weld is flawless, the two parts being united equally throughout the length of contact, and they must be brought together before they will unite. All scale and cinder must be expelled.

"In the presence of a flux, scale and cinders, while hot, are fluid, and it is obvious that if the surfaces are concave, or have concave spots when they are brought together, the sides of the cavity will unite and imprison them before they have a chance to escape, and no matter how hard the metals are hammered or pressed together a flaw is inevitable.

"The best way to join plates with tools at the boiler makers' command is to make a lap weld, as shown in Fig. 2. In placing together allow the plates to shove by enough to make the weld a little thicker than the original plates. This allows for natural waste and to be sure of not reducing the normal thickness of the plates. The appearance of the weld before dressing is like Fig. 3.

"It will be noted in Fig. 2 that the welding surfaces are convex. This allows the middle of the joint to make contact first, and by gradually closing from the middle to the edges it squeezes out all scale and cinder between. It must be borne in mind that the edges of the plate must be the last brought together."

Fig. 4 shows the course bolted in a rigging designed to handle such work while welding. The lever can be hung from a jib crane or other means. The large holes, loose hooks, swivel and double handles allow the work to be swung from position to position very rapidly.

The welding can be done on a long horned anvil, or most any kind of a makeshift that will give a curved and solid bearing. The heating should be done slowly and easily over a clear fire, preferably of coke. If possible the course should be heated full length, though probably but 6 or 8 inches can be welded at one time. It is best to start in the middle and work both ways.

Since there are no rules of which the writer has knowledge wherein the help of the girth joint is considerable, the rules commonly in use will be taken. It is assumed that the welded joint will be a good one, so that with an efficient weld, and the additional strength of the girth seams, it is but fair to assume the strength of the weld at 90 percent. To determine thickness of the shell:

Let $t =$ thickness in inches.
$D =$ diameter in inches.
$P =$ pressure per square inch in pounds.
$C =$ tensile strength of plate $= 55{,}000$.

K = factor of safety = 3.
90 percent of 55,000 = 49,500.

$$t = \frac{D \times P}{2\,C} \times K.$$

Substituting values we have $\frac{10 \times 1{,}000}{99{,}000} \times 3 = \frac{9}{16}$, nearly or nearest thickness of plate.

The thickness of the heads is determined by the following rules:

Let R = ½ radius to which head is bumped = 6.
FS = factor safety = 4.
P = pressure in pounds per square inch = 1,000.

Fig. 2

Fig. 3

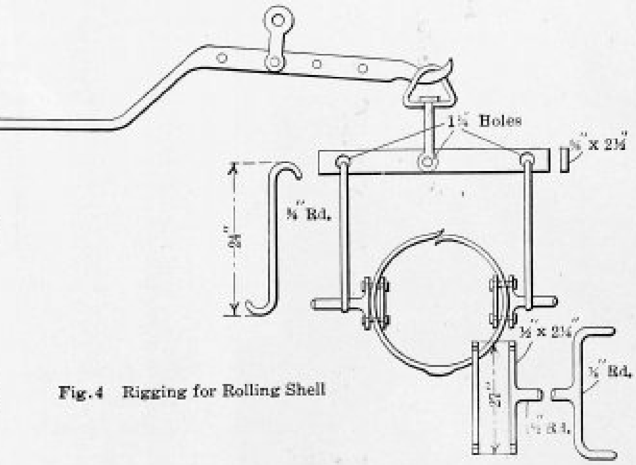


Fig. 4 Rigging for Rolling Shell

TS = tensile strength = 55,000.
t = thickness of head.

For concave head:

$$\frac{R \times FS \times P}{.6\,TS} = t.$$

Substituting

$$\frac{6 \times 4 \times 1{,}000}{.6 \times 55{,}000} = \tfrac{3}{4} \text{ inch nearly.}$$

For convex head:

$$\frac{R \times FS \times P}{TS} = t.$$

Substituting

$$\frac{6 \times 4 \times 1{,}000}{55{,}000} = \tfrac{1}{2} \text{ inch nearly.}$$

It is the writer's opinion that the factor of safety of 3 used for the shell thickness would be, if the formula were a correct one, at least 5 or 6. In testing out a cylinder of this description it should be given, if possible, about 50 percent excess pressure and calipered at the mid-section of the shell to discover any possible distorting.

Obituary

Charles Fell Bennett, a boiler inspector with the Hartford Steam Boiler Inspection & Insurance Company, Hartford Conn., died suddenly Feb. 7 at his home in Bridgeport, Conn. Mr. Bennett was born in Wilkes-Barre, Pa., Oct. 8, 1859. After learning the trade of boiler making he was employed in Wilkes-Barre for a few years, and in 1884 moved to Sayre, Pa. In 1891 he came to Bridgeport, Conn., and became foreman of the Pacific Iron Works. Four years later he became associated with the Hartford Steam Boiler Inspection & Insurance Company as a boiler inspector, a position which he held until the time of his death.

Danger of Handling Heavy Weights in Cold Weather with Chain Slings

A pulley 30 feet in diameter with a 4-foot width of face had been cast in two halves. The joints had been planed, and the pulley was ready to be put in the pit lathe to be bored and machined on the face. There was very little head room to spare, and it was necessary in handling the pulley to use a chain sling around its face, as this gave a shorter bight than the heavy rope slings, and just allowed sufficient hoist to permit the traveling head of the crane to carry its weight out over the center of the face plate of the lathe.

Each half of the pulley had four arms, and it was to be chucked on the face plate of the lathe, which was about 12 feet in diameter, by suspending it on blocks placed under the arms and secured by bolts and straps to the face plate. One-half of the pulley had been placed in approximately the center of the face plate of the lathe, and the machinist was standing on the hub adjusting and securing the blocks, when the chain snapped; the pulley fell, and its overhanging rim striking the edge of the face plate, breaking off big pieces of it and the arms; the whole mass with the machinist was plunged down into the bottom of the pit a distance of 18 feet.

In falling the broken pieces of the rim struck large blocks that were close to the edge of the pit, and that had been used to chock the pulley when shifting the slings as it was being turned rim upwards, and these were carried down with the rest of the falling mass. The jar shook the building as though shaken by an earthquake, and all hands in the shop ran to the scene of the accident.

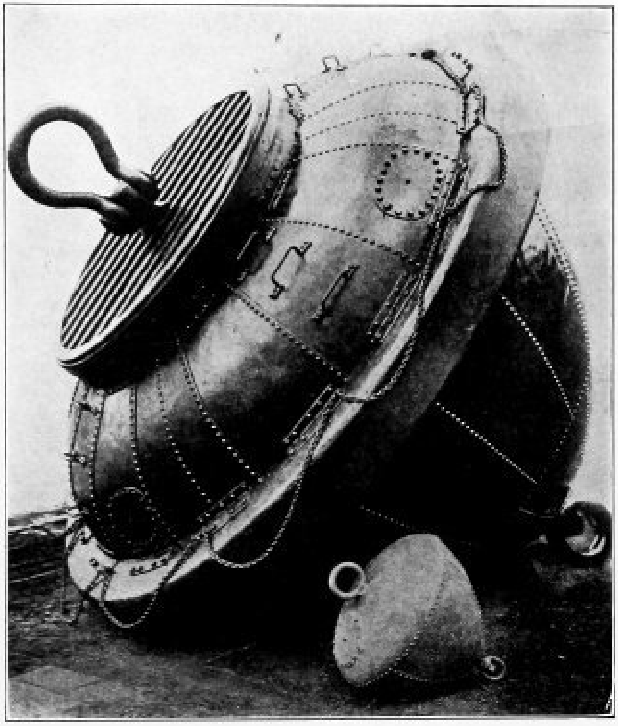
When the dust had cleared a little, a ladder was brought, and the machinist was taken from the pit, not crushed beyond recognition, as every one expected he would be, but with only a bad scalp wound, a bump on the forehead and a bad shaking up. The large blocks in falling in the pit had crossed in such a manner with the large, heavy pieces of the broken pulley as to keep them off the body of the machinist, a most miraculous escape.

The day was bitterly cold, and the doors of the shop being open while handling the pulley, the chain became crystallized and snapped under the strain. J. E. C.

An Unusual Job of Heavy Plate Work

BY FRANK C. PERKINS

In order to carry the exceptionally heavy moorings for the Brazilian super-dreadnought *Minas Geraes*, which is one of the largest and most heavily armored war vessels afloat, the Brazilian Naval Commission had constructed recently at the works of Brown, Lenox & Company, London, Ltd., at Millwall, England, a 15-ton buoy built of ⅜-inch mild steel plates. The buoy itself is 15 feet in diameter, and is divided into four watertight compartments. Through the center passes a forged iron mooring bar designed to withstand a breaking-off strain of 185 pounds. This has a fixed shackle, made from 6-inch diameter iron at the top and a 5¾-inch diameter swivel at the bottom. There is attached to the crown plate a wooden platform, 8 feet 6 inches diameter, to enable the men to stand with safety while making fast or letting go the ship's cable. At the line of flotation the buoy is provided with an elm fender, 15 inches thick and 18 inches deep, to take the impact in the event of collision. With the mooring bar, the buoy weighs 15 tons, and is capable of carrying besides its own weight a load of 7½ tons when one of the watertight compartments is filled with water.



Buoy for Mooring a Super-Dreadnought

How to Graduate a Measuring Stick

BY C. B. LINSTROM*

This article, although not directly relative to boiler shop work, may nevertheless prove of some interest and value to those who are called upon to determine the number of gallons for any given depth of liquid in a cylindrical tank lying upon its side or in a horizontal position.

It will be understood that to make a gage or measuring stick for a tank setting on end, as in Fig. 1, is a simple matter. In finding the volume the following rule is used:

Let D = diameter of tank.
H = depth of liquid.
A = area of head.
V = volume.
Then $V = D \times D \times H \times .7854$.

In the United States Standard Gallon there are 231 cubic inches. The quotient obtained by dividing the volume in cubic inches by 231 equals the number of gallons. The Imperial Gallon, which is the liquid standard of Canada, contains 277.4 cubic inches.

When the tank lies upon its side such simple conditions are not met with in determining the volume or number of gallons contained therein for given depths. This will be better understood by an examination of Fig. 2.

In Fig. 2 the liquid covers a portion of the head only, and that part covered is a section of a circle, commonly called a segment. The area of segments can be found approximately by this formula:

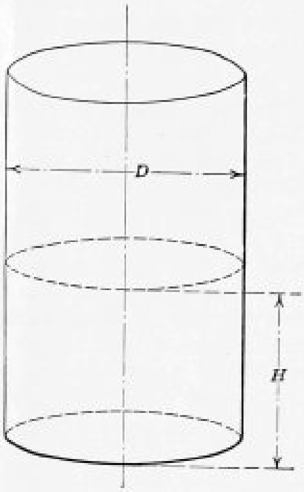


Fig. 1

Let A = area of segment.
D = diameter of head.
H = depth of segment.

$$\text{Then } A = \frac{H \times H \times 4}{3} \sqrt{\frac{D}{H} - .608}.$$

The volume for the segment section for the entire length of tank will be found by multiplying the area of the segment by the length of tank. Dividing the volume by 231 cubic inches gives the number of gallons. A gage, or measuring stick, together with a table giving the number of gallons for each inch, can be readily made by using the above rules. But such a system would require a great many rather long calculations. To obviate this the following graphical method has been devised which very closely approximates the number of gallons for any depth of liquid:

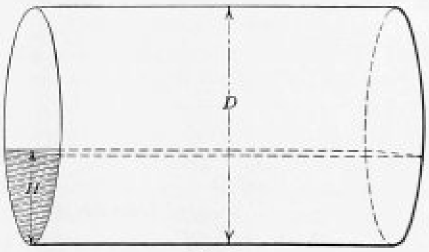


Fig. 2

Assume the tank to be 30 inches in diameter and 96 inches long. The measuring stick is to show the depth for each 10 gallons of the liquid. Obtain a piece of paper ruled into squares, as in Fig. 3. Draw a circle with a radius of 15 spaces. Each space or square represents 1 square inch. The circle represents the head of the tank, and it is divided into horizontal strips 1 inch wide. Count the number of squares for each row, and place the total number in the corresponding

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[*] Assistant Principal, School of Sheet Metal Work, International Correspondence Schools, Scranton, Pa.

row, as indicated in column *B*. In each row there will be fractional parts of a square where the row joins or intersects the arc of the head. By eye, the equivalent number of whole squares can be closely estimated. The next step is to find how many square inches of the head are covered by each 10 gallons of the tank: 10 gallons equals 10 × 231 = 2,310 cubic inches.

The tank is 96 inches long. By dividing the total number of cubic inches in 10 gallons by 96, the area of the head corresponding to 10 gallons will be found; hence, 2,310 ÷ 96 = 24 square inches. Then each 24 squares of the circle will represent 10 gallons; or, in other words, each addition of 10 gallons to the quantity in the tank will cover 24 additional square inches of the head.

To find at what height a horizontal line can be drawn above the bottom of the tank so that there will be 24 squares below it is the next operation. In column *B*, note that at the bottom there are 6 squares in the strip, in the one above the bottom there are 13; in both strips there are 19, hence 5 more squares are needed to make 24. In the third strip there are 16 squares, and 5 squares of the 16 equals, approximately 5/16 of the squares in the third strip. Therefore, for the first 10 gallons a depth of 2 5/16, approximately, is found. For each additional 10 gallons the depth can be readily ascertained in the manner just explained. Ten gallons added to the first equals 20, which cover 2 × 24 = 48 square inches of the head. The first three strips contain 35 squares, 13 more are needed to make the 48. In the fourth strip there are 19 squares, hence the 20-gallon line will be 13/19 inch nearly above the 3-inch line. It may be shown that 13/19 = 11/16 very nearly.

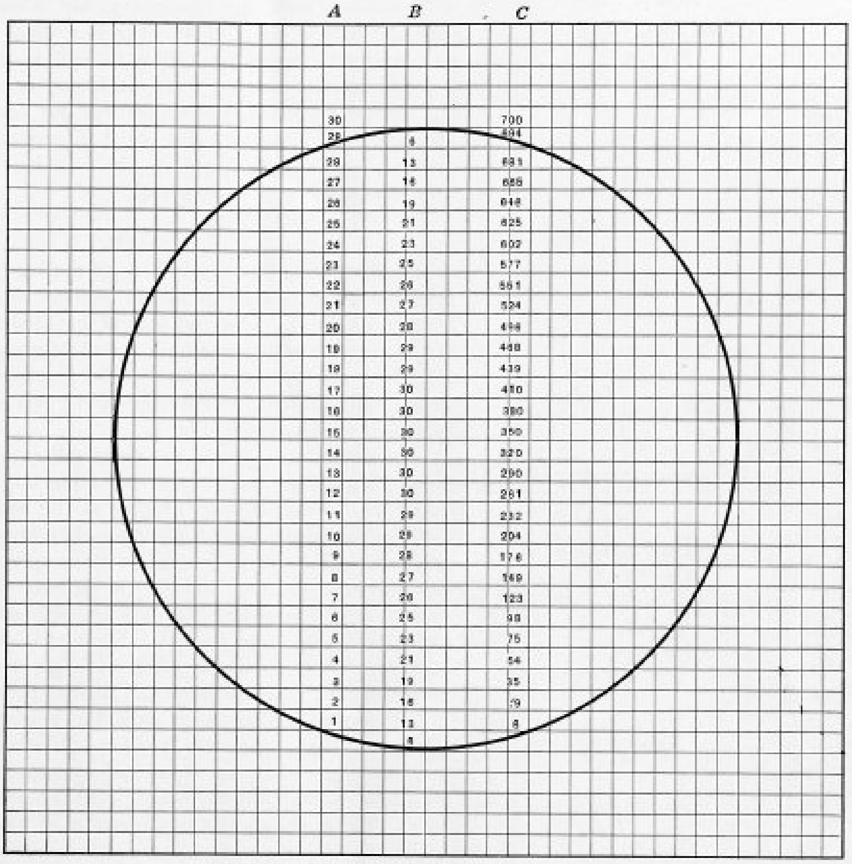
Next proceed to find the 30-40-gallon lines, respectively, etc. The 30-gallon line will require 3 × 24 = 72 squares. The 40-gallon 4 × 24 = 96 squares.

In Fig. 4, set off on the stick the graduations for each 10 gallons in inches of depth; for 10 gallons the depth is 2 5/16 inches, for 20 gallons 3 11/16. The inches in depth can be indicated together with the number of gallons for same. It is a great help in calculating to arrange the total number of squares in the head for each inch of depth, as shown in column *C*.

To construct a scale to show gallons for each inch in depth, find the number of squares, inch by inch, as shown, and multiply each of these numbers by the number of gallons which one square represents. To illustrate: Since the tank is 96 inches long, each square in Fig. 3 corresponds to a capacity of 96 cubic inches, or 96/231 = .42 gallon. There are 6 square inches in the lowest strip, hence, at a depth of 1 inch, the quantity = 6 × .42 = 2.5 gallons, and at a depth of 2 inches it is 19 × .42 = 8 gallons.

In the preparation of this article no attempt has been made to give precise results. With more care much greater accuracy can be obtained than indicated. The number of squares in a strip can easily be estimated to fourths or less. At any rate it can be seen that an error of 1 square means a difference of .42 gallon only. It should be borne in mind that the plates of a tank do not form a true cylinder, and some space is taken up with rivet heads, hence it is impossible to make calculations agree exactly with actual measurement.

If a tank has bumped heads, the area, volume and number of gallons for each inch of depth can be determined in a similar manner; that is, by plotting.



Column *A* = Depth of tank in inches.
B = Sq. in. in each row of one inch strips.
C = Total number of sq. in. covered at depth indicated.

Fig. 3

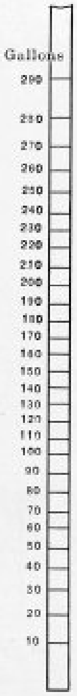


Fig. 4

Old-Time Marine Boilers*

In view of the fact that so many historical events are being commemorated in the present year, the side-wheel iron warship *Wolverine*, formerly the *Michigan*, which was built in 1843 and is still in active service on the Great Lakes, should not be overlooked. One of the most famous events of the war of 1812 took place near the home port of this vessel, and the ships which played a prominent part in that war on the Great Lakes, under the command of Commodore Perry, were built and launched from the same port where this famous "old war horse" is now stationed. In fact, she herself was assembled and launched within a short distance from the place where Perry's fleet of wooden vessels was built, and occasionally she steams majestically down the harbor of her birth as stately and as warlike as any of the latest battleships, varying only in "swell" and "tonnage," but at the same time showing quite a "bone in her teeth" when under way.

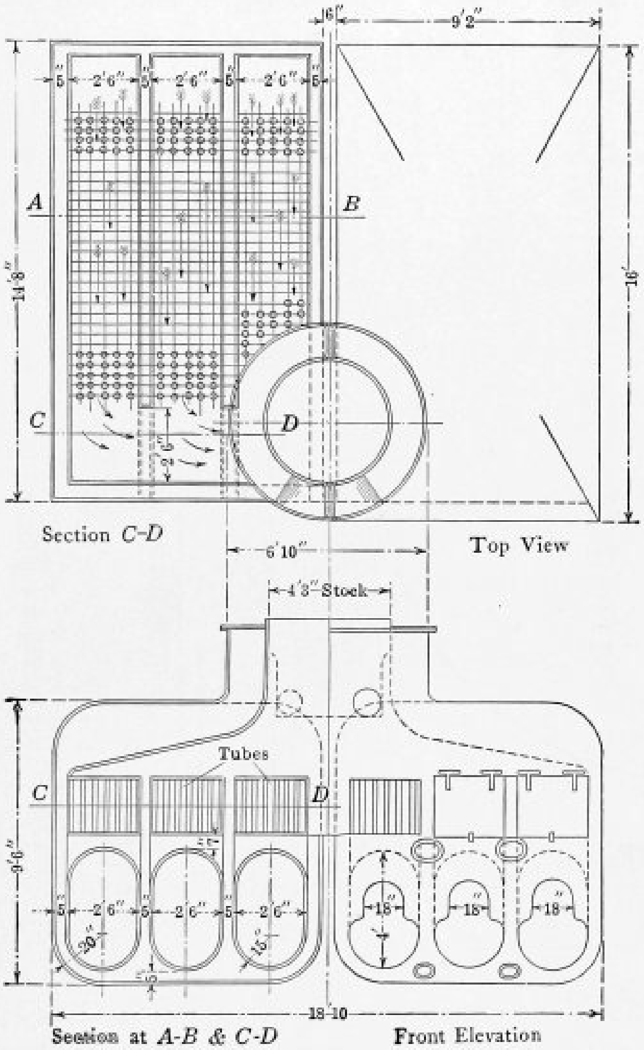


Fig. 1.—The Wolverine's Original Boilers

The *Wolverine* is the oldest iron side-wheel vessel afloat to-day and is in commission when the lakes are open to navigation. Until recently she was a member of the United States Navy and patrolled the American boundaries of the lakes from end to end. In fact, this historic old vessel is no stranger to many of Uncle Sam's naval officers and sailors, and it is a matter of interest that the first assignment of the late Rear Admiral George W. Melville, formerly Engineer-in-Chief of the United States Navy, was on the *Wolverine* in the early fifties.

Recently the *Wolverine* was turned over to the State of Pennsylvania for a naval training ship, to be used on the Great Lakes by the Erie Division, N. F. P. She is used in the winter as an armory, where the crew is drilled regularly and taught gun and signal tactics, together with the numerous other duties which fall to the lot of a good sailor in regular service.

The *Wolverine* was built in Pittsburg, Pa., in 1843, and brought to Erie by mule teams and canal boats. Stackhouse & Tomlinson built the machinery, but whether or not they built the hull is not known. She is a three-masted ship and was originally rigged for sailing as well as steaming, but now depends on steam alone. Her machinery is the most interesting feature on board, and shows that our forefathers had the necessary "gray matter" and put it in proper use, both in the design of the engines and in the way in which allowances were made for adjustment, etc.

BOILERS

The *Wolverine* has two boilers of the leg type. These were installed in 1892, and up to the present time have given no trouble whatever. The first boilers installed in the *Wolverine* at the time the vessel was built lasted fifty years, and were replaced by the present boilers. The first boilers were, so to speak, half-and-half, because they were part watertube boilers, as shown in the sketch, Fig. 1.

This sketch also shows the peculiarities of their construction. There is a long furnace extending the full length of the boiler with a combustion chamber at the back. The gases of combustion return to the stack on the outside of a series of tubes through a square flue. The tubes extend across between two plates in the flue, the flue being entirely surrounded by water. It will be noted that this arrangement provides ample steam space in these boilers. There was also a drum that encircled the stack which acted as a superheater. The coal consumption of these boilers was about 2 tons per hour.

The present boilers were built for a working pressure of 25 pounds per square inch, and are still working at that pressure, although they are inspected annually. The coal consumption of the present boilers runs about one-half ton per hour. Fig. 2 shows the construction of these boilers. The design, by the way, was approved by the late Rear Admiral George W. Melville, formerly engineer-in-chief United States Navy. These boilers are of special interest owing to the low-pressure for which they were designed, and the thickness of plates, staybolts, etc., in comparison with the practice of to-day. The principal dimensions of these boilers are as follows:

Inside width of furnace............	3 feet 6 inches
Length of grate....................	6 feet 6 inches
Grate surface, one boiler...........	45.5 square feet
Heating surface, tubes.............	980 square feet
" " flues	100 square feet
" " furnace	91 square feet
" " flue sheets	10 square feet
" " comb'tion chamber.	105 square feet
Total for one boiler................	1,286 square feet
Ratio of heating surface to grate surface	28.26
Calorimeter	5.93 square feet
Ratio of grate surface to calorimeter	7.69
Number of tubes	78
Boiler pressure	25 pounds

All seams are single riveted except the longitudinal joints of the shell and of the steam drum, which are double riveted.

There is a steam drum built around the stack which serves as a superheater, so it is evident that even in the early days

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* From an article on "An Old-Time War Vessel on the Great Lakes" in International Marine Engineering.

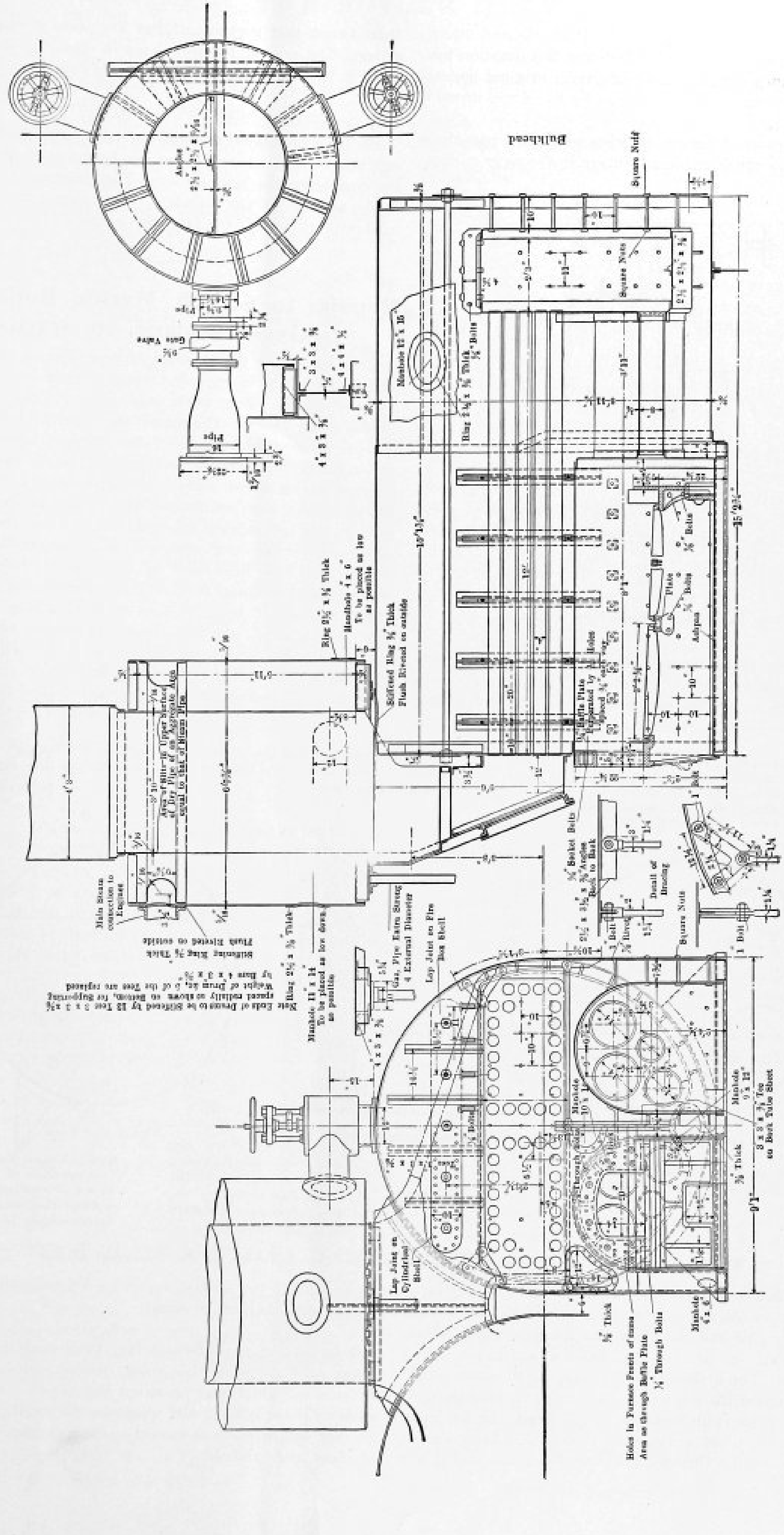


Fig. 2.—Details of Boilers Now Installed on the Wolverine

the engineers have given the question of superheated steam serious consideration. It is also evident that this question has been considered to a certain extent when the original boilers for the *Wolverine* were built, as shown by the drum around the stack in Fig. 1.

Superheated steam, of course, is being used to a considerable extent, and to considerable advantage in the navy to-day, although it has its disadvantages. In the case of the *Wolverine*, the steam can be shut off from the drum by the valves shown on the side of it. The valves, as shown on the drawing, have been replaced with a valve that has a side outlet to which a safety valve has been attached. There is also a safety valve on the top part of the drum. All three valves connect to one common copper pipe and discharge into the port wheel-house.

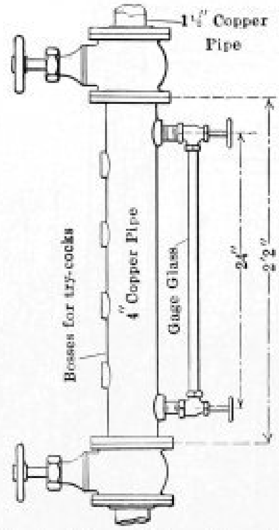


Fig. 3.—Water Column Now in Use

The boilers are set in cast iron saddles, which are bolted to the keelsons. The keelsons, by the way, are the same under the boilers as under the engine; in fact, they continue through the machinery space from bulkhead to bulkhead. In the bilge, under the boilers, about 3 inches of cement has been placed, as the plates showed a little weakness at that point, and it has been found that the cement has decidedly strengthened the plates. The cement has now been in place for several years, and has proved very satisfactory for this purpose.

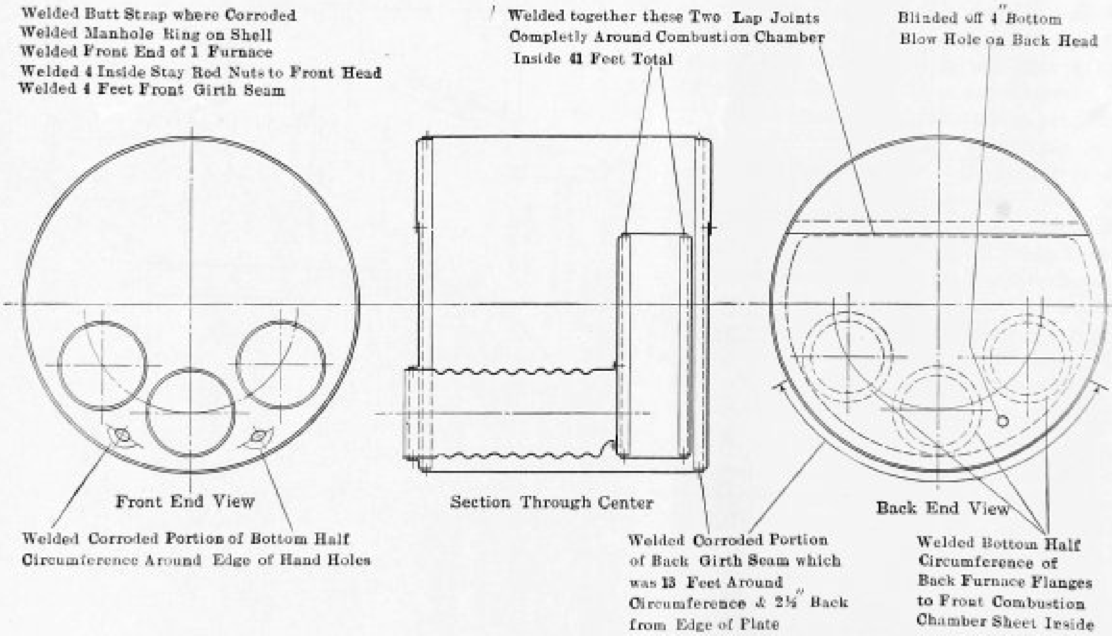
Coal Consumption

The two boilers when carrying 20 to 25 pounds of steam and under way consume about one-half ton of coal per hour, the coal being the best grade of Pocahontas.

The average of 140 pounds per knot brings the evaporation to about 6.17 pounds of water per pound of coal as fired.

Repairs to Scotch Marine Boilers with Oxy=Acetylene Apparatus

Two boilers on the steamer *Meteor*, owned by the Pacific Coast Steamship Company, recently underwent repairs in Seattle, Wash. The work was done by the Olson-Klopf Welding & Cutting Company, Inc., with the Henderson-Willis oxy-acetylene process. On the port boiler 13 feet of calking edge was welded back on the head. One butt-strap was reinforced where corroded, one handhole and blow-off on the back head were reinforced, while in the combustion chamber 41 feet of calking edge, a patch, flame sheet, wrapper sheet and furnace end were welded. One manhole ring was welded and the front end of a furnace reinforced where wasted away. Three feet of girth seam were also welded. On the starboard boiler 12 feet of calking edge on the back head was welded, one butt-strap was welded and reinforced where corroded, one handhole and one blow-off in the back head were reinforced, 41 feet of calking edge were welded in the combustion chamber, and one manhole and 1 foot of shell on the front end of the boiler were welded. This is reported to be one of the largest repairs ever undertaken on boilers by the oxy-acetylene process.



Welding Done with Oxy-Acetylene Apparatus on Two Scotch Boilers of the Steamship *Meteor*

Omission.—Unavoidable delays have made it impossible to begin publication in this issue of the series of articles on "Formulas" which was promised last month. The first instalment of these articles will appear in the April number, and an attempt will be made to unfold to the uninitiated the mysteries of signs and symbols.

John, the Screw and the Lever

John Puts a Load of 50 Tons on a ⅝-inch, 10-thread Bolt, But Doesn't Realize It and Wonders Why the Bolt Breaks—The Mystery is Explained

BY JAMES F. HOBART

"Ginghang the blanked rotten steel they make nowadays! Why don't the steel folks make bolts which will stand a little strain without twisting their blamed heads off?"

"What's the occasion, John? What has the steel trust done to you?"

"Why, here's the third rotten bolt I have twisted the thread off of while trying to draw this gusset sheet into place. Hang such steel, anyway!"

"Wait a bit, John. Are you sure that it is the steel which is to blame? Aren't you asking more of the bolt than it can give? Haven't you been putting more stress on the nut than the metal in the bolt was every intended to stand up under? How about all those things, John?"

"Why, it's in the steel, all right; just look at those threads! They are not stripped or distorted in any way. Here is one of the nuts which just came off with a piece of bolt inside it. See! The thread is O. K., and you can back out the bit of bolt with your fingers. How can it be anything but the rotten steel in the bolt as long as the thread is all right and not stripped in the nut?"

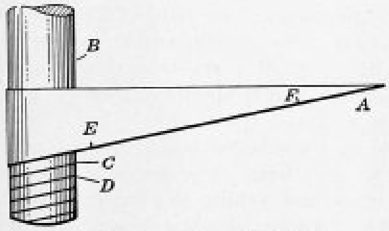


Fig. 1.—Screw-Forming Wedge

"Hold up a bit, John. You are judging the case without having first heard all the evidence. That is pretty bad for a judge, but it is worse for an engineer, who cannot be too careful in getting hold of all the facts before making a statement which may mean safety or danger to a great number of people."

"Why, haven't I heard all the evidence, or seen it, anyway? Here is the bolt which broke—three of them, too, and each and every one broke just about the same. Just 'show me' the evidence I haven't heard in this case, will you?"

"Sure, John, with pleasure; and just call the other boys. They want to be in this, too. Ah, here you all are! We'll just have a little talk about bolts, screws and levers before the whistle blows, and see if we can find out whether John is getting too strong or, as he claims, the steel in those bolts is—'rotten.'"

"I bet you'll find it's in the steel, all right. I don't feel any stronger to-day than I did yesterday, or last week, and I haven't been breaking off any bolts before this lot came into the shop."

"All right, John; let's see just what you are up against, anyway. Here are the facts: You are pulling on the end of a wrench placed upon the nut of a ⅝-inch screw, cut with ten threads—ten threads to the inch. Now, how long was the wrench you were using, and how hard did you pull when the bolts broke?"

"Here's the wrench. It is 20 inches long, solid end, and I had a piece of pipe on the wrench for an extension. Here's the piece of pipe; and when it's on the wrench it makes the whole length of the wrench about 42 inches."

"Well, John, that's some leverage to turn a ⅝-inch nut with; but find out how hard you pulled and then we will tackle the figuring."

"Say! I can't tell how hard I was pulling. If I was lifting I could make a pretty close estimate of it, but to tell how heavy a pull is made on a lever—that's something I don't know much about."

"Never mind, John. We will weigh the force of your pull. I saw an iceman's spring scale or balance in the pattern room. Get it and we will have you pull against that."

"Here's the spring balance."

"Ah, here we go. Just put the wrench on the loose nut of a bolt in this shell. So! Now, slip the ring of the scale over the pipe extension, and you, John, get hold of the extension, with your hands on both sides of the scale ring, so as to pull dead against the scale with the same leverage that was used on the broken bolt.

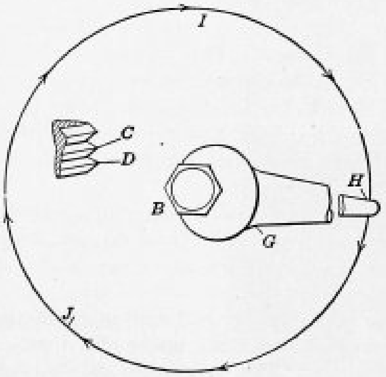


Fig. 2.—The Long Arm of a Screw Lever

"There you are! Now, I will make fast the other end of the scale to this rivet hole, so that all the pull you deliver to the pipe extension will be registered on the scale instead of going to the bolt and nut. Now, are you ready? Then pull! Try it again—two or three times. Say, John, you aren't very strong after all, are you? There is never more than 80 pounds pull registered on that scale during any pull, and it is safe to say that 60 pounds was the stress applied to the wrench when the bolt broke, or did you pull harder then?"

"No! I pulled as hard as I could to bring the sheet down into place, and I can't pull any harder now than I did then."

"A man can't pull very hard horizontally, can he? Can't begin to pull as much as he can lift; so you see that to do the greatest amount of work a man must combine his weight with what he can pull. Then he is getting some work on a lever. But we will let that part of the matter go for the present, and see what will be the effect of an 80-pound pull on the end of a 40-inch lever when attached to the nut of a bolt with ten threads to the inch."

"Oh, Mr. Hobart, you haven't taken into account the diameter of the bolt, which is ⅝ inch. Don't you want that figure in the calculation?"

"No, John, the diameter of a screw don't cut any ice whatever as far as the power of a screw is concerned; so, no matter whether the bolt was ½ inch or 2 inches in diameter, the leverage will be the same and the power remain the same on all screws with No. 10 thread. But change the pitch of the screw and you change the whole business. Now, with that

⅝-inch No. 10 bolt under a pull of 80 pounds on the end of a 40-inch lever, who can tell what power was exerted? How would you go after the problem, John?"

"Why, if you hadn't said the diameter had nothing to do with the power of the screw, I would have said take the radius of the screw for the short lever, the length of wrench for the long arm of the lever, and then multiply pull and long lever together and divide by short lever, to get the force of the screw."

"That would work with plain levers, John, but here things are different. The screw is a lever, all right, but it isn't a plain one. The screw is just a wedge, rolled up on a cylinder. Fig. 1 shows how this is. The bolt *B* represents a cylinder as far as the calculations are concerned. The paper wedge *A* is shown as being rolled up on bolt (cylinder) *B*, and the taper edge of the wedge forms the threads *C D*. Therefore, one circumference of the wedge, represented by the distance from *E* to *F*—this is just the circumference of the bolt-cylinder, and when wrapped around will advance the line of thread another distance equal to *C D*."

"Say, Mr. Hobart; if the bolt is larger there will be more travel and friction in the nut, as *E F* will be greater; and wouldn't that affect the power of the screw so that the diameter would have to be reckoned with?"

"No, John. The books on physics tell us that 'friction is independent of surface.' This means that, no matter how large a surface, or how small, unless cutting starts, that the friction will be the same under the same load upon that surface. So you see, John, that the diameter of the bolt don't count, for it don't even affect the friction, which in bolts and nuts is something immense."

"Well, then, if it isn't the diameter or circumference of the bolt, what in creation is it? How do you find it, and how is it calculated? I don't see any sense to the blamed thing, anyway!"

"Easy, John; the thing to deal with in calculating the power of a bolt thread is simply the pitch—the distance from *C* to *D*, Fig. 1. That is all that represents the short arm or lever; and, John, don't you see that giving the screw a complete turn or revolution advances the nut exactly from *C* to *D*?"

"Yes, I do see that now, but I never thought that this was the short arm of the lever in a screw. But, by Jimmimy! It must be so, come to look it over again!"

"Yes, John, that's the way of the screw; and now to find the length of the long lever. What do you think that will be?"

"Why, the length of the wrench, of course. That is the lever you pull on while turning the nut. That's easy!"

"Not as easy as you think, John, for your answer is entirely wrong. The length of the wrench is not the length of the long arm of the bolt power lever; not by a great big lot, and then some!"

"Then, Mr. Hobart, what in creation can the leverage be? I seem to be all balled up in this screw business. I surely believe I am being educated backwards, for every day I find so much that I don't know that it makes me feel as though what little I do know is too little to be of any use."

"Go to it, John! When a man gets in that frame of mind and realizes how little he really does know, then he is right in position to learn a whole lot; for he won't be satisfied, but will keep studying all the time."

"Say, Mr. Hobart; does a man have to keep studying and learning all his life?"

"Yes, John; he sure does. He is at it as long as he stays on this earth, and for several millions of years afterwards; so don't get discouraged because you can't learn it all in a month or two. What's that length of time against an eternity of study, development and invention? Go to it, John. Don't get discouraged in the kindergarten! Bye and bye you will get a taste of real study, and then they can't keep you away from it, even if they were to put you inside a boiler shell and rivet the heads in tight and screw on the manhole cover."

"All right, Mr. Hobart. I will take your word for it—for a while, until I can see half an inch beyond my nose at least. But, now, please straighten out that screw and lever business for us. Me and the rest of the boys are all balled up and can't tell which is 'tother. What is the length of the long lever, when you are using a 40-inch lever, anyway?"

"Here it is, John. Just what you and the other boys want to know. Look at Fig. 2; that illustration shows the matter very plainly. The end of the wrench at *H* is 40 inches from the center of bolt *B*; now, then, how far does *H* travel during one complete revolution of the bolt?"

"Why, it travels 3.141 × 80 = 251.28 inches. But what has that to do with it?"

"Everything, John. You have 80 pounds traveling 251.28 inches in a certain time, haven't you?"

"Sure! The 80 pounds must swing around a circle 80 inches in diameter, so the power can't help but go that distance."

"All right, John. Now, if the power travels 251.28 inches, and the work travels 0.1 inch, the distance from *C* to *D*, doesn't it seem mighty likely that the distances 0.1 inch and 251.28 inches are the short and long arms of the leverage we are looking into?"

"As sure as little apples have little cores, Mr. Hobart, that is just what! Why, it's as plain as the nose on a dog's face, now that I see into the matter. Why, how simple it looks now! A force of 80 pounds, moving a certain distance, and moving another force, or resistance to a certain force, through a distance of one-tenth of an inch. Of course those are the lever arms of the screw or bolt, and the power exerted at the bolt will be 80 × 251.28 ÷ 0.1 = 201,024 pounds. Over 100 tons pull! Gee, but that is some strain on the bolt!"

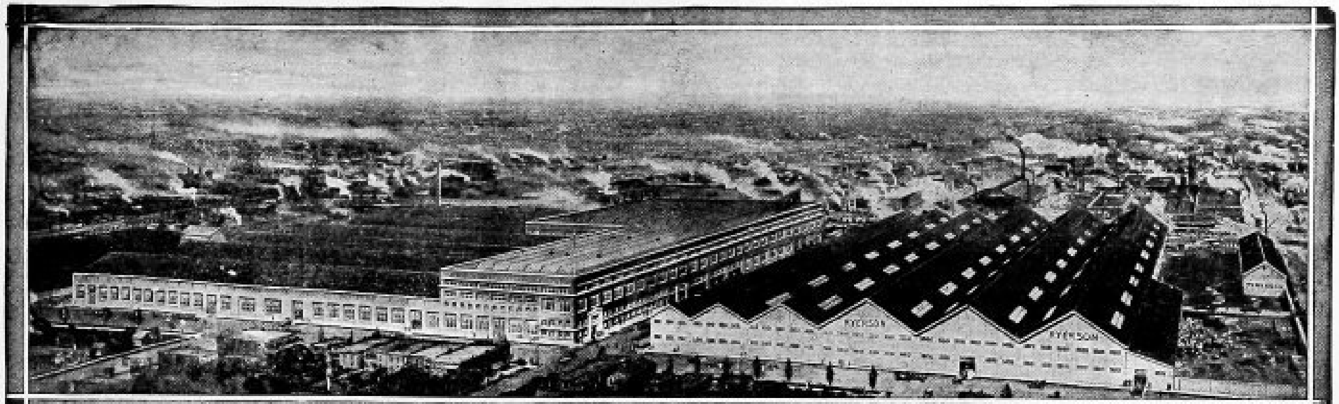
"Yes, it is a heavy strain, John; but there are certain allowances to be made when calculating the power of a bolt and nut. For one thing, there must be a heavy allowance made for friction, and usually 50 percent of the lever-applied power is allowed to be absorbed by friction; which in this case would reduce the stress to about 50 tons, or 100,000 pounds. But, even with this heavy reduction, it is far more than a ⅝-inch bolt can stand up under, John. Is it any wonder that those bolts broke under the strain you put on them?"

"No, Mr. Hobart; come to look down into the matter, I can't blame the steel a bit, and it must be pretty good steel, too, to stand up as well as it did under the load I was putting on those bolts—50 tons net! Why, that's enough to raise up the whole shop, machinery and all! Say, Mr. Hobart, it just makes me sick to realize every little while how many kinds of a fool I am. Gee! but it's discouraging."

"No it isn't, John; not if you look at the matter properly. Just go back a few months or years, and see what you really knew then, compared with the knowledge you have now. See any difference?"

"Well, I should just shout! Then I was a dinged fool and didn't know it, while now I am all kinds of a fool and do know it!"

"Good for you, John; you have learned the one great lesson—that you don't know it all, and never will, and now you are right in line for the best education a man ever had. All you have got to do is to study each thing which comes along until you understand it thoroughly. What's that you ask? What stress had that ⅝-inch bolt really ought to stand up under? Well, John, we will calculate the strength of that bolt, roughly. We have not at hand a table of diameters at the bottom of threads for standard bolts, therefore we will assume that the root diameter of the bolts you broke is ½ inch. Squaring this and by multiplying by .7854 gives .19635 square inch area of the metal at the bottom of the threads. Assuming a tensile strength of 60,000 pounds per square inch for the



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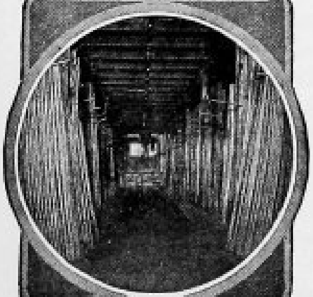
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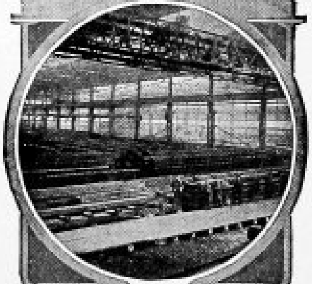
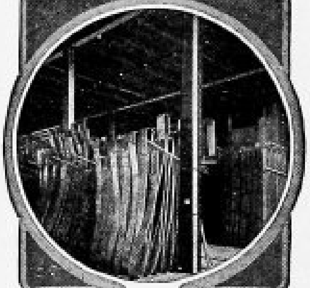

Structural Shapes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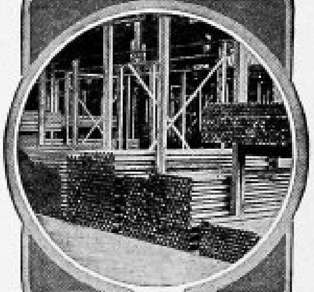
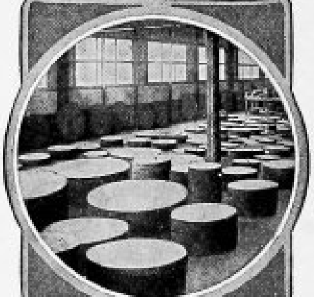

Boiler Tubes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steel of which the bolt is made, the bolt will break under a stress greater than .196350 × 60,000 = 11,781 pounds, or a little less than 6 tons."

"By gracious! And I was putting a load of 50 tons or more on each of those bolts and wondering why it broke, and cussing the poor steel they were made from! Jimminy Crickets, what a double- barreled chump I was!"

Hydraulic Pressing—II

BY C. W. R. EICHHOFF

"Hydraulic Pressing" is the heading which the author has selected for this series of articles, because the articles treat of the management and operation of hydraulic tools used in plate shops and forges, and it is always found that whatever the work to be performed may be, it always is the force exerted by water pressure in the so-called "hydraulic machine" which performs the operation. In the hydraulic flanging press the hydraulic punch, the riveting machine, the hydraulic bulldozer, etc., there is always a pressure of water acting against a ram or plunger which sets it in motion, and the pressure is transmitted to the forming dies or the punches to do the work. In other words, every machine is a hydraulic press with different dies.

The great advantage which these hydraulic machines have over others performing similar operations is the perfect control which the operator has when performing his task. He is enabled to stop his machine instantaneously. If he sees anything going wrong he can give to the moving part its maximum speed, retard it to its minimum, or reduce it to zero at will. The perfect control in this slow motion is very important in the so-called process of "drawing." Take the case of a geared bull-dozer; if anything goes wrong it takes a long time to stop the machine, especially when electrically driven and provided with heavy fly-wheels. The damage done when parts of machinery break is greater and more expensive, and it always happens at the most expensive part of the machine, namely, at the gears. It is for this reason that the writer prefers hydraulic machinery wherever it is possible to use it and it can be used economically.

It is not the intention to give in this article a description of the different hydraulic machines individually. The catalogues of the manufacturers of such machinery give cuts and a lot of information pertaining to same, and these concerns also supply prints showing the general construction; but for a systematic digest of the subject I am writing about I will give a short description of the general arrangement of a hydraulic plant and treat each part individually, so far as operation and management are concerned, and touch upon points which the writer considers important to get good results. The illustrations used are taken mostly from R. D. Wood & Company's catalogue, and are chosen because the writer is more familiar with these machines than with any other make, and has found them highly satisfactory in regard to simplicity and operation. He wishes to mention that he is not, and never was, interested in the sale of such or any machinery, but has made it his point to mention in his article only such matters which he

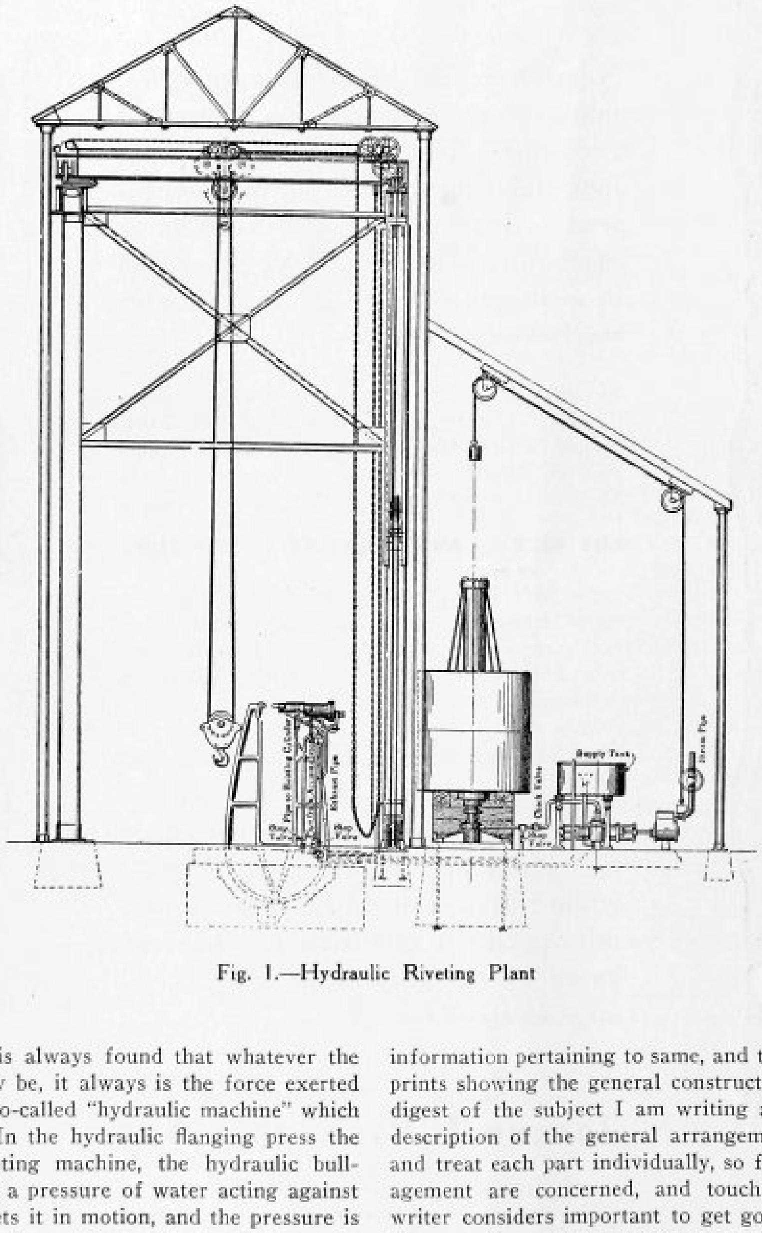

Fig. 1.—Hydraulic Riveting Plant

has found good, which have actually been done by himself, or under his direction or which he has seen done by others. Everything that did not stand the test is left out. It is hoped that these articles will encourage further development in this great field among the practical men in the shops. They might be of some assistance to the inexperienced and they will communicate the writer's ideas and experience to the initiated.

Much has been done since Joseph Bramah built his first hydraulic press in the year 1795. His machine was used for compressing flax, cotton, to operate cranes, etc. It was Armstrong who first applied the principles of the press to machine tools in the year 1840.

The Hydraulic Plant

A hydraulic plant consists of the following:

1. The motive power.
2. Water supply.
3. The pump or pumps.
4. One or more accumulators.
5. The piping with its auxiliaries.
6. The hydraulic machines doing the work.
7. Safety appliances.
8. Auxiliary machinery for transporting, lifting and lowering work.
9. In some cases furnaces to heat material.

The practical man in the shop has nothing to do with the designing and installation of a plant. These are problems to be solved by the mechanical and the erecting engineer, but he should be able to criticise an installation, recommend improvements and make suggestions when called upon. He is the man behind the gun who discovers defects, and he is the person upon whom a manufacturing firm looks for results.

The motive power can be derived from either steam, electricity or gas. At present steam is mostly used in direct connection with the pump. Compared with the final result the use of steam is very economical and has given satisfaction. Electricity and gas are too new in the field, and the writer knows of a case where electrical equipment has not given good satisfaction.

The Pump

The pump used is what is called the "hydraulic pressure pump," designed and built for high pressures of from 1,000 pounds to 7,000 pounds per square inch. It ranges from the small single-acting to the triple or compound condensing pump. These pumps should be invariably of the outside-packed plunger type; the valves should be arranged for easy access and made of the best bronze. The writer has found that such valves of nickel-steel have given good results. These valves and their seats, which should be removable, should be kept in first-class condition, so they do not leak. They are subjected to more wear and tear than any other part of the whole installation. And when a plant does not work satisfactorily, look at your pump valves first; you will find in 90 out of 100 cases that you are operating with defective valves. The frame, with the exception of the steam cylinders, should be made of good cast steel. Steam cylinders are mostly of the best grained cast iron. The other parts should be of either steel or the best bronze.

One of the most common troubles is to keep the stuffing-boxes on the water end tight. There are different packings on the market, but the writer has found that the best is made of either cotton or hemp. Keep your pump in good alinement and tie up your glands evenly, and some of your troubles are removed. In connection with this let me say that your water supply should flow into the suction end from an overhead tank or under slight pressure. Never have your pump supplied by so-called "suction." It is not satisfactory, and is the cause of many troubles, besides the loss of money.

The supply pipe from tank to pump should be large and never smaller than the opening on the pump. I have always made it larger if possible. Your pump will work more satisfactorily without pulsations and shocks. The latter will tend to throw your pump out of alinement and subject it to greater wear and tear, and is often the cause of wreckage of the pump. Any valve or cock between the supply tank and pump should have the full area of the supply pipe. Use a larger valve and bush it down if necessary; avoid all fittings, such as elbows, etc., as much as possible. The water used in the supply tank should be as clean as possible and free from any acid. It is good policy to have water filtered before it enters the pump. It will, of course, make the installation more costly, but considering the cutting of valves, rams and other vital parts of the plant, and the resulting friction and leakage, which are caused by gritty and dirty water, it is a good investment. Where the water does not cost anything there is no economy gained by returning the water from the machines back to the supply tank. Where water is costly, use it over and over again by returning it to the supply tank. Sometimes it is advisable to use the cooling water of the surface condensers, also the waste water of injector condensers when the power plant is of the condensing type, but always filter same before it reaches the pump. In small plants the cooling water of gas engines can be used.

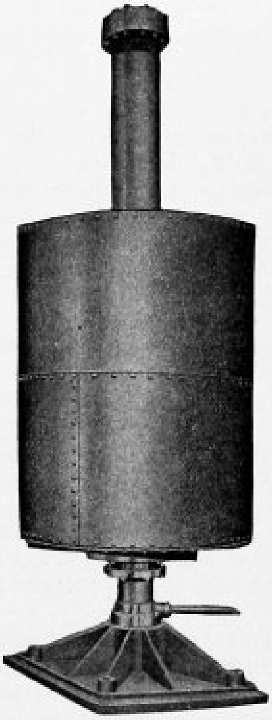

Fig. 2.—Hydraulic Accumulator

The foundations for the pump depend on the type of pump to be used. A direct-acting duplex pump requires very little foundation; single cylinder pumps a somewhat heavier foundation, owing to the shocks to which they are subjected. Crank and fly-wheel pumps require just as heavy foundations as steam engines.

Small pumps of the single or double-cylinder type are supported at the steam and the water end. One end only is often fastened down to the foundation. This prevents the pump from being thrown out of alinement, caused by pulsations and shocks in the flow of water. The size of pump depends on the quantity of water to be used, and is calculated by the designing engineer. The shop man should demand a guarantee in regard to capacity, however.

THE ACCUMULATOR

The next part of the installation is the accumulator. This serves, as the name indicates, to accumulate a supply of water and also as a regulator for the required pressure in the system. This pressure shall be constant. Pumps and the different machines always work with the full pressure of the accumulator. When different pressures are to be used on different machines it is necessary to supply the machines of the same pressure with an accumulator giving the desired pressure; other machines can then be operated by heavier or lighter accumulators as required on the same system. Such installations require, of course, check valves in the different branches of the piping.

The accumulator also regulates the speed of the pump, and thus controls, by a pulley and lever arrangement, or by an electrical device, the demand of water to be used in the different machines. In this manner it takes care of all sudden variations in the demand for water. As a rule an accumulator should be large and the pump can be small.

The pressure varies somewhat during the upward and downward strokes on account of the friction in the stuffing-box. On the upward stroke the pressure is equal to the weight of the loaded accumulator plus the friction load, and on the downward stroke the pressure is equal to the weight of the loaded accumulator minus the friction load. The total variation amounts to about twice the pressure required to force the ram of the cylinder through the stuffing-box. The pressure required is determined by the size and form of the piece to be worked, also the material used, and has in some cases to be determined by experiment.

The water volume of the accumulator should be equal to the sum of the volumes of all cylinders of all machines working at the same time. In large installations we can assume that the pauses are generally greater than the demand for water, and therefore engineers recommend to make the volume of the accumulator equal to one-third of the volume of all the cylinders. The writer prefers to have it larger, as the time will not be very far distant when the "Taylor System of Shop Management" will demand a larger accumulator. For smaller plants the accumulator should be proportionally larger.

There are two kinds of ordinary accumulators—those with stationary ram and movable cylinder and those with stationary cylinder and movable ram. The first one requires less height, but is not as accessible at the stuffing-box. This box is more apt to give trouble. For very important installations it is better to have accumulators with stationary cylinder and movable ram. The stuffing-boxes have to be arranged by special designs for accessibility. The annular weight-cylinder is filled with iron ore, scrap and stone. I prefer to have accumulators provided with guides, so as to guide the weight-cylinder or cast iron weights which are often used in small plants instead of filled shells.

Besides these two kinds of accumulators there are in use so-called steam or pneumatic accumulators. I shall have something to say about them when I write about the piping and the safety appliances.

(To be continued.)

Ten Wheel Type Locomotives for the St. Louis Southwestern Railway

Ten passenger locomotives of the ten-wheel type were recently built by the Baldwin Locomotive Works, Philadelphia, for the St. Louis Southwestern Railway. These locomotives exert a maximum tractive force of 33,400 pounds, and are designed to haul trains weighing 470 tons up a grade of 1 percent at a speed of 30 miles an hour. The total equivalent heating surface, making the usual allowance for the superheater, is 3,256 square feet; the boiler is of the extended wagon-top type, designed to accommodate a 30-element superheater. The tubes, which are 2 inches diameter, are spaced with ⅞-inch bridges, the firebox has a vertical back head and sloping front, and the mud-ring forward of the rear drivers is inclined in order to give the greatest possible depth under the tubes. The front end of the crown sheet is supported by three rows of flexible staybolts. In the fourth row the two center bolts are rigid, and the number of such bolts is increased in each succeeding row from the front, until from the thirteenth row to the back of the box there are twelve. The forward half of the crown sheet is thus supported on each side by a group of flexible bolts covering a triangular area. Flexible bolts are also liberally used in the sides, front and back, the total number employed being 781. The grate is arranged with a central longitudinal bearer, and the grate-bars are interchangeable with the standard bar used by the St. Louis Southwestern in narrow firebox engines. The barrel of the boiler is 72 inches diameter, built of plates ¾ inch and 13/16 inch thick, designed for a working pressure of 200 pounds per square inch. The firebox is 102 inches long, 70 inches wide, with a depth of 72 inches at the front and 58¼ inches at the back. The side, back and crown sheets are ⅜ inch thick and the tube sheet 9/16 inch thick. The superheater tubes are 5⅜ inches thick and the ordinary tubes 2 inches thick. The heating surface is divided as follows: Firebox, 173 square feet; tubes, 2,285 square feet; total, 2,458 square feet, with a grate area of 49.6 square feet.

Talks to Young Boiler Makers*

When the Eureka Boiler Works started up they took on an apprentice, a cousin of Carl's. His name was John—or in German, Johannis—and for short they called him Jack, but on account of his continually asking questions he was soon known throughout the shop as Jack the Asker.

One day he same over to Carl, whom he always called Uncle, and said: "See here, Uncle Carl, I get onto the idea you told me that a chain isn't any stronger than its weakest link. I can see if the chain on the overhead crane busted, and I tied the two links together with a piece of belt lacing, the chain would not lift any more than the strength of the belt lacing; but that idea does not hold out, as far as I can see, always."

"Why not?" Carl asked.

"Well, I don't know; but take this punch, I've been looking it over. The motor that drives it has only an inch and a quarter shaft. Now, that big shaft up on top that drives the ram that carries the punch is about 4 inches diameter. If the ram shaft was as small as the motor shaft it would sure bend when you threw in the clutch to punch a hole, so you see here is a weak thing getting more powerful. Yet you told me that you could not gain power!"

Carl pointed to a little three-year-old boy playing outside the door, and said: "Do you see that yellow kid playing out there?" Jack nodded. "Well, he couldn't carry twenty-five bricks, could he?" "Sure not," was the answer. "Yet he could carry one brick, couldn't he?" Another nod from Jack. "You could carry twenty-five bricks if they were piled up on that board, couldn't you?" Jack said he could. "Well, now suppose we had two piles of bricks right here with twenty-five bricks in each, and I called in the yellow kid, and told him I would give him a nickel if he threw the bricks in a pile out the door. He would get busy and run his little legs off carrying one brick at a time to do the job.

"Now suppose, when the kid started, you began to pile up twenty-five bricks on that board, and when you had them all piled up you carried the lot to the door and dumped them

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* Continued from the February number.

off, and it so happened that just as you did this the yellow kid threw down his last brick. Both you and the kid had done the same amount of work, as you both carried the same number of bricks the same distance. You must remember that while the kid was running back and forth fast, you were moving slowly and but once over the distance he traveled many times.

"In this punch you have exactly the same thing, the shaft is making a lot of revolutions, or trips, as the kid did, and at each revolution delivering one brick-power, so to speak, while the ram shaft is making only one revolution, as you made one trip, delivering 25 brick-power. In other words, speed has to be considered when you are figuring power.

"Take that pry or pinch bar that we use for moving the cars when they come in on the track, you see the heel, or what they call the fulcrum, that sets down on the track is pretty close to the end and the end is broad and thick, but from the heel outward to the end the bar tapers, and when you put your weight on it and press down, the end of the bar goes through an arc, say of 4 feet, while the big end only moves through, say, a couple of inches. But you move the car, so you see the thing balances up. You get great power and very little movement, or you have very little power and a great deal of movement. Do you catch on?"

"Yes, I guess I do; but there is one thing I would like to ask you about. Tim Dorset told me that if you put potatoes in the boiler when you are testing it, the potatoes will make the boiler plates swell up and be tight. Is that so?"

Carl laughed, and said, "Tim is quite a highbrow."

"But, Uncle Carl, I don't believe it, because I put a lot of punchings in an old tomato can with two potatoes and some water, and boiled them three days. The punchings did not swell a bit, but Andy Mack says it's so as he has seen lots of boilers made tight that way."

"I guess we won't teach you anything about that just now," answered Carl, and he went into the office, smiling.

Work began to slack up and Carl and Alex began to worry. They had everything to do with, yet somehow they did not seem to be able to bid as low as other people, and the contracts they had obtained showed very little profit.

Mr. Walter came in early one morning, and said that there was a little work to be done over at the Standard Mills, and he wanted Carl to go over with the gang. Carl objected, as he said he had a good deal to look after, but Mr. Walter explained to him that he would like to get the measurements of the auxiliary boiler which was at the works and how much space there was around it.

Carl got the information, and a few days after worked out a design and estimate for a boiler just half as large again as the auxiliary boiler, and much to the satisfaction of the boys, and a good deal to their surprise, Mr. Walter told them to go ahead and get out the boiler as soon as possible.

"But where is the money coming from?" they asked, "and isn't it a pretty big risk to build a stock boiler of that size?"

Mr. Walter said he thought not, and that he would find the money; so the boys went at it, and as the material was promptly delivered at the end of the month the boiler was complete.

One rainy afternoon Carl was telephoned to come over to the Standard Mills to meet Mr. Walter and explain some items in the bill of repairs made on one of the boilers. Carl always hated to go to the Standard Mills concerning a bill, as the manager was one of those men who seemed to think, or gave you the impression that he thought, you were a rascal and he knew it. Everybody disliked the man, but Mr. Walter got along well with him.

After Carl and Mr. Walter had talked over the bill and made some concessions, the manager remarked, casually, "How much pressure can be put on that auxiliary boiler of ours, Carl?"

Carl was rather mad about the bill, and answered, "Not over 40 pounds." The manager reached for a paper on his desk, and after regarding it a moment, said, "Can't you patch it up so it will stand eighty?" Carl shook his head, and replied, "Even if I could I don't think the inspectors would stand for it. They are so awfully particular nowadays."

The two men rose to go, when the manager said, "Hold on a minute; what's a boiler worth half as large again as that?" Mr. Walter named a price that made Carl catch his breath. The manager frowned. "Oh, that is beyond all reason. Now get out of the clouds and tell me what the boiler would cost me."

Mr. Walter held to his price, but said, "Carl, we have a boiler that size most done, haven't we? Carl answered "Yes." Mr. Walter turned to the manager saying, "If time is any object to you we could steal this boiler and let you have it, if it isn't too large." The manager looked perplexed, then asked, "What size is it?" Carl gave him the information and the two men again started for the door, when the manager said, "Knock off 20 percent and I will give you the order for the boiler." But Mr. Walter only shook his head, and answered, "I have named my best price."

The two men left, but when they reached their office there was a note on the desk, saying that the Standard Mills wanted them on the 'phone. Mr. Walter called them up. After listening a moment, he turned to Carl and asked, "Could you get that boiler out by day after to-morrow on a pinch?" Carl grinned, and said "Yes," and after a few minutes more Mr. Walter hung up the receiver and said to Carl, "I've sold the boiler." Carl was delighted.

"Now that manager," Mr. Walter continued, "thinks himself awfully clever. He made us cut down our repair bill about five dollars and wasted pretty nearly all the forenoon on the job. He has hung off buying a new auxiliary until the inspectors said they would shut down on him and only allow him 40 pounds of steam. As a matter of fact he can't work without 80. It's just in the rush and he could not afford to shut down. I counted on all this, as I knew the old man, and while I took some risk I caught him, getting a good enough price out of him to square up those unjust reductions in our bill. It does not pay to be too clever, and here is a case that shows that knowledge is power." W. D. FORBES.

(To be continued.)

A Boiler Talk with Some Don'ts

Much has been said and written concerning the locomotive boiler and its maintenance that is interesting and instructive. New kinks intended to cheapen and facilitate the work are grasped and tried out by progressive boiler makers. In fact, the rush and stress of a busy season make it imperative that no terminal delays or failures occur on the road, and as a result everybody concerned is on the alert.

This subject is necessarily a broad one, and in these days of massive power, when the tonnage is gaged only by the machine that is to move it, the subject becomes more interesting and perplexing to those who are concerned directly in its operation and care. The conditions vary so greatly in different sections that a general plan of maintenance could not be laid down. A successful method here would be a failure there. Boilers may be likened to men; that is, there is a survival of the fittest. A poorly designed, constructed and maintained boiler is a constant menace, and trouble will never cease until it reaches the scrap pile. I have in mind such boilers now. A considerable number of boilers were scrapped because a crack developed in the barrel and extended into the dome. In another instance, every boiler of a certain class cracked crosswise in the connection sheet near the roof. The boilers go to the shop and a patch is applied. After a short time the patch cracks through, the boss is at his wits' end and orders a new sheet applied, so the engine is held up several weeks when its services are needed the worst. An old boiler maker once remarked when I censured him for turning out a poor job, "It's a poor boiler that won't shed a tear for its maker." This is poor consolation for the man who must explain to the fellow higher up.

A comparison of existing conditions and methods to that of thirty years ago may be interesting to the younger fellows. During the last twenty years the locomotive has doubled and tripled in size and weight; this is in keeping with the times. Trackage and business have also doubled and tripled. The old timers who have kept abreast of the times all these years will hark back to the good old days when a boiler failure was as rare as an orchid in Greenland.

Thirty years ago 125 pounds was the usual boiler pressure, and a pressure of 140 pounds was a curiosity and a thing to be marveled at. Now a pressure of 250 pounds is not uncommon. In those days flues were removed only on general principles, and staybolts were tested only at rare intervals. Boiler explosions were more numerous, too, only we did not hear so much about them as we do now.

It is recorded that the first vessels constructed to hold steam were made of stone and wood, with flues of iron and copper. Pressures of only 1 and 2 pounds above the atmosphere were carried, however. In 1710 the first really practical boiler made its appearance; it was known as the "Haystack" or "Balloon" boiler, on account of its resemblance to the latter. These boilers worked at pressures of from 7 to 10 pounds above the atmosphere.

In 1769 the first vertical flued boiler came into use. From this period the development of the steam boiler was rapid. Little was known concerning the strength of materials or correct principles of design and workmanship, and as a result disastrous explosions took place. It was erroneously supposed that some galvanic action was at work, and that sufficient steam pressure was not generated to cause the boiler to rupture and explode. About this time English engineers took the matter out of the hands of manufacturers and began laying down rules and formulas for the boiler makers to follow. Many of these rules are in use at the present time.

The first locomotives made their appearance after the advent of the internally-fired boiler in 1829. It was employed by Stephenson in his famous "Rocket." The old school of boiler foremen and boiler makers knew but little concerning the strength and safety of the boiler they were called upon to repair or the causes that led up to its failure. This was a State secret guarded in the breasts of the engineers. Good books were not available at that time and the men had no means of knowing. I remember hearing some boiler makers discussing the reason for the different kinds of boiler joints. They came to the conclusion that it was simply a matter of style, like a woman's dress, but they did believe that the more rivets they could work in the stronger it would be.

There were good mechanics in those days, however, men who could apply a copper patch to a back head flange without leaving a hammer mark or hammer a rivet without touching the sheet. How often we meet the old codger who deplores those days! They knew not the murderous effect of the drift pin or the sharp-nosed calking tool, which have long since been supplanted by the reamer and concave fuller. Some of these old boys remain, and shake their heads as they listen to the rattle of the air hammer and buzz of the motor. A campaign of education is going on among the men who are doing things, and to-day it is considered everybody's business to know.

The great sizes and heavy pressures carried are the prime causes for many of the ills of modern locomotive boilers. It is an established fact that a boiler constructed from proper materials, properly built under skilled supervision, correctly designed to work at a pressure four or five times under its calculated bursting point, is as safe as a bridge or any other structure. Such a boiler being subsequently continually subjected to one of the great forces known in nature—*i. e.*, expansion and contraction, coupled with the ravages of bad water—soon starts on the road to weakness and repair. Were it possible to raise the temperature and pressure on such a boiler to its calculated working point, and maintain such temperature and pressure without variance, using no steam and supplying no water, keeping the boiler in a dry place, in an even temperature, it is interesting to know that no leak would develop, and that after many years an examination would develop the fact that no deterioration had taken place. There would be no evidence of crystallization in the plates, no staybolts would be broken, and provided that the water that the boiler had been originally filled with had been ideal boiler water, scarcely any traces of corrosion could be detected. We are told that crystallization in iron is caused by molecular action, and that molecular action is caused by the changes in temperature.

In bad water districts, where the feed-water is impregnated with corrosive and incrustating chemicals, the deterioration of the boiler is greatly augmented by the changes in temperature, or the corrosion and grooving is both mechanical and chemical, so to speak. Chemists tell us that absolutely pure water is not good for boiler purposes. Rain water is very corrosive in its action. A boiler water slightly charged with a carbonate is ideal. This deposits a slight coating of scale on the naked iron and protects it from acid as a coat of paint shields a building from the elements.

The boiler inspector of to-day must be more alert and the boiler maker more conscientious. The quality of the work is more important than the quantity, and a close attention to detail is necessary if good results are to be obtained. Big things must be repaired or a failure is the result, a multitude of little things neglected makes a bad condition and a poor housekeeper and usually ends in chaos and trouble.

Don't replace a mud plug without first examining the threads.

Don't forget to open and look in the front end when you test a boiler.

Don't bend the hand of a steam gage to make it register correctly, it will lie to you.

Don't attempt to tighten a mud plug under pressure, they have been known to blow out and kill people.

Don't take it for granted that the crown sheet is clean, sometimes a bunch of scale is hidden among the sling stays.

Don't allow a leaky mud-ring rivet or seam to run until the corrosion compels you to apply a patch. "A stitch in time saves nine."

Don't forget when you are testing staybolts to look for short and pulled heads. A lot of short and pulled heads are probably more dangerous than broken bolts.

Don't test a boiler with cold water. If hot water is not available, better fire the boiler up until you can lay your hand on it comfortably and then apply the pressure.

Don't allow a leak, even if it is slight, to issue from the barrel of a boiler. Go after it; it may be a crack; it has happened before, and cracks in the barrel are dangerous.

Don't test a boiler until you have made all appurtenances in the dome and cab tight. A boiler is not tested when a flood of water is running over its sides. Such a test is almost useless. Almost anything could be wrong with the exterior and you would not know it.

Don't let the fire give you a welding heat on 6 inches of the flue or superheater tube. Concentrate the flame on the weld as narrow as possible, and make your weld in one heat. Repeated heating wastes and weakens the tube and invites trouble, many flue failures are caused by carelessness at the furnace. Better throw a bad one out than let it get in the boiler.

The Boiler Maker

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CIRCULATION STATEMENT.

Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Now that the convention season for master boiler makers is approaching all hands should get in line for the big convention in Philadelphia May 25, 26, 27 and 28. The secretary informs us that the committees appointed last year have met their obligations faithfully and that an unusually attractive and valuable amount of information will be placed before the association for action. It has always been recognized that the success of such a convention depends very largely upon the thorough and painstaking work carried out by the committees during the year, and with the assurance that this work has been well performed no member of the association can afford to lose the opportunity of meeting his fellow members and discussing this work at first hand.

Meanwhile the supply men have not been idle and the resources of the convention city are being ransacked to provide ample entertainment for the spare moments of the convention week and especially for the ladies and guests of the association.

And while your thoughts are on the convention don't forget the prizes of $50, $35 and $25 offered by the Champion Rivet Company for the best essays on "How to Heat Rivets Satisfactorily." This contest is open to all boiler makers and the papers should reach the office of The Boiler Maker on or before 12 o'clock Wednesday, May 20. The papers should not be signed by the author, but should bear some distinguishing mark, the name of the author being inclosed in a sealed envelope, bearing a duplicate of this identification mark and forwarded with the paper. The prizes will be awarded by a special committee at the convention.

In a recent letter one of our subscribers writes that he has been taking The Boiler Maker ever since it was put on the market. Continuing he says:

"As I have worked at the boiler-making trade for the past thirty-seven years, having served my apprenticeship under my father, who was a first-class layerout as well as a blacksmith and anglesmith and an all-round mechanic in the iron trades, I will say that there has not been a great deal in The Boiler Maker that is new to me in laying out, but once in a while I find something very interesting in the magazine and I never saw anything that hits the spot any better for the young man who tries to make something of himself along these lines than The Boiler Maker. Please do not think from the foregoing that I am an old fossil who thinks he knows it all. You will note that I said I served my apprenticeship. As a matter of fact, I am still learning the trade, for there is something new turning up all the time and it keeps a fellow on the jump to keep abreast of the times. I have been laying out for many years and for the past ten years I have been the only layerout in the —— shops of the —— ——, where over 200 men are on the pay roll, so you can judge from that my standing in the trade. I heartily recommend The Boiler Maker to anyone in the trade and wish you long and continued success in the good work."

We are always grateful for expressions of appreciation and good will such as the foregoing, but we are particularly pleased at the opportunity for emphasizing the idea brought out by our correspondent, that no matter how extensive a man's experience may be and no matter how enviable his standing in the trade may be, nevertheless there is always something new turning up, and in order to stay in the front ranks a man must never cease to keep on learning his trade. There has never been a time when progress in engineering and industrial development was more rapid, and the demand for trained men more urgent, than the present. No beginner and few of the older men can afford to lose any opportunity to add to their knowledge of their trade, both as regards its methods, the tools and appliances used and the failures and achievements of others as well as their experiences and opinions. It is such things secured from reliable sources that The Boiler Maker has conscientiously endeavored to place before its readers, and we believe that every thinking man in the trade will recognize the value of the investment which he is making when he becomes a subscriber to a reputable journal devoted to his trade. If he doesn't, let him ask his boss.

Engineering Specialties for Boiler Makers

The Lennox Serpentine Shear

The Lennox Serpentine Shear, a new type of machine now being offered by Joseph T. Ryerson & Son, Chicago, is designed particularly for the straight and irregular cutting of sheets and plates. The frame is a steel casting of spiral construction designed to provide sufficient clearance for material of unlimited length or width. This machine will handle not only straight cutting, but also in or out curves having a minimum radius only slightly larger than the diameter of the blades. The spiral steel frame carries all gearing and is mounted on a substantial cast iron base. All gears have teeth cut from solid metal and are provided with cast iron gear guards, so the workman is fully protected while operating the machine. The blades, which are made of high-grade tool steel, are set in approximately a horizontal plane. This gives a very large cutter bearing on the sheet or plate and, consequently, there is very little distortion in the cutting. The upper cutter is positively driven, while the lower cutter is mounted in an adjustable sleeve, so that its position may be varied to allow for different thicknesses of material and for redressing. In addition to this, a cam is provided so that the lower blade can be dropped enough to permit the removal of sheets without reversing the machine. The cutters have a flush fastening to the shaft, so that no nut projects to interfere with the handling of the work and the knurled edges feed the sheet automatically into the machine. A tool steel pin is provided to take up the end thrust on the lower cutter shaft. Where a number of sheets are to be cut to the same pattern, a template may be bolted to the work, and this template followed by guiding against the top cutter.

The machine is driven by means of a two-speed pulley, giving slow speed for intricate curve cutting and high speed for straight work. The main drive shaft is extended and squared on one end, so that a hand crank may be used if power is not available. This shear, it is claimed, will reduce cutting costs fully one-half by replacing old-style hand and power cutters, and thus saving time and labor in handling. The shear illustrated has a capacity for cutting No. 10 gage material and lighter, while other sizes having capacities of No. 16 gage ¼-inch and ⅜-inch material can be furnished. All machines are arranged for either belt and hand power or direct motor drive.

Schmidt Marine Superheaters

The Schmidt fire tube superheater, manufactured by the Locomotive Superheater Company, New York, consists of collector castings and a system of units or elements made up of U-bent tubes, the material of which is cold-drawn seamless steel. The collector castings are located in either a vertical or horizontal position in the uptake end of the boiler. The units, which are arranged in groups leading in and out of the uptake end of the flues, are expanded in the flanges or collars, which in turn are fastened to the collector castings. In joining the ends of the unit pipes to the collector castings one end of the pipe is in communication with the header from the boiler and the other with the steam pipe leading to the engines. Thus the steam in passing from the boiler to the engines must pass through the units or elements in the tubes, where the superheating takes place. The connection between the units or elements and the collector castings is made by means of a single clamp using but one bolt or stud, thus facilitating the removal of the units should occasion demand their removal.

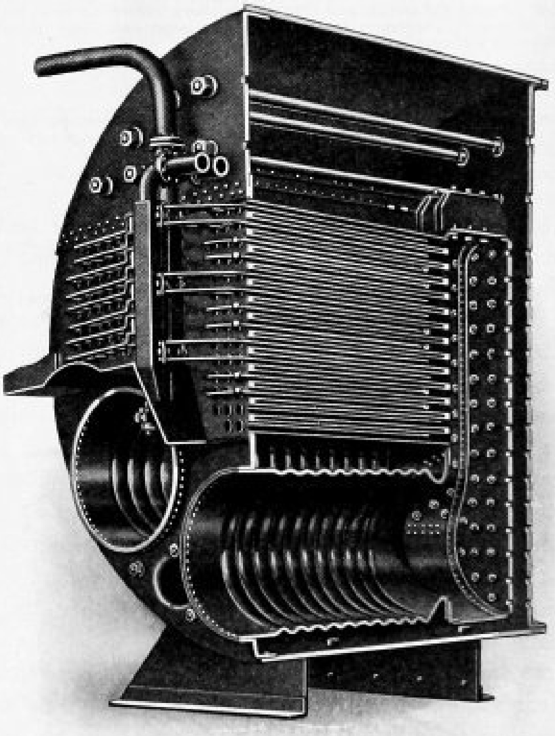


Fig. 1.—Sectional View, Showing Location of Superheater Elements in Fire Tubes

The units are formed by welding the straight sections of the pipe to a forged return bend, whose thickness is somewh greater than the thickness of tube. By this form of construction each unit consists of a single continuous pipe and does away with screwed joints or connections which might be contributory to leaks. The construction of the Schmidt superheater is evident from Figs. 1 and 2, which show its application to an internally fired Scotch marine boiler.

The superheater may be installed in existing power plants at a comparatively low cost, resulting in fuel economy as well as increased power output. The reduction in the flue area for gases by the introduction of the superheater is not a serious matter if sufficient draft is provided and unit pipes of the proper diameter are used. As the coal consumption is greatly reduced by the increased efficiency of the plant, the volume of gases passing through the flues is proportionately reduced. It is claimed that this condition more than makes up for the restriction of gas area resulting from the installation of the superheater. If the draft should prove insufficient, it can be remedied by providing a forced or induced draft system of larger capacity. The cleaning of the superheater and boiler tubes can be easily effected by steam jets specially provided for the purpose and the introduction of the superheater pipes does not interfere with the well-known "Diamond" blower system used so extensively in cleaning flues while under way.

Where superheated steam is used, the material for pipe lines and fittings should be of steel and cast steel, respectively. Other metals, such as copper and bronze, lose their strength in high temperatures and should be avoided in piping and fittings that are to be used in connection with highly superheated steam. In selecting the engines to be used in connection with superheated steam, the high-pressure cylinders should, if possible, be served by either piston or poppet valves. The use of an inside admission piston valve for the high-pressure cylinder, as in ordinary practice, is the type of valve that will give satisfaction. For equal engine power the cutoff when using superheated steam must be somewhat increased above that for saturated steam. This variation can, as a rule, easily be obtained in the adjustment of the valve gear without any alteration in the position of the eccentrics. It is recommended that in new construction the high-pressure cylinder be made somewhat larger than is made for saturated steam, if it is desired to maintain the same cutoff in the low-pressure cylinder.

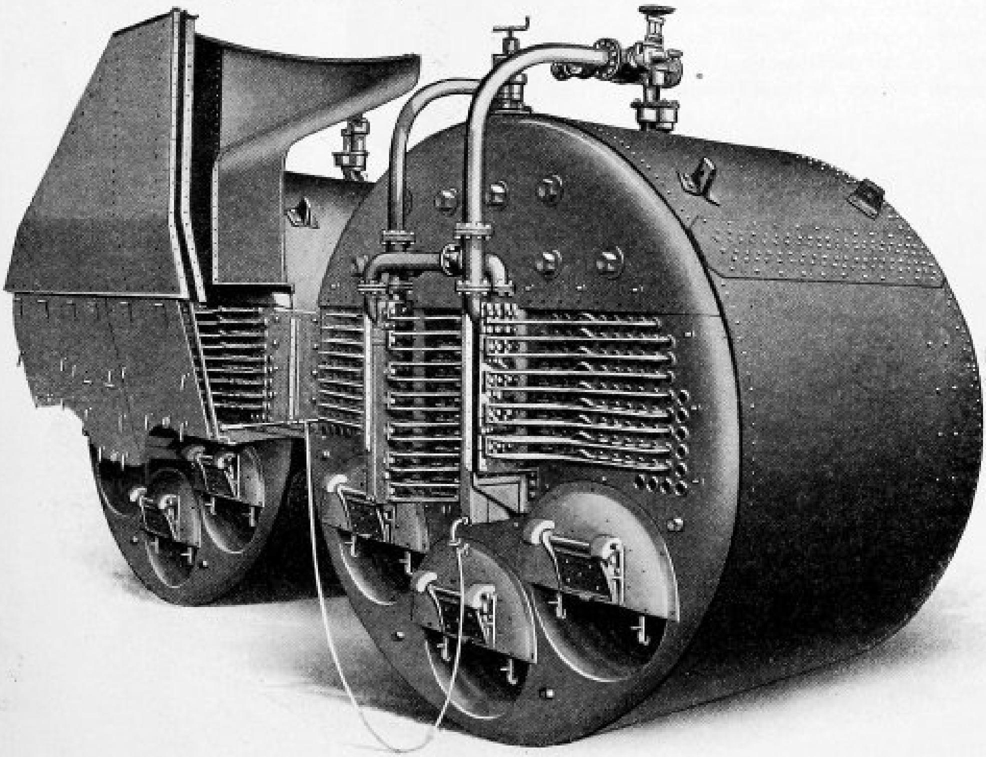


Fig. 1.—Schmidt Fire Tube Superheater Installed in an Internally Fired Marine Boiler

At the present time there are over 900 steam vessels, totaling over 1,000,000 horsepower, equipped with Schmidt marine superheaters.

The most economical results are obtained when a steam temperature of 580 to 620 degrees Fahrenheit is employed. The advantages claimed for this type of superheater are as follows:

1. It is adaptable to either new or existing boilers of the firetube type and can be applied with no change in design or construction.

2. It increases the output of power of a given marine power plant from 10 to 25 percent.

3. It will produce the same power output with fewer boilers.

4. It reduces the size of coal bunkers, thereby reducing the draft of the vessel with a given cargo or making possible an increase in revenue cargo.

5. It results in a saving of fuel over similar plants not equipped with superheaters as follows: Compound engines, 18 to 25 percent; triple expansion, 12 to 18 percent; quadruple expansion, 10 to 12 percent.

6. It reduces the maintenance cost by the prevention of water hammer, leaky flanges and condensation in the cylinders.

7. It permits rapid, thorough and frequent cleaning of the smoke and superheater tubes from ashes and soot without opening the smokebox door.

8. Its construction provides easy access to all screwed joints for ready removal of same.

Powell "Mac" Compression Grease Cup

The Powell "Mac" automatic grease cup, manufactured by the Wm. Powell Company, Cincinnati, Ohio, is especially designed for general all-around use. It is cast of brass sufficiently heavy and well proportioned, and operates equally well on cranks, crossheads, slides and journals of all kinds, meeting the demand for a simple, easily operated, reliable compression grease cup. The plunger, or piston, has a leather packing, insuring a snug fit and preventing the grease from backing up and filling around the spring and thus interfering with its operation. It has a simple feed adjustment, and an automatic lock arrangement, which it is claimed precludes any possibility of the feed being cut off by vibration or jarring of the machinery.

Improved "Little David" Drill

A noteworthy advance in the pneumatic tool line is the improved "Little David" drill which was brought out a short time ago by the Ingersoll-Rand Company, of New York and London. This is the only drill on the market having connecting rods running on roller bearings combined with crankshafts running on roller bearings. In addition, the new tool has all the advantages of the previous type, such as unusual accessibility to all parts, absence of hinged joints on the connecting rods, and cylinder heads cast integral with the drill casing. The fewness of parts and general simplicity of the tool are striking features.

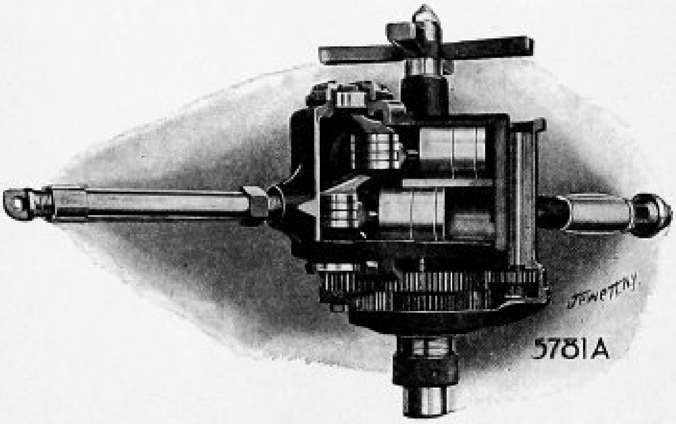


Fig. 1.—Part Section of "Little David" Drill

The shell is so designed that the entire motor apparatus may be assembled or disassembled through the crank case by the removal of the cover. The motor, or engine, is of the angular, four-cylinder, single-acting, reciprocating piston type, each pair of pistons being attached to opposite throws of a double crankshaft, and each acting in balance. All four connecting rods are exactly alike and are interchangeable. Each consists of but a single part, made by drop-forging a piece of selected steel.

The connecting rods run on Hyatt roller bearings, which it is claimed greatly reduce friction and give an easier running tool. The connecting rods are attached to the pistons by ingenious spring arrangements, whereby ease of assembling is secured. The piston ends of the rods are ball-shaped, over which flat steel springs are slipped. These balls have their bearings in the center of the pistons, forming ball and socket joints, permitting the connecting rods to yield to pressure from any direction without causing the pistons to bind in the cylinder. This construction also permits the pistons to turn in the cylinders so that wear is evenly distributed.

The crankshaft works in F. & S. silent-type ball bearings. These bearings are of the separator type, which it is claimed is superior to the full type of bearings for machines of this character operating at medium and high speeds, as, in the full type of construction, the balls come in contact and wear flat rings on their circumferences in very short time, resulting in loose bearings and generally unsatisfactory operation. The rapid wear is largely due to the fact that the balls are rotating in opposite directions at their points of contact, and the wearing effect is therefore doubled. The spindle is provided with a ball thrust bearing interposed between the shell and feed spindle, in such manner that the main frame is relieved of all thrust or strain.

Each valve controls two pistons which act on alternate strokes. As the valves are completely balanced, and of the rotating type instead of reciprocating, wear is equalized. The valves are geared to the crankshaft through the medium of a spindle gear. The valves are steel, hardened and ground, operating in bronze-bushed chests, giving a combination of two of the best wearing surfaces. The setting of the valves is very simple, as it is merely necessary to see that the letters stamped on the valve and crankshaft pinions register with letters on the main gear.

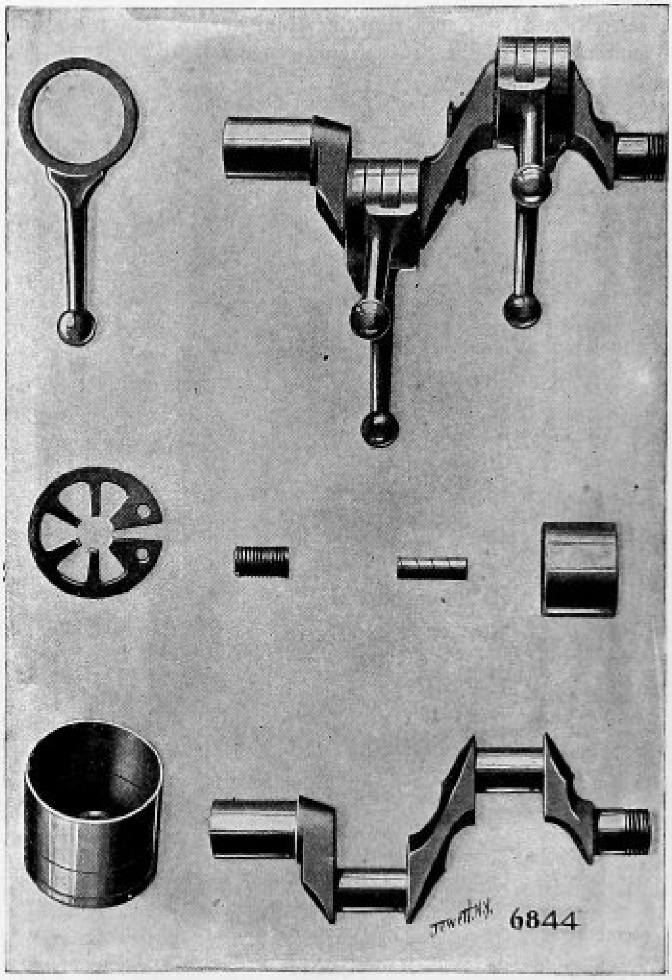


Fig. 2.—Crank Shaft, Connecting Rod, Piston Retaining Spring and Roller Bearings of "Little David" Drill

These tools may be made reversible or non-reversible at the will of the operator. This is accomplished by changing the position of the sliding sleeve on the throttle handle. With the exception of the light wood-boring type, all sizes are provided with compound gearing, insuring great power at all speeds.

The "Little David" drill is made in five sizes. No. 1 is for heavy drilling, reaming, tapping and flue rolling; No. 2 is for similar work of a lighter nature; No. 3 is for light drilling and reaming. The No. 12 size is fitted with a chuck for a 4-inch wood-boring auger, and the No. 13 size has a chuck for a 2-inch wood-boring auger.

Letters from Practical Boiler Makers

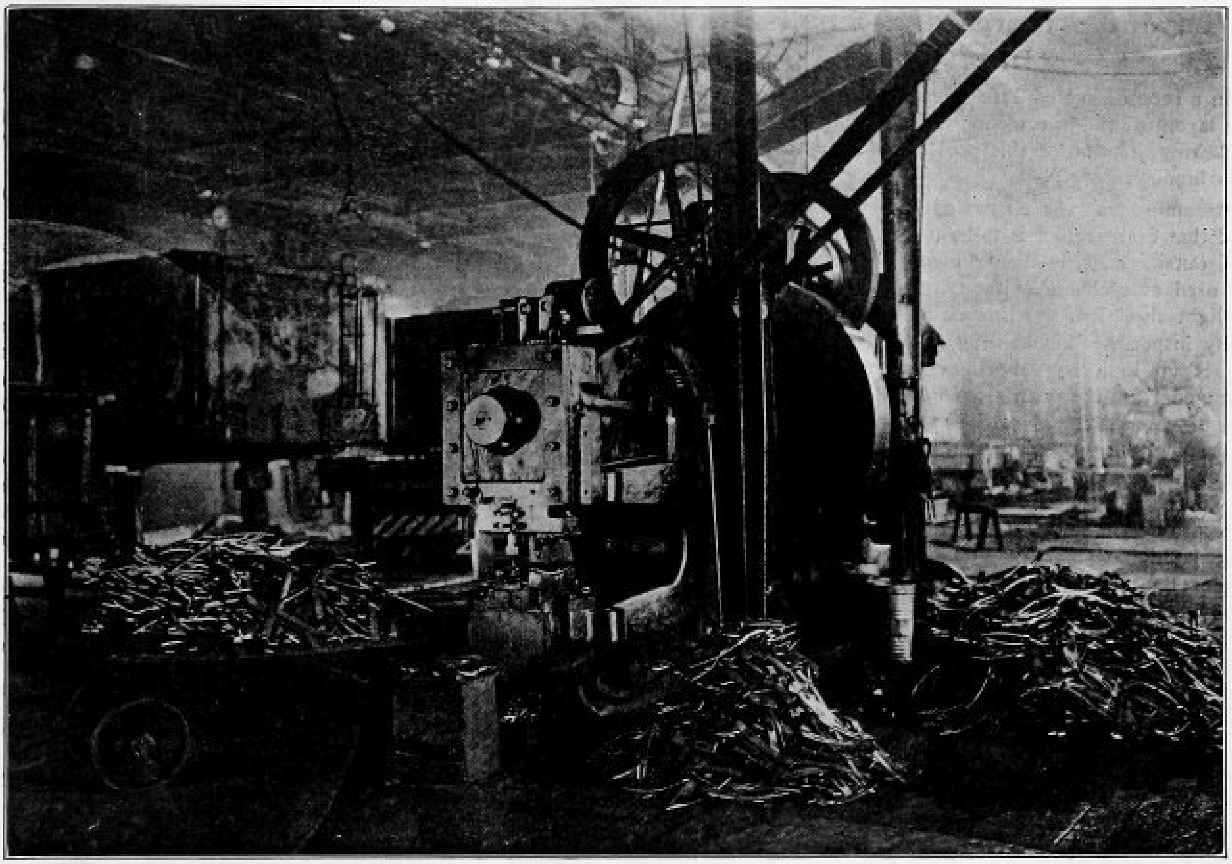
Work at the Milwaukee Shops of the Chicago, Milwaukee & St. Paul Railroad

As is well known, the Chicago, Milwaukee & St. Paul Railroad shop at Milwaukee, Wis., is one of the big railroad shops in this country that does things. It might be considered a manufacturing plant as well as a first-class railroad shop, since not only are a large proportion of the railroad's locomotives of all classes (except the Mallet type) built in the shops, but also the car department is equipped to take care of 70 coaches at one time and builds 26 modern 80,000 capacity cars per day. During the past eight years there have been built at the Milwaukee shops 528 locomotives, which means 528 boilers and 528 tanks, and besides there have also been built 187 pump and stationary boilers.

The Chicago, Milwaukee & St. Paul Railroad practices economy to a considerable extent. For instance, the frames for the new locomotives which they build are all made up from carefully selected scrap, pile-slabbed, and then worked up into frames. All of the main rods, side rods, and many of the axles, mud-rings and guides are worked up in the same manner. The scrap pieces of heavy boiler plate are sheared up in pieces 3½ inches or 4 inches wide and 12 inches or more long, and then rerolled in the small rolling mill in the company's blacksmith shop, and finally worked up into spring hangers and spring hanger gibs, wrenches, etc.

The cylinders for the new locomotives are cast in the railroad's own foundry, a fact which is worthy of mention because the making of good cylinders is ordinarily considered quite a job. The output of the foundry also includes between 500 and 600 car wheels a day, 1,200 brake shoes and 1,200 steel brake-shoe backs per day.

The brake-shoe backs are made up of ¼-inch steel, 1½ inches wide and 13 inches long, with an oblong hole ⅝ inch by 1½ inches punched at each end. The strips are then formed to a radius of 15½ inches, and it has been up to the boiler shop to get these out. The photograph accompanying this letter shows a large double punch and shear manufactured by the Long & Allstatter Company, Hamilton, Ohio, on which we have been making these steel brake-shoe backs, cutting them off to length at one end and punching and forming them at the other end.



Large Punch at the Milwaukee Shops of the Chicago, Milwaukee & St. Paul Railroad, Specially Equipped for Making Brake Shoe Backs

In punching, a special punch and die is used with a stripper bolted over the top of the die, leaving just enough space in which to place the ¼-inch by 1½-inch plate. This allows the punch to strip quickly, and gives the operator a chance to turn the piece and punch the opposite end without missing a stroke of the punch. After both holes are punched the steel back is placed in a forming die, the male die of which, as will be noted from the photograph, is bolted on the top header of the punch, while the female die is bolted to the die plate at the bottom. A guard is placed around the bottom die so that there will be no chance of injury to the operator.

Just as fast as the brake-shoe backs are punched they are formed. When the operator punches the last hole he places the shoe back in the former, and when he punches the first hole in the next back he throws the first one out finished.

This operation is taking place at every stroke of the punch, and in this way we are furnishing these steel brake-shoe backs complete at a cost of about 8 cents per hundred.

In some cases, in order to economize, we have been shearing these pieces up from old plate. This bent and twisted the pieces so much, however, that they had to be straightened out before they would go under the stripper. By referring to the photograph it will be noted that we have bolted a block on the top header so that the pieces could be straightened without increasing the cost. A. N. LUCAS,

General Foreman Boiler Maker, Chicago, Milwaukee & St. Paul Railroad.

Milwaukee Shops, Wisconsin.

Layout of Large and Small Elbow Intersection

In a recent issue of THE BOILER MAKER a reader asked for the layout of the intersection of large and small elbows. The following solution of this problem is submitted in answer to this inquiry:

Assuming that the elbows are to be made of heavy plate, and that each section is to be tapered; that is, to have inside and outside ends, in the following construction a profile will be used at each end, although this would not be necessary in light sheet iron work, such as tinsmithing.

By inspecting the drawing it will be found that the work is set up in a regular elbow of five pieces, the only line changed from the drawing submitted by the reader being the line 1-5-9, section (*a*), which represents the upper end of the main pipe. The dotted line on the drawing shows the original miter line, but it is necessary to extend the outside line 9-9 to intersect line 9-9′ in section (*b*). For convenience, separate drawings are made of sections (*a*) and (*d*).

In laying out the elbow draw a horizontal line. On 5, the center line, measure off the radius for the height of the elbow at *A* and *B*. With the trams on *A* as a center and the point 5 strike the center line 5-*M*. Do the same on line *B*-5-*P*, and on each side of points *M* and *P* set off the required radius for the elbow proper. Strike the outside and inside lines and divide the elbow into five sections, so that there are three full and two half sections, and draw the outlines as shown.

On the center of the miter line, point 5′, section (*c*), draw line 5-*X* at right angles to line *A*-5-*B*. Also draw lines 1-9 from (*c*) to (*f*) parallel to *A*-5-*B*, the slant line 9 to 5, and the line from 5′ down to 5 on the base line and up to 5″, thus forming the outline of the connection pipes between the two elbows.

Line 1-5-9, representing the upper end of the main pipe, will be our base line for sections (*b*) and (*c*). Construct oval sections, which will be one-half of the true profile, on the neutral line of the material to be used. Divide the oval into any number of equal parts, and draw lines to the base line, each line being equal in height to the lines in the semi-circle of section (*a″*).

Next draw the profile *D* at the upper base in a similar manner as at the bottom, each line to correspond with the lines 5′-5′, 6′-6′, 7′-7′, 8′-8′ in *S*, the profile through line *B*-*R*, which is a true circle. Connect the upper and lower bases by drawing lines 5-5″, 6-6″, etc. From these points on the lower base line 5-9 drop lines to the semi-circle, which is drawn for the large end of the main pipe. Also from the upper base line drop lines as shown in the drawing. With the dividers set to the distance 5″-5″, profile *D*, and from point 5 on the center line 1-9″, set off the points at 5″, and so on, locating the various offsets on the respective lines. Draw a curve through the points thus established, and we have a foreshortened view of the plan of the main pipe.

On the working plan draw the solid lines 9-9″, 8-8″, 7-7″, 6-6″, 5-5″ and the dotted lines 9″-8, 8″-7, 7″-6 and 6″-5.

The next step is to lay out the diagram of triangles. Erect the two perpendiculars at (*b*), draw lines from points 5″, 6″, 7″, 8″, 9″, and repeat the same process at the bottom from 5, 6, 7, 8 and 9. Take the distance 8-8″ in the plan and set it off on the left of the perpendicular on line 8. Step back to 7-7″ and set off the distance on line 7. Also take off the distances 6-6″, 5-5″ and set them off on lines 6 and 5. Now take the dotted line from 9″ to 8 on the right of the perpendicular, and set off the distance on line 8. When all four distances have been set off draw lines as indicated and number them with corresponding numbers. We are now ready to develop the pattern.

Line 9-9″ can be taken from the elevation and set off as in the pattern for section (*b*). With dividers already set to the spacing in the profile *C*, with one point on 9, strike arcs on each side at 8-8. Take the dotted line 9″-8 in the triangles, and on point 9″ strike an arc at 8, intersecting the one struck from the point 9.

Turn now to point 8 on the other side; take the solid line 8 in the triangles and from point 8 in the pattern strike an arc at 8″; continue in this manner until all the lines are laid down, when the curved end lines can be drawn, completing the pattern for section (*b*).

Now, taking section (*c*) draw the profiles *E* and *I*, the same being the true profiles on these lines. Also draw *F*, the true profile through the line *B*-*T*. Connect the points with solid and dotted lines, and from points in the upper and lower bases draw lines to the plan (*c*). From the line 1-9′ in the plan as a center line, set down the lengths of the lines to form the foreshortened views which are taken from the proper profiles *E*, *I* and *F*. On the base line, profile *I*, where the lines from the curved line intersect, will serve for that portion in the plan from 1 to 6. With dividers take the space 1-2 and set it off from 1 to 2 in the plan. Going back to *I*, take the distance 1-3, and lay this out from 1 to 3 in the plan. Take the remaining distances with one point of the dividers always on point 1. Now take the lengths of lines 5-5, 6-6, 7-7 and 8-8 in *E*, and on line 1-9 set off the points 5, 6, 7 and 8.

The lower base having been finished, we will work out the view for the upper base. Take the length of lines in *F* and line 1′-9′ in the plan as the horizontal center lines and set off each distance on its corresponding line, then connect all the points so found. To construct the diagram of triangles (*c*) draw lines from the points in the elevation, then take the distances in the plan and transfer them to correspondingly numbered lines in the triangles. Note that the dotted lines begin on the bottom line, 2.

The development of this pattern needs no further explanation, except that three pairs of dividers should be used, one for each of the profiles *E*, *I* and *F*. When a profile is spaced off the dividers should be kept at that setting until the pattern is finished.

Section (*d*) will be treated as an outside course. All the boundary lines in the side view (*d*) should be laid down in the same position as they were in the original view of the elbows. The outside line 1-1′ will be raised according to the thickness of the plate, and will be shortened at point 1 so as to keep the line 1-5 at the original angle.

Lay out the plan and divide each curved line into equal spaces. Draw parallel lines from the small curve to the line 1′-5′ and from the large curve to the line 1-5. Connect these points and construct a diagram of triangles. The pattern will be developed as in the preceding problems.

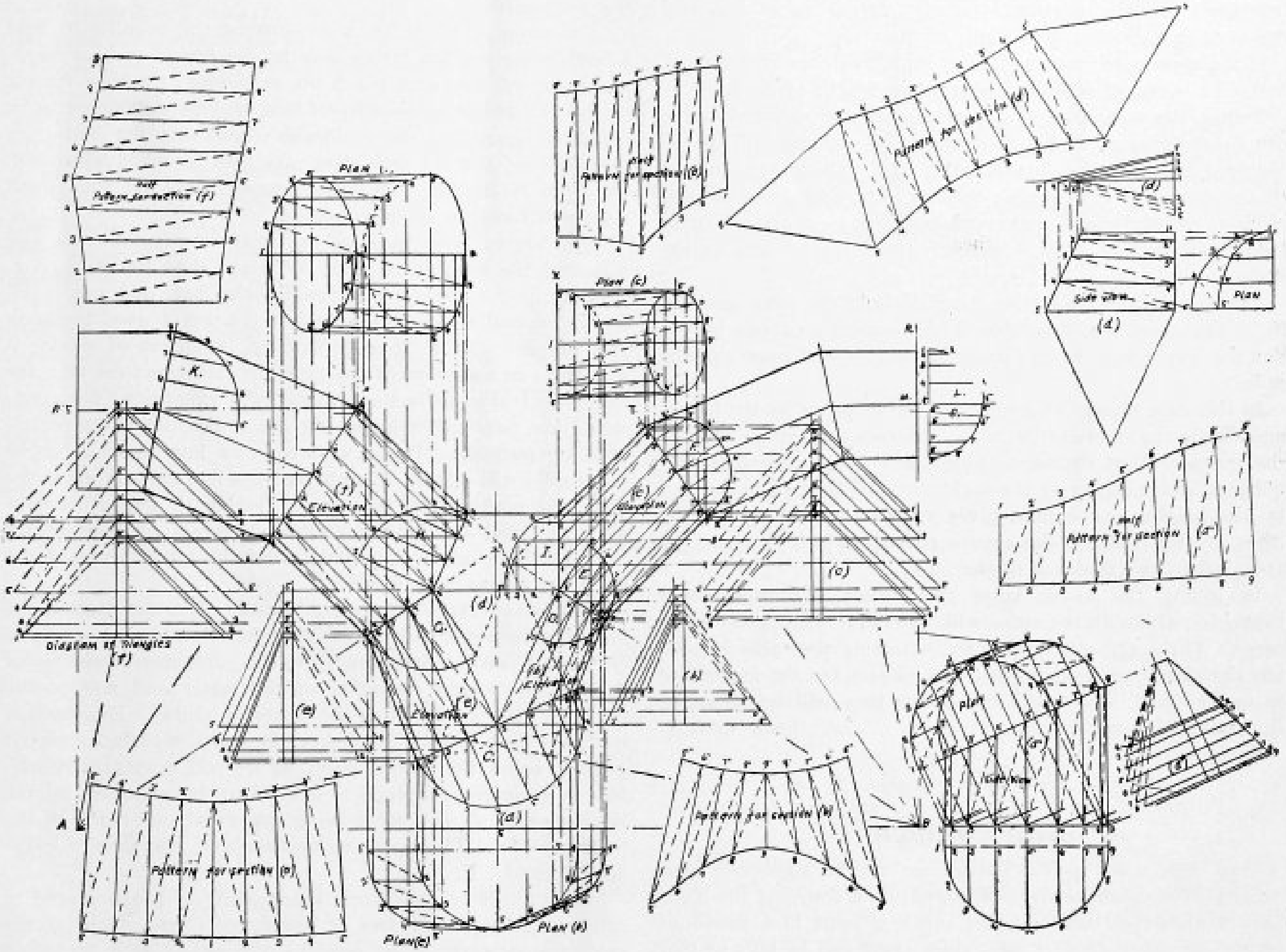
When all of the lines in triangles (*d*) have been laid down on the pattern, step to the triangles (*b*) for section (*b*); take the distance 5'-5 on the solid lines and from the point 5' in the pattern strike an arc at 5. Turn to the other end and from 5" strike an arc at 5. To get the next line, we step to triangles (*e*) for section (*e*). Take the length of the solid line 5'-5, and on the pattern (*d*), from the point 5 at the large end, strike an arc crossing the arc previously drawn from 5'. Repeat the process at the other end and draw lines 5'-5-5, thus completing the flat part of the pattern.

Taking up now section (*a"*), lay this out the same as (*a*) in the main figure. Draw the base line; lay off the diameter 1-9 to the neutral line; draw the center line 5-5'. Inside the points 1-9 mark off the thickness of the plate. From those points with the lengths of lines 1-1, 5-5 and 9-9 in (*a*) of the main pipe on the trams, strike an arc from 1 to 1', from 5 to 5' and from 9 to 9'. With the trams on the center line 5-1 in *C* set one point on 5', and strike an arc at 1' and 9'. Draw the slant line and construct the profile 1'-5'-9'. From the lower base line draw lines from all points parallel to the slant line. On these lines, and from the slant line, lay off the distances 5-5, 6-6, 7-7 and 8-8 in the semi-circle. Conect these points and construct a diagram of triangles by drawing lines as indicated from the lower base line. Develop the pattern the same as before, adding for laps and flanges on all patterns.

The large elbow will be laid out in the same manner as the smaller elbow. As was pointed out at the beginning of the article, half of *C* from 1 to 5 will be used for section (*e*) and *G* for the top base. *H* is the true profile for the lower section (*f*) from 9 to 5 and *K*. From 5 to 1, spaces on the center line 5-6-7-8 can be transferred to 5-4-3-2 on the base line of section (*f*), and spaces 1', 2', 3', 4', 5' in *G* can be transferred as 5'-6', 5'-7', 5'-8', 5'-9' and 5'-4', 5'-3', 5'-2', 5'-1', using point 5' as the center for all spaces. By following the lines and numbers the drawing will be easily understood and a detailed explanation is unnecessary.

C. F. Axelson.

Rutland, Vt.



Patterns for Large and Small Elbows Leading to Main Pipe

Capacity of Tanks

The following explains how to determine the size of a tank when the height and capacity are given or *vice versa.* As an example, assume that a customer has ordered a tank to hold 8 gallons, the bottom or base of the tank being 11 inches by 14 inches. The problem is to find the height of the tank which will be of the desired capacity.

The rule to follow in the case of any square or rectangular tank is to reduce the number of gallons to cubic inches, divide this amount by the area of the base and the quotient will be the height required. For the example given, as there are 231 cubic inches in a gallon, there will be 231 × 8 = 1,848 cubic inches in the tank. The base, 11 inches by 14 inches, contains 154 square inches, and therefore 1,848 ÷ 154 = 12 inches, which will be the desired height of the tank.

Suppose the height of the tank and the length of one of its sides and its capacity are given, what will be the length of the other side?

Assume that the capacity is 8 gallons, the height 12 inches and the given side 11 inches. Divide the number of cubic inches by the height, which is 12 inches, and divide the quotient by 11, the length of one side. The result will be the length of the side required. Thus, 1,848 ÷ 12 = 154, and 154 ÷ 11 = 14 inches, the length of the side.

If a customer ordered a circular tank 16 inches in diameter, to hold a barrel of oil, what must be the height of the tank?

Reduce the volume of the barrel to cubic inches, and divide this by the area of a 16-inch circle. The quotient will be the required height. As a barrel holds 31½ gallons, the volume of the barrel is 7276.5 cubic inches. The area of a 16-inch circle is 201.062 square inches; thus, 7276.5 ÷ 201.062 = 36.19 inches. Therefore 36 3/16 inches is the desired height of the tank.

Assuming that a tank is required to hold the same quantity as in the above problem, that is, the contents of one barrel, and the height is to be 40½ inches, what is the diameter of the tank?

In this case divide the number of cubic inches by the height and divide the quotient by .7854. Extract the square root of the quotient thus obtained, which will be the diameter required. The capacity of the tank, 7276.5 cubic inches, divided by the height, 40.5 inches, gives 179.6667. Dividing this by .7854, we get 228.758, the square root of which is 15.124, or 15⅛ inches, the diameter of the tank.

In giving the above rules the writer has used small capacities, although the rules will, of course, hold good in all cases. There are other rules for obtaining the same results, but the above are the simplest and easiest for the apprentice to understand. The writer hopes that they will be of use to this class of men. JOHN COOK.

Springfield, Ill.

Jim to Jack

"Say, Jim, when a fellow asks one of the highbrows how many heat units there are in a pound of carbon, and the highbrow replies that there are not any heat units in a pound of carbon, and then another guy comes along and he tells us that when carbon is burned to CO something there are 14,600 heat units in a pound of carbon, who is right?"

"Well, Jack, we are only boiler makers and not supposed to know all that highbrow stuff; but when a fellow tells you to put a match to the gas jet and light the gas, it is not only the gas that burns, the light is half in the gas and half in the air, and it must be something like this when they burn carbon, but we will see what we can dig up on the subject."

"Yes, Jim," said Jack, "some of the boys were discussing this subject at noon, but we were north by south and all at sea; I wish we could find out a little about it right from the start on heat and heat units. What is this B. t. u. that they write about, anyhow?"

"Well, Jack, the letters or symbols B. t u. stand for British thermal unit, which is the unit commonly employed in the United States and in the British Empire for measuring the quantity of heat, and this unit is the quantity of heat required to raise 1 pound of water 1 degree F."

"Oh! I see now, Jim, then 20 British thermal units will heat 1 pound of water 20 degrees, or 20 pounds of water 1 degree; is that what it means?"

"Yes, and the term British thermal units is usually shortened to B. t. u. Let us consider the theory of heat for a few minutes. All bodies are supposed to be made up of a large number of very small parts called molecules; they are too small to be seen even with the most powerful microscope. These molecules vibrate to and fro, and having some weight they possess a certain amount of energy due to their motion. According to the modern theory, heat is the energy that a body possesses, due to the continual vibration of its molecules.

"The nature of heat is not clearly understood, but we can see its effects and measure its intensity in any body in degrees of temperature by a thermometer or other heat recording instrument.

"The temperature is not a measure of the quantity of heat a body possesses, but rather may be considered to be a measure of the velocity with which the molecules of a body vibrate to and fro while the quantity of heat may be considered to be the total energy of the molecules composing the body. A ⅜-inch rivet and a 1-inch rivet may both be made white hot, and both rivets have the same temperature, but the 1-inch rivet will have the greater quantity of heat.

"You know, Jack, how we use heat to expand tires, and also that the rivet holes must be larger than the cold rivet, that is because the rivet expands when hot, and nearly all bodies expand when heated, and if you get a good textbook you will find a table of coefficients of expansion of solids; it will give you a number of constants for cast iron, steel, etc.; for linear expansion, surface expansion, cubic expansion; these constants are only approximate, but are sufficiently exact for all ordinary purposes. If you wish to know how much a bar or other solid will expand when heated you find the constant in the table, and multiply this constant by the length and by the temperature; that is, the difference in degrees of temperature between the original temperature and the temperature of the bar after it has been heated.

"We know that when the fire is started in the firebox, the heated water rises, and its place is taken by the cold water, or circulation takes place, and as this continues bubbles of vapor form within the mass of the water and rise to the surface. We say then that the water is boiling. Evaporation is slower than boiling, and takes place at the surface only; it goes on below the boiling point, as ice will evaporate slowly, but to maintain evaporation heat must be absorbed by the liquid exactly as if it were being converted into steam at the boiling points. This gives us another unit, the unit of evaporation, or U. E.

"The unit of evaporation is the quantity of heat required to convert 1 pound of water at 212 degrees into steam of the same temperature; it is equal to 966, or, to be exact, 965.8 British thermal units. This is also called the latent heat of vaporization, or the quantity of heat that disappears in changing the liquid into a vapor while the temperature remains the same.

"There is also a point that I would like you to remember; it is this: that heat is also absorbed in changing solids into liquids. A pound of ice requires 142.65 British thermal units to convert it into water at 32 degrees. The latent heat of ice is thus said to be 142, and if water at 32 degrees is changed into ice at 32 degrees the water will give up 142.65 units of heat. Experiment has verified this. You will find these points all worked out in tables in any good engineering handbook, but for water the temperature of fusion is 32 degrees, temperature of vaporization 212 degrees, latent heat of fusion 142.65, latent heat of vaporization 966.

"Latent heat plays an important part in our lives every day. It takes a long time for heavy ice to form because of the amount of heat that has to be given up by every pound of water; if it were not for this all the great bodies of water would freeze solid."

"I never thought of these things, Jim; it's a wiser head than ours that made all these laws; just think what would happen in the spring when the snow and ice melts; if it were not for the time taken to absorb this heat we would be flooded out."

"Now, Jack, different substances require different amounts of heat to raise equal weights of these substances 1 degree in temperature; water requires more than most substances, and it is taken as a standard of comparison. Water is taken as 1 at its temperature of maximum density, that is 39.1 degrees F. Nearly all substances are lower than this, as stated already, and are expressed as decimals; but it is the ratio between the quantity of heat required to warm a body 1 degree and the quantity of heat required to warm an equal weight of water 1 degree that is called the specific heat of the body.

"You will find a table of the specific heats of many substances in any good handbook, but I will give them to you here so that you will not have to hunt around for them.

Specific Heats of Solids, Liquids and Gases

Solids

	Specific Heat		Specific Heat
Copper	.0951	Nickel	.1089
Gold	.0324	Platinum	.0324
Aluminum	.2143	Silver	.0570
Wrought iron	.1138	Tin	.0562
Steel (soft)	.1165	Ice	5040
Steel (hard)	.1175	Sulphur	.2026
Zinc	.0956	Charcoal	.2410
Brass	.0939	Coal	.20 to .24
Glass	.1937	Coke	.2030
Cast iron	.1298	Masonry and brickwork	.20
Lead	.0314	Wood	.46 to .65

Liquids

	Specific Heat		Specific Heat
Water	1.0000	Lead (melted)	.0402
Alcohol	.6200	Sulphur (melted)	.2340
Wood spirit	.6009	Tin (melted)	.0637
Proof spirit	.9730	Sulphuric acid	.3350
Mercury	.0333	Oil of turpentine	.4260
Benzine	.4500	Glycerine	.5550

Gases

	Specific Heat	
	Constant Pressure	Constant Volume
Air	.23751	.16902
Oxygen	.21751	.15507
Nitrogen	.24380	.17273
Hydrogen	3.4090	2.41226
Superheated steam	.48050	.34600
Carbon monoxide	.24790	.17580
Carbon dioxide	.21700	.15350
Marsh gas CH_4	.5929	.4683
Olefiant gas C_2H_4	.4040	.1730
Blast furnace gas	.2280	
Gases in chimneys of steam boilers, approximate	.240	

"To find the number of British thermal units required to raise or to be abstracted to lower the temperature of a body a given number of degrees, multiply the weight of the body in pounds by the specific heat and by the number of degrees Fahrenheit, or $N = S\ W\ (t_1 - t)$. Where N = number of British thermal units required or given up in changing the body from t^0 to t^0_1.

S^1 = specific heat.
W = weight in pounds.
t_1 = final temperature in degrees.
t = original temperature in degrees.

"To find the weight in pounds of a given substance that can be changed from one temperature to another by the application or abstraction of a certain amount of heat, divide the number of British thermal units by the product of the specific heat of the substance and the temperature difference in degrees Fahrenheit,

$$W = \frac{N}{S^1\ (t_1 - t)}.$$

"The highbrows use the thermal unit in their calculations. The thermal unit is the amount of heat required to raise 1 pound of water 1 degree centigrade. In France, and wherever the metric system is used, the heat unit is called a calorie, and the calorie is the amount of heat necessary to raise 1 kilogram of water 1 degree C., and is equal to 3.96 British thermal units."

"Hold on, Jim; that is too much of a dose of heat. You will be giving me sunstroke; tell me something of that CO_2."

"When carbon and oxygen combine they form carbon dioxide CO_2; when hydrogen and oxygen combine they form water H_2O; these are called the products of combustion."

"But, Jim, one fellow said that combustion was merely the phenomenon of burning."

"Combustion is said to be a rapid chemical combination of two or more substances producing heat, the ordinary combustion which takes place in the furnace is the chemical combination of the carbon and hydrogen of which the fuel is composed, with the oxygen of the air, producing intense heat. Carbon and oxygen, or hydrogen and oxygen, will not combine at ordinary temperatures; their temperature must first be raised to a fixed temperature, called the ignition temperature, before the attraction between the two is sufficient to cause them to combine. When combustion is once begun the temperature is kept up by the combustion itself as long as the supply of oxygen and carbon or hydrogen continues.

"The products of this combustion are gaseous compounds, which pass away through the flue and smokestack. Carbon and oxygen form two compounds—carbon monoxide, called carbonic oxide, and carbon dioxide, called carbonic acid. Carbon dioxide CO_2 is the product of complete combustion of carbon; each pound of carbon unites with 2 2/3 pounds of oxygen, and forms 3 2/3 pounds of carbon dioxide. Carbon monoxide is the product of incomplete combustion; 1 pound of carbon unites with 1 1/3 pounds of oxygen, instead of 2 2/3 pounds necessary to complete combustion.

"Oxygen required for combustion is taken from the air. Air is composed of 23 percent oxygen and 77 percent nitrogen, but the nitrogen takes no part in the combustion, and goes up the smokestack, taking a certain quantity of heat with it, so that we have to supply lots of air, as complete combustion of 1 pound of carbon would require 11.61 pounds of air; that would be equal to 2.67 pounds of oxygen and 8.94 pounds of nitrogen, and the products would be 3.67 pounds carbonic acid and 8.94 pounds nitrogen. For the complete combustion of 1 pound hydrogen it requires 34.8 pounds of air; that would equal 1 pound hydrogen, 8 pounds oxygen, 26.8 pounds air, and the product would be 9 pounds water, 26.8 pounds nitrogen. Air being only 23 percent oxygen we have found that it requires 11.61 pounds air and 34.8 pounds air for the complete combustion of carbon and hydrogen.

"To find the theoretical weight of air required for the complete combustion in any fuel,

$$W = 11.6\ C + 34.8H - \frac{O}{8}$$

Where C = percent carbon,
H = percent hydrogen,
W = weight of air,
O = percent oxygen,

A pound of air at 62 degrees F. occupies 13.14 cubic feet; by multiplying the weight of air in pounds by 13.14 we get the volume in cubic feet.

"In actual practice one and one-half to two times this quantity will be required; but care has to be exercised in this matter, as an insufficient quantity of air leads to loss through incomplete combustion, and an excess of air will so dilute the products of combustion that the furnace temperature will be lowered from 30 to 45 percent. The result of experiment has been that 1 pound of carbon burned to carbonic acid gas gives out 14,500 British thermal units, burned to carbonic oxide it gives out only 4,400 British thermal units; 1 pound hydrogen gives out 62,000 British thermal units, and the heat of combustion of a given fuel may be determined approximately by this formula: $h = 14{,}500\ C + 62{,}000\ (H - O/8)$, where h is the heat of combustion in heat units, and H, C and O the percent hydrogen, carbon and oxygen. The sure way to measure the heating value of any fuel, however, is by the calorimeter.

"Now, Jack, I don't want to worry you any more at present, but you will find lots of articles in The Boiler Maker along these lines."

"Say, Jim, before you go; there were some diagrams in The Boiler Maker showing the action of the pressure on the boiler shell, or rather on a circle; does this apply to any shape of a boiler? There's that locomotive type boiler. If the crown of the firebox is braced from the wagon top then these braces are to support the crown of the firebox, and the pressure will support the wagon top and keep it round, and the stays will hold up the flat crown sheet of the firebox, and everything will be balanced according to the rules that I see the boss and the inspector using. Gee! I wish I could figure out all these different parts of the boiler."

"Well, Jack, what you say regarding this boiler is all right in theory, but in practice it does not hold good; you will observe that the flat side of the wagon top and the side of the firebox are staybolted, I mean the water-leg, and the crown is supported by staybolts. Now at each side from the outer row of radial stays to the top row of side stays there is a part of the wagon top that is not supported in any way; it is circular in form, and according to theory should retain that form under pressure, but it does not retain that form. The boiler is rigid where all the braces and staybolts are, but at this point it is flexible, and the result is that this part moves slightly outward under test pressure. When this movement takes place the rigid part has to move also, and it moves downward. The wagon top lowers from nothing at the front head, where it is well supported by the head, and reaches its maximum movement just above the firebox tube sheet. When the wagon top moves downward the firebox crown has to move downward also. There must be a continual movement, as the pressure is raised and lowered, that in time will affect the tube sheet at the turn of the flange, causing it to crack, and we poor boiler makers are blamed for too much tube expanding and causing a lot of trouble by cracking plates."

"But say, Jim, the boiler could not have been a true circle, and when the pressure was on the boiler then it rounded itself up, and that caused the movement you speak of."

"The wagon top was perfectly circular in form, Jack, so do not worry over that, and the staybolts were all in according to good practice, yet this movement takes place. Theory is all right, but actual conditions on the testing floors tell the tale.

"I guess it's time to get moving, Jack; by-bye."

"Hold on, Jim! Take that tank there, it has two dished heads, one convex and one concave; suppose the top dished head was good for 100 pounds working pressure, and the bottom reverse head was only good for 50 pounds and the shell was good for 100 pounds; if I put stays through the heads, the stays to be good for 100 pounds, would the tank then be good for 100 pounds, and would the pressure keep the top head in circular form, and so support the bottom reverse head, or would they only balance at 75 pounds, I wonder?"

"I wonder," said Jim, moving away as the whistle blew; "but they say if we had any brains we would not be working in a boiler shop." Craglug.

Repairs on Vessels Under Pressure

Reading in the December issue of The Boiler Maker an article on the above subject, brings to my mind very forcibly some fatal accidents that occurred in a shop in which I formerly worked. In that shop it was the practice, when flues became bad and the beads gone, to ferrule them with cast iron ferrules, sometimes using copper liners around the iron ferrule to give them a grip and finally calking the copper back to the flue sheet. A stranger not knowing the condition of the flues would take them to be safe. When those flues leaked they were tightened by driving them with a maul. Such was the condition of affairs at the shop at the time of the first fatality.

It was a Saturday night when engine No. 500 arrived in a leaking condition and was reported to be calked. A young boiler maker, who had come recently from a local contract shop, was assigned to the job. The chances are that the young man was not thoroughly acquainted with the condition of the engine he was to work on. Be that as it may, he went about his work as others had done before him, driving the cast iron ferrules in a little further, with the result that one of the flues was driven through the sheet, and the scalding water and steam caught the young man and scalded him so badly that he died in about three hours.

How ever he got out of the firebox is a mystery, for there was about 70 pounds pressure on the boiler at the time. His helper escaped without injury this time, but met the same fate some few years later.

After this accident no one was allowed to enter a firebox while there was steam on the boiler. This went on for some time until there was a change of officials, when the old rule was again brought into force, and the helper of the victim of the first fatality, who by this time was a boiler maker, was caught in a very similar manner and died in a few hours.

Again a man entered a firebox with his helper to calk what was supposed to be a leaking soft plug, when the plug blew out, catching both men. The helper got out safely and called for help. The boiler maker made for the fire-door, but must have struck his head against the sheet and fallen back into the death trap. The helper, not seeing his partner coming out, entered the firebox again and lifted the unfortunate man out bodily, and then got out himself, but by this time he was badly scalded and was sent to the hospital. Some time after this brave and noble fellow, who, by the way, was an Italian, resumed his work he was discharged from the company's service.

Another cause of serious accidents at this place was the blowing off of engines under high pressure. One case, which was nearly a fatal one, was that of a boiler washer ordered to change the water in a boiler. This man got down in the pit under the engine and began to loosen the nuts on the bottom of the blow-off cock plug. This he had succeeded in doing, and got up out of the pit to open the cock. After doing so there was no escape of steam or water, so he went back to the pit and up to the blow-off cock to investigate. When the mud which had clogged the opening of the cock let go, the boiler washer was struck squarely in the face and badly burned. The writer rendered first aid in this case, and I can assure the reader that he was a sorry looking sight, although not seriously scalded. The escape was within a very small margin.

Now, I am quite satisfied that the men doing this work do not expect a special Providence to take care of them. That is not the case. It is rather this: that the men who follow this class of work, known as hot work in our railway shops, are generally composed of what is known as the home guard, and are family men who are not care-free or in a position to refuse to do work of this kind, although they know the risk, and take it because of the wife and bairns at home, which is perhaps a little home that they are paying for. I do not blame the men, but the foreman who orders men to assume the risk, knowing well the danger the men are exposed to, and that it could be avoided if they were men enough to tell those higher up that the work could not be done under pressure.

I am well aware, also, that there is a certain class of work that must be done under pressure which is considered perfectly safe—that is the testing of new boilers. Even this work is risky, for the writer has known of cases where heads of rivets, patch bolts and crown bolts have come off while a man was in the firebox, but he got away with a bad scare.

The Federal Inspection Law has done away with a lot of this kind of risk, but still there are cases to the writer's knowledge where men have been ordered to do work under pressure since the introduction of the new law, and the blowing off of engines still goes on in crowded round-houses, and frequently the hose that carries the water and steam, although wrapped with heavy copper wire, will blow off the connection and menace the lives of men who are working near by.

It is the writer's hope that the day is not far distant when it will be possible for the common, everyday boiler maker to go about his work feeling that he is perfectly safe as far as working on boilers or other vessels is concerned.

Pittsburg, Pa. Flex Ible.

Safety First

The attention given at the present day by employers to safety devices for the protection of life and limb of employees in shops and factories has lessened the accidents due to carelessness on the part of employees as well as those due to no fault of their own. The unprotected emery wheels and grindstones in the shops in former days were a fruitful source of accident to the employee.

In the up-to-date shop of to-day all grinding wheels are enclosed in such a manner as to protect the employee from the flying parts should the wheel burst, and no longer do you see the projecting set screws securing pulleys to the shafting revolving around with the machinery in close proximity to the clothing of the workmen.

Some years ago the dungaree clothing of a workman in a machine shop, in the presence of the writer, became entangled with a projecting set screw on a shaft of a grindstone, and his clothing was wound round and round the shaft until he had nothing remaining but his shoes and socks. The set screw was then changed to prevent the recurrence of such an accident that might not always end so fortunately. J. E. C.

Annual Dinner of the American Institute of Steam Boiler Inspectors

At the third annual banquet of the New York branch of the American Institute of Steam Boiler Inspectors, held at the Fifth Avenue Restaurant, New York City, Feb. 21, nearly two hundred members and guests of the association enjoyed an evening of entertainment and good fellowship, which was a welcome contrast to the rigorous duties and grave responsibilities undertaken by the men in their professional work. The new officers of the association installed for the coming year were as follows: President, James Gillespie; vice-president, Robert Thompson; secretary, J. H. Pollard; treasurer, George Turnbull; chairman of the executive committee, James H. Kinkead.

Mr. Young, president of the Boston Association of Steam Boiler Inspectors, outlined the work accomplished by the boiler inspectors in Massachusetts, while Mr. Brown, president of the Buffalo association, referred to the progress made in the Buffalo branch of the association, which was formed only a year ago with a charter membership of forty-five.

As a representative of boiler manufacturers, Mr. Bank, of the Heine Safety Boiler Company, discussed the improved efficiency of steam boilers. He pointed out that the fact that power is now available for 1½ cents per kilowatt depends very largely upon the ability to get such great economy from the steam boiler. Another representative of the boiler manufacturers, Mr. Michael Fogarty, discussed the difficulties encountered in attempts to obtain a comprehensive boiler law for the State of New York. He pointed out that the only way to secure legislation of this kind was to enlist the services of influential politicians whose influence, backed by well-known boiler manufacturers, would have weight in the community.

Mr. Hanson, secretary of the Workmen's Compensation Commission of New York, emphasized the value of systematic inspection, by referring to the fact that only one boiler in ten of the boilers which have exploded in the past forty years in the United States was inspected by insurance companies.

Among the other speakers were Messrs. F. R. Low, editor of *Power;* Idel, of the Babcock & Wilcox Company, and James White. At the speaker's table was a fully-equipped model of a single-drum Babcock & Wilcox watertube boiler. Mr. Thompson, the retiring president, was presented with a silver mounted stag-handle umbrella.

Selected Boiler Patents

Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,

Millertown, N. Y.

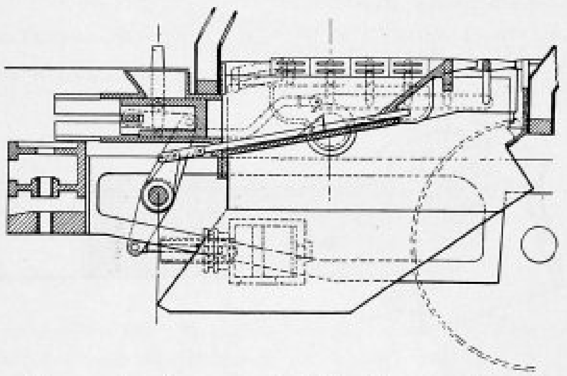
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,083,094. FORCED-DRAFT GRATE. THOMAS HARLEY AND ROBERT G. LONG, OF LAWRENCE, KAN., ASSIGNORS TO THE U. S. MECHANICAL DRAFT COMPANY, OF LAWRENCE, KAN., A CORPORATION.

Claim 1.—A hollow grate bar of the class described open at the bottom and having its side walls provided with downwardly converging shoulders and a series of pivotally mounted valves in said bar arranged for vertical angular movement to open or close the bottom according to the position of the valves, said valves having beveled sides to fit between said shoulders when the valves are closed. Two claims.

1,083,432. LOCOMOTIVE STOKER. DAVID F. CRAWFORD, OF PITTSBURGH, PENNSYLVANIA,

Claim 2.—The combination with a locomotive furnace, of an underfeed trough extending into the furnace, a grate extending along the side of the trough, and a rearwardly inclined drop grate located at the rear end of the furnace and extending transversely of the said grate. Two claims.

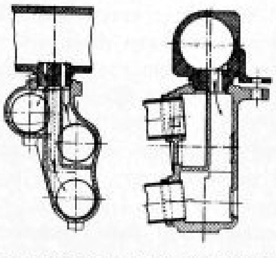


1,081,780. GRATE BAR. GEORGE S. SERGEANT, OF GREENSBORO, N. C.

Claim 3.—The combination in a grate bar with intermediate sections, of a supporting strut therefore shouldered to directly support the sections and having a portion fitting between the sections and sloping outwardly on its edges from its upper to its lower end, and means below and engaging with said strut for supporting the sections thereby. Five claims.

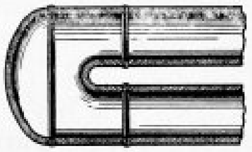
1,083,517. WATER-TUBE BOILER. ROBERT DELAUNAY-BELLEVILLE, OF ST.-DENIS, FRANCE, ASSIGNOR TO SOCIETE ANONYME DES ETABLISSEMENTS DELAUNAY-BELLEVILLE, OF ST.-DENIS, FRANCE, A CORPORATION OF FRANCE.

Claim 1.—In a water-tube boiler in which three coils are employed to constitute an element, the combination with the lower tube of each of said coils and the feed collector, of a lower front box divided into three compartments, and means to place each of said compartments in direct and separate communication with said feed collector. Five claims.



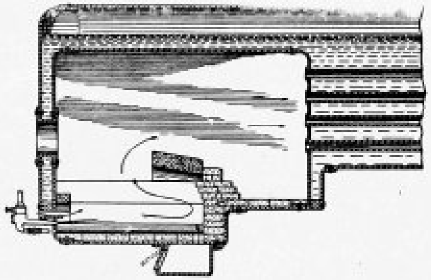
1,083,688. MANUFACTURE OF SUPERHEATER UNITS. COLUMBUS K. LASSITER, OF RICHMOND, VIRGINIA.

Claim 1.—As a new article of manufacture, a superheater unit comprising a return bend body having two cylindrical open-ended projections disposed side by side at one of its ends, each matching the end of a line of superheater pipe and open at its opposite end, two lines of superheater pipe, each electrically welded to the end of one of said projections, and a closure member electrically welded to the opposite end of the return bend body. Three claims.



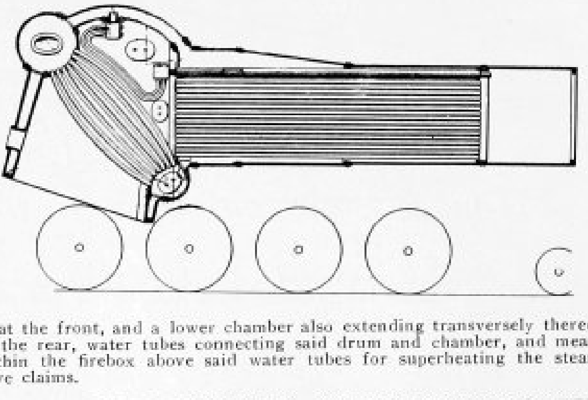
1,084,431. OIL-BURNING FURNACE. JOSEPH J. HASKIN, OF STOCKTON, CALIFORNIA.

Claim 1.—A furnace firebox having substantially vertical and lined side walls and a mud ring, a bottom composed of inclined sides converging from the mud ring at the bottom of the side walls and having inwardly turned, offset supports at right angles, linings for said inclined sides, and a flat inverted arch intermediate of the offsets, and a lining of abutting bricks fitting said arch and forming a continuation of the inclined side linings. Two claims.



1,084,555. LOCOMOTIVE BOILER. JAMES M. McCLELLON, OF EVERETT, MASSACHUSETTS.

Claim 4.—In a boiler of the locomotive type, the combination with a barrel or shell, of a firebox having a drum extending transversely thereof at the front, and a lower chamber also extending transversely thereof at the rear, water tubes connecting said drum and chamber, and means within the firebox above said water tubes for superheating the steam. Five claims.

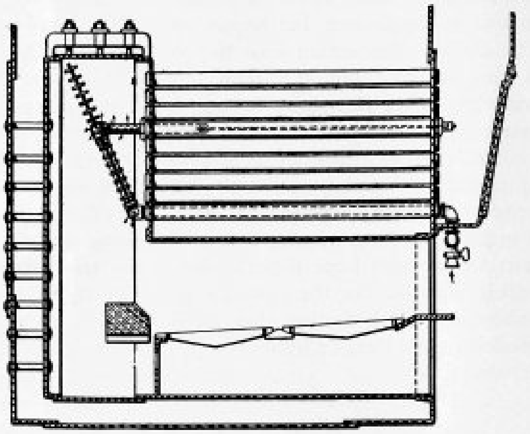


1,082,136. STEAM GENERATOR. EDUARD PIELOCK, OF BERLIN, GERMANY.

Claim 1.—In a boiler, a fire-box provided with side walls and a top having a centrally disposed opening, a flue extending from said opening and having an enlarged portion located above the opening, the upper end of said flue being constricted, a chamber located above the upper end of said flue, a water chamber surrounding said fire-box, flue and chamber, said water chamber being provided with an outer wall and the walls of the fire-box, flue and first-mentioned chamber forming the inner wall of the water chamber, downwardly directed fire tubes leading from the first-mentioned chamber through the water chamber, and a water tube extending transversely through said flue. Two claims.

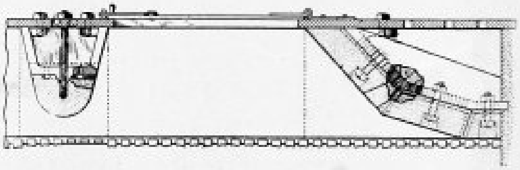
1,084,782. STEAM BOILER. UBALDO BERETTA AND BENVENUTO GIANESE, OF GENOA, ITALY.

Claim 2.—A tubular boiler having a passage for the products of combustion, in combination with upper and lower pipes extending from the tubes of the boiler into said passage and provided with openings discharging air into said passage, staffs mounted on said pipes and extending across the path of the products of combustion at an angle to the vertical, and flat perforated plates of a refractory material mounted on said staffs in spaced relation with respect to each other. Two claims.



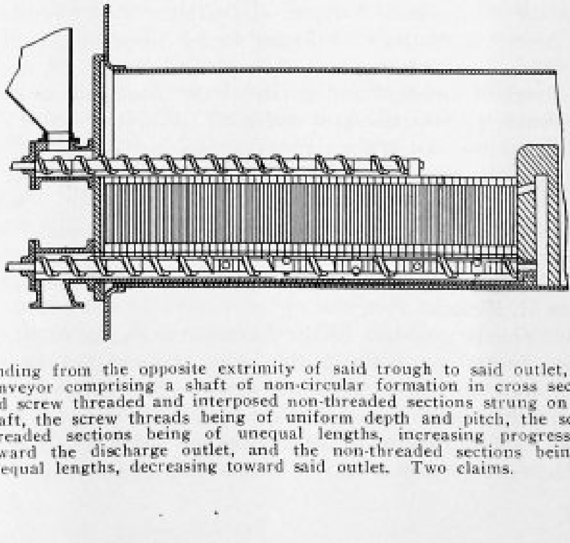
1,084,853. STEAM BOILER FURNACE. GEORGE S. GALLAGHER, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO HENRY GALLAGHER AND ONE-HALF TO EMMA G. GALLAGHER, OF NEW YORK, N. Y.

Claim 1.—In a steam boiler furnace, a hollow metal block, means formed therewith for connecting the same in position in the walls of a furnace, the walls of the block being provided with a plurality of apertures, and fire brick tiles forming faces for the sides of the block, the inner faces of the said fire brick tiles being provided with grooves so arranged as to lie in line with the perforations in the walls of the block, the said fire brick tiles being also provided with edge grooves communicating with the aforesaid face grooves so as to provide passages for the circulation of air from within the said block to the combustion chamber of the furnace. Five claims.



1,085,001. FURNACE. WILLIAM ANDERSON, OF HELENSBURGH, JAMES MEIKLE, OF GLASGOW, AND CHARLES WILLIAM FULTON, OF PAISLEY, SCOTLAND.

Claim 1.—In a furnace, the combination of a grate having inclined sides and an ash-receiving trough into which the inclined sides merge at their lower edges and which trough is provided at one end with a discharge outlet, of a rotary conveyor located in said trough and extending from the opposite extrimity of said trough to said outlet, said conveyor comprising a shaft of non-circular formation in cross section, and screw threaded and interposed non-threaded sections strung on said shaft, the screw threads being of uniform depth and pitch, the screw-threaded sections being of unequal lengths, increasing progressively toward the discharge outlet, and the non-threaded sections being of unequal lengths, decreasing toward said outlet. Two claims.



THE BOILER MAKER

APRIL, 1914

Properties of Superheated Steam

The Specific Heat and Volume of Steam Superheated from 0 to 200 Degrees F. Shown Graphically on Charts

The economical value of superheated steam has been known for fifty years, but its successful use on a large commercial scale does not date back more than fifteen or twenty years. The over-all economy resulting from the use of superheated steam is so large that to-day there is scarcely a power plant of any importance in which superheaters are not installed. The progress in the use of superheated steam on locomotives and steamships has been equal to that in stationary practice, which has been such as to overcome all the mechanical difficulties encountered when superheated steam was first used. The general practice is to superheat the steam from 100 degrees F. to 150 degrees F. above the temperature of saturated steam. The steam temperature rarely exceeds 500 degrees F. Above this temperature there is apt to be trouble with the lubrication of the engine cylinder and valves, though, of course, trouble from this source is not experienced in steam turbines.

The properties of superheated steam which make its use economical in power plants are:

1. It has a much lower thermal conductivity than saturated steam; due to this fact the radiation losses from a superheated steam pipe are much less than those from a line carrying saturated steam. With superheated steam less heat will be absorbed per unit of time by the cylinder walls.

2. Superheated steam has a larger volume per pound of steam than saturated steam of the same pressure. Hence the actual weight of steam per stroke of the engine for the same cut-off is reduced as the superheat is increased.

3. Superheated steam behaves like a perfect gas, and does not liquefy until its temperature has been reduced to that of saturated steam at the same pressure. By virtue of this property, cylinder condensation is greatly reduced, if not entirely

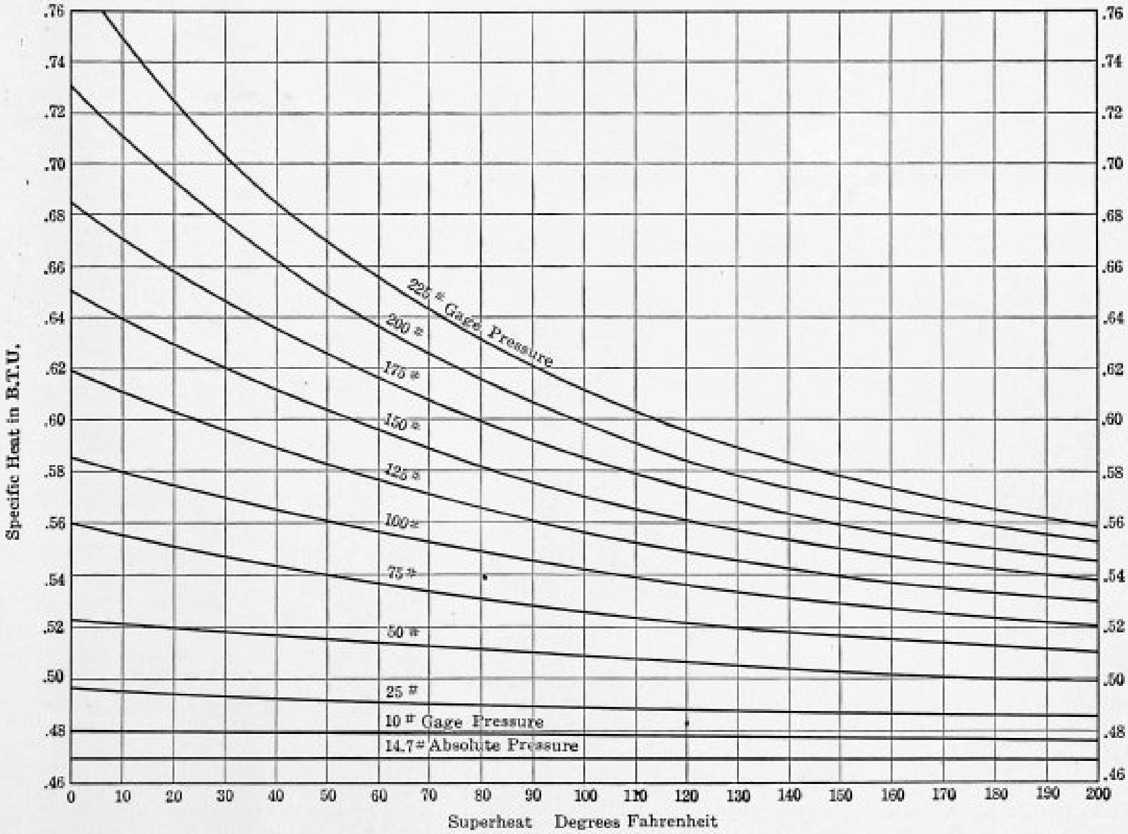


Fig. 1.—Average Specific Heat of Superheated Steam from 0 to 200 Degrees F. Superheat

eliminated, and there is far less trouble with water in steam pipes and mains.

By installing a superheater within the boiler setting, the heating surface of the boiler is relieved of a portion of the work which would be required were the same amount of heat put into saturated steam. This increases the boiler efficiency by reducing the amount of heat to be transmitted by each square unit of boiler heating surface. The installation of the superheater does not increase the size of the boiler, but it does increase its capacity, so that by use of the superheater much more power can be developed per unit of floor space. In many instances independently-fired superheaters have been installed to superheat the steam from a battery of boilers producing saturated steam. Such an installation is now an exception to general practice on account of its increased cost of maintenance and operation, extra setting and floor space required.

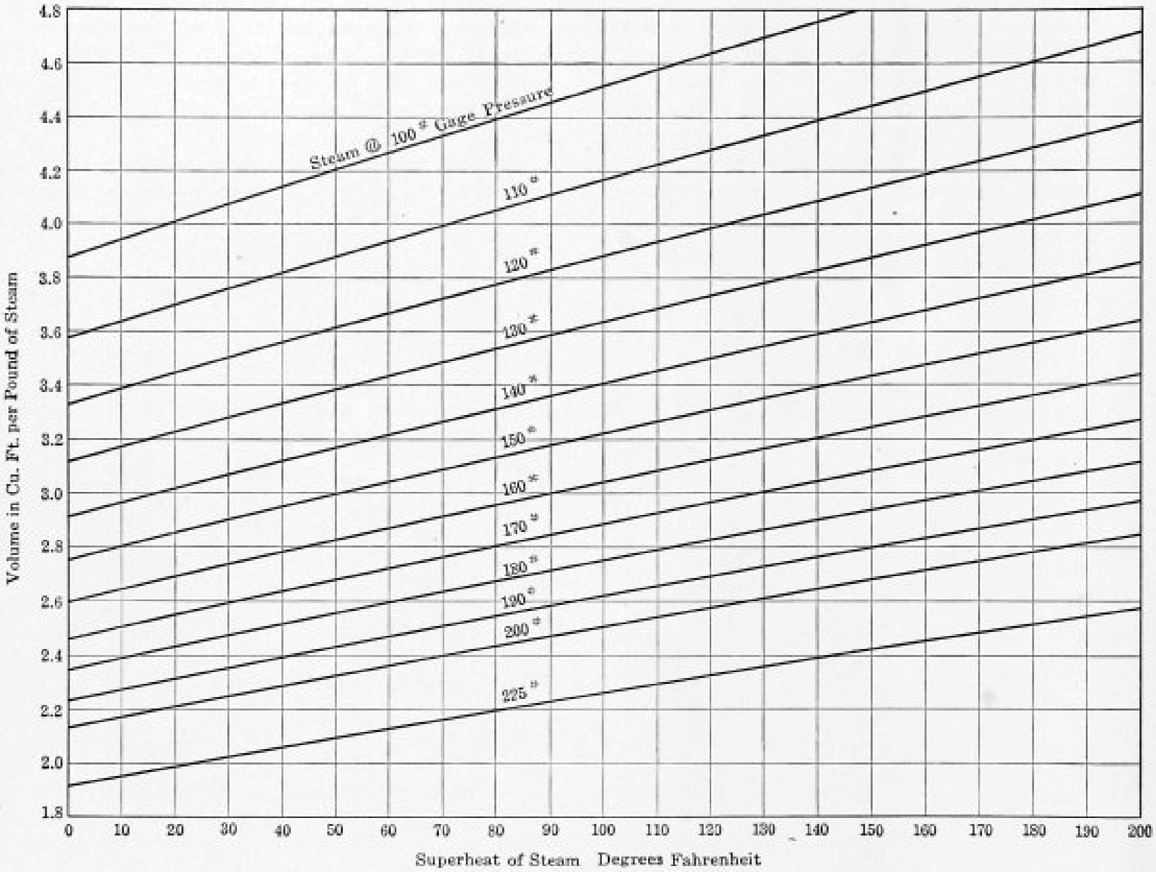


Fig. 2.—Chart Giving Volume of Superheated Steam; Gage Pressure, 100-225 Pounds; Superheat, 0-200 Degrees F.

Due to the increased volume and almost perfect elasticity of superheated steam very high steam pipe velocities can be used with a small drop in pressure. In some plants, especially in Germany, velocities as high as 250 feet to 300 feet per second are attained in what is considered the best engineering practice.

A great many engineers in charge of power plants and boilers do not clearly understand the properties of superheated steam, and have only a vague idea of the difference between it and saturated steam of the same temperature.

Saturated steam is water vapor in the condition in which it is generated from water with which it is in contact. If the saturated steam contains no moisture, it is then said to be *dry saturated steam.* Saturated steam has the same temperature as the water from which it is produced, and for every pressure there is a corresponding temperature, above or below which it cannot exist as saturated steam. Hence the temperature of saturated steam cannot be changed while it is in contact with the water from which it was generated unless there is a change in the pressure of the steam and also a corresponding change in the temperature of the water. If the saturated steam is led to another vessel so that it will not be in contact with water, heat may be added, in which case the temperature of the steam rises above that of saturated steam at the same pressure. If the pressure is kept constant the steam expands so that each cubic foot weighs much less than the same amount of saturated steam. If the volume of the superheated steam were the same as the saturated, then as a result of superheating there will be an increase in the pressure as well as the rise in temperature. From the foregoing remarks it ought to be clear that superheated steam is steam whose temperature is higher than that of saturated steam at the same pressure. In order for superheated steam to condense, its temperature must be reduced below that of saturated steam at the same pressure.

The amount of heat required to raise the temperature of 1 pound of superheated steam (under constant pressure) 1 degree F., is known as "the specific heat of superheated steam at constant pressure." The determination of the exact value of this quantity has been the subject of many researches during the past fifty years. Perhaps the best authority on this subject is the Steam Tables, edited by Marks and Davis. The specific heat of superheated steam varies with the temperature and the pressure of the steam. As the steam pressure rises the specific heat increases in value, and as the temperature rises, the pressure being constant, the specific heat gradually decreases. In order to show this relation in a clearer manner, Fig. 1 has been prepared. This chart does not give the value of the specific heat at any one point, but gives the average value of the specific heat from 0 degree F. superheat (dry steam) to any other temperature up to 200 degrees F. For instance, the average specific heat of superheated steam at 100 pounds gage pressure, from 0 degree F. to 150 degrees F., is .529, and from 0 degree F. to 200 degrees F. is .52. By use of these values of the specific heats, we are able to compute the amount of heat required to superheat any amount of steam. To superheat 1 pound of steam at 100 pounds gage pressure from 0 degree F. to 150 degrees F., requires for each degree rise in temperature .529 British thermal unit, or for 150 degrees 150 × .529 = 79.3 British thermal units. If the steam is to be superheated 200 degrees, then the heat required = 200 × .52 = 104 British thermal units. This heat, which is added to the steam in order to superheat it, increases the heat value of a pound of steam by just so many British thermal units, and it does not increase the steam pressure nor has it any influence upon the evaporation of the steam from the water. In order to find the total amount of heat in a pound of superheated steam the amount of heat in a pound of saturated steam is first found from the steam table contained in most engineering books, to which must then be added the heat required for the superheating as explained above.

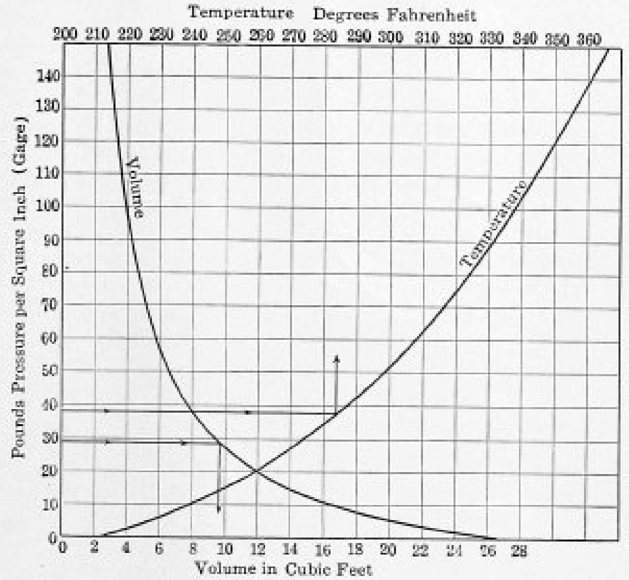


Fig. 3.—Temperature and Volume Curves for Dry Saturated Steam

In order to calculate the size of steam pipes, valve ports, nozzles, etc., for use with superheated steam, it is necessary to know the specific volume of the superheated steam. The term "specific volume" is used to denote the volume in cubic feet of 1 pound of steam, and, of course, it varies with the pressure and quality of the steam. This relation can be approximately expressed by the formula:

$$pv = 85.85\ T - .256\ p,$$

in which

p = absolute pressure in pounds per cubic foot.
v = specific volume.
T = absolute temperature.

In order to facilitate the computation of the specific volume of superheated steam, and to show graphically how the volume increases with temperature, Fig. 2 has been prepared, from which, at a glance, the volume can be read off for any condition of steam from 0 degree F. to 200 degrees F. superheat. For any steam pressure the volume given at 0 degree F. is, of course, the volume in cubic feet of 1 pound of dry saturated steam. By reference to Fig. 2 the specific volume of steam at 150 pounds gage pressure and 0 degree F. superheat = 2.75; *i. e.*, there is 2.75 cubic feet of steam in each pound by weight. At 100 degrees superheat the specific volume is 3.22, and at 200 degrees F. superheat the specific volume is 3.63, from which it is readily seen that the volume of 1 pound of steam at 150 pounds gage pressure and 0 degree F. superheat is increased from 2.75 cubic feet to 3.63 cubic feet by superheating it 200 degrees F. This is an increase in volume of over 31 percent.

To find the actual temperature of superheated steam the temperature of saturated steam at the same pressure must first be found by reference to any tables giving the properties of saturated steam; then to this temperature must be added the number of degrees of superheat. The temperature of saturated steam at 150 pounds pressure equals 366 degrees F., and if it is superheated 200 degrees F. the final temperature will be 366 degrees F. + 200 degrees F. = 566 degrees F. Fig. 3 gives the temperature and volume of dry saturated steam at different pressures, and it is added to simplify the comparison of these properties of saturated steam with those of superheated steam, as graphically shown on the charts in Figs. 1 and 2.

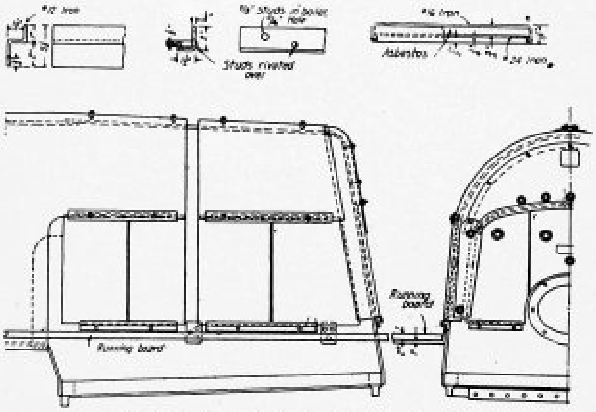
Engineer.

Method of Lagging Boilers

BY P. E. COSGROVE*

The sketch shows an improved way of lagging a boiler on or around the back end, to enable workmen to renew broken staybolts with the least possible trouble and at a low cost. We are using what I call a panel jacket, made in sections and filled with asbestos. These panels can be removed very easily, and it saves making a nasty mess all around the engine. They are made to suit the space, and can be taken off and put back in a short time, as there is no stripping to be done.

We instruct our pipemen, in placing all outside piping around the boiler head, to place it at least an inch and a half away from the jacket. This allows the panels to be slipped out very easily. We also cover all our flexible staybolts with it. We have been applying this for over a year, and find it a very profitable proposition, for where we have only two or three bolts to remove we don't have to strip a whole side. Also, we have done away with all steps near the cab, and have substituted a small ladder from running board to hand rail, thus eliminating all leaky studs.—*Railway Master Mechanic.*



Removable Jacket Panels for Lagging

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[*] Foreman boiler maker, E. J. & E. Railway.

The Champion Prize Competition.—Prizes of $50, $35 and $25 have been offered by the Champion Rivet Company for the best essays on "How to Heat Rivets Satisfactorily." This contest is open to all boiler makers, and the papers should reach the office of The Boiler Maker, 17 Battery Place, New York City, on or before 12 o'clock Wednesday, May 20. The prizes will be awarded by a special committee at the Master Boiler Makers' convention in Philadelphia during the week beginning May 25.

Progress in Locomotive Boiler Design

In a comprehensive summary of the progress made in locomotive design during 1913, the *Railway Age Gazette* has the following to say regarding developments in locomotive boilers:

While each and every part of the locomotive has been subject to careful scrutiny and decided improvement, the boiler has been the point of most searching investigation and greatest advance. The goal of boiler designers is to obtain the largest number of pounds of steam to each pound of metal in the boiler. The various studies and experiments have clearly indicated the advantage of the use of a longer flameway between the fuel bed and the end of the tubes, giving an opportunity for completing the gas reaction before the products of combustion enter the flues.

LENGTH OF TUBES

Experiments on the locomotive testing plant at Altoona, as reported to the Master Mechanics' Association, show that boilers with short tubes have a distinct advantage in increased activity of combustion and in the rapidity of evaporation, or free steaming, but at the same time they also have a slightly lower efficiency, since they absorb less of the total heat available during the passage of the gases through the tubes. It thus seems that the most desirable length of tube depends on how much one is willing to sacrifice in boiler efficiency to obtain rapid evaporation with some loss of heat. Experiments indicated that the rate of evaporation increased as the tube is shortened until it reached a maximum at a length between 12½ feet and 14 feet; after that it decreased rapidly. This information, taken in conjunction with the results of the experiments made at Coatesville in June, 1912, showing the comparative value of firebox heating surface and tube heating surface have had a noticeable effect already in increasing the use of combustion chambers with shorter flues.

The Pennsylvania has adopted a length of 15 feet for 2-inch flues and a length of 19 feet for 2¼-inch flues.

Speaking on this subject before the American Society of Mechanical Engineers, F. F. Gaines, superintendent of motive power of the Central of Georgia, stated that "The most radical improvement that can be made on locomotives, and one which will be rapidly developed, is the use of greater firebox volume and heating surface. This is readily obtained by using a suitable grate area and combustion chamber. In fact, from past experience it would not be surprising if ultimately a flue length of 16 feet would become a desirable maximum and the combustion chamber be substituted for the remaining distance." Experiments that have been made by Mr. Gaines with a type of combustion chamber developed by him indicate the truth of his assertion.

While no distinct movement toward reducing flue length to 16 feet can be discovered, there is a noticeable tendency to increase the firebox heating surface, and this is being done both by the addition of a circular combustion chamber and, where possible, by the use of a firebox arranged on the Gaines principle..

BRICK ARCHES

Brick arches, supported on arch tubes, are now in very general use on all classes of locomotives. An appreciation of the value of the heating surface in the arch tubes is becoming more apparent, and the objections that had previously been made to them seem to have been entirely overcome.

Openings for the admission of air into the ash pan and through the grate are, in a few instances, being given the attention they deserve, and in recent designs, which follow the best practice, as large an air inlet as possible is given. The opening should be 50 percent of the grate area, or more, if possible, on road engines. More study should be given this most important subject, and it is probable that the most marked advance in locomotive operation in the coming year will be along the lines of securing more perfect combustion.

Experiments with a powerful passenger locomotive on the Altoona testing plant early in the year indicated the importance of further study of the nozzle, stack and cylinder passages. This has already had its effect, and the present practice is to place the nozzle as low as it is possible to get it. Where the boiler is large in diameter, the internal extension of the stack is universally used in order to obtain the required length. The use of nozzle tips in shapes other than round has shown a distinct improvement in the exhausting of locomotives under certain conditions. It appears that by the proper selection of the shape of the nozzle tip and the use of tips other than round are of great value in compensation for a poor arrangement of exhaust passages, which in some cases is unavoidable on account of the lack of room. These nozzles in some instances have shown a surprising reduction in the coal consumption and an increase in power in the cylinders.

The study given to this feature has also led to a better design of the exhaust passage in the cylinder itself, with a still further reduction in the back pressure.

Various arrangements of blowers or suction fans for giving the required draft through the tubes have not passed beyond the experimental stage, and there has been no evidence presented as to what practical advantages such an arrangement might have.

Circulation throughout the whole boiler is being improved as the effect of improper flue spacing, narrow passages and trapping of water near hot sheets is better understood. The value of the arch tubes as circulation improvers is but beginning to be appreciated.

STOKERS

During the past year the service of the stokers previously applied, and of the large number placed in service during the year, prove that this device has passed the experimental stage. Thus, after twenty-five or thirty years of experiment, the stoker has reached the position of reliability and serviceability which allows it to be accepted with confidence for use on the larger sizes of locomotives. This is probably as important a development as has occurred this year, since it removes one of the greatest limitations in the way of further increase in the size of locomotives. The service results of the stoker indicate that the capacity of the locomotive as to maximum tonnage and speed will be increased by it in much the same way as has occurred by the application of the superheater.

The overfeed or scatter type stoker is the more popular, although applications of the underfeed or Crawford design continue to be made, principally by the Pennsylvania Lines west of Pittsburg.

Experience with stokers in comparatively large numbers on a single division or on a single road show that the cost of maintenance is low. The reports do not indicate, however, that there is any noticeable saving in coal by the use of stokers, but there is a considerable increase in the capacity of the locomotive in practically every case. Further advantage, particularly in connection with the underfeed design, is the elimination of the smoke, which makes it of especial value for use on switching locomotives.

The Street stoker has received the widest application, and is now in use on thirteen railroads which together have 365 stokers in regular operation and sixty-nine on order. Reports from one of the roads using a large number of these stokers show that the maintenance is less than 5 cents a locomotive mile. In another case where there are eighty-five Street stokers in operation, the reports show 50,000 locomotive miles for each stoker delay of any character. There are 293 Crawford underfeed stokers in use. This type is showing a satisfactory service, both in reliability and cost of maintenance.

In addition to above-mentioned designs there is a single stoker of the Hanna type in use on the Carolina, Clinchfield & Ohio which has been in service for over three years. About three months ago an improved design of Hanna stoker was installed on the same road. Both machines are now operating with complete satisfaction.

Two new designs of stokers have appeared during the year, both being of the overfeed or scatter type. These are the Standard stoker, which is now undergoing tests on the New York Central Lines, and the Gee stoker, which is in experimental use on the Pennsylvania. Experience with the former, covering six months, has led to the decision to make further experimental applications, and it is now being applied to a 2-6-6-2 type locomotive.

In general, the effect of the success of stokers has been a relief from the handicap of having to consider the stoking capacity of the fireman on very large locomotive units, a tendency to somewhat enlarge the size of cylinders on moderately large units and an increase in the tonnage rating of stoker locomotives, due to the assurance of full steam pressure throughout the length of the run. In addition to the economies offered by improved operating conditions, a material saving in the cost of fuel has been obtained in a number of cases, because of the ability to use a poorer and lower-priced quality of coal with stokers.

Stokers have so far been applied almost entirely to freight locomotives, since it is here that the increased capacity is particularly desired. It is also in freight service that the fatigue of the firemen at the end of a long run is most noticeable in its effect on the capacity of the engine.

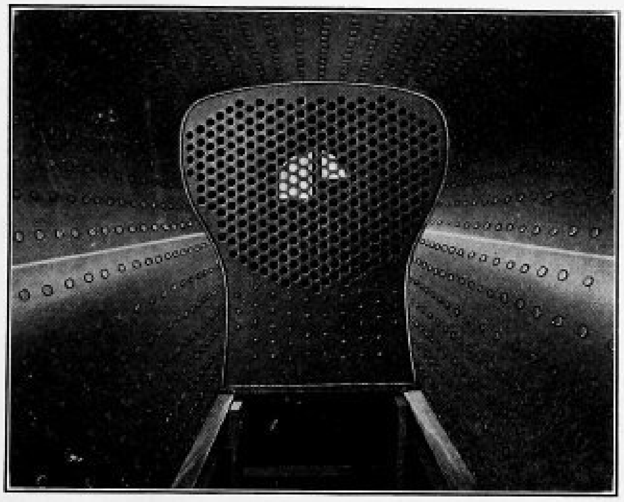

Fig. 1.—Firebox Side Sheets Welded In

ASSISTANCE OF THE SUPPLY COMPANIES

Credit should be given to various railway supply companies, locomotive builders and other auxiliary activities for developing original improvements and the energy put forth in co-operation with the railway companies in bringing locomotives to the highest state of efficiency. Many of the most important and valuable appliances which are now in universal use, would, beyond doubt, have languished for many years had it not been for the interest and energy of supply companies in rapidly developing them to a state of perfection. The superheater, brick arch and stoker are prominent examples. Under the present organization of the motive power departments on many railroads, there is little opportunity for initiative or experiments, and the work of the locomotive builders and supply companies has been of very great importance and value in bringing the American locomotive to its present position.

Oxy-Acetylene Welding in Firebox Repairs

Two of the most common repairs to locomotive fireboxes are putting in half-side sheets and patches. That such work is both simplified and facilitated by welding in the half-side sheets and patches by the oxy-acetylene process is generally understood by those who have had experience with such kinds of work. Examples of this work are shown in the accompanying illustrations.

Fig. 1 shows the firebox of engine No. 25 of the Terminal Railway Association of St. Louis, in which both side sheets were cut out and new sheets were welded in, as indicated by the white lines in the photograph. The proper alinement of staybolt holes and of the holes for the mud-ring was maintained while this work was carried out. Fig. 2 shows a patch welded by oxy-acetylene apparatus in the side sheet of a locomotive boiler. The welding in the above cases was accomplished with Henderson-Willis welders.

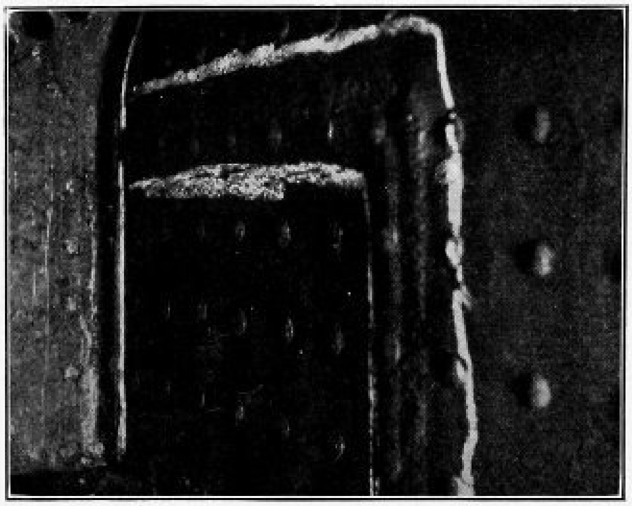

Fig. 2.—Welded Patch

Safety First*

BY JOHN McMANAMY†

Safety first is rapidly becoming the paramount issue in railroad circles throughout the country, and at the present time railroad officials and their employees are working as a unit in their efforts to establish a "Safety First" movement on their respective roads. The important question is: how may the best results be obtained? In my opinion there are two ways of securing immediate results along the lines upon which they are working: First, a strict compliance with the rules of the company by the employees, and, second, a strict compliance with the Federal laws by the railroads. Rules for the government of the employees have been framed and adopted by the railway officials in order to facilitate a prompt movement of the traffic. These rules also specify the class of men that shall be employed and retained, as well as outline their duties. An age limit, ranging between 21 and 45 years, according to the position, is set for the men entering the company's service. A high grade of men are required for all positions.

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* From the *Railway Age Gazette*.

† District inspector, Locomotive Boiler Inspection, Inter-State Commerce Commission, Grand Rapids, Mich.

For employment in locomotive or train service the men must be educated to a certain grade, strictly temperate in their habits, of good moral character, and sound in mind and body. They are required to pass an examination in color, vision and hearing, and must sign a contract before entering the company's service requiring them to comply with the rules of the company while they remain in the service. The rules were made to facilitate the movement of traffic, and for what was considered to be a reasonable protection for railway employees and for the traveling public. A strict compliance with them will tend to reduce the number of accidents and personal injuries.

The railroads have adopted the "Safety First" movement with the idea of eliminating, in so far as possible, the dangers incident to railroading, thereby reducing the personal injury claims. The laws of this country hold the carrier responsible, in some cases, for accidents resulting in the personal injury or the death of passengers or other persons. When the rate of compensation for injuries received in such accidents is not fixed by the Workmen's Compensation Bill, they are usually referred to the courts, and it remains for a jury to decide what the rate of compensation shall be. This is no small item of expense for the operating company when figured up at the close of each year. But when looking at the accident from the employees' point of view it would be only fair to ask, who is going to place the proper value upon the human life?

Take, for example, the young man 21 years of age who is qualified to measure up to all of the requirements, and after passing the examinations, enters the railroad service in the capacity of fireman or brakeman, and unfortunately meets with a fatal accident soon after entering the service, and at the very beginning of his manhood. What rate of compensation can be given for the life that he has lost? Or, again, take the man who has spent years in the service, and unfortunately meets with a fatal accident, leaving a widow and children to mourn his loss. What rate of compensation can be given for the life that he has lost, and what rate of compensation can repay the widow and the children for the loss of a husband and a father?

The only solution of this problem is "Eternal Vigilance" on the part of every officer and employee of the company, and a strict compliance with the rules to avoid such accidents. I know the employees will say they are complying with the rules, but by referring to some of these rules I believe it will be agreed that many are being violated. The rules of all railroad companies prohibit their employees from stepping on the front end of a rapidly approaching engine or car, or walking in front of an engine or car while it is in motion, or between cars or engines in motion except under the most favorable conditions, such as when they are running at a low rate of speed and there is a good footing with the absence of frogs, switches, guard rails, etc. It is only necessary to walk through the yards of any railroad and see flagrant violations of these rules, as well as many others; but I will not devote too much time to discussing violations of the rules, as I desire to call attention to the importance of a strict compliance with the Federal laws on the part of the operating company.

The rules only outline the duty of the employees, while the Federal laws outline the duties of the operating company. The laws I refer to are the safety appliance laws, the locomotive boiler inspection laws, and the hours of service laws. They were framed by representatives of the railroad employees and passed by the Senate and House of Representatives of the United States in Congress assembled, and after being signed by the President of the United States in due time became effective. The safety appliance laws and the locomotive boiler inspection laws provide that rules shall be adopted to govern the standards of safety which shall be lived up to by the carriers. Those rules were framed and adopted by a committee composed of representatives of the railroads, representatives of the railroad employees, and representatives of the Inter-State Commerce Commission. With their adoption they became a part of the laws, and a strict compliance with them will tend to reduce the number of accidents and personal injuries. These laws and rules are only just and fair and are absolutely necessary to give the railroad employees and the traveling public the protection they require, and to which they are justly entitled.

While attending the master mechanics' convention at Atlantic City in June, 1913, I listened to a discussion by the members of that association on the safety appliance laws and the locomotive boiler inspection laws. The committee on standards recommended for adoption as the Master Mechanics' Association standard the "United States Safety Appliance Standards which apply to locomotives," as contained in the order of the Inter-State Commerce Commission, dated March 13, 1911. They also recommended for adoption as the Master Mechanics' Association standard the "Federal regulations for inspecting and testing of locomotive boilers and their appurtenances," as contained in the order of the Inter-State Commerce Commission, dated June 2, 1911.

The sentiments of the members present were strongly in favor of adopting the recommendations of their committee, but both questions were referred to letter ballots. The result of the letter ballot indicated that the members of the Master Mechanics' Association were almost unanimously in favor of adopting both of the recommendations referred to, there being only two votes cast in opposition to the adoption of the United States Safety Appliance Standards which apply to locomotives, and three votes cast in opposition to the adoption of the United States regulations for inspecting and testing locomotive boilers and their appurtenances. What better proof of the fairness of the rules could we ask than to have them adopted as standard rules for this association? But, like the rules of the railroad companies, we have found in some cases they were being flagrantly violated.

During the year ending June 30, 1912, which was the first year the locomotive boiler inspection law was in effect, there were 6,968 locomotives found in service in violation of the provisions of the law, and which were either ordered out of service for repairs, or changed and strengthened to conform to the requirements of the law, or permanently removed from service. During the year ending June 30, 1913, the second year the locomotive boiler inspection law was in effect, there were 6,690 locomotives found in service in violation of the provisions of the law, and which were either ordered out of service for repairs, or changed and strengthened to conform to the requirements of the law, or permanently removed from the service. This a total of 13,658 locomotives found in service in violation of the provisions of the Federal laws during the first two years the locomotive boiler inspection laws were in effect, or an average for each year of 10 percent of all of the locomotives in service in the United States. This, also, is about on a par with the violations of the safety appliance laws and the hours of service laws.

I would recommend that the railroad companies employ safety appliance inspectors and locomotive inspectors, to inspect their equipment and locate the defective conditions, so that repairs can be made before they are discovered by the Federal inspectors. In this way the railroads can avoid expense and delays to the power on account of penalties being inflicted for violations of the laws and rules that they have endorsed, and have recommended for adoption as the standard rules of the Master Mechanics' Association.

POWER FROM MERCURY VAPOR.—W. L. R. Emmet, consulting engineer, General Electric Company, has proposed a system for deriving power from mercury vapor generated in a so-called mercury boiler, expanded in a turbine and condensed in a steam boiler. With mercury vapor high temperatures can be obtained with low pressures and small volumes as compared with steam.

The Boiler Shop Telephone

How Some of its Troubles Can Be Overcome and Good Service Obtained

BY JAMES FRANCIS

"Burr-r-r-r! ting-ding-r-Hello! Bing-ting-Burr-r-r. Yes, this is-ding-bur-r-t, this is Johnson-ding-b r-rs, what is it?"

"By the piper of St. Patrick, Mr. Francis, isn't a boiler-shop telephone enough to drive a boy to strike his daddy? It sure is about the toughest propostion I ever was up against. We can manage to keep the shop phones in fair condition—they aren't out of business much more than one-third the time; but how is a man going to hear anything in such a thundering racket? Here is this phone: I get twenty or thirty calls a day, and how can I receive messages with thirty or forty calking hammers and air guns going in every direction?"

"Why don't you put in a sound-proof booth, same as they have at pay-stations?"

"Sound-proof-nothing—that't just what those stations are! They are all right to stop such sounds as people talking, but they are not worth a 'continental' for stopping boiler-shop noises! Why, I had a 'sound-proof' room right here. It was not only doublewall, but triple wall; yes, there were three separate and distinct walls, one inside the other. How did it work? Oh, yes, it worked fine, all right—nit—why, the whole thing seemed to act as a big sound box, and to concentrate inside of it all the noise in the shop. Nixey! I used that sentry box just twice, or tried to, then moved the phone outside the box and threw the box outside the shop. No 'sound-proof booths' for yours truly!"

"Well, Mr. Johnson, how do you manage to get along without the booth? You surely cannot use the phone and hear anything from it in a noise like this?"

"Bet your boots I do, Mr. Francis, just because I have to. Just have got to do a thing, you know, goes a long way toward doing it! If you notice, you see that I screw the receiver hard against my left ear, and when I am listening the transmitter is pressed tightly against the right ear. This cuts out all the noise of the shop, and it further has the effect of preventing shop noises from reaching the transmitter. That is what makes it so hard to listen on shop phones. The noise vibrations enter your own receiver and are piled on top of the message you are listening to, a sort of 'over-tone' business, and sometimes the 'over-tones' make an under dog of the real tones—the message youv'e got to hear!"

"Well, Mr. Johnson, how do you talk to the other fellow, with the transmitter screwed fast into one ear? I've heard of a man 'walking off on his ear!' But I've never before heard of talking to a telephone transmitter with an ear!"

"Oh! Of course youv'e got to place the phone to your mouth every time you say anything; then put the transmitter back against your ear when you listen."

"So, that's the way, eh? Mighty convenient—nit, I should say! People wouldn't say 'Life is worth living in Detroit' if they had to use telephones in that fashion, up there!"

"Well, that's the way we rub along in this shop, Mr. Francis, and if you know of any way to improve matters I'll be mighty glad to try it out."

"You have twenty to thirty calls a day, Mr. Johnson?"

"Yes, fully as many. Some days twice that number, but a whole lot of those calls are just 'ask-me' messages, where our office central is hunting for some one—perhaps she wants to locate the Super., or the Manager. She rings me up and 'asks me' if the party wanted is in my department. That's what we term an 'ask-me' call!"

"A pretty good name for it, I'll admit, Mr. Johnson, but very annoying to you, and to central, I suppose?"

"Yes, sometimes our 'central' has to ask a dozen different departments before she locates the party wanted, and it takes a large share of her time, and nearly as much time from the several heads of departments through the shop. You see, each time central rings up and asks for a man on my phone it takes a lot of my time to go to the instrument and answer. Say it requires two minutes of my time to make an answer—sometimes it is more than that when I happen to be in the far end of the room. Two minutes of my time, and she asks ten foremen before she finds her man, and there is $10 \times 2 = 20$ minutes of the highest-paid time in the shop gone for 'ask-me' work—and it's no cinch, either, in addition to the waste of time!"

"Oh, say, Mr. Johnson, let's talk some more about the listening business—about getting rid of the shop noises, then we will suggest something about the 'ask-me' business. But I want to suggest something which may help out with the straight telephone work in your shop."

"Shoot it right out, Mr. Francis; anything in that line has got a Maxim silencer for all other guns, large or small."

"It is this, Mr. Johnson: Have all the shop phones wired up with two receivers each, and with a push switch on the outside of one of them! It is very little work to connect two receivers—just connect both double cords into the same holes in the binding posts, then put a little screw hook in the transmitter to hang the extra receiver upon. The extra receiver may lie in the desk, for all it matters, as one receiver hung upon the hook cuts out both receivers and leaves the line all clear for signals."

"Yes, Mr. Francis, that would stop all the shop noise from getting into the ears, but how are you going to cut it off from the transmitter when you are listening? That is what bothers me the most, and I get rid of the noise in both ears and in the transmitter by covering one with the other!"

"My scheme takes care of that point, Mr. Johnson, and it is much more convenient than juggling the transmitter continually from ear to mouth and perhaps trying to talk with your ear and listen with the teeth!"

"But how do you do it, that's what I want to know?"

"I'll tell you. Remember that I called for 'two receivers on each shop phone, and a push switch on the outside of one of them'? Well, that's just what I want; and in addition there will be a quadruple or four-wire flexible cord on the receiver with the push switch, which is so connected that when the finger is placed thereupon the transmitter is cut out, and the wires leading thereto are short-circuited—connected back upon one another instead of through the transmitter."

"Well, how does that work?"

"Why, when you want to make or answer a call, place both phones to your ears and screw them in tight to cut out all shop noise possible. That makes you ready to talk, but when you want to listen, just push the push switch, and you cut the transmitter out of circuit, so that it cannot pick up the shop noises and throw them on top of the message you are listening to."

"Say, that's some stunt; wonder if it is much work to make the necessary connections?"

"No. It is very little work. Just to cut in the push switch connections, that's all. The connecting of the extra receiver is very simple indeed, and need not be considered here."

"But how about that other business—that of cutting out all the 'ask-me' calls?"

"Oh! that is very easy, too. Just put in an auto-call, and save the time of your 'central' and that of the foremen and department heads!"

"An 'auto-call'; what in creation is that?"

"It is exactly what its name implies—an automatic call which, once started, will ring and ring until it is stopped. And it will call the wanted man all day or all night. If he does not show up the call is not cut off."

"But what is it, and how does it work, and how will it find any man wanted, no matter which department he may be in?"

"Go to it, Mr. Johnson; you'll make a fine interrogation point some of these days, especially if you're 'from Missouri!' But the 'auto-call' is a box with a motor inside, driving a revolving shaft, which carries a number of disks, each disk having a certain number of teeth, which engage with a brush, so as to impart electrical impulses to the auto-call lines throughout the shop. There may be any number of disks upon the call-shaft—as many disks, in fact, as there are calls to be made for different men. Take the man most called for—the Superintendent, for instance. Let his call be a single stroke of the bell. We will indicate it by a dash, thus— —.' Now, then, each and every time the call-shaft revolves it brings the single-toothed segment into contact with the brush, and keeps sending a single stroke, thus: —, —, —, —, out into the line, as long as the shaft revolves and the brush is in the calling position. The next disk will have two teeth on it, and will make a call as follows: — —, — —, — —, etc. The third segment will have three teeth, and it makes a call like this, — — —, — — —, — — —. And after all the numbers up to 9 have been used up, there will be segments made which will call like this: — ——, — ——, — ——, etc."

"Why, Mr. Francis, that is a regular fire alarm."

"Sure it is—nothing more or less, and all around in the shop, in each room, and in the yard, are placed single-stroke bells, which are operated by the impulses sent out by the current distributed through the call shaft, its revolving disks, and the little brushes bearing thereupon. And each and every one of those bells will keep ringing and dinging, until the person whose number is being called reports to the nearest telephone, and Miss Central switches off the auto-call by stopping the motor, or by raising from the disks the brushes which deliver current thereto."

"Mr. Francis, such an arrangement ought to save time enough to pay for itself in a very short time. Now, where can such a device be obtained, and how is it installed in a shop?"

"The 'Auto Call' can be purchased in the open market. Some of the telephone companies will supply and install them, and almost any dealer in electrical supplies will estimate upon supplying and installing one of these systems. But, in fact, the installation is so very simple that any electrical worker can put one of the systems in service. All that is necessary is to run the circuits and connect the necessary bells with the auto-call and with the source of current. This done, the system is ready for immediate use."

"There is one thing more, Mr. Francis, which I wish you would tell me. It is this: How can I install a shop phone line, covering 15 or 20 stations, and not have the line continually in trouble? Why, this line, there is something the matter with it somewhere all the time. There is always an instrument out of adjustment, a wire dead, or something or other wrong. I have become tired and thoroughly disgusted in trying to keep the system in working order. Why, it actually requires the time of one man all the time, and frequently we have two men at work, tinkering the system. Now I am aware that we cannot do shop business without the intercommunicating shop telephone, but tell me, or show me, how such a system may be installed and kept up to at least 50 percent efficiency? That is, that it will never be more than one-half out of order at any time!"

"There is no reason, Mr. Johnson, why a shop intercommunicating system should not be installed and maintained with no more trouble than is experienced with an equal number of phones. To secure this result, procure a set of telephones as good as those used in the outside city service. Then put in a regular desk switchboard—one which requires an operator to make the different connections. Do not try to get along with one of these automatic shop systems, with which you simply push a certain button, or move a switch, and then try to talk with the station you want."

"What is the matter with a system of that kind?"

"Never can be depended upon, that's all. Always in trouble, and you can't talk out of the factory with it. When you put in a factory system, use regular long-distance phones—they cost very little more—then from any phone in your factory you can talk with any phone in the town or city, or with any long-distance station which the city service can reach. Some better than a ten-cent intercommunicating shop 'system,' eh? Well, rather."

"But, Mr. Francis, those regular instruments will not prevent wires from going bad and breaking down, and that puts many of our present phones out of business?"

"No; lines will break if you hit them with an axe, or otherwise misuse them, no matter how good the instruments may be. But I find that there is a way whereby shop lines may be made almost, if not quite, proof against any accident save those which will tear things to pieces."

"How is it done, Mr. Francis?"

"Get a cable, Mr. Johnson; a cable with as many wires in it as you have stations in the shop, and then see that the cable contains at least three or four more wires to allow for additional stations when necessary. You will always want more capacity some time, and it is as true of telephones as of motors. Let the cable be tested before you put it into the shop. Tested to see that each wire is continuous and is well insulated from each of the other wires. If the cable will not pass this test, then pass the cable to the discard and make the electrical supply man change it for a good cable."

"How about the return wires, Mr. Francis? Can the several telephones be grounded, or how should they be connected?"

"No! By no means put in instruments which use the earth as one connection. See that there are two wires in the cable for each instrument, and for each spare circuit in the cable. Then, as stated, have each wire tested for insulation and for resistance, and only when fully satisfied should the cable be put in place."

"Say, how is the length of such a cable to be determined? It will not pay to order a cable which proves too short, and how is the length necessary to be determined? And also: I hardly see how all the phones in and around the shop are to be attached to a single cable? Seems to me that wires running in a dozen different directions will be necessary to bring connection from each scattered phone to the factory 'Central.' How is the cable stunt to be worked, anyway?"

"Just connect a bell and a battery to two of the wires. Tag them 1 +, and 1 —. Then connect a bell to two of the wires at the other end of the cable, and try the different wires in succession until you find those through which the bell will ring. Tag these wires the same as at the other end of the cable, then go to the first telephone station and press a point through the insulation until you have found and tagged 1 +, and 1 —, again. Then proceed in the same way with wires 2 +, and 2 —, and tag them at either end of the cable, and at phone No. 2 continue in this manner until all the wires have been tagged in three places, except those which are held in reserve. Tag these at each end only."

"But how is the cable made to reach every phone in the shop, upstairs and down, in the yard and out?"

"That, Mr. Johnson, is just a simple case of laying out on the plans of the shop. The cable should be led from one station to another with as little length of cable as possible, but bear in mind that one office phone may be attached to the cable close to the beginning thereof, while a phone on the other side of the office may be on the other end of the cable, which has been led back after passing all around the plant. In that way, by careful laying out, all the phones can be reached by a single cable, although sometimes it may be economical to use two smaller cables and lead them in opposite directions, instead of a single large cable passing in turn to each phone in the system."

Hydraulic Pressing—III

BY C. W. R. EICHHOFF

Steam and Pneumatic Accumulators; Prevention of Shocks

In the hydraulic system it often happens that the water is used faster than the pump can supply it. In such cases the accumulator cylinder or ram—whichever is the moving part—will drop rapidly and their heavy weights will give them a great amount of kinetic energy. When, however, this rapid downward motion is suddenly stopped by the closing of the valves on one or more machines, and the water supply is shut off to same, these heavy falling masses will also come to a sudden stop. The pressure will be greatly increased above the normal for a moment and severe shocks are induced.

This increase in pressure is an advantage in many cases. When a moving ram with its die runs into a supported matrix it is stopped at the moment where the highest pressure is necessary. This stoppage shuts off the water supply and induces the severe shock. Take the case of riveting two plates together. The highest pressure is needed at the end of the stroke, when the head is formed, and the plates closed together more tightly by an increased pressure.

As a rule, it is to greater advantage to make arrangements to overcome the trouble caused by shocks. This can be done by the use of steam or pneumatic accumulators. In both the steam or compressed air exerts the necessary pressure in a large cylinder, in which a piston and a piston rod form the hydraulic ram. The steam or air pressure exerted replaces the weights (ore, stone, cast iron) of the ordinary accumulator. When sudden stoppages in the hydraulic system occur the air or steam is cushioned and acts like a spring, taking up the sudden shocks. These accumlators are not much used, and only in small installations. It is more practical to insert so-called "shock valves" at intervals in large systems or at the terminal in small installations.

It might happen that the pressure in the hydraulic system is decreased to practically no pressure when a sudden break in the line takes place. The accumulator is liable to come down with great velocity, and when striking the heavy wooden grillage it may do great damage. It is advisable to prevent this trouble by providing the grillage with strong buffer-springs or some other safety appliance (such as a safety stop valve) which closes the accumulator-cylinder automaticall, should a break in the line occur.

Centralization of Machinery; Water Supply Control

It is highly desirable to have the water supply tank, pumps and also the main accumulator, with the necessary safety appliances in the power plant of the works. This machinery is then under the direct supervision of the plant engineer. The control of the water supply, consisting of the lever arrangement between the top of the accumulator housing and the pump throttle valve, is more effective and reliable. For the sake of economy, it is also advisable to group the machinery together as much as possible.

Piping System and Accumulator Control

The piping should be of ample size, of the best material and of extra heavy or double extra heavy stock, depending on the pressure used. Good homogeneous steel should be used for pipe as well as fittings. The piping for large installations should preferably be of the "Ring system." In this arrangement the water passes from the pumps to the machines by two paths, and any section of the main may be cut out by closing two valves without shutting down the whole plant. This adds considerably to the first cost of installation, as the main has to be of the same size throughout, and it requires a lot of additional fittings and valves. By the way, let me mention here that in a first-class plant there should be two supply pumps.

The different branches of an installation should be provided with stop valves besides the operating valves on the machines. Provision should be made at the lowest points for effective drainage, and at the highest points of the piping and machines should be arrangements for the automatic discharge of entrapped air. Air is a nuisance in the system and injures the good operation of the machines. It is also the cause of leakage on flanges and stuffing boxes.

In large installations, with long runs of piping, auxiliary accumulators are inserted. These are to be loaded lighter than the main accumulator, so they rise before the main accumulator and come into action only when great differences in pressure prevail. The main accumulator controls the supply pumps, and these must be stopped before the auxiliary accumulators reach their greatest permissible heights.

There are many persons who have a prejudice against hydraulic plants on account of the danger of freezing in winter. To prevent freezing the use of alcohol and glycerine in the water is recommended. But such an important installation as the hydraulic plant in the boiler shop or forge should be well protected against freezing. There is no excuse for having any part of the plant exposed to this danger. In the first place, proper provisions can always be made for proper drainage, and by covering the water pipe and running steam pipes parallel to it, and included in the covering, freezing can be prevented. But even this would not be necessary if the shops are properly heated. Many boiler and plate shops are not heated properly, only for the sake of imaginary saving. It is a sign of poor economy and foresight to have shops not heated and ventilated. A shop should never be allowed to become very cold in the winter, not only for the sake of the work, but also for the sake of the men. It would not be a hard matter for the owner of a shop to realize the loss if he would take the trouble and spend a few hours in the shops among the men on a very cold winter morning, when the tools are too cold for the men to handle, the water and gas pipes are frozen, the steel plates are very cold and machinery parts so brittle that they break easily. Under such conditions it takes longer to heat plates and they cool off more rapidly, causing cracks and shearing off rivet heads, and last, but not least, time is wasted by the men standing around salamanders. All these items and a lot more should open the owner's eyes.

(To be continued.)

Convention Dates.—The eighth annual convention of the Master Boiler Makers' Association will be held at the Hotel Walton, Philadelphia, Pa., May 25, 26, 27 and 28. Special rates for this convention have been made by the Walton, Adelphia and Bellevue-Stratford Hotels.

The twenty-sixth annual convention of the American Boiler Manufacturers' Association will be held at the Waldorf-Astoria Hotel, in New York City, Sept. 1, 2, 3 and 4.

John and the Boiler Inspector

A First Lesson in Boiler Inspection—The Inspector Shows How an Internal Inspection is Made

BY JAMES F. HOBART

"John, the Boiler Inspector will be here to-morrow, to go over the shop boilers. This is the annual internal inspection, you know. The engineer wants to be off all day, so you will have to be on hand and help the inspector—get what he wants, show him what he wants to see, and help him in any way he asks."

"All right, Mr. Foreman, I'll be here. But, Mr. Foreman, won't you let me go through the boiler with the Inspector? I would just give my boots to know how they inspect, what they do, and what they look for. Won't you let me, Mr. Foreman?"

"Well, well, John, you have got more sides and angles in your makeup than a tetrahedron! Well, say! If the inspector will let you, I am willing, for it won't do a bit of harm for you to know a little about boiler inspecting. The Inspector will be here this evening, to tell you just what he wants, and I'll see if I can fix it with him. Ah! Here's the Inspector now. Good evening, Inspector. Yes? We are all ready, or will be, to-morrow morning. The regular engineer will be off for the day, but John, here, will be with you and get anything you want."

"All right, Mr. Foreman, the young chap and me will get along all right. What's that you say! He wants to put on a suit and 'crawl' with me. Well, what d'ye know about that? So, young fellow, you want to be a boiler inspector, eh?"

"No, Mr. Inspector, I don't expect as good a job as that—not for a long time, anyway, but I want to learn all I can about boilers, and I thought it wouldn't hurt me to know a little bit about boiler inspecting."

"So that's the way of it, eh? Just want a little knowledge for knowledge's sake? Well, young man, I'll go you. You look like a likely young fellow who may be foreman or superintendent some day, and you rig up a suit and I'll push you around for fair, to-morrow, for, evidently, you are the lad who is:—

'A mother's love—
A father's son;
The biggest rogue
That ever run!'

"But be on hand and I'll show you one boiler anyway, in spite of the fact that boiler makers seldom make good inspectors. The reason is, that they are all the time looking for repairs and such things, instead of: *Safety First!*"

"Thank you very much,! Mr. Inspector. I'll be right on hand, and what had I better rig up for a suit?"

"You should have a one-piece suit which will prevent dirt from getting down your back, or down your trousers' legs. If you have got a union suit of overalls, that will do. Strings will do to tie them around the ankle, passing the string under the instep. I have straps, you see, made like an old-fashioned skate strap, but strings will do for odd trips. You also want a head piece. Get a woman's sun-bonnet, with a cape down behind. That will do as long as it lasts. But say! I've got an extra head-piece at the hotel, and I'll bring it over for you to-morrow."

"Thank you very much, Mr. Inspector; I'll do as much for you when I get the chance."

"All right, John; now get yourself a little cross-pene hammer weighing about a pound—yes, that little riveting hammer will do first rate. That and a candle will be all you need for this trip. Now, so long,John; I'll see you to-morrow!"

"Good-by, Inspector, I'll be right on hand and on time!"

THE NEXT MORNING

"Good morning, John; is the boiler ready for inspection? Are the handhole and manhole plates off, the boiler cleaned and washed inside and swept outside?"

"Yes, Mr. Inspector, the engineer showed me how to get the boiler ready, and it has been all washed out clean and had time enough to get dried off a bit."

"That's good, John. Now we will get at the work. I see you have your suit on already. Just tie down the bottom of the union overalls, fasten the cape of the hood closely under your chin, light the candle, put the hammer and a few matches in the breast pocket, and slide into the boiler. We will take the space underneath the tubes first—it makes little difference where we begin, and this place is as handy as any. You slide in first, John; there will probably be little trouble to be found in this boiler, so I am going to let you do the looking in the back end, and I will come behind and see how you make out."

"But what are we going to look for, Mr. Inspector?"

"Everything, John! Just everything which is not right or in A1 condition. Now, then, here we are. You are clear back over the blow-off pipe. What is the condition of the metal around the opening? Is the pipe clear, or clogged with dirt or scale? Are there any signs of corrosion or wasting around the blow-off opening, or along the flange of the rear head? Is there any accumulation of dirt, mud or other deposit in the rear end of the boiler, or any sign of wasting away of the tubes at their ends, where they joint the head?"

"No, everything seems clean and in good shape, except there is some loose mud near the blow-off opening."

"All right, John; now roll over on your back, pass the candle up as far as possible in the spaces between the vertical rows of tubes, and look carefully for scale or other deposits, for signs of corrosion—little blisters where action is taking place under the skin of the tube-surface. All clean, eh? Good! Now roll over again and back out until you come to the first girth seam, but all the time keeping an eye upon the shell in the bottom of the boiler, the other eye up among the tubes as far as you can see. At the first seam, better roll over again and take a 'little more astronomy,' as the boys call it when they are looking upwards from below the tubes."

"Here is the first girth seam; what shall I do here?"

"Look it over carefully, from as far as you can see up past the tubes on either side, down to the bottom of the shell. Look for signs of distress in the seam, pockets and bulges in the fire sheet, and see if the sheet is clean and smooth. Most of these things, when they are present, will best be seen from inside the firebox and the back combustion chamber, but I always make it a point to look for them also, inside the boiler. We probably will find nothing of the kind in this boiler, but we must be all the time looking for everything which can possibly happen to a boiler, also for seemingly impossible things. In fact, like the scarey horse, we must be all the time 'looking for something to be afraid of!' And, John, if it is there, be *sure* to find it!"

"Say, Mr. Inspector, I wish they would make more room inside of boilers. Why, I don't believe they even gave a thought to the comfort of an inspector when they made this narrow, contracted space between the two big through stays under the tubes."

"That's right, John, but the man who worked the worst grudge against the inspector was the designer of the old-time, triple-draft Hennesy boiler. That surely was a 'peach' to inspect, with its double number of tubes, built in almost to the bottom and top of the shell! But, here we are, at the second girth seam, and no trouble met with yet. Look this seam over even more carefully than you did the first one, for this is over the grate, or nearly so, and has more to stand up against. Also look closely for burning-on of scale, grease deposits, and 'sich like.' Now, John, I am at the front head and will back out of the boiler. You roll over and look up as far as you can at that girth seam, through each tube-space, then back out as close to the front head as you can and look at everything there. Much of this looking will have to be done with your body out of the boiler, and lying on your back on a plank, one end of which rests level with the lower edge of manhole opening. After you come out you can put the plank in position, lie upon it on your back, poke your head and shoulders through the manhole, and look over the front head flange with ease and comfort. It is hard to get a good look at this head unless you can turn around in the boiler, or use the plank, as noted above. But first make sure that the far end of the plank rests upon a secure foundation. Any letting go of the plank at this end, while you are on it, would break your neck like a pipe stem."

"Well, I don't want any post-mortem inspection over the inspector, so I'll watch out. I don't like to take chances of that kind."

A "Safety First" Kink

"That's right, John, and here's another 'Safety First' matter. You see these three light chains and three padlocks which I carry in my bag? Well, John, I never go into one of a battery of boilers, while one or more of the other boilers is under steam, without first making personally sure that each and every valve is securely closed, which could flood the boiler under inspection, either with steam, feed water, or through the blow off. And once these valves are closed, I lock 'em up, so no 'Hunky,' 'Pollack' or other 'European Importation' can possibly open one of these 'danger valves' while I am making the inspection. I had a race once, John, out of the boiler ahead of hot feed water, and I never intend to repeat the experience. Therefore, watch out for safety first.

"Now, John, we will go in on top of the tubes and look things over there. And on your way look at everything you see and see everything there is. I'll go ahead this time, John, for we can both line up in the larger steam space. It won't be as crowded as below the tubes. Now, on our way to the back end of the shell, we will look down between the tubes as far as possible and note everything there. We will also look down at the girth seams, but will not bother with them overhead. We will do that coming back.

"Now, then, here we are at the back head again, with our heads jammed among a lot of braces. Hit each one with your hammer, and see if any are loose. If so they must be reported and tightened. Next look at the tube-ends and the shell and head where they join together, and if there are any signs of corrosion, pitting, or similar ills, they must be found. Likewise, any caked-on-the-shell deposit of grease or floating mud. Scale deposits, too, must be knocked away at the tube ends, to see what exists underneath the scale."

"I don't find a thing wrong, Mr. Inspector. The boiler seems as clean as a whistle, and everything is in good shape."

"That's good, John, but when you find things thus, in a boiler, never let up a bit in your inspection, for there *may* be some one thing wrong which could cause disaster; therefore, take absolutely nothing for granted while inspecting any boiler, and give a new one just as much close scrutiny as if it were the worst old scrap tea-kettle you ever dropped into. That is the only way to inspect boilers and to do it right."

"Thank you, Mr. Inspector, I will remember that, and every time I have to look over a boiler I'll see for sure that nothing gets away from me without being seen—and heard, too, if the hammer will sound it up!"

"Good, John. Just stick to that and you never will 'fall down' on any boiler inspection. Now, as the back head is O. K., we will work along toward the front. And, John, I want you to sound each and every inch of the shell overhead as you work along. Some boilers are covered with brick, arched over—this one is not, however—and you can't see the outside of the shell on top, and there is a possibility of water leaking down through the brick and corroding holes through the shell. And if there is anything of this kind going on, we want to know it. I remember one case, where I had been all through the inside and was about to come out. I was lying on my back under the manhole, and chanced to see a little discolored spot a few inches from the manhole frame. Of course I hit that spot with the hammer and it didn't sound right. I kept on hitting, and soon a dent appeared. A bit more hammering, and the peen went right through the shell of the boiler—there was nothing but a section of rust. The metal had entirely disappeared and only the oxide remained."

"Say, what was the cause of that corrosion?"

"Water, John, just plain water. A pipe ran across, over the boiler, and a slight leak had existed there for several years. The water found its way through the brick to the shell, and corrosion slowly but surely cut its way through the plate."

"I'll bet you were mighty glad that this defect didn't get away from you?"

"I was that, John; but the owner of the boiler didn't seem to feel that way."

"How was that?"

"Why, the owner sent in a bill to my Inspection Company—said the 'inspector broke the boiler'!"

"Well, I'll be swiggered! That sure was the limit, wasn't it?"

"No, John; the limit was the time when the Insurance Company paid the bill—and it hasn't expired yet!

"Now, John, look out for the feed-water pipe. In this boiler it enters through the front head, runs to the rear end across the boiler, and terminates in an elbow, looking forward, and discharging between the tubes and the shell. See that the feed pipe is not filled with a lime deposit, and also see that each and every opening into the boiler is clear and free. This applies to each and every pipe opening in the shell, and is a very important matter. Next, we will look the front head over and make sure that all is well there—that the braces are all tight and properly attached to shell and to head. If it is a boiler to be insured, we must make notes of the number and size of the braces, and see if there are enough of them to properly support the head. We must also get the thickness of the inner straps, and of the shell plates, and calculate the bursting pressure of the boiler and see that it is safe to carry the pressure desired, under a factor of safety varying from 4½ to 6 or more, according to the age and condition of the boiler. And when we get ouside we must measure the thickness of the outside straps, and determine the pitch and diameter of the rivets as closely as possible and use them as factors in the strength calculations."

"And what do we do next, Mr. Inspector?"

"We will go outside, John. Look over the pipe connections on top of the boiler. See that there are no stop valves between the shell and the safety valve or between the shell and water glass, except the shut-offs at the top and bottom of that appliance. Then look over every inch of the shell on the top that can be reached, and watch closely for leaks of water or other liquids upon the shell from passing pipes or overhead tanks."

"Say, Mr. Inspector, the steam gage on this boiler doesn't tally with the one in the engine room. What's the cause of that?"

How the Steam Gages are Tested

"We will find out the reason, John. In my bag is a little test pump and a good gage which I compare with a mercury column every few days. We will test and adjust the boiler gage with my pump and test gage, then the engineer can adjust the engine-room gage to travel with this one. Perhaps the pipe is so arranged that several feet head of water of condensation is exerting pressure in the engine-room gage. That should be determined by examination, and if so, that gage may be made to run with the boiler gage by proper adjustment. You can usually adjust gages, within limits, to run faster, slower, or to read uniformly fast or slow, as required, by a proper change in the adjusting screws in the gage mechanism."

"How about the back arch of this boiler, Mr. Inspector? It doesn't look right to me, for some of the bricks are out of place and bear directly against the head. Some more bricks are gone and heat can reach the head for quite a distance above the top row of tubes?"

"We will look at those matters very closely when we crawl under the boiler, which we will do directly, as soon as we complete the work overhead and in the smoke box at front. I like to do the dusty work the very last thing, for then we can remove the dusty suits at once and thresh the dust out of them. If we crawl underneath first, we have to carry the dust all through the boiler, and the dirt gets into our own clothing, and into our own skins as well."

"Now for the front head in the 'smoke-box.' Here you want to look for leaky tubes, corrosion and wasting of the head by leakage running down and uniting with the steel, forming grooves full of oxide. Sometimes rain washes down the stack, particularly while the fires are banked, and picks up chemicals which can unite with the steel head, causing a corrosion or wasting of the metal which, if not stopped, can have only one effect, viz., the thinning of the head and the increase of the factor of safety after inspection."

"Wouldn't too much corrosion condemn the boiler, Mr. Inspector?"

"Inspectors do not condemn boilers nowadays. Only the owners of boilers can do that. Insurance companies can only refuse to accept for insurance above certain pressures to be carried; therefore the inspector and his company have to content themselves with cutting down the acceptable pressure. This they do by simply increasing the factor of safety at which they will accept the boiler for insurance. Some companies will not accept at a less figure than 5, and as the boiler gets old and wears, they increase the factor to 6, 7, and in some cases, to 10 or more. This stirs up the owner, and he acts. Should he desire normally to use steam at 125 pounds boiler pressure, and the boiler stands for that pressure under a factor of 5, all well and good for some time; nevertheless, if by-and-bye an inspector finds the plates getting thin, and the factor is increased to 5.5, then, later, to 6, this means that the boiler, which is on the limit at 5, will be allowed only 104 pounds working pressure at a factor of safety of 6. This hits the owner right in the pocket-book, and he gets busy with bids for a new boiler forthwith."

"And so that's the way the increase of safety factor works, eh? Just a very polite way of telling the owners their boilers are on the bum, and need replacing with new ones. Well, it's a slick way, though."

"Now, John, it's getting dinner time. There's a whole lot to do to the outside of that boiler, and I must get away directly, for I have another inspection at two o'clock, and I'll have to hustle to get there. Now, we will go right over the outside of that boiler as quickly as we can, then I will come over in the morning and we will talk over the inspection together, just as we have to-day talked over the internal inspection. See?"

"All right, Mr. Inspector, I'll go you. I will watch closely everything you do, and you can tell me, when you come over again, what each thing was for, and why you did it in that particular way, same as you have told me to-day."

"All right, John, we will leave it that way. Now don't set up as a full-fledged boiler inspector before I see you again, for there are some things which I haven't told you about yet which you will need to know."

"Say, Mr. Inspector, do you think I really could inspect a boiler satisfactorily, right now, after the one lesson I have had?"

"Yes, John, you could inspect a boiler which had nothing wrong with it, but when you meet trouble you haven't had enough experience to treat it right."

Talks to Young Boiler Makers*

There were three very serious and sober-looking men seated in the office of the Eureka Boiler Works eighteen months and two days after work had been begun.

Mr. Walter was the first one to speak.

"Now, boys, we are right up against it. Our by-laws say that we must pay the interest on our bonds if we have money enough on hand and due us at the end of each year. At our meeting day before yesterday I was directed to pay the interest, and I did, and to-day we have $137.56 left in the bank, $18.42 in petty cash, and some postage stamps. Our books show that we are owed $2,376.50; $2,000 of this is owed us by the Fluit Co., which is busted up, and it will be two years before we get any of the money. The balance is in small accounts, which may be paid next week, next month, next year, or never. Thank the Lord, we don't owe a dollar to anybody and our taxes and insurance are paid up to next January. We have not got a tap of work in the shop. We were the lowest bidders on the eight boilers for the General Company, but our time of delivery was four months longer than the time named by the Boss, and he got the job at higher figures; this difference of time was due to the mills not being willing to name us as quick deliveries as the Boss got. Why, I don't know and can't see. You two fellows tell me that the Boss can't turn out the boilers with his present plant."

Here Alec broke in and said: "There is something mighty funny about it. The Boss has let his plant run down like everything, and his rolls are too light to bend the plates for those boilers."

"All right," said Walter, "I have found out that it takes more than good tools and good workmanship and equipment to make money out of a boiler shop. The trouble with us lies in having all the brains in the mechanical end. We need more in the management end, which is my end. In the first place, we don't advertise enough. People don't know us. If we had gold dollars here to sell for eighty cents in silver, unless people knew it, we could not sell them. But, there is something besides this. In my old business we had more than one string to our bow. If one thing did not sell, another would, so we kept going. But here it is just boilers and a little sheet iron work. My brother has telegraphed me that he is sick, and I am going down on the four o'clock train to Evansville to bring him back if he is able to travel. While I am away I want you boys to go and see the Boss and try to get him to sub-let you those eight boilers. We can build them, and if we don't make a cent it is better to keep open

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* Concluded from the March number.

than to shut down completely. Now you put it up to him that I think it is my fault and not yours that we are fixed as we are."

Both the men demurred at this, but Walter said: "I know what I am talking about. Will you go and see the Boss?"

The boys replied that they would.

The next day, after a sleepless night, they walked into the Boss's office at half-past ten, and found him sitting in his shirt sleeves, smoking a cigar and looking very happy. He was very glad to see the boys, asked them to sit down, and handed them out cigars. Both the boys were nervous, and did not know how to begin, but, after a few remarks about the weather, the Boss said:

"They tell me you are kind of slack for work?"

"We haven't anything to do," Carl answered, and Alex broke in with "Why can't you sublet those eight boilers to us, Boss?"

The Boss was silent for a few moments, apparently watching the smoke curl up from his cigar; then, looking at them very intently, he said: "I'm going to make you two fellows mad, I guess; but if I do, don't say anything now but just think the matter over.

"About two years ago, I made up my mind that I wanted you two young men in my business as partners."

Alex and Carl looked at each other, but said nothing.

"I went down to old man Lawson, my lawyer, to talk it over. I told him that I was not getting any younger; that I wanted more time to go fishing in, and told him to draw up papers making you boys partners with me. You know what a queer old fellow Lawson is? He shook his head, then began to walk up and down the room, and finally said:

"'No, Boss, you don't want to do it that way. These two young men are all right, and they know the business of boiler making, but they don't know the troubles of running a boiler-making business, and they never will know if you make them your partners now. Now this is what you must do. Those two young men have got a little money, and have been talking some time about starting in business for themselves, establishing an opposition shop to you, but they have not got enough capital to fit out a really good shop. You must furnish them the money.'

"I did not know what the old man was driving at, and I told him so. So he explained.

"'The railroad wants to get the property on which your shop stands, but it will not really need it for a couple of years or so. I know a man by the name of Walter, a little older than the boys, who will make a cracker-jack man for you at the business end. You and I know the proper place to start a new boiler works, and I can arrange it so that your name will not appear. The best kind of a boiler shop can be built on the property, and in a year or two the boys will have learned what it means to run a boiler shop, and then you want to take then into partnership.'

"I thought this all over, and made up my mind that old man Lawson was right, and here is where you'll get mad, as all the money, except your own, in the Eureka Boiler Works, is my money, and I really own it because I have more money in it than you fellows have. You know that I can't build those eight boilers in this shop, and they are just fitted for the Eureka Works. You may not believe it, but it is my ambition to leave my name as a boiler maker. I have no children and it comes right down to this: I know you, and I like you, and there are not two better boiler makers in this country than you are. With me to guide you and get the work, we can make a handsome thing of the business. Walter has done mighty well by you, and you by him. This is my proposition: We will call the works the Boss Eureka Company, so that when I am dead my name will be seen somewhere besides on a tombstone. I will arrange it so that Walter and you two can finally buy all my interests, and will then become the entire owners of the business. By the time I am ready to slip off you will have twice as big a plant as you have now. One thing more. I'll confess to you that I got the plate mills to name you a long delivery, so that this matter could be brought to a head. I own a good deal of the stock in the mills, and so have a pull. To wind up, I am not going to force you to do this, if you do not think it is to your own best interest, but I shall be awfully disappointed if you take it the wrong way, or at least what I think is the wrong way. If you feel sore now, go home, talk it over with your wives, who are both sensible women, and with Walter, and come back and let me know. Have another cigar."

Carl was the first to break the silence.

"I don't want to do any thinking, Boss. Old man Lawson was right. You never know anything until you go through it, and I am ready to say I'm with you, and am very thankful to you."

Alex looked at the Boss, and, putting out his hand, said: "I'm lucky and you have acted just right. I could never have learned what I know now without the last eighteen months' experience. A fellow in the shop is apt to think, in fact he is sure to think, that laying out work, rolling plates, calking seams and driving rivets is all there is to a boiler business. The only way to get that notion out of his head is to let him go through the trials and tribulations of running a boiler shop. Carl is right, and I will have the best night's sleep to-night that I have done in two years.'

The Boss's voice was a little unsteady as he said: "I am mighty glad that we have got together, and one thing more, it is a good plan to get your lawyer first and have him steer you around a hole, and not wait until you tumble into it, and then get him to pull you out." W. D. Forbes.

Rapid Boiler Making

BY C. E. LESTER

While boiler making to-day is in most plants done against a short-time limit, the unusual features of an unusually quick delivery order generally finds a good organization ready and fit to cope with it. The job described below is rather unique in the rapidity with which the work was completed.

A recent order placed with the Brooks plant of the American Locomotive Company called for the delivery of a boiler on extremely short notice. The order was for a Japanese railway, and to insure the delivery to the consignee on the contract date it was necessary that the boiler leave the plant not later than Saturday, March 28, to ensure shipment on a boat via Hong Kong.

For some reason the material did not reach the plant until Saturday P. M., March 21, and, as no work was done on Sunday, the last of the material was not unloaded until 10 A. M. Monday. The laying out had, however, started at 7 A. M., and 7 P. M. saw all sheets developed and all flanged sheets formed.

The flanging was all hand-turned except the dome flange and the shell bend of the throat sheets. The punching, drilling and forming of the other plates were going on rapidly, and 6 P. M. Tuesday saw the boiler at the bull floor with the shell courses completed and the casing sheet bolted up and reamed ready to be riveted at the connections.

The boiler was delivered to the day gang next morning with the firebox, back head and braces applied, mud-ring rivets bulled, a goodly number of staybolt holes tapped and some few bolts applied. During the day, Wednesday, all flexible and rigid stays, except button head crown stays, were applied, and cut off for driving, and the flues run in and fastened. Wednesday night the boiler was completed and delivered to the testing floor at 7 A. M. Thursday.

Some trouble was experienced with the button-head radial stays, and it was necessary to renew fifteen of them. This delayed progress somewhat, but the boiler was, however, turned out at 6 A. M. Friday in the remarkable time of 96 hours from the time of starting its development.

The specifications for the boiler were as follows:

One boiler complete, tubes tested and boiler painted.

Type, extended wagon top.

Roof and sides in one piece.

Back head taper. Throat sheet straight.

62 inches O. D. front course, 72 inches at throat.

First course, 9/16-inch; second course, ⅝-inch; third course, ⅝-inch.

Front tube sheet, ½-inch; roof, ½-inch; sides, ½-inch; back head, ½-inch.

Dome, 30 inches diameter on third course.

Horizontal seams, butt joint sextuple riveted.

Firebox: Narrow; length, 103 3/16 inches; width, 40¼ inches; depth, 72¼ inches front and 59 inches back.

Staybolts and radial stays, double refined iron. (No make specified.)

Back tube sheet, ½-inch; wrapper sheet, ⅜-inch; door sheet, ⅜-inch.

A. L. Co. flexible bolts in breaking zone; 196 bolts.

All threads on staybolts in radial stays, 12-thread Whitworth.

Two front transverse rows to be expansion stays.

Six center rows to be button-head radials.

Mudring cast steel in one piece, double riveted.

All boiler tubes prosser expanded.

290 2-inch O. D. No. 12 knobbled charcoal iron boiler tubes 12 feet 2 inches long.

¾-inch tube spaces. Tubes set with soft-iron ferrules on firebox end.

Boiler 180 pounds working pressure.

Boiler test: Boiler to be filled with warm water (not over 150 degrees F.) and pressure raised by means of injector or pump to 25 percent above working pressure. No calking to be done while boiler is subjected to pressure in excess of working pressure.

The construction was done as a whole according to the A. L. Company's standard practices, which have been adopted to insure good workmanship, and particularly toward uniformity in construction, and that shells and back ends made from the same print be interchangeable.

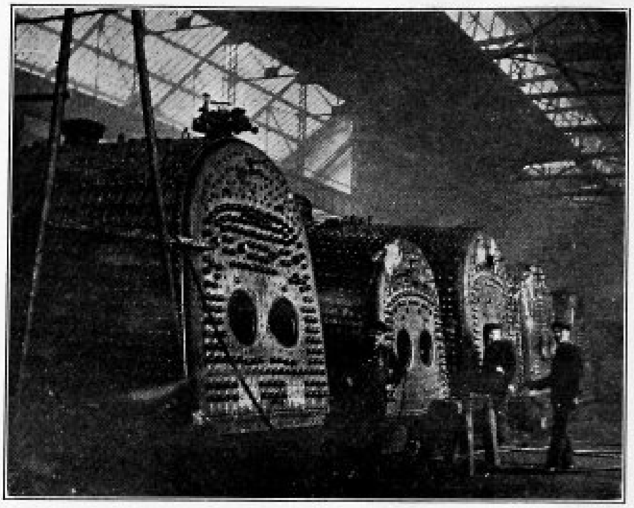
The writer does not know that this time breaks any records, but surely it is rapid work, and demonstrates what organization will do. It is hardly to be expected that this performance will be duplicated in an emergency case such as this, unless the best of the organization and the principal part of the supervisor's time can be devoted to the work.

Record Work at the West Albany Shops

The accompanying photograph shows two weeks' output at the West Albany Shops consisting of five of the class I. K. boilers converted into superheaters with new fireboxes. The boilers are on the test pit ready for testing. In addition to the work shown in the photograph, twenty other fireboxes and five new boilers were under way at the same time, and will be ready for the test pit in a few weeks.

The men shown in the photograph from right to left are Albert F. Stighmeier, assistant foreman boiler maker; Robert Hoey, chief boiler inspector; and the writer, who is assistant boiler inspector. Credit for this excellent record at the West Albany shops should be given to the general foreman boiler maker of the shops, Joe McAllister, who during the past year has vastly improved conditions in the shops and organized the work so that such records have become possible. Mr. McAllister deserves great credit for his mechanical and executive ability, as well as for his knowledge of boiler making.

At the lower end of the shop there are three stripping pits on which engines requiring new fireboxes are run for the stripping of the boilers. When this work is completed, the boilers are removed from the frames and set on the floor, where a gang of men is ready for removing the fireboxes. This work is accomplished in from twelve to sixteen hours' time, and includes all drilling of holes for Tate bolts, the cutting of flues and placing them on a rack in front of the boiler ready for the flue rattler. While the firebox is being removed, the layer out, Joe Havlak, manages to get all the dimensions necessary to check up with the drawing.



Two Weeks' Output at the West Albany Shops

The method of driving staybolts at this shop is interesting, as compared with old methods. A staybolt man, F. Johnson, who makes a specialty of driving staybolts with an automatic hammer, drives 800 bolts or 1,600 staybolt ends before five o'clock daily. Besides this, he has sufficient time to go back after the bolts are driven and open all tell-tale holes and snap the bolts down to the sheet, which gives the job a much better appearance. When the boiler is received on the test pit, it is very seldom that the boiler inspectors find many leaky staybolts to mark up for re-driving. The men often remind Mr. Johnson of the five o'clock whistle, but he seldom has any trouble with completing this amount of work in nine hours daily, and usually has plenty of time to make the work-train home.

Harry A. Lacerda,
Assistant Boiler Inspector.

West Albany Shops, New York.

American Iron Works.—The American Iron Works of Louisville, Ky., formerly the American Boiler Works, was established in April, 1909, by Mr. C. H. Gerrard. The business was incorporated in the fall of 1913 and the name changed to the American Iron Works in order to indicate more comprehensively the present scope of the company. When it was first established, it was engaged in a general jobbing repair and contract work, including boiler repairs, sheet iron and heavy plate metal construction, smokestacks, etc. In November, 1913, the present building, which is of brick, 52½ feet wide and 204 feet deep, with a trussed roof giving a clear space of 10,000 square feet, was purchased. The roof of the building is of saw-toothed construction, giving ample light and air. The trusses in the roof are amply strong to carry overhead trolleys for handling materials and work. The plant is divided into a machine shop and boiler department, each of which is equipped with modern up-to-date tools and equipment with ample space for handling any kind of general repair work on machinery and boilers. Mr. C. H. Gerrard is president and general manager of the company, and Mr. John Hardy vice-president.

Electric Arc Welding*

BY OTIS ALLEN KENYON

In general two kinds of arcs are used for welding purposes, namely, the carbon arc and the metallic arc. In each case the heat of the arc is utilized to bring the metals to be welded to the melting temperature, when the joint is filled with molten metal, usually introduced in the form of a rod or pencil.

As is well known, the positive side of the direct-current arc generates heat at a rate approximately three times as great as that at which heat is generated at the negative side. Therefore, it makes a considerable difference to which side of the circuit the material to be welded is connected. As a general rule, on account of the comparatively large mass and heat conductance of the material, it is connected to the positive side.

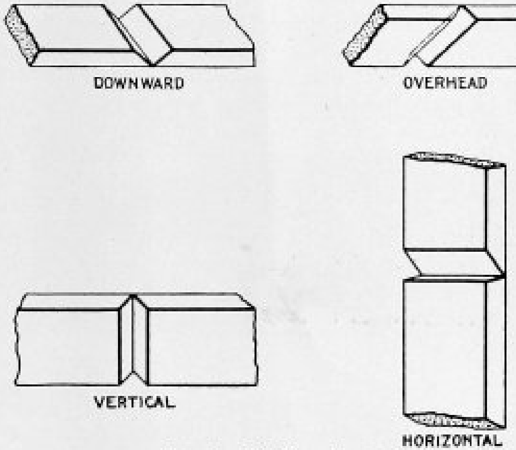


Fig. 1.—Welding Positions

Carbon Arc

The carbon arc generates heat energy at a higher rate than the metallic arc and is therefore best adapted to use in places where comparatively large masses of metal are to be heated, such as in the cutting of iron and steel and the filling of blowholes in castings, as well as in making some kinds of welds where temperature stresses do not play an important part.

In working with the carbon arc the operator holds the carbon electrode in one hand and a melt bar in the other, the arc supplying the heat by means of which the melt bar is worked into the space between the metals to be joined. The carbon arc requires an e. m. f. varying between 50 volts and 100 volts, and the value of the current is varied over a range between 150 and 700 amperes, according to the nature of the work to be performed. Very high values of the current are not as frequently used now as formerly, 300 amperes usually being sufficient for welding and cutting work.

With the carbon arc both hands are occupied with the welding, and a mask must be worn to protect the head and face from the powerful heat and ultra-violet rays of the arc. This mask is somewhat of a disadvantage, as the operators find it is disagreeable to wear and also because it interferes with easy inspection of the work.

The carbon arc, employing a comparatively high voltage, varies in length from 1 inch up to 6 inches and therefore it spreads over the surface somewhat as does the oxy-acetylene flame. On account of this action the heat is applied to a surface considerably larger than it is desired to raise to the melting point for welding. For this reason the total amount of heat required to melt the surfaces to be joined is greater than would otherwise be the case, and hence the temperature stresses set up in the metal to be welded are correspondingly great.

In planning the method of welding in any given instance it is of the greatest importance to take into careful consideration the possible temperature stresses and so to lay out the work as to reduce them to a minimum, otherwise the entire mass of the parts to be joined must be preheated.

The carbon arc is much better adapted to cutting metals than is the metallic arc. However, the oxy-acetylene flame with the oxygen jet is very much better than the electric arc wherever the metal to be cut is steel, because the oxy-acetylene process, by means of the oxygen jet, burns up the metal and hard steels lend themselves best to rapid oxidation. When cast iron is to be cut the oxidation method cannot be applied and the carbon arc gives the best results, as it permits the application of enormous quantities of heat necessary to melt the metal. Cuts made with the arc are always more or less ragged and must be so arranged that the freshly molten metal can run clear of the cut before hardening.

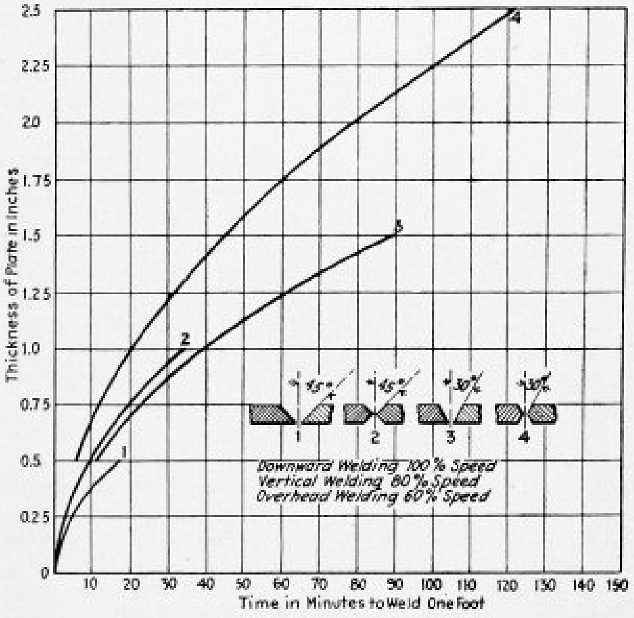


Fig. 2.—Relation of Thickness of Plate to Time of Welding

The Metallic Arc

In the metallic arc process the welding electrode or pencil is incorporated with the melt bar itself, and as this pencil is consumed in the arc the greater part of it passes over and is deposited in the joint to be welded. This process has two distinct advantages over the carbon method: First, by eliminating the carbon the possibility of carbonization of the weld is removed; and, second, by incorporating the melt bar with the welding electrode only one hand is required for welding, and therefore the opartor can hold a mask or screen in the other hand while welding and lower it each time the arc is broken; thus the operator can inspect his work with the naked eye at frequent intervals.

The metallic arc requires only a very low e. m. f., namely, from 15 volts to 30 volts. The length of the arc is very short, usually being less than ⅛-inch. The voltage seems not to vary greatly with the length of the arc, because the arc vapor is a very good conductor, practically all the voltage being consumed at the surfaces of the electrodes.

The ability to use an extremely short arc is simultaneously an advantage and a disadvantage of this process. The disadvantage is that more skill is required to work with a short

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* From the *Electrical World*.

arc than with a long one, as the long arc is more stable. The advantage lies in the extreme localization of the heat, which if of transcending importance. The extreme localization of the heat generated by the short arc permits the melting of metal immediately under the end of the welding pencil, the particles of molten metal traveling from the pencil through the arc and combining with the molten metal at the point opposite the end of the electrode.

In this arc it is not necessary to give the electrode a rotary motion. On the contrary, it is held perfectly quiet for an instant and then moved ahead one step, the metal being deposited in a series of drops which are run together as a string.

Temperature stresses with a properly manipulated metallic arc are practically negligible, and wherever they are liable to occur they can be taken care of without resorting to preheating or any complicated method of procedure except in massive and complicated castings in which large quantities of metal are deposited within a small radius. In the metallic arc process practically all the heat is utilized for welding, very little being dissipated uselessly in the mass of the metal.

Energy Supply

The welding-arc circuit should preferably have a constant-current characteristic so as to produce stability in the arc. Where only one arc is used a constant-current generator may be used. In other cases the constant-current characteristic can be obtained by connecting a rheostat in series with the arc across a constant-potential system. The series resistance gives greater voltage across the arc when the current tends to decrease and less voltage across the arc when the current tends to increase. In this way the voltage across the arc varies with the length of the arc and the current is kept approximately at a constant value. Naturally the resistance method of stabilizing the arc is extremely wasteful, according to usual practice from 40 to 60 and more volts being consumed in the rheostat as compared with about 20 volts in the welding arc. The carbon arc may be operated without a series rheostat, but means must be provided for protecting the generator from dead short-circuit when the arc is struck.

When using constant-potential machines the only limit to the number of arcs that can be connected in parallel is the current-carrying capacity of the machine. For metallic arcs with series rheostats it is usual to estimate 150 amperes for each arc, the arc itself consuming 25 volts. The current for carbon arcs is usually estimated at 300 amperes and the e. m. f. at 70 volts. Welding generators wound for low voltages are now manufactured by several different firms.

Operation

The joint to be welded is prepared by cutting away the edges in such a manner as to allow the insertion of the electrode or welding pencil into the innermost part of the joint for drawing an arc at that point.

The angle of bevel depends on a number of factors: the kind of metal to be joined, the composition of the joint, the direction in which the welding is to be done, and the strength required. For very high-strength joints it is desirable to have a comparatively large area of contact between the deposited metal and the original metal.

There are several different positions in which welds can be executed, namely, downward, vertically, horizontally and overhead. These various positions are shown in Fig. 1.

In downward welding full advantage can be taken of gravity. Horizontal welds can sometimes be arranged so as to be almost as easily executed as downward welds. Vertical welds require about 25 percent longer time than downward welds, and overhead welds require about 67 percent longer time.

Overhead welding is not practicable with the carbon arc. However, it is easily performed with the metallic arc provided that the welding electrode is coated with a refractory flux. This flux coating, which was invented by Kjellberg in Sweden, performs two functions: It applies flux to the welds at the rate which bears a definite relation to the rate of consumption of the welding pencil, and it forms a tiny crucible which holds a small quantity of molten metal on the end of the electrode upon which the "pinch effect" of the current may act. In this way the molten metal on the end of the pencil is squeezed outward and upward onto the joint, where it sticks. Without the coating on the electrode the metal does not travel against the force of gravity, but falls in a stream onto the floor.

Fig. 2 shows the time in minutes required to weld steel plates of different thicknesses and by different methods of cutting the joints. In these curves no allowance has been made for time required to change welding pencils or prepare the work. They cover simply the actual time of welding. Ten seconds is sufficient time to allow for changing a welding pencil by properly trained men.

The success of an arc weld is determined by a number of factors, as follows: First, the work must be planned by some one who understands both the welding and operating conditions to be met by the apparatus that is to be repaired. Second, the composition of the welding pencil and the flux used with the pencil must be chosen with due respect to the metal to be welded. Third, the value of the current must be determined with reference to the metal to be welded as well as the liability to temperature disturbances.

Applications

Arc welding is one of the oldest practical applications of electrical energy, and yet only in recent years, comparatively, has it come into very extensive use. The slowness of the development of a process which offers such great possibilities is attributable entirely to a failure to consider the necessity for an enormous amount of special knowledge. Arc welding was originally supposed to be extremely simple, and this supposition resulted in many failures, which greatly retarded its development.

The beginning of the present activity in arc welding dates back to only a few years ago, when the metallic arc with the coated electrode was first taken up in Europe. This process greatly simplified the matter of temperature stresses as well as the control of energy and therefore met with more general success than any method previously known. At the present time it is recognized that successful arc welding can be accomplished only by skilled operators under the direction of competent superintendents. There is no longer a question as to the possibility of producing strong welds; in fact, the welds are just as strong as the original material. Nevertheless, most engineers are ready to use welded joints only in places where tests can be applied after the work has been finished.

In boilers, pipe lines, tanks, etc., where working pressure can be applied with little trouble, arc welding has been successfully introduced. It is also very generally used for reclaiming defective and broken catings, for filling holes and building on projections.

Lack of experience has led engineers to regard arc welding suspiciously wherever important work that cannot be tested in place is involved. At present only those trained in the art of welding are competent to pass upon the quality of a joint, and hence unless some method is devised whereby an ordinary mechanic can ascertain the quality of a welded joint by simple inspection the art of electric welding will suffer from the lack of knowledge and experience in its use by those who have to pass upon and determine the design of structures.

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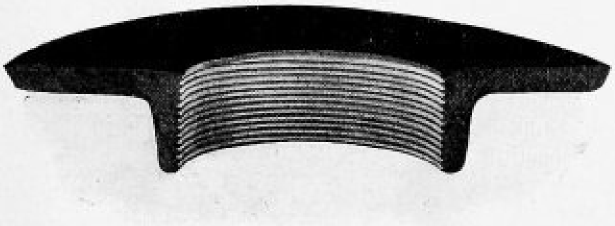
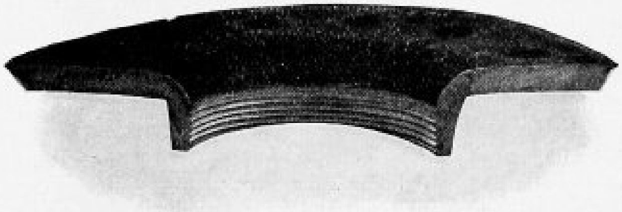


Ryerson Flanges are forged from open hearth steel billets, core punched under the hammer, allowing an exceptionally large number of full threads and leaving the metal thickest at the foot of the hub where strain is greatest. All our flanges are beveled for quick, economical calking and are carefully finished in a lathe.



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Notable Application

Probably the most noteworthy application of electric arc welding was that of the steel lining of the Rondout siphon of the Catskill Aqueduct, executed by the Electric Welding Company. In this instance the metallic arc process was applied to butt-weld 15-inch, 55-pound channels into the form of rings, which were then riveted together and protected from corrosion by concrete placed outside and inside. The total head of water acting upon this tunnel, which is 14 feet 2 inches inside diameter, may be as high as 750 feet, although the external ground-water pressure will compensate for a good deal of the internal pressure.

In sanctioning this application of electric welding the Board of Water Supply of the city of New York very carefully investigated the process by welding full-size specimens and subjecting them to tests. In October, 1913, the water was let into the tunnel and the job accepted as perfect.

Apprenticeship*

BY GEORGE M. BASFORD

Where are the boiler maker foremen and the boiler makers of the future to be had? How many real boiler makers are you training? Boiler work constitutes the larger part of locomotive repair expense, and yet who has any boiler shop apprentices? Even the roads having the best apprenticeship schemes have very few of them. What are you doing about this to attract boys of the right sort to this vitally important trade? The right sort of boys will not take their chances in a boiler shop to-day. You yourself would not. For the best of reasons you would not willingly allow your sons to do so.

Someone may ask what apprenticeship should be. The apprentice problem is very simple. For the shop it should be the old-time apprenticeship brought down to date, changed and improved to meet present conditions. Several essentials must be provided:

First is the training of the hand, eye and judgment in the shop by men who have no other duties. The course should be short, active and thorough to render the boys good, quick, accurate and intelligent workmen, and good citizens, in the shortest possible time. Three years of intensive training is sufficient for the course itself. The shop training must replace the "master" of the past by a bright shop instructor who will personally teach the progress of the trade he himself commands and who will see to it that the boys of other trades are properly and consistently taught by competent men and methods. The boys must be taught direct and correct methods and they must understand the value of time and material.

Second is mental training coincident with the manual development. This means night schools or day schools conducted by men who understand the shops and who can show the boys how to educate themselves. These schools are to unfold the reasons for everything done in the shop and to lead the boys to look back at preceding processes and ahead of the processes which are to follow and to enable them to understand the materials, processes and forces with which they are dealing and to conduct their work without waste of energy, of time, or of material. Few men in the shop think of the cost of the work they do. If they did they would effect great savings. This is an important part of the school work. Boys in a year may know many things that their foreman required many years to learn, and which some foremen have never learned. For instance, our boiler shop apprentice will know how to design boiler seams. I know of a capable foreman who recently reduced the strength of a joint below safe limits, believing that by putting in a surplus of rivets he had made a strong repair job.

Third and most important is the personal responsibility over the boys centering in one man, the apprentice supervisor, whose duty is to know and understand them. He must know the boys intimately, thoroughly understanding their capabilities and their personalities. He must know them better than parents usually know their boys and be able to guide them in all the affairs of young manhood. He must know them well enough to guide them into the right work, and he must have natural ability as an educator, so that he can deal with each personality in accordance with its peculiar needs and its own peculiar possibilities. This man must know the essentials of the makeup of a machinist, boiler maker, pipe fitter, millwright, pattern maker, carpenter, fireman, clerk and all the rest. With this knowledge and with great care he must help the boys to select their work and guide them in such changes as may be necessary. He must be able to adjust misfits which are sure to be found and must interest all the foremen in the boys. He must also be a man of high moral character, one with a personality that will enable him to influence the boys and lead them to be honorable, upright men. He must have that enthusiasm that makes work of any kind successful. He must reveal to the lads their duty to themselves and to the country. A good citizen is likely to be a good workman, and a good workman is likely to be a good citizen. You will say that these specifications are very severe and that it is difficult to find such men. The answer is that the fact that it is so difficult to find such men in itself reveals the weakness of present methods and the need for an awakening. The man who can do such work properly and who can exert this influence continuously will prove to be one of the most important subordinate officials of the whole railroad organization. A few such men are available and more are coming along.

Is your organization qualified to receive and retain apprentices when through their time? If not, as I have endeavored to show, you have a great work to do before you begin to talk about training young men for railroad service. Do you encourage capable young men and do you have automatic means whereby able men will reveal their qualifications for promotion? Do you promote men and thereby encourage your subordinates, or do you import strangers when you have good places to fill? If you can not answer these questions look up the plan for studying and recording the characteristics of men, which was so successfully introduced on the Lake Shore & Michigan Southern Railway (*see American Engineer*, December, 1908) about five years ago by Mr. Le Grand Parish. Does your president give it out as a basic principle of organization that every officer on the road must train and otherwise educate his own successor? Progressive promotion presents a problem, but until it is solved or partially solved it is fruitless to consider recruiting systems. The best possible recruiting and training methods will fail if recruits, however well trained, are brought up against continual discouragement.

Your office is not what is should be, neither is your shop or your drawing room if it leads to blind alleys from which there is no promotion and no outlook. You must find outlets, or the equivalent, for capable men in every department. If not outlets then you must find ways in which able men may so improve their work that they will not cease to grow, expand and become more able, more valuable to the company and to themselves. Railroads and industrial concerns are not thinking of this to-day!

To-day the locomotive and its operation offer greater possibilities for improvements in net earnings than ever before in the history of railroads. To-day the locomotive presents problems as well as possibilities requiring knowledge, experience and good judgment that were never required before.

(*Concluded on page* 125.)

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* From a paper on the Development of Young Men for Railroad Work, read by George M. Basford before the New England Railroad Club, Boston, January, 1914.

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Sworn to and subscribed before me this 12th day of March, 1914.
OSCAR M. PICKRUHL.
(My commission expires March, 1915.)

Recent progress in boiler design has been more pronounced in the case of the locomotive boiler than in any other type of fire-tube boiler. While the general proportions and details of construction of Scotch marine and horizontal tubular boilers remain practically unchanged, each year brings out some new departure in the design of the locomotive boiler which is the result of painstaking investigation and experiment. The reason for this is plain: the tremendous growth of the railroads and the constantly increasing demands for more power per unit of weight from a single boiler have made it imperative for locomotive designers and builders to direct their undivided attention to the question of improvements in the boiler. Along with the increase in size and power of the boiler, however, have come more difficult problems in the matter of upkeep and durability, none of which can be neglected without involving expenditures which would soon offset the gains made from the increased power and efficiency first obtained. Considering the many features involved, it is not surprising that some of the improvements proposed which at first sight seemed to offer exceptional advantages have met with tardy recognition. It is only after prolonged trial and investigation that even the most optimistic railway officials can be expected to accept and endorse new improvements, especially if they are in the form of some radical departure from former practices. That such rapid strides in the development of the locomotive boiler have been made is due very largely to the work of the supply men, whose energetic attacks upon individual problems in connection with locomotive construction have made possible to a certain extent the high state of efficiency which is now being obtained in the modern locomotive boiler, and without which this rapid development would have been greatly retarded.

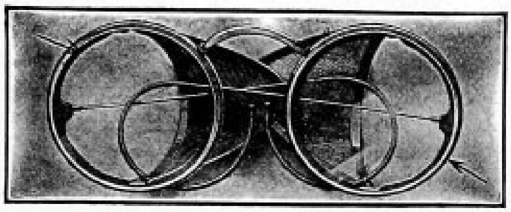
How about your boy? Do you want him to go into the shop and take his chances at learning the boilermaking trade on his own responsibility? Do you want him to shift for himself and follow his own inclinations, guided only by the necessity of obeying orders and doing as he is told, with perhaps little conception of the importance of learning something besides the use of tools and how to beat the time card? Do you think that the men he is working for, unless they are personal friends of yours or are under some obligation to you, are going out of their way to teach him the fine points of his trade? Or would you like to see a chance to put him under the supervision of a trained man who is a crack-a-jack at the trade, who knows more about it than you do yourself, and who is a man of high moral character capable of influencing the boy so that he will not only become a good workman and a good citizen, but will be able to make the most of his opportunities as they come to him? If so, read what Mr. Basford says in this issue about apprenticeship. A thorough system of apprenticeship provides training of the hand, eye and judgment by one who is devoting his whole time to the task. It teaches the direct and correct methods, points out the mistakes made by others, and teaches the value of time and materials so that waste of time, energy and materials will be avoided. It also provides adequate mental training so that the boy can understand the reason for everything in the shop, and gives him as good, if not a better, grasp on the nature of the work than perhaps the foreman has acquired in a life-time of experience. All this has been proved by experience, and by its aid the trained apprentice is given an opportunity to better himself to the fullest extent of his possibilities. If this seems worth while, do your part towards bringing about a systematic training of apprentices in your shop.

Engineering Specialties for Boiler Makers

Improved Eye Protector for Industrial Workers

Safety goggles, which are claimed to embody new principles in industrial eye protection, have been brought out by T. A. Willson & Company, Inc., Reading, Pa. Instead of the saddle resting upon the bridge of the nose there is an adjustable brace bridge designed to distribute the weight evenly upon the sides of the nose and the cheeks.

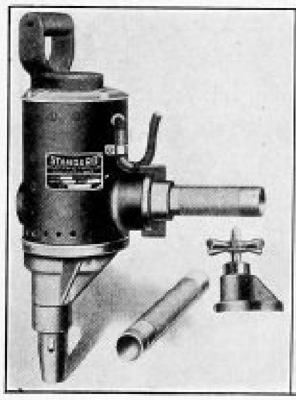
A safety flange, which is part of the rim, extends over the back edge of the glass to give resistance to blows struck on the lens and holding the glass securely, thus, it is pointed out, preventing injury to the eye from splinters. The wire side screens are either detachable or else are fastened so that they cannot be removed. The shape of the screens is rather unusual, being long and narrow, which, it is emphasized, gives protection without the irritation caused by the edges rubbing and pressing into the cheek and forehead. The screens are placed on the outside of the cable bow temples, to insure cleanliness in the screw joint and eliminate the danger of the bows breaking at the joints. These temples are found to rest easily about the ears and to hold the glasses securely in place.



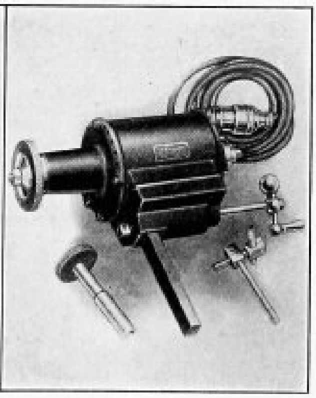
The glass used for the lenses is ground and polished on both sides. A simple screw joint is employed to hold the lenses in place, so that broken ones can be readily removed and replaced, this feature resulting in a saving to plants, as it is possible for them to make their own repairs.

New Universal Portable Electric Drills and Grinders

The Standard Electric Tool Co., of Cincinnati, O., has developed and is now placing on the market a new line of Universal portable electric tool post grinders. These operate on both direct current and alternating current 0 to 60 cycles, being developed particularly to meet the demand for grinders that will operate on both 25, 30 and 40-cycle circuits.



Drill



Grinder

These grinders are ball bearing, the highest grade of bearings being used, and they are packed in grease in dust-proof chambers. This, it is claimed, eliminates oiling and prevents flooding with thin oil and damaging motor windings as well, as it precludes the possibility of trouble from bearing adjustment.

These tools are manufactured in 1/6 and ¼ horsepower sizes, and they have a speed of approximately 6,000 revolutions per minute, which, it is claimed, makes them very effective for internal grinding.

In addition to the above grinders, this company is now placing on the market two new sizes of universal drills, ⅝-inch and 1-inch capacity. These are in addition to the seven sizes they have had on the market for some time, and which were illustrated and described in these columns at an earlier date.

The drills operate on both direct and alternating current, 0 to 60 cycles, and, as with the grinders, are especially adapted for 25, 30 and 40-cycle circuits. The drills are ball bearing throughout. The ⅝-inch size is fitted with No. 2 Morse taper socket or with chuck, and the 1-inch size with No. 3 Morse taper socket. The gears are generated from a special grade of steel, and are case-hardened and run encased in grease.

The motors in both drills and grinders are form wound, and are impregnated in Bakelite, a method of winding and insulation which prevents grounds, short circuits and other troubles incident to high speed apparatus, if constructed according to slow-speed motor practice. All tools are air cooled by means of a high-power fan. The motors develop high power and are capable of severe overload without damage.

The idea of simple, rigid construction has been followed throughout, although weight has been kept down to the minimum. Both drills and grinders are built on the unit plan, which makes them very easily dismembered; all electrical connections are made in the frame unit.

The ⅝-inch and 1-inch sizes of drills have also been added to their line of drills for direct current only, as well as that for two and three-phase alternating current.

The Use of the Non-Return Valve in Preventing Accidents

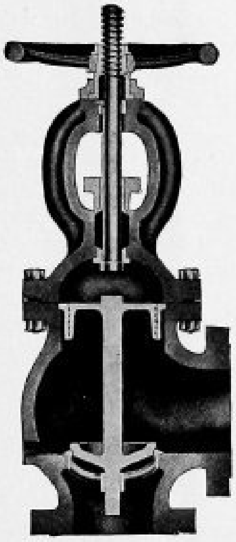
The various types of valves used around a power house may be divided into two classes: those which perform their function of opening and closing when operated by external force, and those which operate automatically to perform that function, when conditions of operation, or the unexpected, make it necessary that they shall operate quickly and positively. As an illustration of a type of automatic valve which must open when the pressure in a boiler reaches a predetermined amount is the well-known safety valve of either the lever or spring type. In contrast to this type is a form of valve which must close automatically under conditions that are practically the reverse of the conditions under which the safety valve must operate. These types of valves are known an non-return valves.

The most important uses of the non-return valve are to equalize the pressure between the different units in a battery of boilers, and to prevent the flow of steam from traveling in a reverse direction to its normal flow.

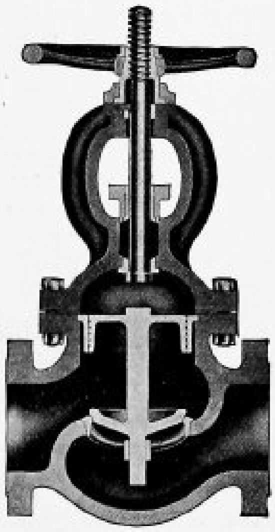
In case a tube blows out in a boiler, the non-return valve closes automatically, owing to a reduction of pressure, and prevents the header steam from entering the boiler. It acts also as a safety stop to prevent steam being turned into a cold boiler when men are working inside, because it cannot be opened when there is pressure on the header side only.

The greatest danger to which boiler men, repair men and insurance inspectors are subjected when working around a power plant is when they are required to enter an empty boiler which is connected by pipe lines to other boilers under steam. Should the steam be allowed to enter the boiler when anyone is working within it, there is no way in which the man inside can protect himself, and his life is in jeopardy. This occurrence takes place all too frequently, and may be due to a leaky stop valve, or it may be due to the negligence of some employee who, being ignorant of the fact that some one is inside the boiler, turns on a steam valve, which allows live steam to enter the boiler, and a death is apt to be the result.

While, therefore, the use of the non-return valve possesses many advantages in that it protects power-plant equipment from danger, the humanitarian side of its use is sufficient reason for its increased adoption in power plants where safety to employees is not only a moral but a legal requirement.



Angle Cushioned Non-Return Valve



Straightway Cushioned Non-Return Valve

To be successful, a non-return valve should not open until the pressure in the boiler is equal to that in the header. It should not stick and become inoperative; it should not hammer or chatter while performing its work, and it should be so designed that wire-drawing will not cause wear on the seat and the resulting leak.

In adopting these fundamental principles of safety necessary for the operation of a non-return valve, the Nelson Valve Co., Philadelphia, Pa., have added many additional operating and construction details to the Nelson Cushioned Non-Return Stop Valve, which are interesting from an engineering standpoint, and necessary for reliable operation.

The valve is so constructed that it operates automatically, like an ordinary check valve, and it can be used as a stop valve. It contains an internal dash-pot, having the full area of the valve opening, which acts to cushion the effect of opening and closing the valve. The dash-pot is always at the same temperature as the other working parts, so that contraction or expansion of all parts will be equal, and there can be no binding of the piston; it is, therefore in condition to operate uniformly under all conditions. It is made separate from the body and bonnet castings, thus allowing perfect alinement with the piston.

The piston is made the same depth as the dash-pot, so that in traveling up and down in normal operation there can be no shoulder formed, thereby the cause of sticking, which is fatal to a valve of this type, is removed.

The piston and disk are made in one solid piece of bronze. The disk is provided with a lip below the finished seating surface, which is designed to give an easy flow of steam.

Since a valve of this type must necessarily operate continuously with a short-stroke the damage from wire drawing is considerable, and naturally, with incorrect design, this wear will cause serious leakage. In the Nelson Cushion Non-Return Valve, the lip located below the seating surface absorbs this wear; the seating surface remaining in a smooth condition.

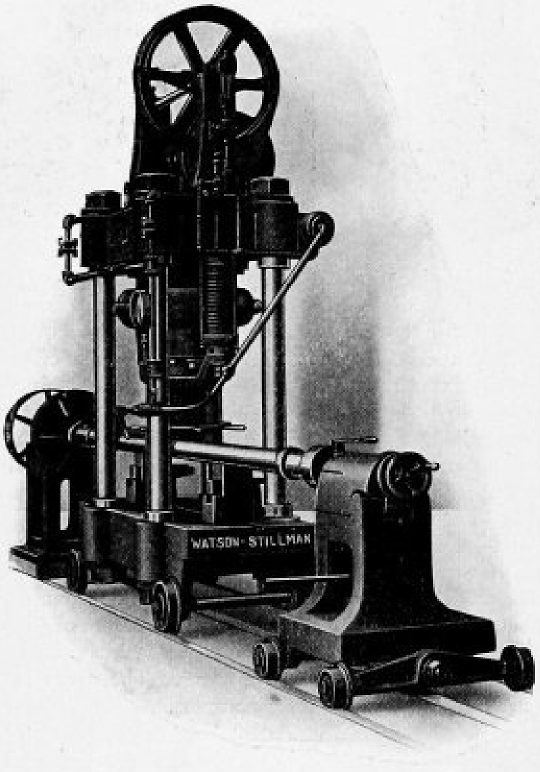
When it is desired to use the valve as a non-return valve, the hand-wheel is opened, as with an ordinary stop valve. This allows the disk, which is a part of the piston, to operate automatically in the dash-pot with slight changes of pressure. When it is desired to use it as a stop valve, the hand-wheel is screwed down in the usual manner. The hand-wheel is made stationary, so that the valve may be operated with small head room, which feature is often of great importance in many boiler plants.

In the installation of these valves of either the angle or globe pattern, they should be so placed that the pressure is always under the disk, with the stem vertical. They can then be packed when open and under pressure.

Hydraulic Shaft Straightener

The Watson-Stillman Co., New York, has recently produced an hydraulic press that has a capacity of 325 tons, which is sufficient for taking the bends out of any steel shaft up to 10 inches diameter, the length being limited only by the extent of the foundation provided.

As shown in the illustration, it is a motor-driven, self-contained unit, requiring no outside air or hydraulic system. There are three independent parts: the head stock, which is stationary, and the press and tail stock, which are on rollers to permit their adjustment to varying lengths of shafts. The bed rails are flush with the floor, so that when not in use the movable parts can be rolled to one side, leaving the floor clear of obstructions. The head and tail stock are similar to those of a lathe, except that the centers are hinged to follow the movement of the shaft ends when the bend is made.

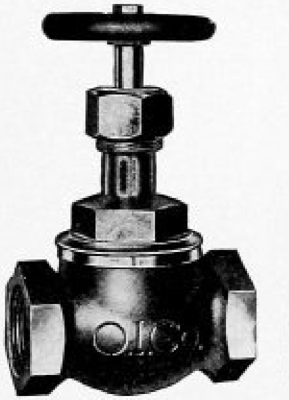


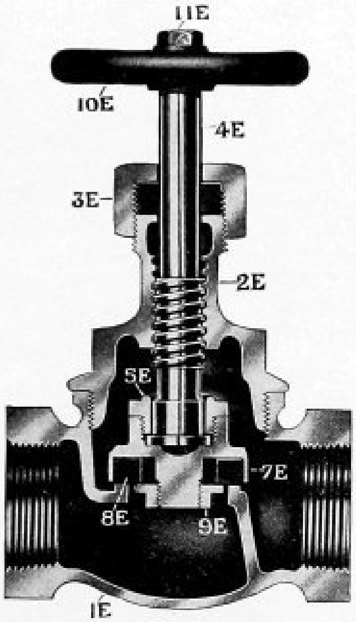
The shaft is revolved from the head stock and the "high point" marked. The press is then moved to that point and the bending blocks adjusted. The ram has a maximum movement of two inches and screwed concentrically into it is a square-threaded adjustment screw, which compensates for the different diameters of the shafts, and also enables the operator to predetermine the flexure desired. This, it is claimed, positively eliminates all danger of overbending.

The entire hydraulic power plant, including a 5-horsepower motor, pump, reservoir, etc., is mounted on the top platen of the press. The floor space required is 3 feet 6 inches wide by the length of the shaft, plus 6 feet. The total net weight of the press is 19,300 pounds.

The "O. I. Co." Composition Disk Valve

The composition disk valve manufactured by the Ohio Injector Company, Wadsworth, Ohio, is made of a high grade of steam metal, all parts being made to gage in order to insure perfect fits in pipe threads and interchangeability of parts. The composition disk is made of a special compound especially adapted for use under severe service of all kinds. It is claimed that the composition disk will not break, crack or become brittle and pit. The disk wears down to a thin ring, thus giving an exceptionally long service, with the advantage over re-grinding or metal disk valves that it costs much less to renew a disk than it does to regrind a valve. The valves are designed for working pressures up to 200 pounds per square inch and have been approved by the United States Steamboat Inspection Service. The packing for the spindles consists of a special molded split ring which fits the stuffing box and spindle accurately and requires very little compression to make a steam-tight joint. This ring is composed of braided asbestos thoroughly lubricated and coated with graphite to prevent friction and wear on the stems. The areas in the valves are far in excess of the pipe areas.





Cost of Electric Welding.—In a paper on "Repairs and Welds by Electricity," presented by Evan C. Price before the Ohio Society of Mechanical, Electrical and Steam Engineers, May, 1913, it was stated that a large locomotive shop operating an electrical welding apparatus, having made a careful tabulation of the total cost of the repair work, including material, time of the operator, the current and overhead charges, obtained an average cost of 1 cent per minute. The saving effected by this method is shown in the following example: The cost of repairing forty cracks in side sheets of fireboxes by means of the metal electrode method was $6.50, while to renew the damaged parts would have cost about $1,300.

Personal

Charles Lynch has been appointed foreman boiler maker of the Rock Island Lines at Manly, Iowa.

E. W. Richey, formerly secretary and general sales agent of the Standard Forgings Company, has become associated with A. M. Castle & Co., Chicago, Ill.

H. Alaman, general foreman boiler maker of the Vandalia at Terre Haute, Ind., has retired on a pension. Mr. Alaman has been in the service of the company for forty-nine years.

George Hill, who is well known in the field of electric welding appliances, has been appointed general sales agent of the Siemund Wenzel Electric Welding Company, with headquarters at 30 Church street, New York.

Walter C. Allen, for the past five years general manager of the Yale & Towne Manufacturing Company, New York, has been elected vice-president and general manager of the company for the ensuing year. Mr. Allen entered the company's service in 1891 in a minor position, and has steadily worked his way up through the various departments, including the machine shop, drafting room and executive work. In 1905 he was appointed assistant general superintendent, a year later superintendent, and in 1909 he became manager of the company.

Obituary

George Westinghouse, famous the world over as an inventor, engineer and manufacturer, died of heart disease in New York City, March 12, at the age of 67. Mr. Westinghouse was born at Central Bridge, Scoharie County, New York, Oct. 6, 1846. His first experience in mechanics was gained at the Schenectady Agricultural Works, which was established by his father in Schenectady, N. Y., in 1856. In 1863, when only 17 years old, Mr. Westinghouse enlisted in the army, and served in the infantry and cavalry, until in 1864 he was appointed third assistant engineer, United States navy. At the close of the war, he resigned from the navy and entered Union College, which he left at the end of the sophomore year to take up his career as an engineer. In 1865, he invented a device for replacing railway cars upon the track, which was manufactured at Troy, N. Y. Soon after that, what is generally recognized as his greatest invention, the air brake, was brought out. The first patent for the air brake was issued April 13, 1869, the Westinghouse Air Brake Company was formed July 20 and a factory was established in Pittsburg in 1870. At first Mr. Westinghouse had difficulty in introducing the air brake, but he was continually perfecting the device, until in 1886 he brought out the quick action brake, with its triple valve. The introduction of switch and signal systems operated by compressed air, controlled by electricity, soon followed the introduction of the air brake, and in 1885 Mr. Westinghouse began to develop the alternating current system, which has meant so much to the industrial, manufacturing and commercial world in the last generation. It was Mr. Westinghouse who introduced the Parsons turbine in the United States. He has long been interested in the question of ship propulsion and has brought out, in collaboration with the late Rear Admiral Geo. N. Melville and John H. MacAlpine, the highly ingenious reduction gear for turbine-driven ships, which is now being applied to both naval and merchant vessels. Mr. Westinghouse received decorations from the French Republic, the King of Italy, and the King of Belgium. He was the second person to receive the John Fritz medal, and in 1912 he was awarded the Edison medal by the American Institute of Electrical Engineers. Last December he received the German Grashof medal.

Letters from Practical Boiler Makers

Learn to Layout

"Learn how to layout," is the advice given to the young boiler makers of to-day, and good advice it is. If followed it will be the means of making boiler makers of a higher grade than the general run of men of the present time.

Many of our young men are discouraged on account of a lack of education, thinking that they must be good scholars before they can understand the mysteries of laying out. Others are discouraged at the formidable array of lines to be seen when the layerout is at work on some very crooked layout, and here it may be said that many men insert lines in their layouts that are of little use except to discourage and confuse those seeking after knowledge.

Many, again, are under the impression that the layerout is born and not made. It is true that some men work so quickly and with such ease and at the same time are so accurate in their layout that the above impressions are easily conveyed to the minds of those not familiar with the work, but the following may show our young men who are anxious to layout that, although an education is a good thing to carry around with you, it is not absolutely necessary to enable a capable man performing many jobs which he now thinks he is incapable of on account of the want of proper education.

Some years ago, I worked for a foreman who was quite illiterate; in fact, he could not sign his own name, yet he was an excellent layerout, and to see the work turned out by him would make many of our present-day layerouts sit up and take notice. His locomotive boilers were things of strength and beauty, and he received the highest praise from our Mechanical Engineer. His work for blast furnaces was always made square; that is to say, alternate rings were large and small, with both ends of the small rings fitting inside the ends of the larger ones, and his fit was perfect.

His method of finding the circumference of a given diameter was as follows: He would first describe a circle of the diameter required, then add the thickness of the iron to be used, describing another circle, thus getting a true end view of the article to be made. Then he would set his trams to half the thickness of the iron and again strike another circle between the inner and outer circles, thus getting the neutral diameter, without really knowing the meaning of it. Then he would set his dividers to 1 inch and step off his middle or neutral diameter, getting the exact length of iron from center to center of holes, and by allowing the proper amount for lap, he got the total amount of iron required. Some of you readers may think that his method was very far-fetched, looking at it from our present-day methods, and no doubt it is, but it is *practical geometry,* and when we remember that this man was ignorant of the English language, that he could not read or write, and all that he could and did understand was the two-foot rule, while the proper formula for that purpose was *Greek* to *him,* we cannot help but admire the man.

Again, to see him make a 90-degree elbow, and that a true circle both ways, would make many of our best men sit and think some more. There are many layouts that require very little figuring, and any boy with a common school education can master them in a very short time, once he is familiar with some of the simple problems found in any good text book on laying out.

Nichols was, perhaps, the first writer of a practical text book on the subject of boiler making, and was a man of about thirty years of age before he made his first template or pattern. He was a self-educated man, and spent his evenings and his spare money in obtaining books and an education. His work, "The Theoretical and Practical Boiler Maker," should be in the hands of all young boiler makers who think of improving both mind and condition, and once obtained, do not throw it one side, but start out with the determination that you will master some, if not all, of the various problems it contains.

Another layerout that I worked with for some years was a man with but a common school education, yet he was one of the best layerouts on locomotive work that it has been my lot to meet. There is a possibility that you may never become an expert at the business, but don't be discouraged, for you are better equipped to do a job when you are called upon to do it than the man that cannot lay off a simple patch without the assistance of some one who knows how.

One of the greatest drawbacks, and at the same time the most discouraging one of all, and the one that keeps many good men from following the profession of laying out, is the wages paid for this class of work in our railroad shops. The difference in wages between a layerout and a boiler maker is so small that a good mechanic would rather work at boiler making than take up layingout for so trifling an increase in his wages. Some short time ago I saw an advertisement for a layerout capable of laying out a Scotch marine boiler, and other heavy plate iron work. To such a man there was two years' steady work at 40 cents per hour. Who of you readers would believe that any sane manufacturer would have the nerve to ask a *man with ability enough* to *layout* a Scotch marine boiler to work for such wages, when there are shops in this country that pay common, every-day boiler makers more per hour? If manufacturers are anxious to fill the scrapyards, then I say continue to pay the princely sum of 40 cents for a layerout. Again, a particular friend of mine, a capable man, laying out on very heavy pipe, stack and tank work was paid $150 per month. Good wages, you say. So it is, but did he get it for his 9-hours' shop work? No; after his little 9-hour shop work was completed, he would carry home with him drawings and specifications and work on them until midnight, getting out estimates for some job the firm was figuring on. Was this man paid enough for his labor? Not by a long shot.

Of course, there are large shops that carry a staff of men for all office work, and the layerout's work is strictly shop work alone, which is right and proper. Another discouraging feature in being able to layout is the fear that many foremen have that the layerout may get his job, and often the layerout's life is made miserable on this account. Happily, these cases are not numerous.

I am a firm believer in giving every apprentice at least six months with the layerout, and this should be the last six months of his term, for by that time, if he is any good at all, he will soon catch on to layingout, and will not hinder his instructor. He should be instructed in a general way on the work that comes to the layingout bench. I also believe that the layerout should be compensated for the knowledge he imparts to each apprentice, for it must be borne in mind that the layerout spent time and money to acquire a knowledge of his business, and should be properly paid for it, independent of his regular wages, and should be according to the results shown by an examination of the apprentice at the end of his term. This would insure the learner getting the best that the instructor had to give, and at the same time the instructor would be more patient and painstaking with a dull pupil.

We cannot all be layerouts. Some will never have the chance to use this knowledge. To such, I would again say, do not be discouraged, for it will make you a far better man than the man that cannot layout at all, and you well be better able to understand work that comes to you for fabrication. Do not let the words, geometry, projection or triangulation frighten you, for you are doing it every time you strike a circle or draw a line. When you see something being done in the shop that interests you, and you feel that you would like to know how to do it, try doing it on a small scale at home at night, either on cardboard or any other paper that you have at hand, and you will be surprised to see how soon you can get next to the job. By trying to make small articles on paper or tin, you become familiar with the lines used to make domes, branch pipes, elbows, etc., which you are working upon daily in the shop, and you gain confidence in yourself. In a short time you become a seeker after knowledge and the battle is won.

When disheartened at some failure, remember my old foreman, who, without education, was able to do such good work and keep a shop employing 75 men in full blast. I would like very much to give this man's name to the readers of The Boiler Maker, but his relatives may object. Therefore, I would say, "Go to it" and learn to layout, for, by so doing, you are not only improving your own condition, but you will help to put the trade on a higher plane, for there is scarcely a trade to-day that requires the uplift as much as boiler making. Flex Ible.

Layout of a Branch Pipe

In answer to T. F. E., on page 338 of the October issue of The Boiler Maker, I submit the following:

The most important measurement given is the 8-foot radius. Having drawn this radius, and having divided each side of the radius into eight equal spaces, as in Fig. 1, and having affixed the required mean diameters, respectively 36⅝ inches and 24⅝ inches, all other measurements will follow correctly, providing each division of the radius makes an angle of 11 degrees, 14⅜ minutes, 37½ seconds.

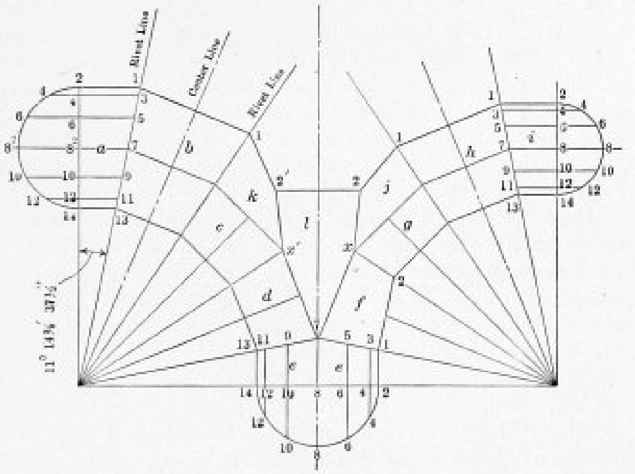


Fig. 1

Taking every second division in Fig. 1 as the center line, and drawing lines perpendicular to them, the outline of *a*, *b*, *c*, *d*, *e*, *e*, *g*, *h* and *i* will be obtained, leaving the outline of *k*, *l*, *f* and *j* to be determined. To obtain the outline of *k*, *l*, *f*, *j*, take radii 8², 8², Fig. 1, and lay them off at 2' x' and 2 x on *l*. Now from the points so obtained draw the outline 1, 2', x', 7, x, 2, 1, which completes the elevation shown in Fig. 1.

Having completed the elevation we will proceed to lay out *a*, Fig. 1. The diameter 36⅝ times 3.1416 equals 115 1/16 inches. Divide this circumference into 12 equal spaces, as shown in *a*, Fig. 2, and draw perpendicular lines from points 2, 4, 6, 8², etc. Take the lengths of the lines 2-1, 4-3, 6-5, etc., from *a*, Fig. 1, and place them on 2-1, 4-3, 6-5, etc., in *a*, Fig. 2. Through these points obtained trace a line as 1-7-13-7-1, Fig. 2, *a*. Now, if we take *a* in Fig. 2 and double it, it will then become equal to the layout of *b*, Fig. 1. Take the length just laid out for *b* and use one-half of it, which will answer for patterns *c* and *d*, Fig. 1.

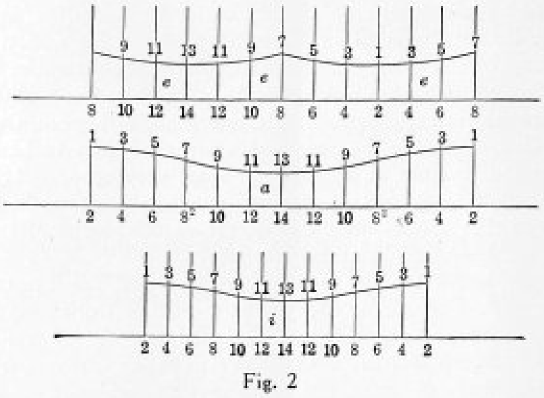


Fig. 2

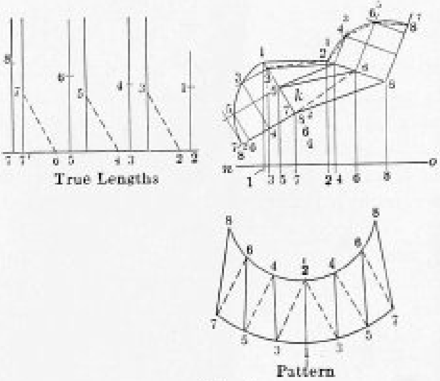


Fig. 3

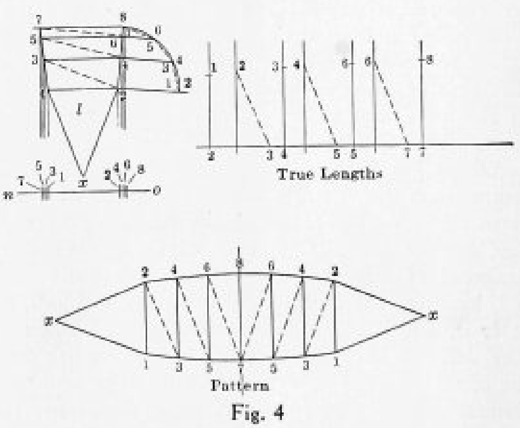


Fig. 4

To get the pattern out for *e e*, Fig. 1, lay its length on *e*, Fig. 2, 115 1/16 inches, and divide it into 12 equal spaces, as 8-6-4-2, etc., in Fig. 2, *e*, and draw perpendicular lines from these points. Take the different lengths, as 2-1, 4-3, 6-5, etc., in *e e*, Fig. 1, and place them in Fig. 2, *e*. Trace a line through these points, which completes the pattern for *e e*, Fig. 1.

The diameter of *i*, Fig. 1, 24⅝ inches by 3.1416, equals 67¼ inches circumference. Divide it into 12 equal spaces, as 2-4-6-8, etc., in *i*, Fig. 2, and draw perpendicular lines from these points. In Fig. 1, take the lengths 2-1, 4-3-6-5, etc., and place them on *i*, Fig. 2. Through these points trace a line, as 1-7-13-7-1, Fig. 2. Now double *i*, Fig. 2, which will be equal to *h*, Fig. 1. One-half the bottom part, *h*, Fig. 1, will be equal to *g*, Fig. 1.

To lay out *k* in Fig. 1, transfer the outlines to Fig. 3. At the left of *k*, Fig. 3, draw a line, as 7 to 7, at right angles to 1-7. Next takes the heights 7 to 5, 5 to 3, 3 to 1 in Fig. 1, *a*, and place them as 7 to 5, 5 to 3, 3 to 1 in *k*, Fig. 3. At *a*, Fig. 1, take the lengths 8² to 8², 6 to 6, 4 to 4 to the left of *k*, Fig. 3. From these points at the left of Fig. 3, draw lines parallel and perpendicular, so as to intersect at 1, 3, 5, 7. Through these points draw the outlines of the circle. As that circle to the right of *k*, Fig. 3, is just the same as that at the left, we have only to transfer it over on the right side of *k*, Fig. 3.

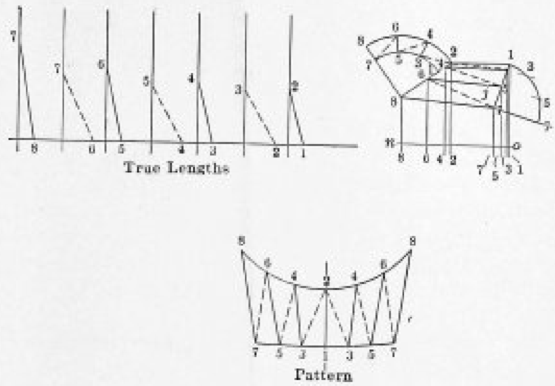


Fig. 5

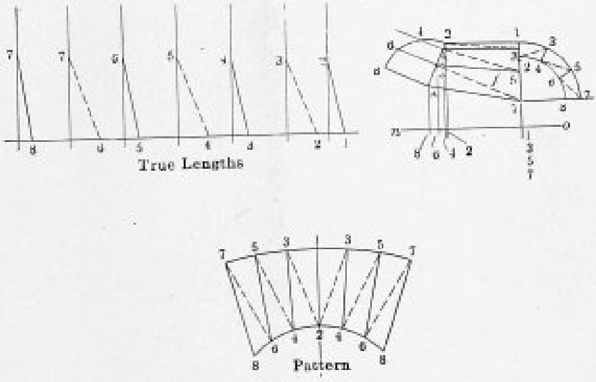


Fig. 6

In *k*, Fig. 3, draw from the points obtained from the circles the lines 1 to 2 full line, 2 to 3 broken line, etc. Now, at the very extreme right circle, draw the broken lines 7 to 6, 5 to 4, 3 to 2. In Fig. 3 draw line *n-o* parallel to 1, 2. From the points let fall lines perpendicular to *n-o*. We are now required to get the true lengths.

Take the length of 8 to 7 in *n-o*, and place it on true length 8 to 7. Next take the length of 7 to 6 in *n-o*, and place it on 7′ 7 of the diagram of true lengths. Next take the length of broken line 7 to 6 in right-hand circle of *k*, and place it on 7′ to 6 in the diagram of true lengths. Continue in this manner until all the true lengths are obtained.

Having obtained the true lengths we can make the pattern. Take 1-2 from the true lengths and place it on 1-2 of pattern. Take 2-3 in the true lengths, and with its length and 2 in pattern as center draw arcs 3,3. At left of *k* take the length of the arc 1-3, and place it from 1 to 3 on each side of 1 in the pattern. At the circle to the right from *k* take the length of the arc 2-4, and place it on the pattern 2 to 4. Continue in this manner until all the points are obtained in the pattern, then trace a line through these points.

As Figs. 4, 5 and 6 are similar in all respects to Fig. 3, it is only necessary to follow the instructions for Fig. 3 to get Figs. 4, 5 and 6.

E. EATON.

Jersey City Heights, N. J.

A Vital Question for Discussion

The writer is considering starting a shop for general plate work. In going over the preliminary details of such a shop, I find that from the nature of the business I am going to have considerable overhead. Can any of the readers of THE BOILER MAKER give me a little information upon the following points regarding it?

What should be the percentage of overhead to productive labor?

Would it be a good business policy to take a few contracts at a small profit in order to increase the productive force, thereby decreasing the overhead and enable me to bid lower on future business? This is assuming, of course, that I base my overhead upon labor instead of sales, and that I have sufficient business in order to start with a nominal force.

In making out my sales proposition, should I charge a profit on material? Would not this be taken care of by the addition of my profit after all costs had been figured?

I would be pleased to have this subject thoroughly discussed by readers of THE BOILER MAKER, as to my mind it presents the most vital point of a business venture.

ERNEST PATRICK.

Adjustable Holding-On Bar

Fig. 1 shows a device which the writer has invented for holding on rivets in back flue sheets, or where wedge rivets are driven. The device was designed some twelve years ago and was first used on the Santa Fe Railroad at San Bernardino, Cal. Since then, the writer has had this tool made up for twenty-seven different railroads throughout the country.

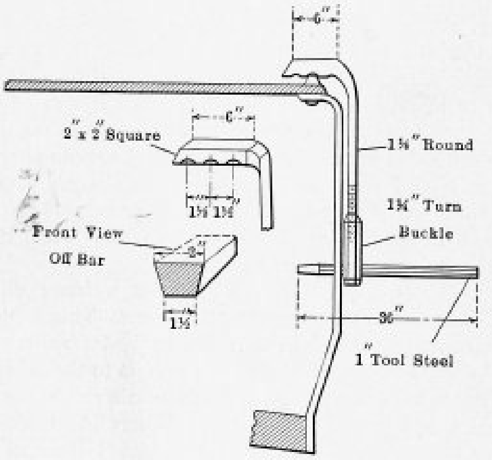


Fig. 1.—Adjustable Holding-on Bar for Holding on Rivets in Back Flue Sheet

In Fig. 1 can be seen a side view of the adjustable holding on bar with a 1¼-inch turn buckle supporting the handle in the flue hole or staybolt hole, an arrangement which brings the bar on the rivet head with such force that it is almost impossible to get off the rivet head. Two or three notches may be drilled for rivet heads on the bar, as shown in the sketch. This is to bring the bar square on the rivet heads where there are different lengths on the flue sheet flanges.

This device can be used on any style of locomotive boiler. If the staybolts are out on the throat sheet, anyone can easily start down within twelve rivet holes from the mud ring and go clear around to the other side of the sheet.

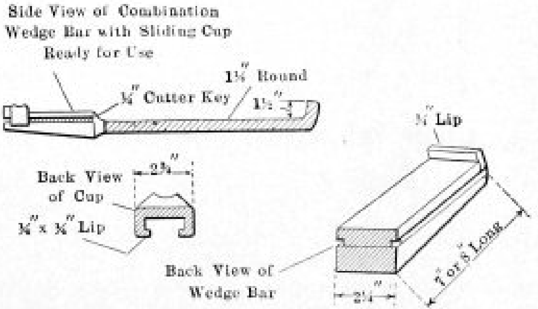


Fig. 2.—Combination Wedge Bar for Wedging Rivets with Two Different Sizes of Wedge Cups

Fig. 2 shows a successful combination wedge bar with which anyone can easily wedge the first rivet starting from the mud ring and go up high enough to start holding on with the adjustable bar shown in Fig. 1. The combination wedge bar and sliding cup shown in Fig. 2 are self-explanatory. The wedge bar is milled out with a quarter-inch lip at the end which supports the cup when the bar is in use. A few different sized cups are used where the water space is larger. This does away with the blocking commonly used in old methods with a separate cup and wedge bar, when it was oftentimes necessary to have an extra man to place the cup on the rivet head. With this device the cup stays on the wedge bar, which slides back and forth and eliminates the danger of the cup falling off. A quarter-inch cutter key is removed from the back end of the bar, as shown in the sketch when it is desired to remove the cup from the bar.

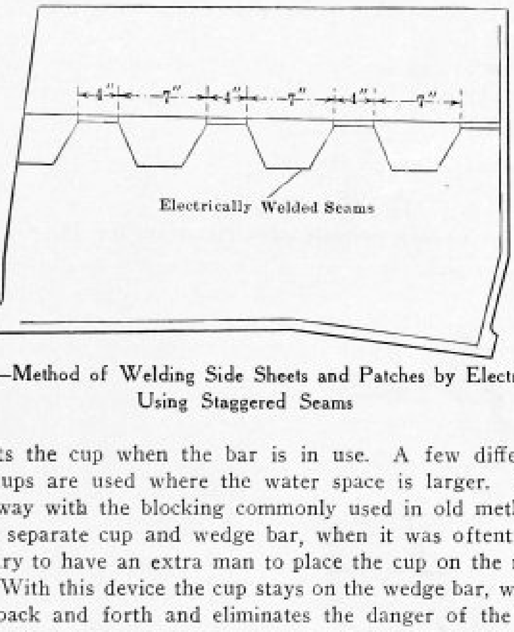


Fig. 3.—Method of Welding Side Sheets and Patches by Electricity, Using Staggered Seams

Fig. 3 shows a successful method for welding side sheet seams, and patches by staggering the seams. This method was recommended by the general foreman boiler maker of the West Albany Shops, Joe McAllister, and up to the present time no failures have been recorded from using this method of welding.

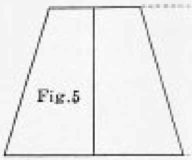
Harry A. Lacerda,
Assistant Boiler Inspector.

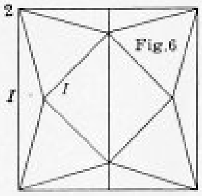
West Albany Shops, New York.

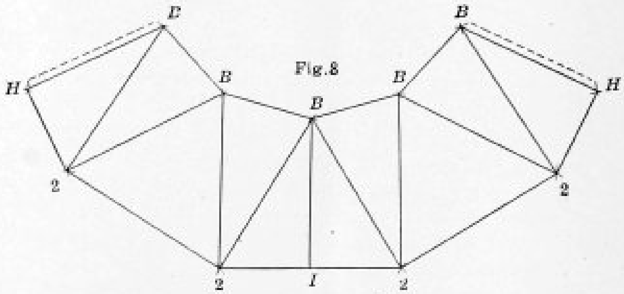
Two Easy Lessons for the Apprentice

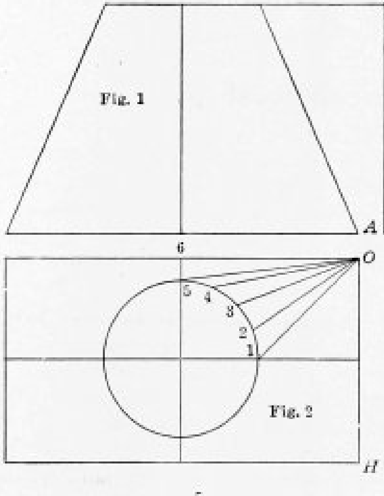
Figs. 1 and 2 show the plan and elevation of an article with rectangular base and round top. This is generally made up in two sections. To procure the pattern we will commence by dividing one-fourth of the circle in the plan into equal parts and connect the points thus found to the corner at *o*. Construct a right angle, as *A B*, Fig. 3, making the height equal to the straight height of the article. From *A* set off the distances 1-*o*, 2-*o*, 3-*o*, 4-*o* and 5-*o*, as found in the plan, Fig. 2, and connect up to *B* as shown.

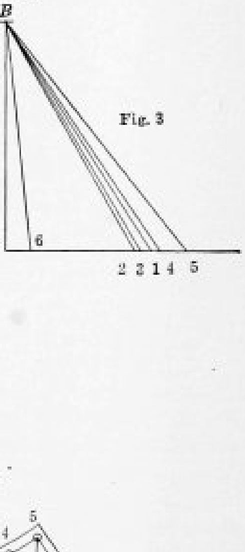
Erect a perpendicular as in Fig. 4, and on each side draw a line at right angles, making the length equal to *H-O*, Fig. 2.

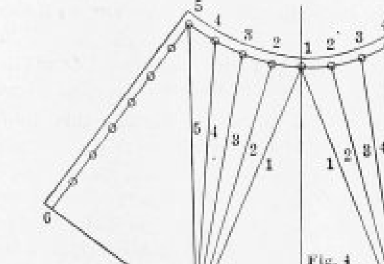


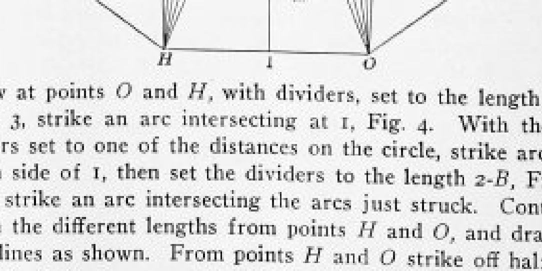












Now at points *O* and *H*, with dividers, set to the length *I-B*, Fig. 3, strike an arc intersecting at 1, Fig. 4. With the dividers set to one of the distances on the circle, strike arcs on each side of 1, then set the dividers to the length 2-*B*, Fig. 3, and strike an arc intersecting the arcs just struck. Continue with the different lengths from points *H* and *O*, and draw in the lines as shown. From points *H* and *O* strike off half the length of the base, as taken from *O* and 6, Fig. 2. Take the short distance 5 and 6, Fig. 2, and set it off from *A*, Fig. 3. Set the dividers to the length 6-*B* and carry to points 5-5, Fig. 4. Strike an arc intersecting at 6-6, and draw in the lines, allowing for the lap. This completes the half pattern.

Figs. 5 and 6 show the plan and elevation of a tapering square article. An examination of the plan will show that the top is smaller than the bottom, and is also twisted, as we might say. An article of this kind really belongs to the ornamental class of light iron work, but in itself will prove an interesting study for the apprentice.

To secure the pattern, we will erect a right angle, as at *A-B*, Fig. 7, making the height equal to the straight height of the article. From *A* set off the short distance 1-1, Fig. 6, and connect up to *B*, as shown. Now take the length of the slant line 1-2, Fig. 6, and set it off from *A*, Fig. 7, connecting to *B*.

Erect a right angle as 1-*B*, Fig. 8; make the bottom line 2-1-2 equal in length to one side of the square at the bottom. Take the distance 2-*B*, Fig. 7, and from point 2-2 strike arcs intersecting the line 1-*B*, Fig. 8, at *B*; drawing lines to 2-*B* as shown. From point *B*, with dividers set to the length of one side of the square at the top, strike arcs which intersect with the length 2-*B* struck from points 2-2. On each side of 2-2, at the bottom, set off another length of base, which intersects with the length 2-*B* from *B-B* at the top. Set off from *B-B* two more lengths of the square at the top which intersect from 2-2 with the distance 2-*B*. Now from 2-2 set off two half lengths of the base, as shown. Take the distance 1-*B*, Fig. 7, and strike an arc *B-B*, Fig. 8, as shown, interesting at 1-1. Draw in the lines and the pattern is complete to the rivet lines. Bending lines are denoted by points *B*-2.

Lorain, Ohio. J. Smith.

Apprenticeship

(Concluded from page 116.)

To-day is the day for improvements in the use of fuel, for fuel saving devices and capacity increasing factors in locomotive design, for improvement in service and for improvement in equipment and methods for maintenance, and for the training of the men of the future. Will the railroads measure up to their opportunity?

Apprenticeship has made good where it has had half a chance, and it has had a chance on a few progressive railroads. It is not a failure. Its value is established beyond a question. The only failure has been a lack of backing. The only trouble has been in educating the managements to what they ought themselves to know to be their duty. It is fruitless to start apprenticeship unless the very head of the organization plants himself squarely for it, insisting that every one get in line and stay there. If he does this no subordinate will dare ignore it, simply because he is looking only for the things of to-day. The world will not long excuse neglect of apprenticeship and that which goes with it, and this applies to every department. Not until railroads provide proper methods of recruiting for all departments, and not until adequate methods of training these recruits, and not then until the organizations are prepared to receive and properly provide for retaining competent, able and ambitious young men, will the railroads begin to climb out of the personnel difficulties in which they are now submerged.

Business Report.—The Joseph F. Wangler Boiler & Sheet Iron Works Company, of St. Louis, Mo., has secured a contract from the Odin Coal Company, of Odin, Ill., for two horizontal high-pressure firetube boilers of the perfected Wangler type, to be installed in the early part of April. The company reports that the business outlook in their line is steadily improving, promising well for the future.

Selected Boiler Patents

Compiled by

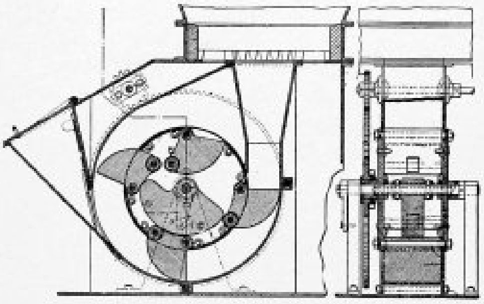
DELBERT H. DECKER, ESQ., Patent Attorney,

Millertown, N. Y.

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

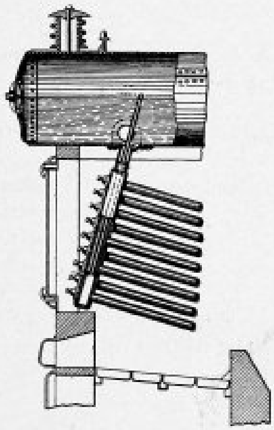
1,085,248. STOKER FOR UNDERFEED FURNACE GRATES. FRED E. DAVIS, OF MORGAN PARK, ILLINOIS.

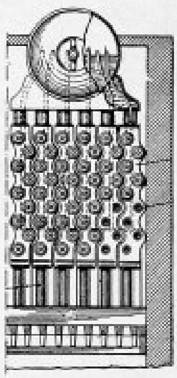
Claim 1.—In an underfeed stoker the combination with a substantially horizontal grate having an opening therein, of an upwardly extending feed chute below said grate terminating in a substantially vertical exit pipe leading upwardly to said grate opening, a series of shovels adapted to fit within said feed chute and advance separate charges of coal therethrough and driving and guiding mechanism for moving said shovels in succession upwardly through said chute to the lower end of said vertical exit pipe and then withdrawing the same laterally from beneath the mouth of said exit pipe in a direction transverse to the upward feeding movement of said shovels. Fourteen claims.



1,085,241. SECTIONAL HEADER FOR WATER-TUBE BOILERS. HARRY EUGENE BOYRIE, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR OF ONE-HALF TO HAYDEN HOMER TRACY, OF BERKELEY, CALIFORNIA.

Claim 1.—In a watertube boiler, the combination with a suitable furnace; a steam and water drum located at a high level between the front and rear walls of the setting; a plurality of banks or rows of water tubes inclined downward from front to rear underneath the drum and connected to their respective headers; a front header composed of inclined or vertically disposed sections at right angles to and receiving the forward ends of the water tubes; of a bell-mouthed transverse diaphragm near the lowermost end of each sectional header, thereby dividing the header into upper and lower separate chambers; a removable jointed pipe within each header section and extending from the diaphragm to the water level in the drum. Two claims.



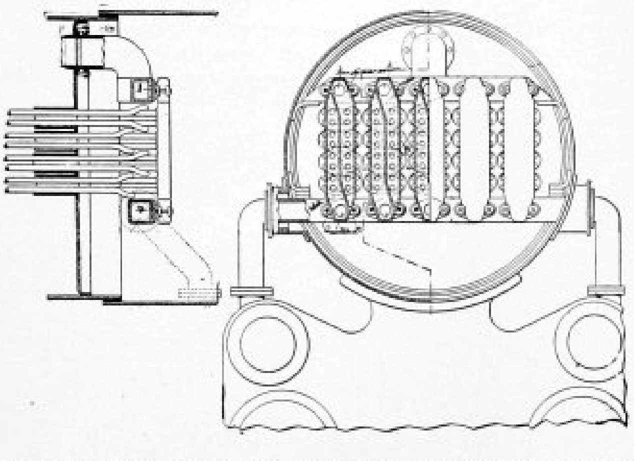


1,085,859. STEAM BOILER FURNACE. GEORGE S. GALLAGHER, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO HENRY GALLAGHER AND ONE-HALF TO EMMA G. GALLAGHER, OF NEW YORK, N. Y.

Claim 1.—In a steam boiler furnace, a hollow spacing block tapering in plan from a larger to a smaller end and adapted to be built in the wall of a furnace with the smaller end toward the combustion chamber, marginal ribs in the smaller end and side portions on the said block extending upwardly from the lower part and downwardly from the upper part and spaced from the body of the block so as to provide grooves between the said ribs and the body of the block, and fire brick tiles provided with edge grooves adapted to receive the said ribs so that the tiles are moved horizontally to place on the block, the tile at the smaller end of the block extending over the adjacent edges of the tiles at the side of the block and being provided with a rounded outer surface. Two claims.

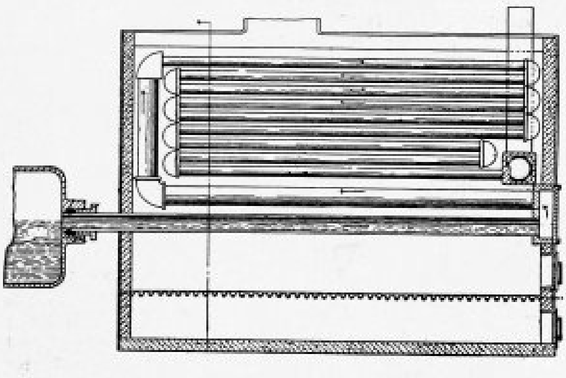
1,085,107. SUPERHEATER. ALFRED W. BRUCE, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO LOCOMOTIVE SUPERHEATER COMPANY, OF WILMINGTON, DEL., A CORPORATION OF DELAWARE.

Claim 4.—In combination, in a boiler provided with flues, an upper and lower main header extending across the smoke box, a plurality of independent vertical headers attached to and between each of said main headers and each provided with parallel laterally disposed separate chambers, one of which opens into the upper header, and the other into the lower header, and superheater elements connected between said chambers and inclosed within said flues. Twelve claims.



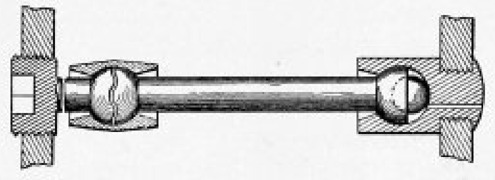
1,085,634. SEMI-FLASH STEAM BOILER. CHARLES A. SAWTELLE, OF DAYTON, OHIO, ASSIGNOR OF ONE-FOURTH TO JAMES SAUNDERS, ONE-FOURTH TO EDWARD L. McCLEARY, AND ONE-FOURTH TO ELWOOD C. BAVER, ALL OF DAYTON, OHIO.

Claim 2.—In a semi-flash steam boiler, a primary bank of semi-flash tubes, means for constantly maintaining fluid in said tubes at a level equal to approximately half their depth, means for converting said fluid into saturated steam, a secondary bank of semi-flash tubes communicating with and mounted above said first named bank for receiving said steam in its saturated condition, a series of transverse tubes mounted above said semi-flash tubes for superheating said steam, and risers disposed between said secondary bank of semi-flash tubes and said superheating tubes for relieving said steam of moisture. Three claims.



1,086,145. STAY-BOLT. ETHAN I. DODDS, OF CENTRAL VALLEY, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—A stay-bolt comprising a two part bolt, a coupling flexibly connecting the said parts of bolt, means for limiting the relative rotary movement of said bolt parts independently of each other, and a universal joint connection between one section of the bolt and the wall to which it is attached. Nine claims.

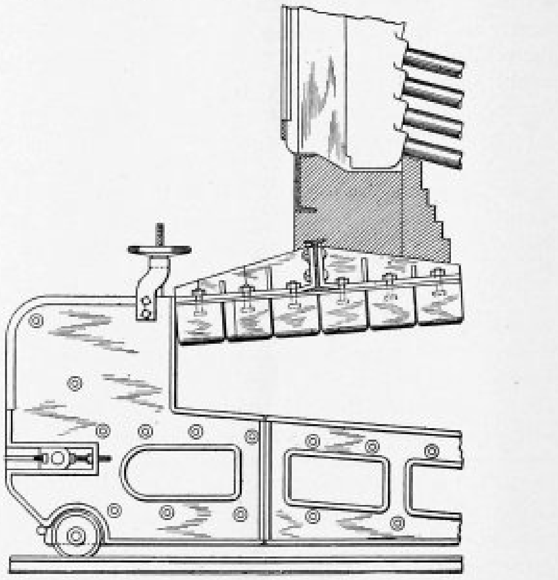


1,086,715. APPARATUS FOR BURNING FINELY DIVIDED FUEL. DAVID J. IRISH, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—The combination with a burner, of an air-deflecting device consisting of a substantially flat plate having a central opening and comprising a plurality of blades spaced apart to provide apertures for the admission of air and inclined to the plane of the plate to give to the air a whirling motion, the inner ends of said blades terminating adjacent said central opening, and said burner terminating in proximity to said opening. Six claims.

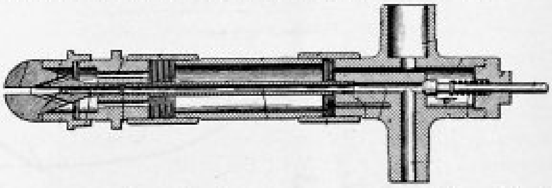
1,086,467. FIRE ARCH FOR FURNACES. JOHN ROSBOROUGH, OF ST. LOUIS, MO., ASSIGNOR TO LACLEDE-CHRISTY CLAY PRODUCTS COMPANY, OF ST. LOUIS, A CORPORATION OF MISSOURI.

Claim 3.—In a furnace, a framework, a series of blocks placed side by side below the framework and adjacent thereto to form a lining for the furnace, each block having a T-shaped cul-de-sac opening on its outer side, and removable T-head bolts for said blocks engaging the respective openings in the blocks, said bolts securing the blocks to the framework. Four claims.



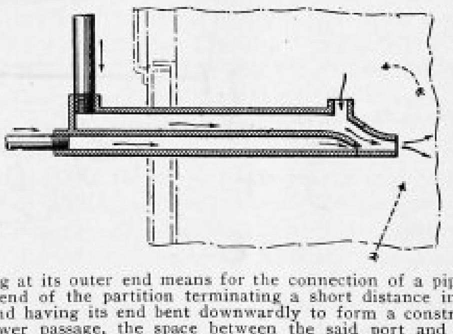
1,086,998. LIQUID FUEL BURNER. GEORGE EDMOND DENMAN, OF FRUITVALE, CAL.

Claim 1.—A device comprising an outer casing, an inner casing, independent inlets to said casings, a tip body connected at one end to both of said casings having a lateral extension, and a threaded shank on said extension, said tip body having a central passageway leading from said inner casing within said shank and terminating in a lateral outlet passage and a plurality of passages surrounding said central passage leading from said outer casing to the surface of said lateral extension, a distributing cup on said shank communicating with said outlet passage, and washers intermediate said lateral extension and said cup having means for forming a spray by the liquid flowing from the cup and the compressed fluid flowing from the end of the central portion. Three claims.



1,086,956. OIL BURNER. JOSEPH ARTHUR TRIMBLE AND CARL HENRY MILLER, OF PORTLAND, ORE.

Claim 1.—A burner, comprising a hollow body having its upper wall at its inner end depressed to form a nozzle and provided with a port in its top adjacent the nozzle, the body being further provided with a horizontal longitudinal partition dividing the same into two passages, each having at its outer end means for the connection of a pipe thereto, the inner end of the partition terminating a short distance in front of the port and having its end bent downwardly to form a constricted port for the lower passage, the space between the said port and the inner end of the nozzle forming a mixing chamber. Two claims.



1,088,445. STOKING GRATE FOR FURNACES. DAVID F. NISBET, OF CRAFTON, PA.

Claim 1.—A stoking grate mechanism consisting of a series of spaced, overlapping, oscillating grates pivoted in suitable carrier frames or bars, each grate being supported independently of the other grates of the series and adapted to rotate through a limited angle in a direction opposite to that of the adjacent grates of the series, thereby varying the lap of adjacent grates while preserving a substantially constant vertical distance between the overlapping surface thereof. Ten claims.

THE BOILER MAKER

MAY, 1914

Low Pressure Dog House Marine Boiler

Description of Type of Shell Boiler Particularly Suited for Installation with Long Stroke, Slow Turning Marine Engines

The Kingsford Foundry and Machine Works, Oswego, N. Y., recently built for the steamer *Apollo,* of Fairhope, Ala., a dog house type of boiler to replace a lobster back boiler, which was originally installed in the vessel. The dog house type of boiler is particularly suited for use on side-wheel shallow-draft steamers, and, in order to supply a large storage space for steam, what is called a steam chimney or superheater is supplied. This type of construction economizes in space as compared with the lobster back type of boiler formerly used, besides being a quick steaming and economical boiler.

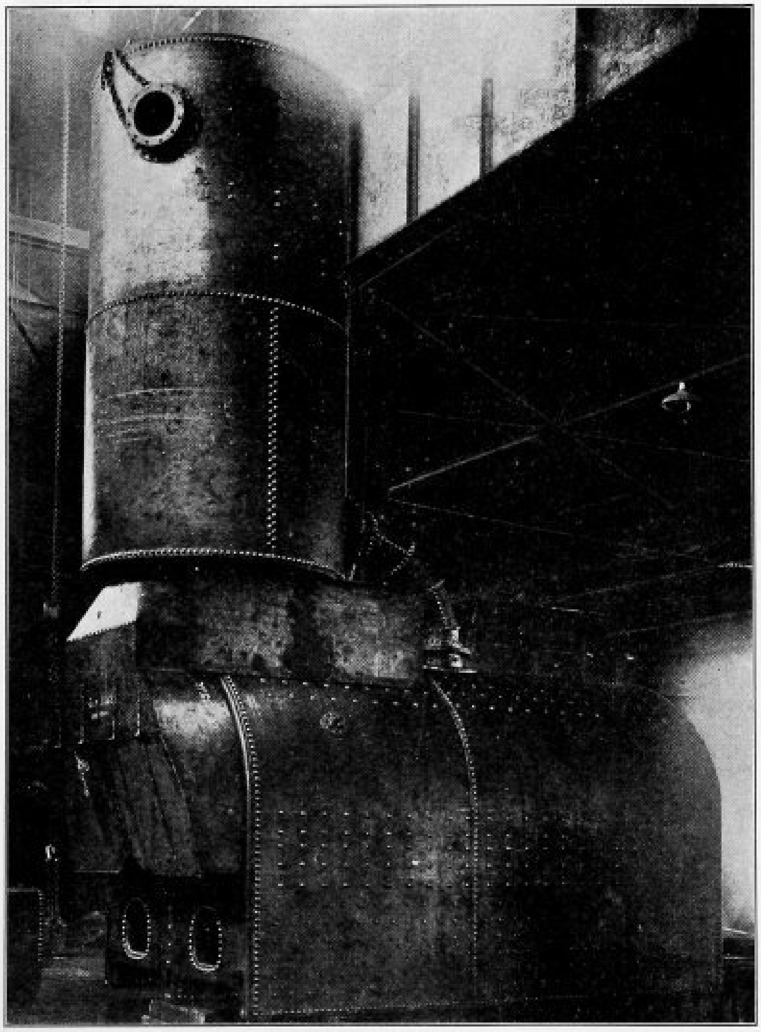


Fig. 1.—A Boiler that is Superseding the Lobster-Back Type

(From the *Marine Journal*)

The boiler itself is 15 feet 6 inches long overall, 9 feet 3 inches wide, and 9 feet 4 inches high, designed to carry a working steam pressure of 70 pounds per square inch. There are two furnaces 46⅞ inches wide, 37 inches high, and 14 feet 4 inches long. The furnaces lead to a combustion chamber 28⅛ inches deep. The gases of combustion are returned to the smokebox through 146 tubes 3½ inches diameter, .12-inch thick and 12 feet 7 inches long. From the smokebox the products of combustion are led to the stack through the steam chimney or superheater, which is cylindrical in shape, 7 feet inside diameter and 13 feet high, made of ⅜-inch plate in two courses with 7/16-inch heads, in which is fitted a 42-inch diameter flue of the Adamson type, made in three sections, each 52 inches long and of 13/32-inch plate.

The shell of the boiler is in two courses of 39/100-inch plates. The heads are 7/16-inch thick and the furnaces, ⅜-inch thick. The back tube sheet is ½-inch thick, while the combustion chamber is of 7/16-inch plate. The water space around the furnaces is 4½ inches wide, and at the back of the combustion chamber, 6 inches wide. The mud ring is of flanged plate of channel section.

The back head of the combustion chamber is supported by ⅞-inch staybolts, 75/100-inch diameter at the bottom of the thread. The staybolts are threaded 12 threads per inch with a 3/16-inch telltale hole drilled ½-inch beyond the inside surface of the plate. The staybolts are spaced 5¾ inches by 5¼ inches on the furnaces and 5¾ inches by 5¾ inches in the combustion chamber.

The upper parts of the boiler heads form segments whose area is 1,857 square inches. The segments are reinforced by 5/16-inch plate, making the total thickness of the heads in the segments ¾-inch. The heads are further stayed by through braces of iron 1.61 inches diameter at the bottom of the thread. These are spaced 13½ inches horizontally and 14 inches in the vertical direction.

Bracing of the furnaces, the tops of which are nearly flat, is accomplished by crowfoot braces 2½ inches by 9/16-inch, extending to the shell plate and spaced 7½ inches horizontally in three rows on each furnace. The sides of the boilers are also braced by two rows of crowfoot braces 2¼ inches by 9/16 inch, spaced the same distance as the vertical braces.

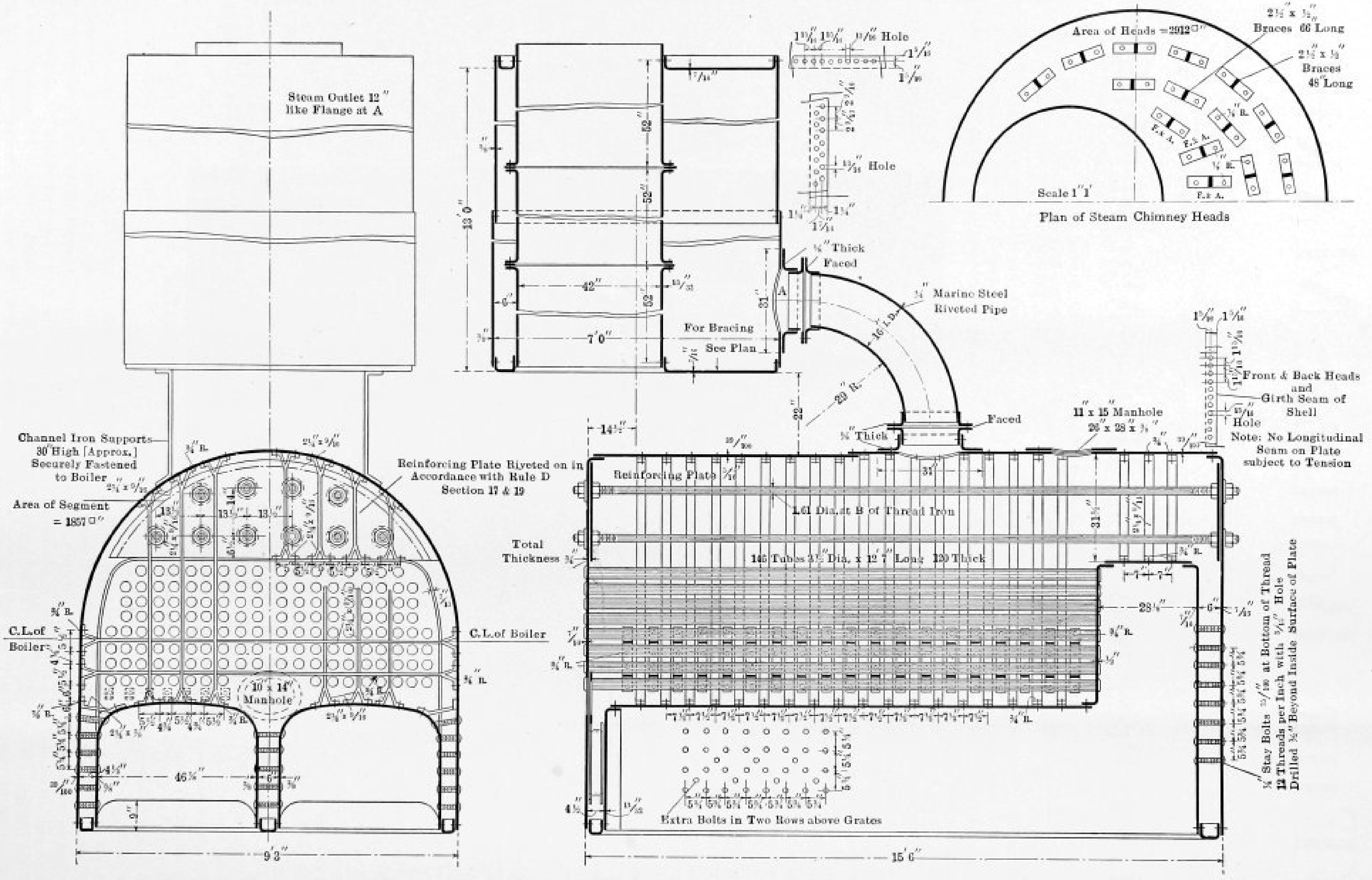


Fig. 2.—Detail Plans of Dog House Boiler Built by the Kingsford Foundry & Machine Works for the Steamer *Apollo*

A steel-riveted pipe, 16 inches inside diameter, making a right angle bend, leads from the top of the boiler shell to the vertical steam chimney. The heads of the steam chimney, the area of which is 2,912 square inches, are braced by 2½ inches by ½-inch forked braces, the outer braces being 48 inches long and the inner braces 66 inches long.

The Foreman Boiler Maker

We have had several discussions in The Boiler Maker and other mechanical journals on the care and maintenance of boilers, but I have not heard much said in defense of the man who is responsible for the care of boilers, namely, the foreman boiler maker, and would ask why is he not given more authority over his class of work instead of being governed by the engine house and general foreman, whose duties and experience should fully occupy their time in their own departments?

First, let us take up the work in the engine house. When an engine is run in for repairs, such as leaky tubes or a staybolt test and washout, very seldom, if ever, does the engine house foreman take it up with the man who has charge of boiler work, and ask him how long it will take him to complete his work, or when he can have the engine for her train. He generally marks the engine up on the bulletin board to take train number so and so, with engineer and fireman so and so at such an hour. Before the job is completed the engine house foreman sends word that he wants to fire up the engine and have her ready for her train in an hour, not giving the boiler maker time enough to do a good job. Should the tubes leak, or some other boiler troubles cause a delay, the man who has charge of the boiler work is called down for the poor job he did, whereas if he were asked or consulted in regard to how long it would require to complete repairs, the engine would have had proper repairs made and be kept in service for some time to come. It should be thoroughly understood that the engine house boiler maker will do a good job if he is given time, but he is unable to do ten hours' work in five hours and get good results from the engine.

Second, let us take up the shop work when engine is to receive general repairs. Say the foreman boiler maker has from 75 to 300 men in his employ, and he has new boilers, new fireboxes, new tenders and several other new things required by the company, beside turning out from four to ten general repair engines a week. If a firebox is in such a condition that a new one is required, the general foreman will not want to put in a new firebox, as the running parts are in fair condition. He wants three or four patches applied and several cracks in the side sheets plugged, so as to carry her through and make her mileage until the next shopping. Should the boiler develop any leaks or fractures in a few months the foreman boiler maker is surely reprimanded for the poor job he did while the engine was in the shop.

In some railroad repair shops the foreman boiler maker is not allowed to hire his own help, and oftentimes should he report a man for dismissal, the general foreman will simply tell the man to give his work more attention or he will let him go. At the present time there is more work to be done on a boiler than there was five years ago, especially since the Inter-State Commerce Commission laws went into effect. I think that the foreman boiler maker who is responsible for his class of work should have full charge of the boiler department and the hiring and discharging of his help and adjusting the grievances with his men.

As the boiler is the heart of the locomotive, we cannot admit that the foreman boiler maker should take the blame of some repairs that are made, but he is the man who, as a rule, is generally criticised when anything is wrong after the work on the engine is completed. I have been employed in engine house nine years, five years as a layerout, three years as assistant foreman and ten years as foreman, so you will see I have had some experience in railroad work, and am fully acquainted with all branches of boiler making. As The Boiler Maker is read by nearly, if not all, foremen boiler makers and assistants, I would be pleased to have some, if not all, voice their opinions, as I think our opinions and ideas should be exchanged, and there is no better way to do so than through The Boiler Maker.

As the master boiler makers' convention will be held at Philadelphia this month, from the 25th to the 28th, I trust all foremen will attend who are able to do so, as it is their duty as well as for their benefit and for the benefit of the companies who employ them. I also hope that all superintendents will see that their foremen boiler makers receive their transportation to attend, as they have all to gain by so doing. I trust that we will hear from some other foreman on this subject, and also that we have a good attendance at our convention.

Archtube.

A Lesson in Practical Boiler Making

BY C. F. BENNETT

The writer has found by experience in past years that the average young man who finds his way into the shop enters without any fixed purpose in view other than getting his keep, and will add that in many cases it is "me for the circus when the blue birds sing." Not all shops are suitable for the young man to learn the art of boiler making in, beyond the duties of a laborer. There are, however, a number of small shops where a bright, quick young man may obtain a "look in," and it is conditions of this character that prompted the writer to present this article.

The article refers to building an ordinary open tank, say by way of illustration, a tank 10 feet diameter by 8 feet high. The material for the bottom or head is ¼ inch and the shell 3/16 inch. In the first case we will build it as practiced in the early days. A head of the above diameter was usually made in two parts, or two half circles. The first operation consisted of scribing the flange line and the layout of rivet holes across the center, possibly 2 inches being allowed for flanging. The job was then turned over to the flange turner for flanging, and during this operation it was customary to lay out the shell from data for a 10-foot tank. The plates were then punched, sheared, rolled and assembled, and after this the flanged head was laid upon the floor, flange up and the shell placed over it.

Do you not recall in the olden days how many of those heads proved too small for the shell? Well, to make a long story short, the head was returned to the fire and set out copiously; time was no object, after which it was placed on the floor and no doubt weighted down in places to overcome its warped condition. Now if it was found loose, no matter if it was marked and the holes gaged to a line and re-marked, it was punched and again assembled. It was surprising how the "fit up" bolts would break and in some cases the rivet heads snap off. But no matter, it was finally riveted, and during this operation it was found that they had neglected to scarf the head at the side lap to the shell, and the seam holes across the head were found to overlap at the center.

Upon completing the riveting and calking, a "dope" in the way of sawdust thrown in when the tank was filled would keep considerable of the water from escaping. A good coat of paint applied before delivery would do the rest. So endeth the first lesson.

Now let us tackle another tank of same size and material. In case it is possible to obtain flanged heads from the mill, it is advisable to do so. On the other hand, we will proceed to make one. First, to avoid overlap of holes at the center of the head, as mentioned above, which was due to the shrinkage of the material in a girthwise direction, I advise that you leave one piece or half of the head blank. Suppose that you place the center of the rivet line across the head about 3/16 inch out of line as a starter. Lay off the holes, and after punching lay the two halves together in the regular way and mark the other half. This done, proceed to prepare the block for flanging by providing a V-shaped frame with a hole rivet-size at the center for a spud to hole the head in the proper place while flanging.

Scarf the two corners of this sheet, then proceed to flange all but a half. Heat at each end, after which test your center line of holes for shrinkage; this found, make allowance on the second half, and after punching proceed to flange to the extent above.

The next operation is to assemble the head with one or two rivets driven inside to keep the joints firm at the ends. Next proceed with a good final heat to finish the lap and your work will show a pleasant contour to fit the shell. Before proceeding with the next operation, observe a few preliminary observations. In the old days the wheel was used to find the circumference of the head after flanging. I will suggest that you procure a 50-foot steel tape and use it in all measurements possible in the performance of your work. A few small clamps will also prove handy.

Place the head in a position to enable the marking off the rivet holes about the flange. Obtain the correct circumference of head found by the tape, and add to this not less than three thicknesses of the shell. Divide this into, say, four equal parts, and mark these quarters on the head. Now scribe your line about the head. A piece of lath of the same thickness as the shell bent and clamped on one quarter of the head can be marked with all rivet centers in one quarter; this will prove your template to lay out the shell. You are now prepared to lay out the shell and arrange both the head and the shell for assembling.

In case you have kept the head to the proper center, allowing for slight shrinkage, it will be found the proper size, and the shell should fit snug with all holes fair.

If the tank can be varied in diameter and length you may be able to speed up the work in more ways than one. For instance, the size of head and shell may exceed your requirements. If the tank described above can be assembled with ½-inch rivets, about 1½ inches allowance for the head flange will be ample. The shell sheets may prove long enough to allow an increased diameter; in that case you avoid shearing the circle on one hand and use less depth of flange. You can also consider each part of the shell separate—that is, you may be able to gain one or more holes girthwise and avoid shearing three or four sheets. If there is no restraint as to height you may avoid shearing any of the plates in that direction.

There is no doubt that at least a few struggling boiler makers have use for this article; if so, the writer will feel not only gratified, but feel inclined as others to contribute to the cause. Probably there are young men at present in small shops who form the idea that they could obtain better advantages by changing to a shop where extensive work is carried on. The principal object in learning a trade is to become familiar with the tools used in that particular line of endeavor. Let us take, for instance, a small shop located in an isolated locality. The character of the work is such that the variety is rather limited. Now these conditions should not prevent the average young man from making a start. The writer can recall instances where young men were employed in just such small shops as these and assumed the responsibility of a wife and children. They made good by patience and perseverance and are now holding good positions. It is for such young men that this article is written.

Shearing Strength of Rivets*

The shearing value of rivets in single and double shear, as specified in the rules and instructions for the inspection and testing of locomotive boilers and their appurtenances, issued by the Interstate Commerce Commission, specifies a value in double shear to be equal to double that of single shear, these values being as follows:

Iron rivets in single shear....................	38,000 lbs.
Iron rivets in double shear....................	76,000 lbs.
Steel rivets in single shear....................	44,000 lbs.
Steel rivets in double shear....................	88,000 lbs.

The table given below serves to illustrate the value of the shearing strength of rivets as used by several large builders of boilers, and also as given by different authorities.

Table 1 gives the value of rivets in single shear and covers a range in shearing strength from 38,000 pounds to 50,000 pounds, the driven rivet or rivet hole being based on 1/16 inch larger diameter than the initial size of the rivet.

Table 2 gives similar information for rivets in double shear, the value being 1¾ times that of single shear. If it is desired to base the value equal to two, the figures shown in Table 1 can be doubled. While, as mentioned above, the Interstate Commerce Commission allows a value for rivets in double shear equal to twice that of single shear, it is the practice of some of the State boiler commissions to allow a maximum value of 1¾.

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* From an article on the Strength of Locomotive Boilers, by Wm. N. Allman in the *Railway Age Gazette*, mechanical edition.

Resistance to Shearing—Pounds per Square Inch.				Relative Value Double to Single Shear.		Value Based on Driven or Initial Size of Rivets.	Authority.
Single Shear.		Double Shear.					
Iron.	Steel.	Iron.	Steel.	Iron.	Steel.		
38,000	......	76,000	......	2	....	Driven	Railway Master Mechanics' Association.
38,000	44,000	76,000	88,000	2	2	......	Proposed Government Rules. Adopted June 2, 1911.
41,000	47,000	82,000	94,000	2	2	Driven	W. C. Unwin.
......	......	......	......	2	2	......	Thurston, R. H. "Manual of Steam Boilers."
50,000	......	......	......	2	2	......	Weisbach, Julius. "Theoretical Mechanics."
......	......	......	......	....	2	......	Cambria Steel Company.
......	50,000	......	......	....	2	......	Carnegie Steel Company.
......	Note.	......	......	....	2	......	Bureau Veritas (French).
40,000	49,000	78,000	84,000	1.95	1.71	Driven	Master Steam Boiler Makers' Association 1905.
......	......	......	......	....	2	......	Engineering Department, B. & O. R. R.
......	Note	......	......	....	*1.75	......	British Lloyds.
40,000	50,000	......	......	....	....	......	Pencoyd Iron Works.
40,000	†	......	......	....	....	......	National Tube Company.
40,000	49,000	74,000	84,000	1.85	1.85	Driven	The Baldwin Locomotive Works.
38,000	42,000	70,000	78,000	1.84	1.86	Driven	Board of Boiler Rules of Massachusetts.
38,000	42,000	70,000	78,000	1.84	1.86	Driven	Hartford Steam Boiler Inspection and Insurance Company.
......	48,000	......	72,000	....	1.75	Driven	Maryland Steel Company.
......	Not specified — Rivets proportioned to thickness of plates.						Board of Supervising Inspectors, U. S.
......	46,000	......	80,500	....	1.75	......	British Board of Trade.
......	Note	......	......	....	....	Driven	German Lloyds.
40,000	......	75,000	......	1.85	....	Driven	Philadelphia Rules.
......	......	......	......	1.75	1.75	Driven	American Locomotive Company.
......	......	......	......	1.75	1.75	Initial	Public Service Commission, New York.
40,700	......	75,300	......	1.85	....	......	Shock (Chief Engineer Naval Academy).
......	50,000	......	......	....	....	......	Kennedy, Alex. B. W. (Test made for British Inst. of Mech. Eng.

Note.—85 percent of the tensile strength of the plate.
* Where experiments have been made.
† 43,000 pounds to 68,000 pounds.

TABLE 1—SHEARING VALUE OF RIVETS (DRIVEN SIZE).
Single Shear.

Diameter of Rivet. Inches.	Driven Rivet or Rivet Hole.		Ultimate Shearing Strength (Pounds per Square Inch.)												
	Diameter Inches.	Area, Square Inches.	38,000	39,000	40,000	41,000	42,000	43,000	44,000	45,000	46,000	47,000	48,000	49,000	50,000
1/2	9/16	.2485	9,443	9,691	9,940	10,188	10,437	10,685	10,934	11,182	11,431	11,679	11,927	12,175	12,425
9/16	5/8	.3068	11,658	11,965	12,272	12,578	12,886	13,192	13,499	13,806	14,113	14,420	14,727	15,033	15,340
5/8	11/16	.3712	14,106	14,477	14,848	15,219	15,590	15,961	16,333	16,704	17,075	17,446	17,817	18,189	18,560
11/16	3/4	.4418	16,788	17,230	17,672	18,144	18,556	18,998	19,439	19,881	20,323	20,765	21,207	21,649	22,090
3/4	13/16	.5185	19,703	20,221	20,740	21,258	21,777	22,294	22,814	23,332	23,851	24,369	24,888	25,406	25,925
13/16	7/8	.6013	22,849	23,451	24,052	24,653	25,255	25,856	26,457	27,058	27,660	28,261	28,862	29,464	30,065
7/8	15/16	.6903	26,231	26,922	27,612	28,302	28,993	29,683	30,373	31,063	31,754	32,444	33,134	33,825	34,515
15/16	1	.7854	29,845	30,631	31,416	32,202	32,987	33,772	34,558	35,343	36,128	36,914	37,700	38,485	39,270
1	1 1/16	.8866	33,691	34,577	35,464	36,350	37,237	38,123	39,010	39,897	40,784	41,670	42,556	43,443	44,330
1 1/16	1 1/8	.9940	37,772	38,766	39,760	40,754	41,748	42,742	43,736	44,730	45,724	46,718	47,712	48,706	49,700
1 1/8	1 3/16	1.1075	42,085	43,192	44,300	45,407	46,515	47,622	48,730	49,837	50,945	52,052	53,160	54,267	55,375
1 3/16	1 1/4	1.2272	46,634	47,862	49,088	50,315	51,542	52,770	53,997	55,224	56,451	57,678	58,905	60,133	61,360
1 1/4	1 5/16	1.3530	51,414	52,767	54,120	55,473	56,826	58,179	59,532	60,885	62,238	63,591	64,944	66,297	67,650
1 5/16	1 3/8	1.4849	56,426	57,911	59,396	60,881	62,365	63,851	65,336	66,820	68,305	69,790	71,275	72,760	74,245
1 3/8	1 7/16	1.6230	61,674	63,297	64,920	66,543	68,166	69,789	71,412	73,035	74,658	76,281	77,904	79,527	81,150
1 7/16	1 1/2	1.7671	67,150	68,917	70,684	72,451	74,218	75,985	77,752	79,519	81,287	83,054	84,821	86,588	88,355
1 1/2	1 9/16	1.9175	72,865	74,782	76,700	78,617	80,535	82,452	84,370	86,287	88,205	90,122	92,040	93,957	95,875
1 9/16	1 5/8	2.0739	78,808	80,882	82,956	85,030	87,104	89,178	91,252	93,325	95,399	97,473	99,547	101,621	103,695

TABLE 2—SHEARING VALUE OF RIVETS (DRIVEN SIZE).
Double Shear=1¾ Times Single Shear.

Diameter of Rivet. Inches.	Driven Rivet or Rivet Hole.		Ultimate Shearing Strength (Pounds per Square Inch.)												
	Diameter Inches.	Area, Square Inches.	38,000	39,000	40,000	41,000	42,000	43,000	44,000	45,000	46,000	47,000	48,000	49,000	50,000
1/2	9/16	.2485	16,525	16,937	17,395	17,829	18,265	18,699	19,134	19,588	20,004	20,438	20,872	21,306	21,744
9/16	5/8	.3068	20,401	20,939	21,476	22,011	22,550	23,086	23,623	24,160	24,698	25,235	25,772	26,308	26,845
5/8	11/16	.3712	24,685	25,335	25,984	26,633	27,282	27,932	28,583	29,232	29,881	30,530	31,180	31,831	32,450
11/16	3/4	.4418	29,379	30,152	30,926	31,752	32,473	33,246	34,018	34,792	35,565	36,339	37,112	37,886	38,657
3/4	13/16	.5185	34,480	35,387	36,295	37,201	38,110	39,014	17,110	40,831	41,739	42,646	43,554	44,460	45,369
13/16	7/8	.6013	39,986	41,039	42,091	43,143	44,196	45,248	46,300	47,351	48,405	49,457	50,508	51,562	52,614
7/8	15/16	.6903	45,904	47,113	48,321	49,528	50,738	51,945	53,153	54,360	55,569	56,777	57,984	59,194	60,401
15/16	1	.7854	52,229	53,604	54,978	56,353	57,727	59,101	60,476	61,850	63,224	64,999	65,975	67,349	68,722
	1 1/16	.8866	58,959	61,210	62,062	63,612	65,165	66,715	68,267	69,820	71,372	72,922	74,473	76,025	77,577
1 1/16	1 1/8	.9940	66,101	67,840	69,580	71,319	73,059	74,798	76,538	78,277	80,017	81,756	83,496	85,235	86,975
1 1/8	1 3/16	1.1075	73,649	75,586	77,525	79,462	81,401	83,338	85,277	87,215	89,154	91,091	93,030	94,967	96,906
1 3/16	1 1/4	1.2272	81,609	83,758	85,904	88,051	90,198	92,347	94,495	96,642	98,789	100,936	103,084	105,233	107,380
1 1/4	1 5/16	1.3530	89,974	92,342	94,710	97,078	99,445	101,813	104,181	106,549	108,916	111,284	113,652	116,020	118,387
1 5/16	1 3/8	1.4849	98,745	101,344	103,943	106,542	109,139	111,739	114,338	116,935	119,534	122,132	124,731	127,330	129,929
1 3/8	1 7/16	1.6230	107,929	110,770	113,610	116,450	119,290	122,131	124,971	127,811	130,651	133,492	136,332	139,172	142,012
1 7/16	1 1/2	1.7671	117,512	120,605	123,697	126,789	129,881	132,974	136,066	139,158	142,252	145,344	148,437	151,529	154,621
1 1/2	1 9/16	1.9175	127,514	130,868	134,225	137,580	140,936	144,291	147,647	151,002	154,359	157,713	161,070	164,425	167,781
1 9/16	1 5/8	2.0739	137,914	141,543	145,173	148,802	152,432	156,061	159,691	163,319	166,948	170,578	174,207	177,837	181,466

The Combustion Chamber

There has been a tendency of late, among certain master mechanics and locomotive designers, to introduce the combustion chamber to locomotive boilers. During the time that locomotive engines have been in use, many devices have been applied as improvements, found unsatisfactory and abandoned. Then, years afterwards, others have reinvented and even patented the same device and made it work successfully. That being the case there may be prospects of the combustion chamber becoming an economical arrangement for locomotive boilers. The tube arrangement of a steam superheating boiler may make the combustion chamber more useful than it has been with plain tubular boilers.

The combustion chamber was first introduced in locomotive practice and thoroughly tested by James Millholland, master of machinery of the Philadelphia and Readinng Railroad about 1850. This was done in connection with efforts made to burn anthracite coal in locomotive boilers. A variety of experiments were made by Mr. Millholland in which the combustion chamber figured. A famous locomotive of that time, the Pawnee, had a combustion chamber at nearly the middle of the boiler, a combustion chamber being in front of the firebox. Flues 3 inches diameter connected the front and the back combustion chambers. The engines did not steam freely and various changes were tried, but eventually the combustion chambers were removed. The decision arrived at by Millholland was that to burn anthracite coal successfully, a large grate and long flues were necessary.

The locomotive engineering practice of the United States followed Millholland's practice closely, as far as burning anthracite was concerned.

In those days, most of the locomotives in the United States burned wood, for which they used plain deep fireboxes. When wood was becoming scarce, and the burning of bituminous coal was becoming a necessity, inventors began to offer for adoption various novel forms of furnaces and fireboxes, guaranteed to extract the greatest amount of heat out of the coal, along with some heat that was not there. The old Hudson River Railroad took a lead in trying out so-called improvements designed for the purpose of burning soft coal properly. Among these devices, the combustion chamber was tried in various forms. It was tried from one foot to five feet long. Large flues and flues as small as 1½ inches were tried in connection with the combustion chamber; while brick arches of various forms were tried to prevent the combustion chamber from filling up with cinders. Various methods were adopted to mix air with the gases of combustion in the combustion chamber. Nothing that skill, directed by zealous intelligence, could do to make the combustion chamber promote steam generation was spared, but without success. When a courageous master mechanic abandoned the combustion chamber and substituted plain flues the full length of the boiler, the steaming qualities of the engine were always improved, and so the combustion chamber fell into innocuous desuetude.—*Railway and Locomotive Engineering.*

CORRECTION.—In the article on "Progress in Locomotive Boiler Design" on page 102 of the April issue of THE BOILER MAKER, under the heading of "Stokers," it is stated "Reports from roads using a large number of stokers show that the maintenance is less than 5 cents per locomotive mile." This should read ".5 cent [or ½ cent] per locomotive mile," instead of 5 cents per locomotive mile.

Some Modern Methods of Welding[*]

Various Processes Used in Electric and Gas Welding—Application to Boiler and Tank Work—Tests of the Welds

BY THOMAS T. HEATON

The old blacksmith's method of welding by heating in a coke fire and hammering is well known. It is known also to suffer from drawbacks of various kinds. The heat cannot always be regulated as well as could be desired. Impurities are often introduced into the joint. The weld itself is sometimes found to be defective, that is to say, it is not welded throughout, and the defect may be hidden, as there may be an outside weld of no depth. Great skill is therefore necessary with this class of welding. The methods the author proposes to describe are quite different, and for certain classes of work produce far superior results to any that the blacksmiths can attain. Often welds can be made which no blacksmith could undertake.

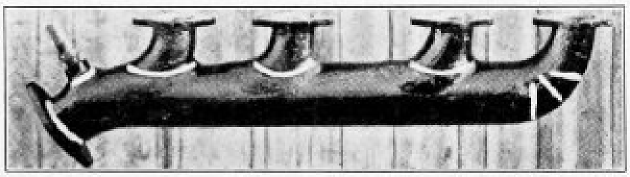

Fig. 1.—Acetylene Welded Non-Jacketed Exhaust Pipe

Broadly, the systems may be divided into two:

(*A*) Electric Welding, in which the heat required is produced by the electric current.

(*B*) Gas Welding, in which the heat is produced by a gas or mixture of gases.

These divisions may be subdivided, as in both cases there are variations both in method and in means.

In Electric Welding, the chief variations are as follows:

(1) The electric arc, as in the Benardos system and its variants.

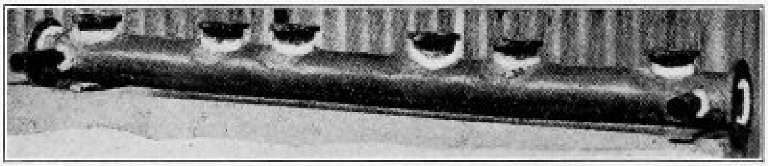

Fig. 2.—Welded Pipe Work

(2) The system invented by Mr. Arthur Strohmenger, and owned by Messrs. Slaughter & Co.

(3) The contact system, as in Thomson-Houston method, The Pontelec, The Helsby and the Allgemeine Elektricitäts Gesellschaft.

(1) *The Benardos System*, if properly adapted to the work to be done, and with the plant well designed for generating, distributing and regulating the current, is practical, simple and effective. It demands a *direct* current of about 90 volts. The quantity of current used depends on the thickness to be welded, and may in ordinary practice range from 200 to 500 amperes. The work itself forms the positive pole of the arc, and a rod of carbon the negative pole. By this arrangement the greatest amount of heat is in the weld, as the positive pole is the hotter.

Where a number of welders are employed, it is necessary that the current shall be supplied in such a manner that one welder shall not affect the arc of another. This is effected very simply by generating in a compound-wound dynamo of ample capacity, and the machine should be slightly over rather than under-compounded. By this arrangement an increase of load does not lower the voltage. In a well-designed machine the voltage scarcely varies, provided the engine driving it is efficient to maintain its speed. The arcs are arranged in parallel, and each arc is provided with a regulator to adjust the current to the work to be done. The rod of carbon forming the negative electrode is fastened in an insulated holder of light construction. The workman holds this in his hand, strikes the arc by placing the carbon in contact with the work, and manipulates it so as to spread the arc and heat the work at and near the point to be welded with what is described as a soaking heat. When the welding heat is attained, the work is hammered or not, according to circumstances. Screens with colored glass windows are used to protect the eyes and skin of the workman from the effect of violet rays.

Zerener Process.—This is an arc-welding system which was introduced by Dr. Zerener of Berlin some twenty years ago. In this there are two carbons in the same holder, and there is a magnet which deflects the arc produced between these two carbons downward on to the work. No current passes through the work at all. There have been modifications of this system. The object is to maintain a constant voltage in the arc by having a constant length of arc. In Benardos process the length of arc varies slightly as the workman moves the carbon nearer to or farther from the work. There is, however, in practice, no disadvantage in this.

(2) *The Strohmenger-Slaughter System* is worked with either direct or alternating current. Alternating is, the author believes, preferred. The voltage is not very high, and its amount, within limits, not important. He has seen 85 volts used with direct, and 220 volts with alternating current, both effective. The quantity of current depends on the work.

The parts to be welded are placed in juxtaposition, and an electrode is laid upon and along the welding line. This consists of a soft iron rod covered all over, except at the extreme ends, with a flux which may be constructed chemically to suit the metal to be welded. Contact is made between the work and one end of the electrode, which fuses by a series of arcs along the welding line, melting the electrode into the work and coating the weld with a vitreous flux. It is claimed that this flux prevents oxidization. It flakes off when the metal cools. This system is interesting. The author understands that it is used with success in the welding of rails and their repair by building up worn places, but he has no experience in it beyond experimental demonstration, carried out to see whether it would supersede efficiently and economically other systems in use.

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[*] A paper read before the Institution of Mechanical Engineers, London, England, February, 1914.

(3) *Electric Contact Welding.*—This is performed by machinery. The Thomson-Houston process was introduced into this country about twenty years ago, and with it the pieces to be welded are fixed in a machine, one immovable and the other in a slide-rest. The piece in the movable slide is pressed by means of the screw against the other, and a very heavy alternating current, the amount depending on the area of the weld, is passed through. The electrical resistance of the joint causes a rise of temperature to welding heat, and the movable piece is pressed forward until a complete union is made. A little hammering is sometimes applied to finish the joint. This system is applied to the welding of hoops for the tires of cart, etc., wheels, angle irons and other comparatively heavy sections, and also wire down to small dimensions. The voltage is very low, only about 2 to 4 volts. The current per square inch is about 16,000 to 20,000 amperes.

A more Recent Method of Contact Welding is also performed by machinery, but in a different manner, and it is rather delicate in its adjustment as to time and current in relation one to the other. The voltage at the welding point is low. In thin work about 6 volts, and the current, which is alternating, is also low, but the amount depends on the thickness of the pieces to be welded. In this system there are Spot Welding and Roller Welding.

In Spot Welding the work is laid upon a fixed copper contact-piece or electrode. When placed in position a second movable electrode is pressed upon it immediately above the fixed electrode. Current is then switched on, and in passing from one electrode to the other heats and welds the work. The current is sometimes cut off automatically and sometimes by hand.

In Roller Welding the system is similar, except that the electrodes are rollers which grip the work overlapped between them, heating and welding it as it travels. This system requires good quality metal; it should be homogeneous, and free from scale or dirt. The adjustment of the time the metal is between the electrodes, and the amount of current required to produce the necessary welding heat and no more within that time, are somewhat difficult to estimate. It is, however, quite a practical system, and can produce most remarkable results in good welding. The greatest care must be exercised to produce these results with regularity.

The Spot Welds are not continuous and are like a series of rivets without rivet-holes or heads. They can be made continuous by a series of spots overlapping one another. The Roller Welds are continuous. The Pontelec system is spot welding and is similar to the above. But in this system a small disk is placed between the pieces to be welded immediately between the electrodes, and the disk is crushed down into the weld. It is claimed that this disk tends to concentrate the welding heat at the weld more thoroughly than with the spot welding described in previous paragraphs. This contact welding is very economical in labor for small thin work. It requires skilful attention to keep everything properly adjusted.

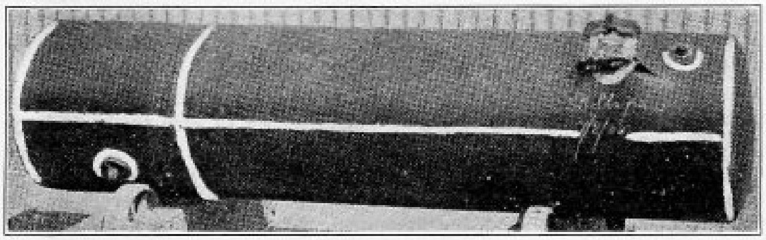

Fig. 3.—Welded Cylinder Tested to Destruction

GAS WELDING

The heat is produced by a mixture of gas, of more or less good calorific value, with oxygen. The gas is led from its source of supply through a flexible pipe into a burner, held in the hand of the operator, and oxygen is also led into the same burner in a similar manner. The pressure of the gas and of the oxygen is regulated with suitable apparatus. The proportion of gas and oxygen is adjusted by opening or closing their respective inlet-valves on the burner, and means are provided in the burner to prevent back-firing. The gas and oxygen issue from the burner through a small orifice at the mouthpiece, and are ignited with a match, the proportions of the two being adjusted until a clear flame shows itself in a fine point. The work is heated by this flame at the welding point, and soft iron (or other metal according to the kind of metal being welded) is melted into the joint to increase its thickness and therefore its strength.

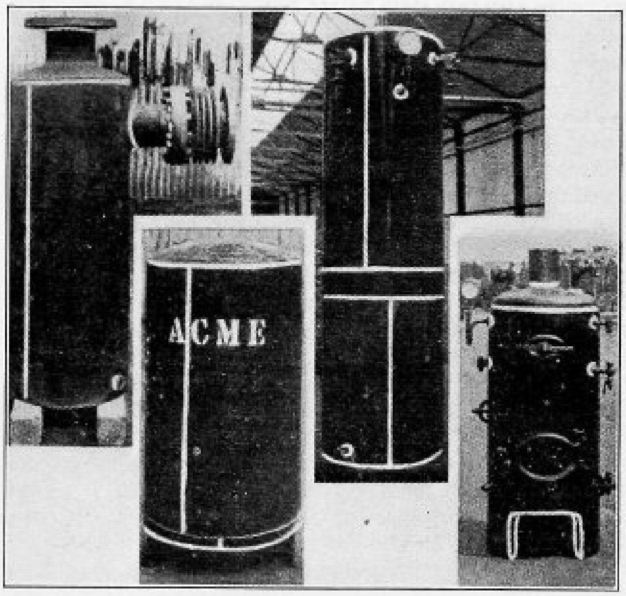

Fig. 4.—Welded Tank and Boiler Work

With regard to the gas used for this class of welding, the author thinks the best is acetylene, but other gases are used in conjunction with oxygen, namely, benzol vapor, coal gas and hydrogen, the last being used more especially on the Continent, but acetylene, oxygen and coal gas can be used together. Acetylene and oxygen, however, form as good and effective a mixture as can be desired. Of the various systems referred to herein, the author regards electric arc welding and oxy-acetylene welding as the two systems most suitable for general application, and the rest for special work. In some classes of work the electric arc is the more suitable, and in others the oxy-acetylene system, while in some cases both systems are equally applicable. Each is more economical in its own sphere. Owing to the lower temperature, the oxy-acetylene flame is better for thin work than the electric arc, because the risk of burning the metal is not so great. The temperature of the electric arc has been calculated as about 7,500 degrees F., but will vary with the amount of current. That of the oxy-acetylene flame is about 6,000 degrees F. (Murray B. O. Co.).

In the author's opinion, the electric heat must be far more effective, however, because it is produced within the work itself, whereas the heat of the gas flame is applied entirely from outside. Where the work is suitable for the electric arc, welds can be made far more quickly than by the oxy-acetylene flame. The proportions of the two gases in welding vary somewhat, but should be in the neighborhood of 1.5 volumes of oxygen to 1 volume of acetylene. This proportion is given by Mr. Murray, and agrees approximately with the author's own experience in practice. The character of work done varies very largely. The electric arc is used successfully in the repair of steel castings in which, for instance, blow holes may be effectively filled up.

Both systems are used in the welding of mild-steel plates, steel barrels and drums, steel tanks of all shapes and sizes, compressed-air receivers, steam boilers (in their manufacture and in their repair), steam piping and fittings of all sizes, angle and tee irons and other sections; the welding of bosses or flanges into vessels. Receptacles for highly inflammable and searching liquids are made in many thousands every year for petrol, bisulphide of carbon, acetone, etc., and are quite free from leakage or evaporation. The welds are capable of withstanding high pressures; indeed, the author's firm have made welds in gas cylinders which have successfully withstood a pressure of 4,000 pounds per square inch, and welds in mild-steel tube 3/16-inch thick by 1¼ inches diameter inside, which have withstood an hydraulic pressure of six tons on the square inch = 20 tons on the metal. They are entirely unsupported as against the pressure. It is clear that these welds must be sound and homogeneous. It is necessary to point out that this is not amateur work. To weld properly and to make the joint sound throughout, skill and training are required, together with knowledge how to apply the system as well as how to design and prepare the work for being welded.

In regard to designing the work for welding, there is a wide field, and one serious consideration is the avoidance of internal stresses caused by contraction. These stresses are unavoidable, but their effect may be minimized or nullified by properly designing the shape of the article to be welded. For example, a steel boss has been welded into the center of a flat circular mild-steel plate ½ inch thick, with the result that in cooling radial cracks appeared. It is probable that the material was not of the most suitable quality, but the stresses were indicated. If the same plate had been dished or curved, and of good soft quality, it would have yielded to the stresses, and would have been free from fracture or risk of it. If two plates are butted together, and a third be welded upon them, there is a stress in cooling due to the contraction forcing the butted plates together in conflict with the welds. If instead of allowing the two plates abutting to touch, a space be left between, all stress is avoided. These are examples of design which may be multiplied, and will perhaps serve to illustrate the author's meaning, as they are typical cases.

Much depends on the kind or the quality of the material, which is generally steel or iron. For the generality of this work mild steel made by the Siemens-Martin process or wrought iron cannot be excelled, and the steel should be very soft and low in carbon to get the best results. Bessemer material is not so good, as it varies greatly in the same piece, and therefore often much internal stress exists in it to begin with. The advantage of the kind of welding referred to herein is that, unlike the ordinary blacksmith's work, it is possible to be sure of a sound, homogeneous weld. The weld is built up from its foundation, and in most cases can be seen and its soundness and strength ensured, always provided it is properly and intelligently done.

The author has heard the argument advanced that in electric or gas welding the result depends on the individuality of the workman. To a certain extent this is true, as it is true of most mechanical operations. In a weld, however, there is this difference from some other kinds of work, that a defect is not always apparent. With proper training and adequate supervision, however, and a suitable test, there is no reason at all why full confidence should not be felt to a much greater extent in electric or gas welding than in blacksmith's welding. To give examples:

A cylinder of Siemens-Martin mild steel, 20 inches internal diameter by ¼ inch thick, designed as an air receiver for a working pressure of 100 pounds per square inch, and test pressure of 200 pounds per square inch, was submitted to a destructive test some time ago at the works of the author's firm before an engineer from the Admiralty. The cylinder was 6 feet 9 inches long, made in two sections of length united by a welded joint with a butt-strap welded round the cylinder. The two abutting ends of the cylinders joined were kept slightly apart to avoid internal stresses as before described. The ends were both domed outward to a radius of about 24 inches, rather too flat, but as specified, and they were ⅜ inch thick. Near one end a handhole of oval shape without any stiffening ring was cut out of the body, and a ¼-inch cover plate put inside with central bolt and bridge piece. At 825 pounds pressure per square inch this cover plate pushed through the cylinder sufficiently to split the body in the solid plate, Fig. 3. The part thus split was then cut off and the end rewelded in, somewhat shortening the cylinder, and pressure again applied, until at 975 pounds per square inch one end was pushed out. This cylinder had a longitudinal weld made by the electric arc system for its full length. The two ends were flanged, inserted into the ends of the body, and welded in by the oxy-acetylene process. The method of inserting the ends is indicated by Fig. 3.

In the course of the test the circumference of the body permanently increased 2 inches, or ⅝ inch in diameter. The electric longitudinal weld showed no sign of weakness, but became extended transversely in the circumferential direction. The butt-strap prevented the cylinder becoming stretched in its immediate neighborhood, so that the cylinder after the test appeared as if it possessed a waist. The effect of the increase in diameter was to tear the body from the ends. The stress on the metal itself just before the end came out was about 17½ tons per square inch. Another cylinder, 6½ inches diameter inside by 3/16 inch thick, made of a lap-welded boiler tube, welded by producer gas, in the usual way of such tubes, and with ends welded in by oxy-acetylene flame, burst at 1,850 pounds per square inch at the producer gas weld, all else remaining intact.

The author has tested steel barrels by hydraulic pressure with ends quite flat and only 5/64 inch thick by 21½ inches diameter, and they begin to leak at a pressure of about 65 to 70 pounds per square inch. The flat ends push outward so as to tear the weld in this case, which is simply a fused weld made by the electric arc; the ends being flanged, fitted into the body, hooped inside and outside with light steel hoops, and the weld made by fusing the four thicknesses, body, flange of end, and two hoops together, to a depth of about 3/16 to ⅛ inch. The thickness of body ⅛ inch, inner hoop ⅛ inch, flange of end 5/64 inch and outer hoop 1/16 inch. At the author's works there is a vertical steam boiler working at 80 pounds per square inch, and all welded by the electric arc or by gas. Hundreds of boilers have been repaired by both processes, and their lives prolonged for years in consequence. All these examples go to show that these systems of welding are practical, reliable, and worthy of confidence in every respect. Naturally, the character of the metal at the weld is changed to some extent. It loses some of its ductility, and some of its strength, but loses far less than does a blacksmith's weld. Many tests have shown that 89 to 96 percent of the original strength of metal can be relied on in the electric weld. It has been said, but quite wrongly, that the electric welding hardens the metal by filling it with carbon from the electrode. This is not the case. For example, in welding mild-steel the fierce heat of the electric arc burns out all the impurities, more or less, including carbon, and leaves the metal at the weld purer iron. If any hardening effect has ever been found, it has been due to bad manipulation or to the fact that the metal was never of a properly weldable quality, or the polarity was wrong.

Tables 1 to 3 are valuable in that they go to show the effects of the welding upon the metal.

TABLE 1
Chemical Analyses

Chemical and Mechanical Tests of Acetylene and Electrically Welded plates, received from Mr. Heaton, of The Steel Barrel Co., Ltd., Uxbridge.—*27th August*, 1913.

	Electrically Welded.		Acetylene Welded.	
	Unwelded Metal.	Welded Joint.	Unwelded Metal.	Welded Joint.
	Percent	Percent	Percent	Percent
Silicon	0.069	0.003	0.069	0.002
Carbon	0.15	Trace	0.15	Trace
Sulphur	0.025	0.020	0.085	0.071
Phosphorus	0.068	0.013	0.068	0.067
Manganese	0.64	0.27	0.49	0.34
Iron (by difference)	99.108	99.664	99.198	99.520
	100.000	100.000	100.000	100.000

TABLE 2.
Mechanical Tests on Mild Steel ⅛ inch Thick.

	Electrically Welded.			Acetylene Welded		
	Unwelded.	Welded Joint.		Unwelded.	Welded Joint.	
		Transverse.	Longitudinal.		Transverse.	Longitudinal.
Elastic Limit (tons per sq. in.)	15.20	17.60	Nil	11.76	11.60	Nil
Breaking Weight, Tons per sq. in.	26.66	24.00= 90%	25.60= 96%	23.14	18.24= 78.8%	23.20= 100.2%
Contraction of area (percent)	47.25	Nil	Nil	46.66	49.60	Nil
Extension on 4 inches (percent).	23.16	5.00	0.50	26.33	13.50	4.25
Extension on 2 inches (percent).	30.33	7.00*	1.00†	33.66	22.00‡	8.00

* Broke in weld. † Broke outside gage length. ‡ Broke clear of weld.

TABLE 3.
Mechanical Tests on Two Strips of Siemens-Martin Mild-Steel Sheet ⅛ Inch Thick, by Mr. Jenkins.

	Breadth of Testpiece.	Thickness.	Area.	Maximum Load.		Extension on 4-in. Length.	Reduction of Area.	Remarks.
				On Piece.	Per Square Inch.			
	Inch.	Inch.	Square Inch.	Tons.	Tons.	Per cent.	Per cent.	
1	1.480	⅛	0.185	4.06	21.95	32.03	29.63	Original.
2	1.478	⅛	0.185	3.59	19.41= 38.428%	10.93	5.23	Electrically welded.

One of the strips tested (Table 3) consisted of the original material, and the second one was a piece cut from the same sheet, cut into two and electrically welded at the joint.

This material was of a somewhat softer nature than that referred to in Table 2.

For these analyses, drillings were obtained from the plates themselves and also drillings from the welded joints. The plates were tested mechanically, both longitudinally and transversely along the welded joints, and for comparison the unwelded metal. The results of the mechanical tests of the unwelded metal are the mean of three lots.

These chemical analyses and also the mechanical tests were specially made for the author in August, 1913, by Mr. F. C. Tipler, Chief Chemist, Locomotive Department, London and North Western Railway, Crewe. The pieces of material were prepared at the works of the Steel Barrel Company, at Uxbridge, and were of Siemens-Martin Open Hearth Steel one-eighth inch thick.

Triplex Articulated Locomotive

A radical step in advance of anything hitherto attempted in the United States in locomotive design has been made in the construction of a triplex articulated locomotive which develops a tractive force of 160,000 pounds, built by the Baldwin Locomotive Works for the Erie Railroad. According to the following description from *Railway Review* it is by far the most powerful locomotive yet built, and the enormous capacity is obtained by the novel arrangement of placing driving wheels under the tender, and thus making the weight of the tender available for adhesion. In heavy grade work especially, the weight of the tender detracts materially from the net hauling capacity of the locomotive of the usual type, while in this case the tender is used as a means for increasing the hauling capacity.

The locomotive is built in accordance with patents granted to George R. Henderson, consulting engineer of the Baldwin Locomotive Works. There are three groups of driving wheels with the rear truck placed under the tender section. Power is developed in six cylinders all of the same size, two of which act as high-pressure and four as low-pressure cylinders. The two high-pressure cylinders drive the middle group of wheels, the right-hand high-pressure cylinder exhausts into the two front low-pressure cylinders, and the left-hand high-pressure cylinder exhausts into the two rear low-pressure cylinders under the tender. This arrangement is equivalent to a compound engine having a ratio of cylinder volumes of 1 to 2.

The boiler has a conical connection in the middle of the barrel, and is fitted with a Gaines type of furnace. The firebox has a total length of 13 feet 6 inches, and of this the grates occupy 10 feet. The combustion chamber, 54 inches long, extends forward into the boiler barrel, while the tubes have a length of 24 feet. The brick arch is supported on six 3½-inch tubes, and heated air is delivered under the arch by seven 3-inch pipes which are placed vertically in the bridge wall. There are two fire doors, placed 32½ inches between centers. A Street mechanical stoker is applied.

The barrel of the boiler measures 94 inches in diameter at the front end and 102⅛ inches at the dome end. The centerline of the boiler is 10 feet 7 inches above the rail. The circumferential seams are triple riveted, while the longitudinal seams have sextuple riveted butt-joints, which are welded at the ends and have an efficiency equivalent to 90 percent of the solid plate. The dome is of pressed steel, 33 inches in diameter and 13 inches high. The superheater is composed of fifty-three elements, and is the largest ever applied to a locomotive, the superheating surface being 1,584 square feet. The header of the superheater is divided, separate castings being used for the saturated and superheated steam sections. The front end contains a single cast nozzle with a ring blower. The size of the nozzle can be varied by a simple adjusting device placed inside the smokebox. The stack is 22 inches in diameter, and has an internal section which extends down to the centerline of the boiler.

The boiler is built for a safe working pressure of 210 pounds per square inch. The grate area is 90 square feet, and the total heating surface 6,886 square feet, in addition to which there are 1,584 square feet of superheating surface. The heating surface is divided as follows:

	Square Feet
Tubes and flues	6,418
Firebox	272
Combustion chamber	108
Arch tubes	88

John and the Perspective Sketch

The Principles of Perspective—How to Make Perspective Sketches, with Special Reference to Circles and Ellipses

BY JAMES F. HOBART, M. E.

"Hello, John! What's the word of progress this morning?"

"Good morning, Mr. Hobart. It seems to be about as usual—draw your pay and spend it, get into trouble and get out of it best you can—just one d—— thing after another! That's about what the 'word of progress' is with me to-day!"

"Gee whiz, John! What's the matter with you this morning? Bilious? Love affair, or what?"

"Naw, none of those things ain't botherin' me. It's just a confounded sketch which the Old Man wants me to make of a couple of boilers and their fittings down in Screwtight's factory! You see, it's like this: This concern put in the boilers and piping on contract, and Screwtight claims things are not connected up just right, so the Old Man wants me to go down there and make a sketch of the boiler room, and show each pipe and connection! Now, ain't that a peach of a stunt to run up against? Wonder if the Old Man thinks I've got a photo camera in my head? Why in creation don't he run down there and see for himself just what has been done and ease off the screws which seem to be pinching Mr. Screwtight?"

"Say, John, you are dead wrong and shinning up the wrong pole. Just come down 'already once' and listen to this. Here is a mighty fine chance for you to get a bit more experience and to learn something new which will be mighty useful to you forever! What if you don't know a thing about sketching? You can learn, can't you? Other people do sketching, don't they? Well, then, get busy and look up a book or two on drawing and sketching. There is a little 25-cent pamphlet, 'The Principles of Perspective,' which can be obtained from the D. Van Nostrand Publishing Company, New York, or probably from any other bookseller, and a little study of this book will help you to make a pretty good perspective sketch; also to lay out a regular double-jointed, full-fledged perspective drawing, to scale, both ways, and made to look exactly as you see a thing; large, close to, and smaller the farther away from you it is placed. Get one of those little books, John. It will be a good investment for you."

"I'll do it, Mr. Hobart; but that won't help me out on this job. And what the Old Man wants, as near as I can make it out, is for me to show those two boilers hanging in the air with nothing to support them, but with all the pipes and connections sticking out where they are located, and to show three sides of everything in the same picture just as if I was looking at the layout from one of the top corners of the boiler room."

"Well, you can do that, can't you, John? Just think a bit with that 'ivory dome' of yours! Just do that, and take in the few little tips I'm going to hand out to you, and you can make Screwtight's sketch to suit the Old Man, and you won't have to write under your picture, 'This is a boiler, not a rosebud!'"

"But, Mr. Hobart, it bothers me to get the sketch started. After I get the lines started in the right direction I can get along pretty well, except when there are circles to be put in, and they do 'get my goat' every time!"

"Never mind, John. We will fix all that right by and by, and now, just listen, and look at Fig. 1, sketch A. There are two kinds of perspective drawings, and one kind is shown by Fig. 1. This kind is commonly called 'parallel' perspective. Some people call it 'bastard' perspective. Another name is 'isometric projection.' In the other kind of perspective, all the lines of a side run toward a distant point, called the 'vanishing point.' In 'true perspective' drawings there are usually two such points, one for the sides and another for the ends of the object. But we will only talk about 'parallel' perspective this time, for that is the kind sometimes used in the shop, and the 'know-how' of drawing by that method is one of the most valuable things the young man can learn.

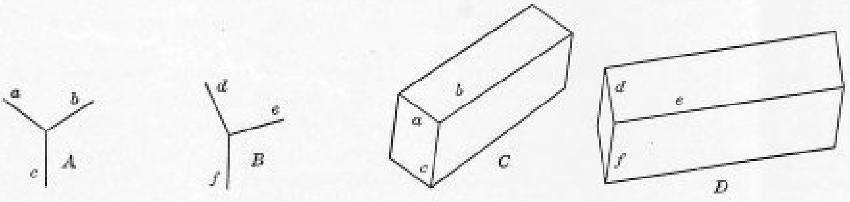

Fig. 1.—Starting a Perspective Sketch

"There are several ways of starting and arranging a perspective sketch. Two methods are shown by Fig. 1. One method at *A*, where the three lines *a*, *b* and *c* are drawn at 120 degrees from each other. In a drawing of this kind actual dimensions may be laid off on each of the lines in three directions on the same sketch. The angles shown at *A* are laid off by the eye, but they are supposed to be made by the side of a 30- and 60-degree triangle. In a sketch made by this layout, each of the sides will show alike. If, however, it be convenient or desirable to show one side more than the two others, then the sketch may be started as shown by sketch *B*, where the lines are at different angles from each other, as shown by *d*, *e*, and *f*."

"Oh, say, Mr. Hobart, but how do you start any sketch with a thing like sketches *A* or *B*, anyway? I don't see much there to begin a sketch with."

"But you can, John. If you will look at sketch *C*, Fig. 1, you will see that the three lines, *a*, *b* and *c*, in that sketch are the same, and at the same angles to each other as the same lines in sketch *A*. Isn't that so?"

"Golly! I believe they are, that's a fact."

"Well, then, are not the lines *e*, *f* and *g* in sketches *B* and *D* exactly the same at the place where they join each other?"

"I believe they sure are, Mr. Hobart."

"All right, then. Now, when you want to start a perspective sketch—that is, until you get the knack of it—always make a little sketch like *A* or *B* in one corner of the picture. Do this to begin with, and after that every line you make must be parallel to one of the three lines in the sketch *A* or *B*. Just note in sketch *C* there is not a line in that figure which is not parallel to one of the three lines *a*, *b* or *c*, and as long as you have only square or rectangular objects to draw there will be only the three lines, but should it be necessary to show something at a different angle, say like the boiler house roof, or a pipe running at an angle, then another 'direction line' will have to be used. But such lines are so few that we will say nothing about them just now. Always make up and down lines truly vertical, as shown by *c* and *f* in the sketches. Vertical lines remain as in nature, and are never changed in perspective sketching. It is only the horizontal lines which are varied as in sketches *A* and *B*, to suit our convenience; and, John, when you have once started a sketch, keep the lines always in the directions in which they were commenced, for there is nothing in a boiler room, with the exceptions mentioned, which cannot be shown by the lines in three directions noted above."

"What about circles, Mr. Hobart? There are circles in the sketch, and these have given me no end of trouble. You know I am to show these boilers 'hanging in the air'; therefore the square brickwork will not show, and instead of a figure like sketch *C* or *D*, there will be a round shape to show, and I haven't been able to get it to look right."

"I know what your trouble is, John. You can't make the highest and lowest portions of the boiler come in the middle? Is that it? Something as shown by Fig. 2? You tried first by laying out a square shape for the boiler, didn't you? Same as the dotted lines in Fig. 2? I thought so. And when you come to draw in the center lines, preparatory to attaching the main steam pipe, you found, didn't you, that the center line (*CL*) of the dotted shape did not agree with the *CL* of the round boiler, as at center line *F*, Fig. 2?"

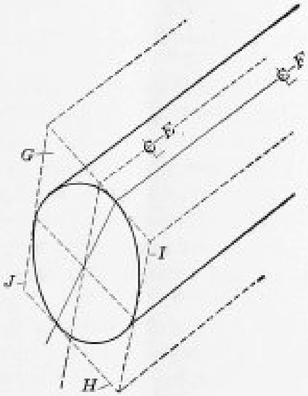

Fig. 2.—The Sketch Which "Stuck" John

"That was the trouble, Mr. Hobart, and I never could get the two lines to come together and have the boiler look right. You see, there seems to be about twice as much corner cut off at *G*, *H*, as at *I*, *J*. Now, what is the reason for that, and how will I get around it?"

"That is the point, John, where the beginner usually gets balled-up in perspective drawing and sketching. You are trying to make the end of the boiler look like a circle instead of an ellipse, which it truly represents when turned at an angle to the eye. Just take a look at Fig. 3 and you will see another sketch, also not properly drawn, but which looks better than Fig. 2. In Fig. 3 the vertical and horizontal center lines seem to correspond, all right, but the more you look at Fig. 3 the more there seems to be a long axis or center line through the diagonal corners as shown by *CL M*. It seems as though *CL F* (Fig. 2) had been moved to *CL M*, Fig. 3."

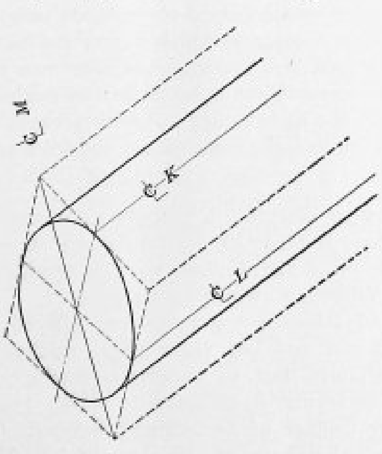

Fig. 3.—Another Sketch Made Better

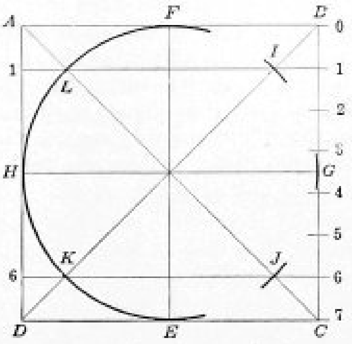

Fig. 4.—Sketching a Circle

"What is the reason for this, Mr. Hobart? Why can't I make the end of that boiler look right in the sketch?"

"Because, John, you are trying to guess at the shape of the head which, as stated, becomes an ellipse when you move away from square in front of the boiler head, and in guessing at the outline of the ellipse you 'fall down' and get the bum-looking shapes shown in Figs. 2 and 3."

"But what can be done about it, Mr. Hobart? Those sketches seem about the best I can do with my 'know-how'; but I've got the best pair of listen-ears in the United States if you can 'show me'!"

"There is a way of laying out circles, ellipses and similar figures, John, which is a combination of geometrical and rule-of-thumb methods, but which makes a man get results quickly and accurate enough for sketching purposes. Figs. 4, 5 and 6 show this method. In Fig. 4 a square, *A*, *B*, *C*, *D*, is given and a circle is to be sketched inside of it, just touching the four sides."

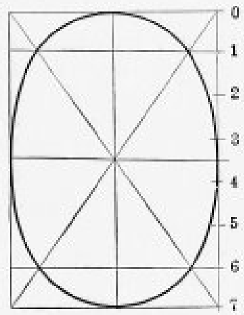

Fig. 5.—Sketching an Ellipse

"That's easy. A fellow could measure off half the width on the diagonals and then sketch in the circle same as is done in Fig. 4."

"But that's not in the game, John. No measuring is to be done when sketching, so that way will have to be barred. Just space off one side of the square as closely as possible with the eye, dividing the side into 7 equal spaces, as shown in Fig. 4. These divisions are marked 1, 2, 3, etc., up to 7. Draw the first and last, 1-1 and 6-6, clear across the square, as shown, then draw the diagonals *A C* and *B D*, also the center lines *E F* and *G H*. Next, mark the points where these lines cross each other, as at *I, J, K* and *L*, and these points are in the circle to be drawn and may be marked by short arcs, as shown at *I* and *J*. Next mark similar short arcs at *E, F, G* and *H*, then sketch in a curve connecting all these short arcs, and the result will be the circumference of the circle inside the square."

"Say! That's a good stunt. Will it work every time?"

"Yes, John, every time that you space off the first side accurately. Now, then, when we want to draw in the perspective of a circle, or draw an ellipse, we only need to draw the rectangle to contain the ellipse, as shown by Fig. 5, then go ahead, divide either side into seven squal spaces, draw the center and diagonal lines as in Fig. 5, mark in the short arcs, then sketch in the ellipse same as we did the circle. And now, John, we come to the 120 degrees parallel perspective of the boiler end, same as you tried to show by Figs. 2 and 3. We will work here, just the same as in Figs. 4 and 5. And Fig. 6 will show the result of an accurately made, free hand perspective sketch of a circle. You will see, after looking this sketch over, that Fig. 3 is not so bad after all. Also that there is an apparently long diagonal axis to the boiler head; and this really is the case, for the reason that we are actually looking at the boiler head from a double angle—cornerwise, so to speak, and the long axis of the head actually lies in the direction *M*-7, as shown by Fig. 6."

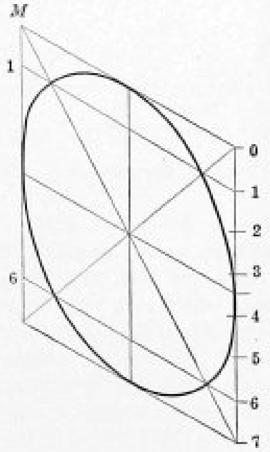

Fig. 6.—Sketching the Perspective of a Circle

"I'll bet I can work in those boiler heads all right now, Mr. Hobart, and I think I can start the sketch and finish it, too, without any more trouble."

"That's good, John—but hold on a minute. There are a couple more things which I want to tell you about in regard to this perspective business. When you get down to true perspective, the method will work as well as with the ways shown. Fig. 7 shows the outline of a boiler sketched in double perspective, with two vanishing points, one of which is located to the left, the other at a distance to the right and not shown in the illustration."

"Say, do all the lines run to these two points?"

"Yes, John, each and every one of them!"

"Well, say! It must be easy to draw regular perspective—easier than the 'parallel' perspective which you've been showing me! Why, in the regular thing you've only got to stick a couple of pins in the paper and aim each line at one of the pins. That's a whole lot easier than trying to keep all the lines parallel with each other, and same as the little sketch *A* or *B*, Fig. 1, in the corner of your paper. Me for the regular perspective. It looks more like what you are making a picture of."

"Go to it, John, but better not try regular perspective until you can do a handy job with the 'bastard' kind. And then there's another thing. The regular perspective is not as good for what your foreman wants down in Screwtight's place, for with true perspective everything gets smaller and smaller the farther away it is, and it is not as easy to lay it down properly and dimension it well, as it is in a parallel perspective sketch. So you had better stick to the parallel for shop work, and after you get that down handy, then study the real perspective. And you had better get that little book before you get any false notions which you might have to drop when you started right, according to the book."

"Oh, tell me, Mr. Hobart, how do you use that perspective of a circle business when you get to using a vanishing point and the sides are smaller far off than close to?"

"You use the perspective trick in the same way, John. You will find it all laid down in that little book, and you will also find a lot more than I have told you—a lot about finding the far side of a square or circle or ellipse, without measuring or assuming a distance therefor as we did in Figs. 4, 5 and 6."

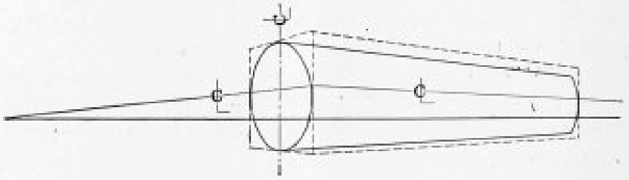

Fig. 7.—True Perspective Sketch

"Gee, Mr. Hobart! Will I ever get done buying books? This makes six I have got since I began to talk over these things with you. It sure costs me something!"

"Well, don't it pay? Haven't you had your pay raised, meanwhile, enough to buy a hundred books?"

"That's so, I have; and I didn't think that the books might have something to do with it."

"Pretty likely they have, John, but just remember that as long as you keep on learning things you never will stop buying books. I have just bought one, a $5 book at that; all about machine design."

"Why, Mr. Hobart, I thought you had all that sort of thing in your head?"

"Not a bit of it, John. I can keep a little of it in my head, and manage the rest by knowing where to find the 'know-how' when I want it. You will have to do that, too, by and by."

Semi-Centennial Anniversary of the Joseph F. Wangler Boiler & Sheet Iron Works Company.—The Joseph F. Wangler Boiler & Sheet Iron Works Company, St. Louis, Mo., celebrated its semi-centennial anniversary March 28, having been established in 1864. The founder of the business, Joseph F. Wangler, recently celebrated his seventy-seventh birthday. He is a practical mechanic, having worked at his trade for a number of years before establishing the business which bears his name, and which is now conducted chiefly by his sons. In 1863 Mr. Wangler was employed by the United States Government in the construction of gunboats for river use, and when the Eads bridge was built across the Mississippi at St. Louis he had the contract for the iron and steel work in his line.

University of Wisconsin Summer Engineering School.—Announcement is made of the fourteenth annual six weeks' summer school of the College of Engineering of the University of Wisconsin, which opens June 22. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, test of materials, machine design, shop work and surveying, in addition to which subjects may be taken in the College of Letters and Science. Copies of the Summer School Bulletin can be obtained by addressing F. E. Turneaure, University of Wisconsin, Madison, Wis.

Locomotive Staybolt Structure

Cause of Staybolt Breakage—Its Effect Upon the Life of Fireboxes—How Flexibility is Obtained in the American Staybolt

BY C. A. SELEY*

Why do staybolts break and fireboxes fail before they have returned a reasonable term of service? Based on past experience with the older types and sizes of boilers, modern performance seems to fall short, although there are many elements now entering into the problem which our forefathers did not have to contend with. Their boilers were smaller, pressure lower, inspection less technical, and the stress of competition and the accompanying closeness of supervision had not set in as is now the case.

Locomotive engineering has done wonders in keeping pace with the demands for greater tractive power in the evolution of steam railroading, and of course the boiler has shared in the development. In the human body the lungs are considered the master organ, even the heart being secondary, and the performance of a locomotive is limited only by the boiler capacity, hence the importance, the vital necessity, of an adequate boiler which may properly be termed the lungs of the locomotive.

To be adequate in all its parts means a balance of its proportions and materials as to performance and life, and to this latter feature it is proposed to devote the present consideration. There is no doubt that it is the general intention to use the best of materials available for locomotive boilers, and the range of quality of shell and firebox steel, of tubes and staybolt iron is not great, judging from prices and the material inspection reports. Much could be said in respect to the development of these materials, but time and space limit us to consideration of the staybolts and fireboxes.

With the old designs, employing lower pressures, the staybolts were smaller, although the tensile strength and factor of safety were probably much the same as used at present. Breakage of these bolts undoubtedly brought about the opportunity for special consideration on the part of iron makers of the desirable features of iron to stand the stresses incident to that service. This has resulted in giving considerable choice of brands of special staybolt irons, produced by varied methods of piling and working to obtain the qualities desired. What is wanted is a loose, open structure, not of high tensile strength, but with considerable elongation and reduction of area under pulling test. Such properties give flexibility, the sine qua non, for staybolts.

There is, however, some breakage of solid staybolts even of most desirable qualities. Records of less than one bolt per engine per month have been obtained by use of the best staybolt iron and favorable design of boilers, but it is not always possible to obtain such material or conditions. The average performance of solid staybolts is from 50 to 75 percent good, if the life of the firebox is taken at 100 percent. Little breakage is experienced the first two years with a well-designed boiler, but they develop in increasing ratio following years. Old engines with fireboxes renewed many times are prolific staybolt breakers unless care is taken to keep down the size. This in connection with the fact that the older engines have narrow water-legs, more abrupt curves and short bolts makes them a harder problem than the modern power in which the bolts are generally longer, which contribute to flexibility. This is generally true of the radial stays, although the short rows at the corners of the firebox are peculiarly stressed in some designs which do not favor their being truly radial.

It is quite general practice to keep track of the locations of broken staybolts, and by these records the so-called "breaking zone" for each class of engine can be fairly closely defined, so that remedial measures can be taken when new fireboxes are applied. These may be in a more favorable arrangement of the staybolts or the use of an improved form or material.

On account of the Government inspection requirements, which are now so well known as to be unnecessary to quote, great care is taken to avoid broken bolts, but in addition to the safety reasons therefor are economic reasons of great importance.

A locomotive is a valuable machine, and any loss of service should be reckoned in terms of the value of that service, in addition to the cost of repairs. It may be claimed that engines must lay in for washing and running repairs, which is true, but the broken staybolt renewals generally extend that time very considerably and are often the prime cause of the laying up and the other work is secondary.

Paradoxical as it may sound, it may be safely stated that staybolts generally break because they are too strong. In proof of this, take the factor of safety of four, as required for boiler seams, etc., and by calculation find that for 4 inches by 4 inches spacing and 200 pounds steam pressure it would require only about .26 square inch of minimum cross section for each staybolt, which corresponds to a diameter 1/32 inch less than ⅝ inch. The fiber stress in this case is 12,000 pounds, while one of the principal locomotive builders has set an arbitrary 5,500 pounds minimum fiber stress for staybolts, which for the above case would require .58 square inch of cross section, or nearly ⅞ inch minimum diameter. There is a question whether this is the best practice. With each renewal of side sheets or fireboxes the staybolts are applied larger and larger, unless great care and expensive methods are used to keep size of holes and bolts near to the original sizes used. It is believed that it will be entirely safe and conduce to better average staybolt life if the allowable fiber stress on new installations was raised to 7,500 pounds per square inch, which with average staybolt iron would give a factor of safety of 6.6, and this would permit the use of ¾-inch minimum body diameter bolts for our supposititious case.

If now we analyze staybolt action and seek the cause of breakage the reason will be clear why the smaller bolts are desirable and not "if a thing breaks make it bigger." It is clear that they do not break from the direct or tensile load. The liberal factors of safety used are sufficient proof of that, and it is evident that there is some other stress that is accountable.

There is no very accurate information available as to the amount of movement of the firebox sheets in relation to the outer or casing sheets, back head and throat sheet. There is no doubt that the movement is considerable, due to the different conditions affecting the sheets. The outer sheet is exposed to the atmosphere and to the water temperature, the inner sheet to the water and fire temperatures, and these are modified in turn by mud and scale to the serious disadvantage of the firebox sheet, hindering its conductivity of the heat to the water and causing a high degree of expansion and subsequent contraction or relative movement.

The belief is quite general among those who have studied

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* President, American Flexible Bolt Company, Pittsburg, Pa.

this matter that the staybolts are given an angular or lateral pull by these movements, and the most severe of these are when there are the greatest temperature differences within the firebox.

These extreme differences occur in hasty firing up, cooling down, cold water washing or filling, and from cold drafts after fires are knocked out, and in most of these cases there is no pull on the bolts from much, if any pressure, nor is there water circulation. When the boiler is in normal operation, it is doubtful if the angular strains are excessive, and it is probable that the initial rupture, the first start of the breakage, occurs at some firing up time or other period of extreme temperature variation.

Staybolts break under the pull due to pressure, but only after the cross section has been reduced by checking or partial fracture induced by over-stressing of the outer fiber at times of extreme movements, which are at times when there is probably little or no pressure.

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

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

The comparative flexibility of various sizes of solid staybolts can be approximated mathematically, and also roughly, by vibratory machinery, although no machine has yet been devised to give accurate comparison. This is perhaps also due to lack of complete knowledge of the laws governing the effects of repeated stresses on materials. At all event, the vibratory test is not yet in good repute among engineers, and this puts an uncertainty on determining the real merits of staybolts by test other than service, save what can be deduced from the results of pulling tests in the elongation and reduction and in nicking and bending tests.

It is now clear that flexibility consistent with strength is a desirable and necessary feature of locomotive staybolts, and that increase of size and strength decreases the more vital element of flexibility upon which largely the life of the staybolt depends. The average performance has already been stated, and it is apparent that the needful and necessary thing is to increase the body flexibility to withstand without failure the vibrations that may occur during the life of the firebox at least. Much more than that is not necessary, nor justified, at least so far as the staybolts themselves are concerned.

There is another feature, however, of prime importance, interdependent with staybolt life and flexibility—i. e., firebox life. The effect of stiff, rigid body staybolts on the sheets has not been generally appreciated as to their destructive action. To give perfect freedom for parallel movement of the inner and outer sheet consequent on unequal expansion and contraction, it is evident that the staybolts should be provided with the equivalent of a universal hinged joint at each end or that the body should be so flexible as to yield the necessary flexure. If the bolt body is stronger than the sheet then the angular movement of the bolts tends to buckle the sheet. As the outer sheet, on account of its thickness, is generally stronger than the bolt, it does not buckle, but the bolt bends close to the sheet, and if the bending overstresses the outer fiber it starts the check or initial fracture then and there. These, oft-repeated, account for broken staybolts, but what about the other end? The inner sheet being lighter is not as strong as the staybolt and yields by buckling around the hole to the angular movement of the bolt. Every boiler maker is familiar with the worked appearance of the sheet around staybolt holes in sheets which have been renewed. The bolts act as levers in the holes, stressing the material beyond the yield point, causing leakage, and this many times repeated leads to failure induced by radiating cracks. The extension of these cracks means firebox failure; their prevention means a measure of firebox life, as fireboxes seldom fail without premonitory cracks. The cracks as a rule start at the holes, and the evidence seems to be against the leverage action of the staybolts as being responsible. Here again flexibility seems to be the quality necessary to effect a reform that will add life to fireboxes as well as to staybolts. The comparative value of the two is manifestly in favor of the firebox. It costs about $1,000 to renew the box of an average size of engine, without counting the value of the loss of its time, and the addition of a year or two or more is well worth while. Stiff rigid body staybolts may be used with apparent good life, but at the expense of the flexibility of the firebox sheets, and it is not a hard question to solve as to whether the box does not cost much more in the end than the staybolts. The life of the two should be as coincident as possible, there being no salvage except scrap value of staybolts when the firebox is renewed.

As additional flexibility of the staybolt body seems most desirable to conserve firebox and staybolt life, a little study of the situation and possibilities will yield good economic results. From the foregoing arguments it is evident that large stiff body staybolts are a mistake—a costly one—as they fail because of their own rigidity and lack of flexibility to respond freely to the lateral movements required, and they also buckle and work the firebox sheets, inducing cracks and early failure. It would seem, therefore, that staybolts as small as a sufficient factor of safety will permit should be used and maintained so far as possible in firebox renewals.

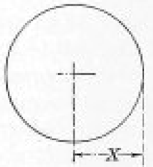


Fig. 1.

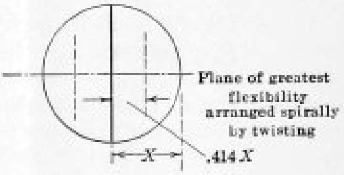


Fig. 2

Additional flexibility which will increase the staybolt and firebox life can be obtained by further sub-dividing the body of the staybolt, and it has been said that a rope or cable would make an ideal staybolt. The principle is true, but the practical application would be difficult on account of many factors. Manufacture of such a product must turn out a structure that will not greatly exceed the cost of the common staybolt; must have and maintain threads in continuous pitch during its application; must take the telltale hole required by law and also indicate the staybolt condition by the hammer test; must not too greatly multiply surface that corrosive waters can act upon to its early destruction.

These features have all been duly considered and the results are exemplified in the American Staybolt, which has a two-piece body, and this is twisted so that its most favorable plane of flexibility is presented in every direction. Fig. 1, below, represents the cross section of a solid staybolt body of approximately ⅞-inch minimum diameter. The relative flexibility of this size as compared with any other size, measured in outer fiber stress, is in proportion to the respective radii, this distance being shown by "X," which is the distance from the center or neutral axis to the outer fiber. This statement is true provided the sheets do not buckle and thereby relieve the bolt to some extent. The American Staybolt body cross section, as shown by Fig. 2, consists of two half rounds. Now there are two neutral axes instead of one, .414 of the distance from the center to the outer fiber, in the plane of greatest flexibility, which is a line drawn through the two neutral axes. The outer diameter being the same as in Fig. 1—*i. e.*, ⅞ inch—Fig. 2 presents a cross section in which the outer fiber stress for a given angular movement is practically cut in half that of Fig. 1.

This means much more than the ability to stand twice the number of angular movements, because the fiber stress in Fig. 1 is manifestly but a little below the yield point, as proven by the gradual fracture. If the stress be cut approximately one-half it will then be so low as to permit almost indefinite vibration of the above given amount.

So much for the addition to staybolt life. The effect on the firebox in the stressing of the material around the holes is reduced in even greater proportion, although the mathematical expression of this amount would be very difficult to derive, owing to the complex features of the problem introduced by the twist of the members. This feature seems essential, however, as it is not possible to say in just what direction each staybolt may move laterally, nor to arrange a bolt not twisted to meet any direction of strain. The problem is primarily that of a cantilever beam, anchored in the outer sheet and loaded at the inner end by the movement of the firebox sheet. A very simple practical experiment will show the great reduction in the leverage value of such a structure as compared with that of a solid bolt; the following test will illustrate: An 8-inch American Staybolt with ⅞-inch diameter body had one end solidly anchored on the bed of a lathe. The other end was fitted with a ball which ran in a cup, chucked ⅛ inch out of center so that the end of the bolt vibrated around a circle ¼ inch in diameter. The lathe belt was easy to pull by hand, the chuck could be run continuously at over 300 revolutions per minute without heating up or distress of the bolt body, and in fact was so revolved continuously for over twenty-four hours without effecting any failure. The two halves of the body could be felt and seen moving on each other. A solid bolt of the same dimensions was given a similar test except that it was impossible to run it over 100 revolutions per minute, and then not continuously, without very considerably heating up due to the working of the outer fibers. The belt was hard to pull by hand, indicating a very considerable addition of torque necessary to vibrate the bolt as before. Vibratory machine tests with the bolts under load gave corroboratory results, but due to reasons already explained are not considered as any more conclusive than the simple practical tests related.

The best test is, of course, that of service, and the American Staybolt has been marketed on a large number of railroads and in considerable quantities the past year, and is emerging from the experimental stage, having fulfilled expectations and requirements.

Undoubtedly the best results in staybolt and firebox life can be obtained by use of full installations, except possibly of the long radials. It is very difficult to map out the breaking zone so exactly as to include all the bolts liable to break. Convenience and economy of application and moderate cost favor the full installation of bolts having such features as will conserve the life of bolts and fireboxes.

Preparations for the Boiler Manufacturers' Convention

The executive committee of the Supply Men's Association of the A. B. M. A. will hold a meeting at the Waldorf-Astoria Hotel, New York, Tuesday, May 12, to formulate plans for the entertainment of the American Boiler Manufacturers' Association, which will hold its twenty-sixth annual convention in New York, Sept. 1, 2, 3 and 4, with headquarters at the Waldorf.

Hydraulic Pressing—IV

BY C. W. R. EICHHOFF

The Hydraulic Press

The most important hydraulic machines in a boiler shop are the flanging press and the hydraulic riveter. There are two styles of flanging presses in use—the so-called sectional flanging machine and the four-column hydraulic flanger. Both of these machines should be in a large boiler shop. The kind of work to be done will determine if a sectional or four-column flanger is more appropriate in smaller plants.

Both machines have their advantages, but for more general use the sectional flanger is more desirable. In shops where there is a great variety of work or where standard sizes of flanged or other work cannot be rigidly adhered to the sectional press is in its proper place. Fewer dies are required than in the four-column press, although the work is slower on large pieces of work. On small work the sectional machine works as rapidly as a four-column machine. The capacity of the sectional flanger is limited by the gap and the distance between the table and the vertical rams in their highest position. The four-column press is more rapid on large work, and the capacity is limited by the clearance between the four pillar screws. It is in its proper place where a great amount of standards have to be fabricated.

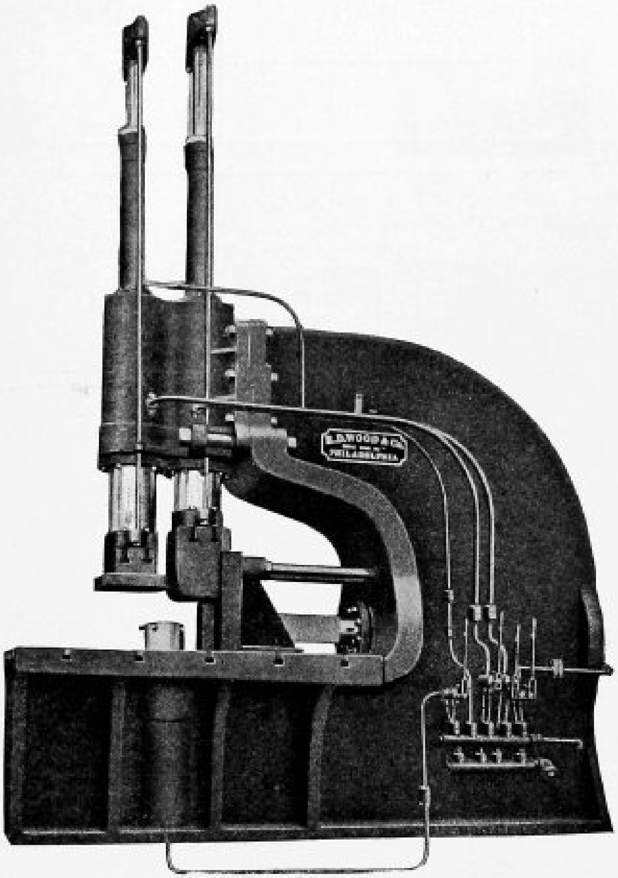


Fig. 3.—Hydraulic Sectional Flanging Press

All flanging operations should be performed on the machine if time and size of work justify it. Only lack of time and the amount of work can permit hand flanging. All standard dies and formers should be made of steel when a great quantity of work has to be turned out by the same former. These dies should also be machined and finished with great accuracy. It saves a lot of time, and corrections by hand operations are avoided. Lack of time and the small size of work again justifies the use of cast iron and unfinished formers. It should not be overlooked that even in such cases machine flanging might be preferable to hand work. Cast iron is good stock even as scrap, and can be broken up and used over again or sold.

It is the practice to make the patterns for formers and dies with a standard rule, if cast iron is the material of which they are to be made, and the forming is done on red-hot iron or steel. It should be borne in mind that the shrinkage of cast iron is about ⅛ inch per foot in light work; in heavy work the shrinkage is sometimes less than 1/10 inch; this is especially the case in round work. Steel castings shrink ⅛ inch to ¼ inch, and even more, depending on the kind of casting and the temperature at which it is poured.

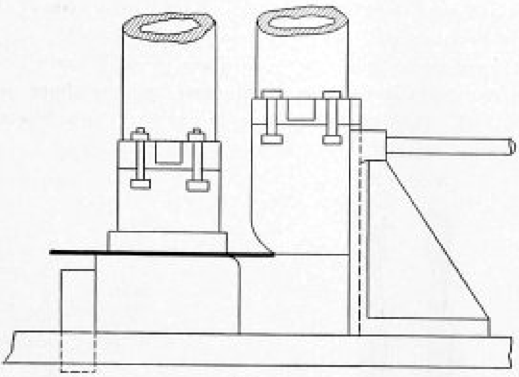


Fig. 4

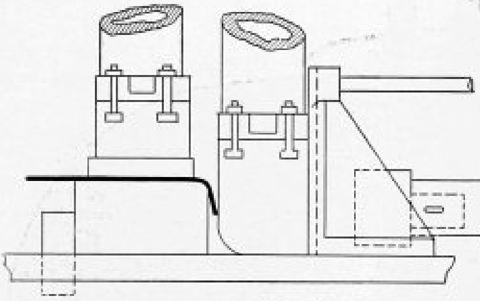


Fig. 5

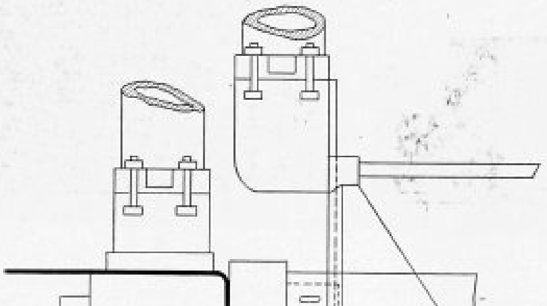


Fig. 6

The exact amount of shrinkage on hot plate work is a very varying quantity, and depends on many conditions, such as the temperature to which the material was heated, the temperature of the atmosphere, the form of the blocks, the clearance between the male block and the matrix, etc. It is, therefore, a practical impossibility to set down a hard and fast rule for shrinkage of such work. Where work of the simplest nature is required, one might get satisfactory results by adhering to shrinkage rules, but in cases of more complicated character the right results will only be obtained by experience and experiment. Common sense, good judgment and experience are a good guide in designing dies. For standard work it might be of advantage to make the formers first in cast iron, and when the correct result is obtained measurements can be taken for reference, and in case the cast iron die becomes unfit for any reason, the new former can be made of steel according to the measurements made.

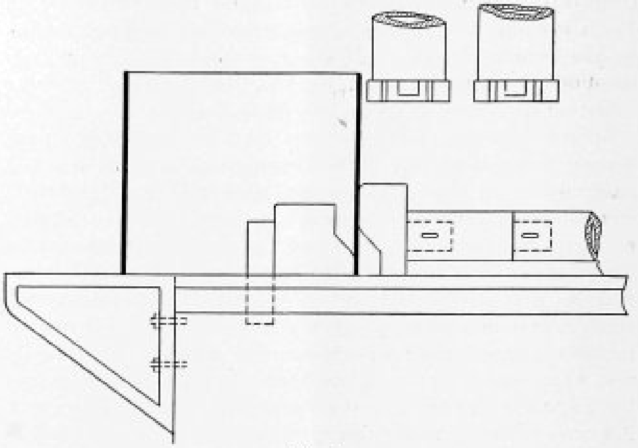


Fig. 7

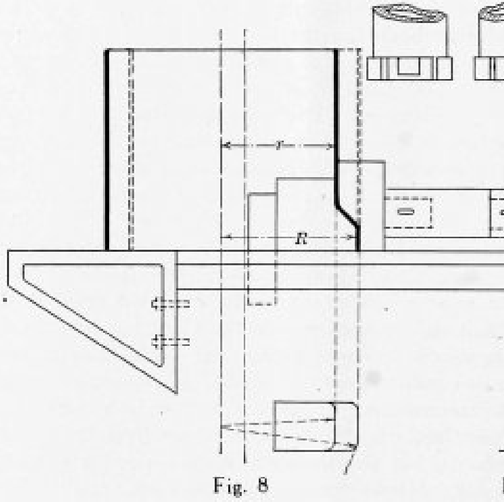


Fig. 8

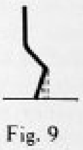


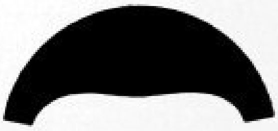
Fig. 9

For important work, such as for boilers, cold flanging and forming should never be resorted to. But there are cases where cold flanging is not objectional. In many cases the size and shape of dies can be determined only by trial. The springing of cold plates renders it practically impossible to determine the right shape at first hand. Light plate springs to a greater extent than heavy stock.

The designing of complicated dies and formers sometimes takes a lot of patience and money. It is for this reason that only men with a practical experience should be entrusted with such work. Flanging formers are sometimes designed in the drafting room without consulting the shop force. This is entirely wrong unless the draftsman has practical experience in that line. In such case the designer should be given all encouragement and authority in directing the first experiments with new formers; in fact, he should convince himself of the merits of his work by practical observation. It is entirely wrong to have jigs and tools designed in the office, and then the rest is simply left to the mercy of the shopmen. If anything goes wrong the draftsman gets the blame, where in many cases the ignorance of the man in the shops is respon-

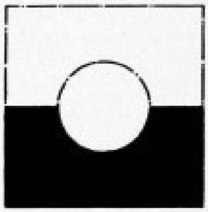
Lennox Serpentine Shear

SERPENTINE CUT



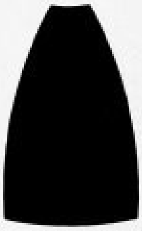
DEVELOPMENT OF CONE CUT ELIPTICALLY.

SIDE OF GEAR GUARD

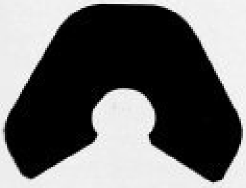


CULVERT SHIELD

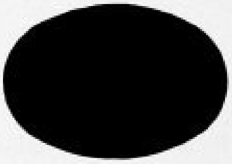
DEVELOPMENT OF CONE SHEET.



SECTION OF HEMISPHERICAL TANK BOTTOM.



DEVELOPMENT OF SHEET FOR TAPERING BODY WITH OBLONG BOTTOM & ROUND TOP.



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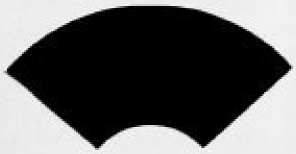
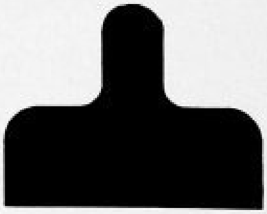
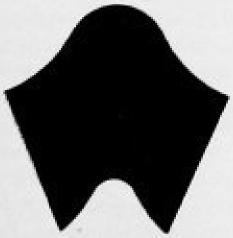


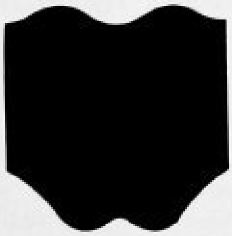
DEVELOPMENT OF CONE SHEET.



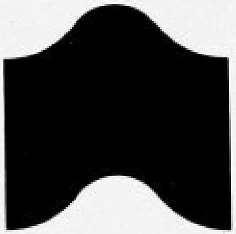
END OF CAR SEAT.



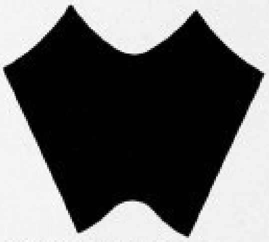
DEVELOPMENT OF OBLIQUE CONE SHEET



DEVELOPMENT OF SHEET FOR SLANTING TEE



DEVELOPMENT OF OBLIQUE CYLINDER SHEET



DEVELOPMENT OF TAPERING ARM OF Y-CONNECTION.

sible for the failure. Getting out good formers for intricate work is a task where brains, good judgment, patience, and experience are set to trial, and it does not require much to discourage a man in charge of such work when proper authority and encouragement are not given. The designer should co-operate with the foreman or flanger, and such co-operation will always lead to a successful end.

On the other hand, only persons directly interested in the work should be instrumental in the building of formers, and these are the designer, the patternmaker, foreman and flanger. In writing this I cannot help thinking of a concern, which is well known in the profession for its baboon system of management (as Mr. Emerson so strikingly calls it), where everyone from general manager, salesman, etc., down to the flanger's helper were designing flange blocks, making the job a source of disgust to the man familiar with such work.

THE SECTIONAL FLANGER

The sectional flanger as built to-day consists of a cast iron or steel frame, sometimes made in two parts bolted together. In this are contained two vertical and one horizontal cylinder, each provided with a ram. Most machines at present in use have a supplementary ram carried in a cylinder in the lower part of the frame. The following figures explain the operation of these different rams. In Fig. 4 is shown the position of the rams in flanging large plates, such as heads for marine boilers. The outer vertical ram in this case is used to clamp the plate on the anvil with a flat die. On the lower end of the second vertical ram is fastened the "plow," which is a die of suitable shape for bending down the edge of the plate. To resist any lateral strain this plow is sliding down in a strongly designed guide. In its downward motion the plow gradually bends the plate over the edge of the anvil, the plow then returns, the clamping die is raised some, and the plate moved along a trifle less than the width of the plow, when the operation is then repeated. The heated part being thus flanged, is then straightened and evened up by the horizontal ram. Straight as well as curved work can be flanged in this manner. For circular work it is well to build up an extension where a pin is fastened which guides the head by means of a hole in the center of the plate.

Fig. 5 shows the position of the rams after the plate is bent down, and Fig. 6 the position of horizontal ram when evening up the work. The anvil and the extension fixtures cannot be wedged or fastened down too strongly—in fact, all appliances should be strongly designed and the fastenings so arranged that no moving of the stationary parts can occur. The anvil die should be as high as the work allows. If this die is not high enough, the ram is traveling so low that the stuffing box leaks over the work in an annoying manner.

Fig. 7 shows the forming of an ogee on a vertical firebox boiler with the horizontal ram before forming, and Fig. 8 shows the operation when just completed. This forming required very much experimenting and patience before the writer had formers that gave good satisfaction.

In the first place, it is advisable to ogee only welded cylinders. With riveted cylinders the flange usually needs handwork afterwards to make corrections so as to make up a practically true cylinder. The anvil die has to be fastened very rigidly and the dies should be machined and finished. In cooling the flange has a tendency to bend inwardly, as shown in Fig. 9. This can be improved by making the dies tapered. But be careful not to give too much taper.

(To be Continued)

Drills, Reamers and Taps

A Few Pointers on the Upkeep of Small Tools —The Loss Due to the Use of Dull Tools

BY JAMES FRANCIS

"Blinkerty-blank the blankerty tap to Blankville——"

"Did you hear that, Mr. Francis? Isn't that awful? What is a superintendent going to do when a boiler maker talks like that?"

"Were it my business, Mr. Superintendent, I would do just two things—find out what made the man talk so, and then remove the cause!"

"Why, they all talk so. There isn't a day when you won't hear somebody 'cussing out' some tool or operation which is being performed. I don't like to hear it, but what can I do? You might post all the notices you had a mind to regarding the use of profane language, but still you could hear it if you were out of sight somewhere. What is the cause of all that talk, anyway?"

"The cause, Mr. Superintendent, seems to me that your shop tools and equipment are not what they should be, that——"

"Why, we have the best tools money can buy in this shop, and everybody used to say that it was the best equipped shop in the state!"

"Used to? That's all right. Perhaps they 'used' to say so, but do you hear them say that it *is now!*"

"N-n-no! Can't say as I remember hearing it said just that way."

"Well, Mr. Superintendent, if you want it right straight from the shoulder, here it is: You have got some mighty good machine tools in your shop. Good serviceable tools, capable of doing good work and lots of it. Tools a few years old, but still up-to-date and worthy of being kept in service."

"Thanks, Mr. Francis; I am glad to hear you say so, but we think we have a pretty good shop equipment."

"You have as far as the large tools and machines are concerned, but Mr. Superintendent, do you think that man would have 'cussed out' that tap if it had been just right—just what it should be to correspond with your machine equipment?"

"Why! What is the matter with that tap? We never have heard any complaints regarding taps which are in use in the shop!"

"Wasn't that a complaint which we heard just now? And a pretty loud and emphatic one, too! Why do you suppose the man was bawling-out that tap so, if the tap was working to suit him? Did you ever hear a man make such remarks about his hammer or about any of his personal tools? No? Well, I thought so. If a man has a hammer which don't suit him, he gets rid of it mighty quick—trades it off for a bunch of chewing or a dog. But he can't do that with the defective shop tool. He *must* use that tool when he can't get a better one, or when he can't break it without standing for a penalty. And his only safety valve in such cases—and there are too many of them in some shops—is in the use of language such as we heard—worthless, to be sure, but as the Irishman remarks, it 'aised his moind'! Now, Mr. Superintendent, if you don't want to hear constantly such remarks in your shop, then go on a still hunt after the cause therefor. Remove that cause and the boys won't cuss, even if they don't hold prayer-meetings every noon hour!"

"But I don't see what can be the matter with that tap. There is a tool room in the shop where all the tools are kept by one man and given out on checks as the tools are wanted. But let's go over to the tool room and look around a bit. If there is anything wrong with the taps or other small tools, then, Mr. Francis, you just 'show me,' and see how quickly I will 'show you' something!"

"All right, Mr. Superintendent, I'll go you. And here we are. Let's look at the taps first, then we will have a run-in with the drills, reamers and other small tools."

"Good. And, Mr. Francis, just take a look at this staybolt tap. Do you see anything wrong with it? Not a tooth missing, in good shape, and as fit for use as the day it came into the shop!"

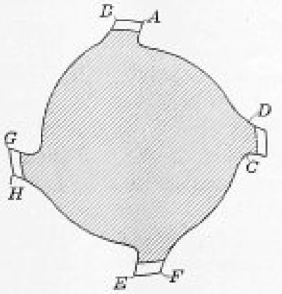


Fig. 1.—What Happened to the Worn Tap

"Wait a bit, Mr. Superintendent. Let's look a bit closer at that tap. There! Do you see, down pretty close to the tip end, that it seems worn extra bright, and that the cutting corners of the teeth seem a bit rounded? Yes? Well, that means that your tap has been worn smaller at the cutting edges, and that when run into a hole it cuts hard, binds in the metal, and requires great pressure to force that tap to its work. Now, just ask the first man who comes for a tool and listen to what he will say about that staybolt tap. Here is a man now. What's that he said when you asked him if anything was the matter with that tap? Said it 'cut harder'n hell!' Well, Mr. Superintendent, don't that show you?"

"But how can a tap get dull like that? Now here's a piece of tap which has been broken square off, same as shown in Fig. 1. Just 'show me' exactly what you mean, will you?"

"Sure I will, and mighty glad to do it, too. Here—I will change your sketch a bit and make some of the teeth, as at *A B* and *C D*, like new ones, while those at *E F, G H* are the same as all teeth in this piece of tap. Now just look closely at *A B* and you will see that the edge *A* is very sharp and square. The angle *B* is likewise very clean cut, and in a new tap, if you put a micrometer gage across the corners *A E*, it will be found a little larger there than across the corners *B F*. Only a very little, and in small taps the distance may be the same. But in large taps the 'relieving of the tap,' as it is called, has made the cutting diameter *A E* a very little greater than the clearing diameter *B F*."

"Say, Mr. Francis, won't that make the tap wear out quicker? After the sharp corners *A* and *E* become worn down the tap will be too small, won't it?"

"Yes, it will, a very slight amount, but the difference in diameter between *A E* and *B F* is so very slight that the tap should be practically worn out by the time the diameter has reduced appreciably. But the very slight difference makes all the difference in the world between the easy cutting and the hard-cutting 'man-killer' taps."

"Then if a tap is 'relieved' in the manner shown at *A B*, why does it get to cutting hard after a while?"

"Look at *G H*, Fig. 1, and see for yourself. Do you see how the corner *H* has been rounded off by wear until the diameter *C G* is actually less than the diameter *D H*? Well, that is what has actually happened to each and every one of your taps which 'goes hard' in the work. The taps have become dull. They are worn out, and you are losing money each and every time you use such a tap, in your shop or out of it!"

"How's that? We are getting the regular percentage on the time of all the men, and their time is counted whether they are working with dull taps or sharp ones, so what difference does that make about losing money by using dull taps?"

"It makes a big difference, Mr. Superintendent. It makes the difference as to whether you do three jobs or four jobs in a certain time. With the sharp tools your men turn out four pieces of work while they are turning out three with the dull tools. Now, then, don't it pay you better to turn over four sets of material per time than it does three sets? It sure does, even if the labor is lessened on each job. Just figure it this way, if you please: on similar jobs, where the material costs $24 per job, with 20 percent, or $4, for the shop. The labor required four days with the dull tools and three days on each job with the sharp tools. This, at 60 cents per hour, left 20 cents, or $2 per day per man 'for the shop,' and the balance sheet would read like this:

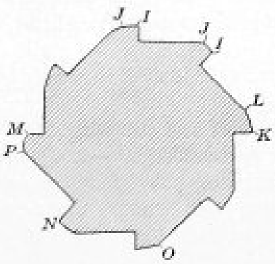


Fig. 2.—Worn Reamer

Work done Material profit at $4	Profit with dull tools	Profit with sharp tools
Four days' time, profit.........	$12	$16
Three days' time, profit........	8	6
Total	$20	$22

"What's that, Mr. Francis; $22 against $20 in favor of sharp drills and taps? Why, there must be some mistake there somewhere!"

"Dig out the mistake, if you can find it, Mr. Superintendent, but that's the way the dull tool business always looks to me. And that loss isn't a circumstance to what happens when you are doing piece-work, rushing repair jobs and working overtime at time-and-a-half or double time. Just figure some of those things and see what loss you can charge up each day, week and year, to the 'dull tool account'?"

"Why, great snakes! I can't see yet where there is such a loss just by having a few taps around the shop which are not quite as sharp as they were when first bought?"

"Why, if you make $4 more per day on material and $2 less per day on labor, it will leave you $2 to the good daily, won't it?"

"Oh, I see how it is! Say, I wonder if it is like that all through the shop?"

"Don't see why it should be any different in one part of the shop than in another. Just you dig into the time you are putting in on account of dull, imperfect, or out-of-date small tools, and see what saving could be made by a few hundred dollars expended for new drills, taps and reamers?"

"But, tell me, how do reamers and drills go wrong? They grind those tools when they get dull, so why don't they keep in good working order all the time?"

"The same things which dull taps also dull the reamers, and do it in a manner which cannot be cured by grinding without reducing the size of the reamer so it would be useless for standard holes. Fig. 2 shows how the thing is done. This picture shows the section of a reamer, supposed to be cut or broken square across. Note the sharp cutting points *I I*, which may be ground upon their radial face to sharpen the reamer. These cutting lips are relieved at *J J* by the metal being ground away until the reamer is smaller in diameter through *J O* than it is through *I N*. This gives the cutting edge a little clearance in the finished hole and permits it to enter without great friction. But the very fact of the metal being removed back from the cutting edge causes the reamer to become slightly smaller, as it is sharpened by grinding back the radial faces, *I I K*. This does little harm, and if that alone caused trouble there would be little of it in the boiler shop."

"Then what does cause the reamers to stick and go so hard, Mr. Francis?"

"It is this: Look at *M* and you will see that the cutting edge or point has become rounded off—exaggerated in the sketch so as to be clearly seen, but otherwise exactly as found in practice—and among your reamers when you look closely for that trouble, this wearing away of the diameter at the cutting edge causes the back of the lip to be greater in diameter, as through *J O*, than through *I N*, and this, of course, causes the reamer to bind and stick in the hole it is working. And it is for this reason that it takes so long, and so much hard work and 'elbow grease,' to ream holes in your shop."

"But why should the reamers do this? I don't see why the cutting edge should wear away. I supposed the cutting edge always cut itself clear and made a hole large enough for the body of the reamer?"

"And so it should do, Mr. Superintendent, and so it will do if you keep the reamer always sharp and not let it work after it is dull and needs sharpening a bit. Then is when the work of wear gets in its business. A sharp reamer never wears a bit—that is, in size reduction; it is the dull one which gets smaller very fast, each and every time it is used."

"But how does it do it? Why does a dull tool wear faster than a sharp one?"

"Because when you use a dull tool the pressure is very great upon the sides of the tool. It does not cut itself free, and every bit of chip, or grain of sand or dirt, is forced into action and digs and tears away the surface of the tool slowly but surely reducing the diameter and making the tool fit tighter in its hole, therefore requiring much more power to turn it ahead. Consequently the tool cuts with less speed, requires more power to drive it, and before you are aware of the fact all the ills and troubles pertaining to the use of a dull tool are upon you and the shop work, just as you are finding things in the shop now!"

"But, say! If the tools are worn small by dirt, sand, scale, etc., why don't that wear reduce the whole edge of the cutting lip? Why should the reamer (Fig. 2) wear smaller at *M* than at *P*? Why doesn't the dirt, if your claim is correct—why doesn't it wear off the whole surface from *M* to *P*, and therefore simply reduce the diameter of the tool, permitting it to cut as freely as it did when new, but making a smaller hole. Why doesn't it do this?"

"For the very simple reason, Mr. Superintendent, that the dirt and scale, grit, etc., as soon as caught between the lip of the tool *M* and the side of the hole, proceeds to tear chunks out of both the reamer and the work it is cutting. The grit manages to take a pretty fair-sized bite from each surface, but the work proves too much for the gritty particles, and they are crushed into dust after their first bite into the metal, the rolling action between the surface of the reamer or drill and the inside of the hole, proving too much for the particles, which are ground into dust by the gyratory action of the two surfaces. Therefore the grit particles are quickly torn to pieces and are unable to cut much of a chip by the time they reach the point *P* on the reamer; therefore the wear here is less than at the cutting point *M*, and therefore our reamers become worn smaller on their cutting lips, strike the work back from the cutting edge, and soon we can't force the tool forward with sufficient power to make the cutting edges spring forward enough to reach and 'bite' the inside of the hole to be reamed! And then, there you are, with a dull tool on hand which it don't pay to keep or to use again."

"Well, well! I never thought there was so much business going on at the business ends of taps and reamers as there seems to be. But how about the drills? They seem to hold their size pretty well, but we have a few which are smaller for an inch from the end than they are the rest of their length. What is the cause of such wear?"

"The same cause, Mr. Superintendent; gritty matter brought up by the twist of the drill and the grinding action set up thereby, as described above, only in this case it lasts long enough to reduce the entire width of the cutting lip. In fact, the drills run around and around in freshly brought up grit particles, until the entire diameter of the tool is reduced slightly. And, Mr. Superintendent, did you ever find a drill smaller at the cutting end, which has been used in deep holes?"

"N-n-no, don't know as I ever did."

"Well, I am willing to guarantee that most of the "worn-smaller-at-the-end-drills" are those which you have used almost entirely in short or shallow holes—say in thin castings, etc. Is not that a fact?"

"Well, I declare, I reckon it is so, come to think of it. Those drills which we use on radiator work always go small at the cutting end after some use, and we have to keep grinding off the ends of those drills to make them follow their own holes."

"There you are, Mr. Superintendent. That shows you what sand and other grit can and will do with drills, and don't you find similar troubles with the taps used in radiator work?"

"Yes, I do; radiator taps wear out faster than any other taps in the shop. They don't seem to give half the wear they ought to. By George! I begin to believe that there is a whole lot in what you have been telling me about the small tools in the shop, and I'm going to keep tabs on some of those tools to see what can be done to make them last longer and keep in better condition. Just watch what I do in the tool room during the next three months!"

The Champion Prize Competition

As the competition for prizes of $50, $35 and $25 offered by the Champion Rivet Company, Cleveland, Ohio, for the best essays on "How to Heat Rivets Satisfactorily" closes on the 20th of this month, all boiler makers who wish to compete for these prizes should forward their papers to THE BOILER MAKER promptly. The conditions for the competition are as follows:

The competition is open to all boiler makers.

All papers submitted in the competition should reach the office of THE BOILER MAKER, 17 Battery Place, New York City, on or before 12 o'clock, Wednesday, May 20.

The papers should not be signed by the author, but they should bear some distinguishing mark, and enclosed with the papers should be a sealed envelope bearing a duplicate of this identification mark and containing the name and address of the author.

The prizes will be awarded at the master boiler makers' convention in Philadelphia, May 25 to 28, by a special committee of three appointed by the president of the association.

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Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

According to figures published in *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company, there were 499 boiler explosions in the United States in 1913. The number of deaths resulting from these explosions was 180 and the number of persons injured 369, making the total number of killed and injured 549, or 1.4 per accident. As these statistics are based partly on press reports gathered throughout the country, their accuracy cannot be vouched for, but, in the main, they represent the average results from the explosions of steam boilers during the year. In connection with the statistics of boiler explosions there are also published statistics of the work of the inspection department of the Hartford Steam Boiler Inspection and Insurance Company. The total number of boilers examined by the company's inspectors in 1913 was 357,767; the number of boilers inspected internally, 144,601; and the number of boilers found to be uninsurable, 8,777. A summary of the defects discovered in these inspections discloses the fact that the main cause for trouble in boiler operation is poor feed water, as is evidenced by the number of cases of scale and sediment, together with defects due to corrosion. These items constitute by far the greater part of the defects discovered by the inspectors. Next to the feed water defects, the largest single item is that of defective tubes, including leakage around the tubes. Tube defects, especially if they are not attended to in time to prevent tube ruptures, are becoming a frequent form of trouble with watertube boilers, and they are very fruitful of personal injuries, often of a serious nature. The proportion of defects which might be attributed to poor workmanship in boiler construction, such as defective bracing, defective staybolting, defective riveting, leakage at seams, etc., appears to be much less than that due to defects brought about in the operation of the boilers, and this fact can be looked upon as an indication of the high standard of work which is being turned out in the boiler shops in this country.

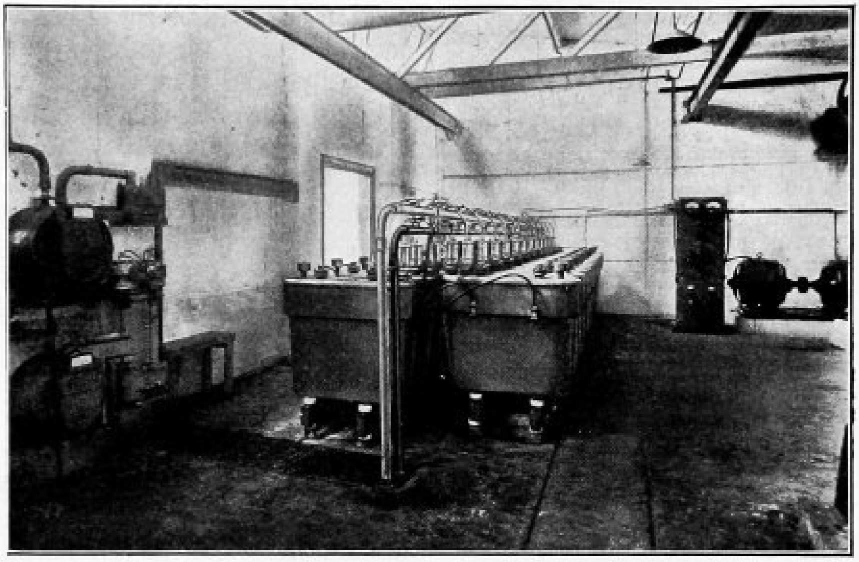
Master boiler makers should not fail to attend the eighth annual convention of the Master Boiler Makers' Association, which opens at the Hotel Walton, Philadelphia, Pa., on the twenty-fifth of this month. The benefits derived from intimate association with the leading boiler makers in the country and from active participation in the discussion of the most important questions affecting the trade will far outweigh the expense and inconvenience involved in attending such a convention. Moreover, such benefits as are derived by the foremen themselves will be a direct gain for their employers, and every possible aid should be given by employers to their foremen to enable them to be present at every session of the convention.

A paper describing four years' work of experiment on an apparatus for obtaining energy from the sun by means of a low-pressure boiler whose only fuel is the heat radiated from the sun was read recently before the Society of Engineers, London. After giving determinations of the solar constant and explaining the various percentages of this quantity that are available through the day for power purposes, the author describes four types of sun heat absorbers, and gives in detail the result of forty-eight trials of these absorbers, the latest pattern of which give a maximum thermal efficiency of not less than 40.7 percent and a maximum output of steam of 1,442 pounds per hour at a pressure of 15.8 pounds per square inch absolute. The results of these types of absorbers are compared by means of tables and curves, and from these the author has constructed a formula by means of which it is easy to calculate for a given type and size of absorber the total output of steam per hour if three things are known: First, the time of day; second, the humidity; third, the steam pressure. It has been known that humidity adversely affects the quantity of solar radiation arising at the earth's solid surface, but this is the first time that its effect on solar steam production has been quantitatively determined. The difference between the thermal efficiency of the solar boiler and the commercial value of the steam produced is ingeniously brought out by making it clear that in the case of such low-pressure boilers a high thermal efficiency is not necessarily the same thing as the most economical conditions of working, and that up to a certain limit the higher the steam pressure the more economical the working, though the thermal efficiency is then lower.

Engineering Specialties for Boiler Makers

The I. O. C. System in Australia

The advance of the art of welding and cutting of metals by the autogenous method is constantly creating a greater demand for pure oxygen. Since the purity of the oxygen plays such an important part in the speed and economy of any welding or cutting operation, it is evident that oxygen 99 percent pure will produce a better cut on a steel plate or billet in less time and with a smaller expenditure of oxygen than where oxygen of an inferior purity is used.

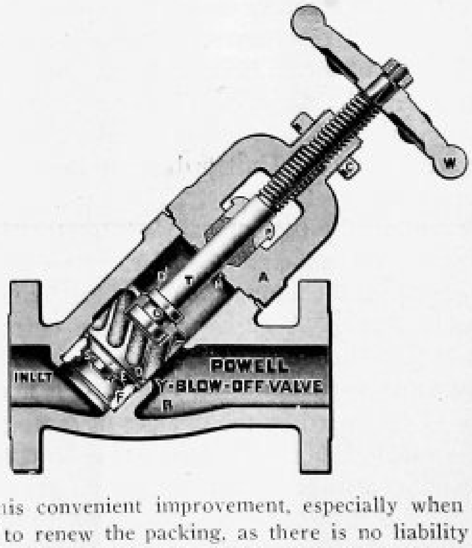


To obtain oxygen of so high a degree of purity, the only known method is the electrolytic, through the decomposition of water into oxygen and hydrogen by the aid of the electric current. As produced by the I. O. C. system of the International Oxygen Company, oxygen is 99.4 percent and hydrogen 99.8 percent pure. The fact that gases of such purity can be produced, coupled with the low cost of production and the facility of operation of an I. O. C. plant, brings the electrolytic method to the fore, not only in this country, but all over the world.

The accompanying photograph shows an I. O. C. plant installed by the Australian Oxygen Company, Melbourne, Australia. This plant was shipped from the works of the International Oxygen Company, in Newark, N. J., to Australia, where it was set up by the Australian Oxygen Company according to instructions furnished. The I. O. C. system is practically automatic, and once the current is turned on it will work continuously without any loss of efficiency or deterioration of parts. The Australian Oxygen Company is finding a considerable market for its hydrogen, which is produced simultaneously with the oxygen. For cutting steel and iron over 6 inches thick hydrogen is admittedly the best combustible, permitting of work which could not be done with acetylene. Hydrogen is used likewise in the manufacture of filament lamps, in the chemical industry, in the hardening of oils, etc.

The Powell Extra Heavy Iron Body Straightway White Star "Y" Blow-Off Valves

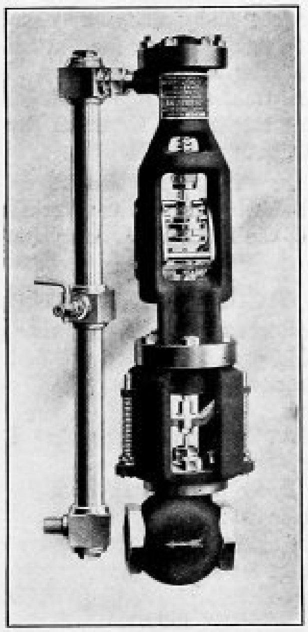
Of the various services to which valves are adapted, there is none which subjects the valve to such severe strains as the blow-off service. It is a common complaint that such valves break down or leak badly after a few months' usage, and are rendered practically useless. The Wm. Powell Company, Cincinnati, Ohio, has given this particular class of valve a thorough study, in an endeavor to remedy all the weak points and defects, and as a result, by adding many new and important features, have brought out the Powell "Y" blow-off valve, shown in the illustration. *B* is the body or shell. The yoke top *A* is secured to the body by studs. The packing is secured and regulated by the Powell patent pusher gland *P*, which is operated by the outside screw nut *C* above the bridge of the yoke *A*. This simple construction enables the engineer to adjust the pressure at any time with an ordinary monkey-wrench, without having to fuss with the old-fashioned bolt and nut style. All engineers will appreciate this convenient improvement, especially when it is required to renew the packing, as there is no liability of skinning his knuckles when doing so. The faces *D* and *H* fitting tight, permit the valve to be repacked under pressure when wide open. The plunger *D* is of brass, milled to receive the collar on stem *T*. Spiral grooves are cast on the outer face, which, receiving the pressure from the steam as the valve is opened, cause it to revolve as it nears the seat when closing. This gives the disk a grinding motion, and keeps both disk and seat clean of scale and sediment. The seat ring *F* has



been dropped down lower to better protect it from the cutting effect of the rushing steam as the valve is opened. To this plunger is attached the Powellium white bronze reversible and regrinding disk *E*, secured to stem by the disk nut *S*. The disk face and seat-bearing are constructed with such an angle that it is impossible for any sediment or scale to lodge between the same, either while blowing off or closing down the disk, and the superior metal of which they are constructed insures a long life to the valve. They are made in 2-inch and 2½-inch sizes, with either screw ends or flanged. To regrind, it is only necessary to stick a plug or nail through the hole *R* in the plunger, which locks the disk, and then rotate back and forth with a little fine brick dust or sand on the bearing. The seat ring *F* is of Powellium white steam bronze, and has two faces, so that when one is worn the ring is readily removed and reversed by means of the lugs cast in the throat of the ring. The disk *E* is not only regrinding and reversible, but is also renewable. It is made from "Powellium," a white bronze, which, in point of service and durability, it is claimed, will outlast any other known disk metal. It is guaranteed to stand 2,000 degrees of heat. Each valve is tested to 250 pounds' hydraulic pressure, and passes through a careful inspection before leaving the factory. It is guaranteed to stand the severe service to which such a valve is subjected.

"Thermofeed" Differential Pump Governor

The "Thermofeed" differential governor, which is manufactured by Ronald, Trist & Company, Ltd., 4 Lloyds avenue, London, E. C., is a device which shuts off the supply of steam to any class of steam or power-driven pump whenever the pressure becomes excessive, the excess sufficient to stop the pump being anything from 3 pounds per square inch upwards. The device also admits a supply of steam to the pump by opening a double-beat throttle valve when any predetermined lower pressure is attained. A closed cylinder fitted with a piston which is fitted with a rod extension receives the main water pressure from the feed line on its upper side, while on its lower side is fitted a spiral steel spring. In this way the pressure on the feed line is converted into mechanical movement which is utilized to operate the control mechanism.



A downward movement of the main piston and its rod with its movable head pieces depresses a spindle to which is fitted the "thermofeed" double valve. This permits steam entering into a small cylinder, which, in turn, by means of a piston directly over the rod or spindle and the double-beat throttle valve, closes the latter. One of the circular plates or head pieces on the upper or power cylinder will, on a drop in the pressure of the feed line and on its upward journey, engage with a pair of projections attached to a curved trigger piece. This trigger piece, having previously held the control valve in its down position until the upward pull on the projections permits it to trip, causes the small cylinder to exhaust to the atmosphere and thus readmits steam to the pump.

The control spindle, to which the control valve is attached, has a central poppet piece working in conjunction with a spring. The object of this is to prevent injury to the valve mechanism from any violent blow which might be given by the upper piston through erratic movement of the pump, such a blow being taken by two projections cast on the frame.

Personal

Henry Siem, for many years foreman boiler maker of the Union Railroad Company, Hall, Pa., resigned April 7. Mr. Siem recently rented a very large farm and intends to devote his time in future to farming.

Albert H. Bair has been promoted to the position of foreman boiler maker at the Union Railroad Company shops, Hall, Pa., succeeding Mr. Siem. Mr. Bair is a young boiler maker of great promise, and his many friends are greatly pleased at his promotion. At the present time the Union Railroad shops are very busy, running double time. The work consists principally of renewing fireboxes and general overhauling of their engines. During the winter four tanks of large capacity were built at the shops.

Theo. T. Mersereau, for many years an assistant inspector of boilers in the United States Steamboat Inspection Service, was appointed March 16 State Inspector of Boilers and Engines, Department of Public Works, State of New York, as the result of a competitive examination previously held to fill the position. Although Mr. Mersereau resigned from the Steamboat Inspection Service several years ago, since then he has been engaged in educational work and has represented various business enterprises. At the time of his appointment Mr. Mesereau was the New York representative of the Kingsford Foundry & Machine Works, of Oswego, N. Y., with offices at 80 Broad street, New York City. John W. Waters, formerly assistant local inspector of boilers for the United States Steamboat Inspection Service in New York, has succeeded Mr. Mesereau as the New York representative of the Kingsford Foundry & Machine Works.

N. S. McDonnell, a well-known boiler maker at Des Moines, died recently at his home in that city at the age of seventy-two. Mr. McDonnell learned his trade as a machinist and boiler maker at Memphis, Tenn., and from there he moved to Des Moines, where he became established in the boiler making business.

Technical Publication

The Engineering Index Annual for 1913. Size, 6½ by 9¼ inches. Pages, 510. New York, 1914: The Engineering Magazine Company. Price, $2.00.

The publishers of The Engineering Index Annual are to be congratulated upon their promptness in issuing the volume for 1913. The book was on the market within six weeks of the close of the calendar year, a service that will be greatly appreciated by the users of such an index. As has been the case in previous years, the book comprises a complete index of all articles published in the engineering press during the year, so classified and cross-indexed that a few moments' search will inform the specialist of the number, length and nature of all articles that have been published during the year on any engineering subject. Furthermore, the publishers of the index are in a position to supply at short notice and at a minimum cost copies of any of the articles indexed, if not out of print. The value of this book is obvious, and a copy of it should be in the library of every engineer.

Programme of Master Boiler Makers' Convention

The business sessions of the eighth annual convention of the Master Boiler Makers' Association will be held in the Hotel Walton, Philadelphia, Pa., May 25, 26, 27 and 28.

Immediately upon arrival each member should report for registration of himself and ladies, etc., and receive convention badges with such instructions as may be of value during the progress of the convention. The programme is as follows:

MONDAY, MAY 25

Registration of members and guests begins at 9 A. M. Convention called to order at 2 P. M.

Invocation, Bishop Joseph F. Berry.

Addresses by Honorable Rudolph Blankenburg, Mayor of Philadelphia; Mr. Alba B. Johnson, President, or Mr. S. M. Vauclain, Vice-President and General Manager, Baldwin Locomotive Works, and Mr. Wallace W. Atterbury, Vice-President, Pennsylvania Railroad.

Responses by Mr. M. O'Connor, Past President; Mr. C. P. Patrick, Fifth Vice-President, and Mr. G. W. Bennett, Past President.

Annual address by Mr. T. W. Lowe, President of the Association.

Routine business, annual reports of the Secretary-Treasurer.

Miscellaneous business, appointment of special committees, announcements, etc.

TUESDAY, MAY 26 (MORNING SESSION)

Convention called to order at 9 A. M.

Addresses by Mr. S. G. Thomson, S. M. P. & R. E., P. & R. R. R., and Mr. Frank McNanamy, Chief Boiler Inspector, I. C. C.

Responses by Mr. William M. Wilson and Mr. J. B. Tate, Fourth Vice-President.

Report of committee on "What are the Advantages or Disadvantages of Using Oxy-Acetylene and Electric Processes for Boiler Maintenance and Repair?" F. A. Griffin, chairman.

Report of committee on "What Benefit has been Derived from Treating Feed Water for Locomotive Boilers Chemically, etc.?" T. F. Powers, chairman.

Report of committee on "What can the Association do to Get a Uniform Rule Regarding the Load Allowed on Staybolts and Boiler Braces?" C. P. Patrick, chairman.

Report of committee on the "Advantages or Disadvantages of Flexible Staybolts to be used in Crown Sheets to Take the Place of Sling Stays." C. E. Steward, chairman.

Report of committee on "The Advantages or Disadvantages of Combustion Chambers in Large Mallet or Pacific Type Engines Other Than a Shorter Flue." A. N. Lucas, chairman.

AFTERNOON SESSION

Convention called to order at 2 P. M.

Report of committee on "What Shape and Size Head of a Radial Staybolt in Crown Sheet of Oil-Burning Engines Give the Most Efficient Service?" C. L. Hempel, chairman.

Report of committee on "Does the Method of Flue Cleaning or Rattling Have Any Effect on the Further Scaling Up of Flues?" B. F. Sarver, chairman.

Report of committee on "Combustion and Fuel Economy." C. F. Petsinger, chairman.

Report of committee on "Proper Inspection of a Boiler While in Service." C. E. Fourness, chairman.

Announcements.

WEDNESDAY, MAY 27

No business session.

Members and visitors will go to Parkesburg and Coatesville by a special train and trolley cars as the guests of the Parkesburg Iron Company and the Lukens Iron & Steel Company to visit their plants. Luncheon at Coatesville.

THURSDAY, MAY 28

Convention called to order at 9 A. M.

Addresses by Mr. Henry B. Hartley, Past President American Boiler Manufacturers' Association, and Superintendent Boiler Department, William Cramp & Sons Ship & Engine Building Company; and Mr. John M. Lukens, Chief Inspector Bureau of Steam Engine and Boiler Inspection Department of Public Safety, Philadelphia, Pa.

Responses by Mr. A. N. Lucas, Past President, and Mr. E. W. Young of the Executive Board.

Committee reports on "Law" and "Topics for Convention of 1914-1915."

Unfinished business.

Election of officers.

Good of the Association.

Announcements and closing exercises of the convention.

ENTERTAINMENT

The annual dinner will be served at the Walton at 7 P. M. on Thursday, May 28. The Women's Auxiliary of the Association will hold its annual meeting at the Hotel Walton at 11 A. M. Tuesday, May 26.

The Boiler Makers Supply Men's Association has arranged the following programme of entertainment for the members of the Master Boiler Makers' Association and the Women's Auxiliary:

MONDAY, MAY 25

Informal reception to the ladies, Hotel Walton, 4 to 6 P. M.

General reunion and reception, Hotel Walton, 8 P. M.

TUESDAY, MAY 26

Automobile trip for the ladies with luncheon at Valley Forge, 11.30 A. M.

Theater party, 8 P. M.

WEDNESDAY, MAY 27

Trip to Parkesburg and Coatesville by special train, leaving about 9 A. M. to visit plants of the Parkesburg Iron Works and the Lukens Iron & Steel Company. Return to Philadelphia by special train about 4.30 P. M.

Moonlight boat ride on the Delaware River with light refreshments and dancing, 8 P. M.

THURSDAY, MAY 28

Visit to the Baldwin Locomotive Works in the afternoon.

Annual dinner of the B. M. S. M. Association, Hotel Walton, 7 P. M.

Addresses Wanted

The correct addresses of the following members of the Master Boiler Makers' Association are desired by the secretary of the association, Mr. Harry D. Vought, 95 Liberty street, New York:

L. Fenstermaker, foreman boiler maker, Erie Railroad, 621 South Union street, Galion, Ohio.

John Greene, boiler foreman, C. H. & D. R. R., 1416 East Ohio street, Indianapolis, Ind.

Charles J. Murray, foreman boiler maker, C. & N. W. R. R., 125 North Main street, Chadron, Neb.

F. E. Owen, boiler foreman, C. H. & D. R. R., Belmont street shops, Indianapolis, Ind.

Michael H. Newgirg, foreman boiler maker, C. & N. W. R. R., 1127 Benton avenue, Boone, Iowa.

Hugh McKay, foreman boiler maker, Canadian Northern Railroad, Beresford Block, Fort Route, Suite 2, Winnipeg, Canada.

S. L. Brakebill, foreman boiler maker, L. & N. R. R., Etowah, Tenn.

Mail matter sent to the above addresses has been returned as undeliverable by the Postoffice Department because the individuals have moved without giving notice of change of address. Any information regarding the whereabouts of these members of the association will be greatly appreciated by the secretary.

Letters from Practical Boiler Makers

Welding Firebox Patches

It really seems strange that a welder on firebox work can weld cracks successfully, and yet have trouble in getting a patch to hold, as the writer has found welding of cracks to be the more difficult operation, for even if the weld held, a crack very often would open up adjacent to the weld.

The welding of free end patches, that is, patches where two sides would not require welding, should be welded without the least difficulty, inasmuch as there is no expansion and contraction to be overcome, due to the free ends taking it all. In selecting the design of the patch, if it happens to be in the side sheet near the mudring, the writer favors extending the patch down to take in the mudring rivets, and thus making a patch with one free end. In applying a patch like this, the writer has found the following method the best of several tried.

If a cutting torch is available, cut the patch out with it and cut it bevel, so that when chipping to finished size the chip will be a very light one. Chip off all scale. In laying out the patch in order to insure good mudring holes, it may be well to leave them blank and drill after the patch is applied, although after a few patches are applied, the workmen become familiar with the action and holes can be laid out and punched before the patch is applied. Measure off the patch opening to get the size, and make the patch about 3/16-inch longer from top to bottom than the opening. Get the length of the opening in a horizontal direction and make the patch long enough to allow for about ⅛-inch or 3/16-inch opening at each side of the patch, and about 1-inch camber in the patch. Roll the patch and fit, as shown in the sketch.

In welding vertical welds, it has been found best to work from the bottom. Tack the two top corners to keep the patch from warping and creeping, and then start at one bottom corner and work up. Work up one side to the top and then across the top, and finally up the last side. In welding across the top, warm up the plate occasionally all over to equalize the expansion somewhat.

In applying an enclosed patch, or one that requires welding on all sides, the patch should be dished or expansion grooves be fullered or rolled at right angles to each other on a side and end of the patch. In making the weld, the writer favors working up one side, and then weld about 3 inches first on the top and then on the bottom, and work these two sections about 3 inches at a time alternately all the way across the patch. This causes the patch to expand equally, and it is now ready to weld the last end, welding from the bottom up.

The first patch mentioned will be practically straight when the welds are completed. In the enclosed patch, the expansion grooves should be heated frequently. This will make them more susceptible to the expansive and contractive strains and place the strains where intended.

The main object in welding from the bottom up is that it is much simpler, due to the fact that a base is first formed that acts as a bottom for the flowing metal, and there is no slag formed to drop into the molten metal. Get the metal thoroughly heated and red hot at least 1 inch from the weld. It should be remembered that there is a large area of metal that should be heated to give proper radiation and prepare the plate for the quickly molten fusing rod.

There are many things imperceptible to a beginner that are contributing factors to a successful or unsuccessful weld. For boiler welding, a knowledge of boiler construction and repairs is a valuable thing. The knowledge of how steel acts under certain conditions is something that is acquired only by experience. Impure oxygen is a prolific source of trouble. Oxygen (high-pressure) purchased from oxygen manufacturers is as a rule better than 95 percent pure, and as such makes a good weld, although the writer frequently finds tanks containing quite a percentage of moisture and other impurities. "Home made," or chemically-made oxygen (made on the premises from chlorate of soda or potash, and black dioxide of manganese) is frequently impure, due to the filtering water in the scrubbing barrels not being changed regularly, air in the gas bell, and a vacuum not being on the oxygen tanks before charging. As a rule, cheap labor does this work and these men do not realize the importance of care in the manufacture.

How the Patch is Fitted

In welding a perfectly neutral flame is necessary to have a high efficiency weld. An excessive flow of oxygen oxidizes the weld. An excess of acetylene carbonizes it. A too rapid flow of acetylene from a compressed acetylene tank draws acetone into the torch, making an impure mixture. Use good welding wire. If you are not sure of a good grade of iron wire, cut strips of firebox plate, which is a very acceptable substitute. Above all things, do not hurry a weld. Get to the bottom of the opening, get your flame right, and take your time.

C. E. Lester.

Dunkirk, N. Y.

How About an Education?

Flex Ible's article in the April issue of The Boiler Maker is timely and should appeal strongly to apprentices and boiler makers who are anxious to rise above the regular nine or ten-hour daily routine of manual labor.

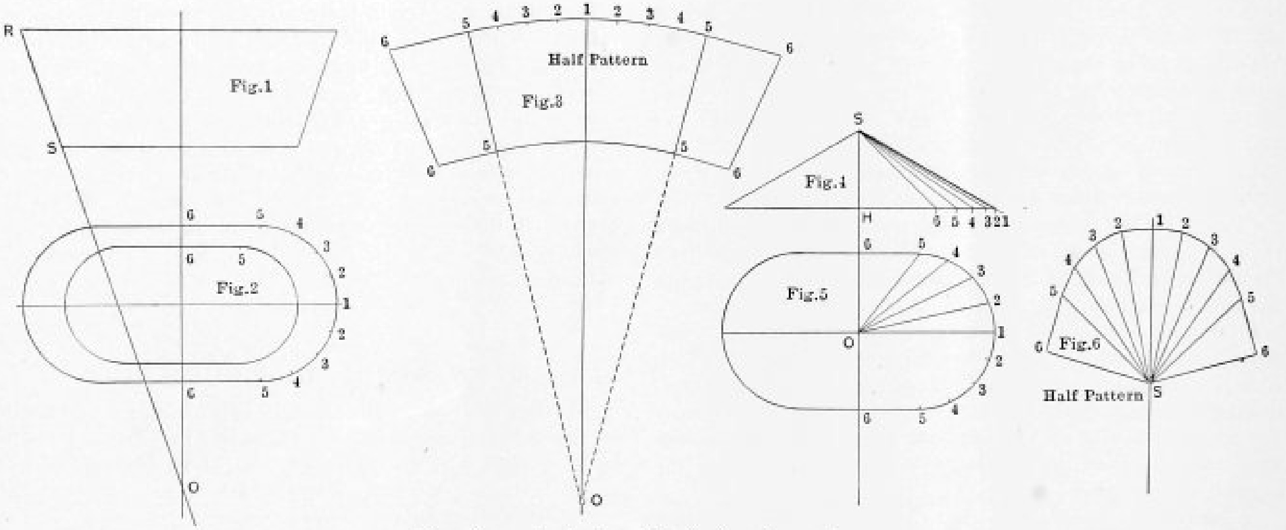
No other work in the boiler shop is so interesting and of a more educational character than the work on the laying out bench. The development of boiler plate and light sheet metal problems involves a technical understanding of the principles and their application to practical problems which arise. There is much responsibility placed upon the layer out, and if he does not understand the requirements of his work much time, money and labor will be lost. Boiler manufacturers want capable men to handle this branch of the business. Some shops pay high salaries, but, in general, more should be paid to the men who are employed in this work.

It is imperative that one who lays out patterns must understand how to make the proper allowances for all plates which are to be either rolled or flanged. He must also understand mathematics, projection and triangulation systems of development. These terms may sound theoretical and cause one to shrink from the study of them. They are unfamiliar to most of the men employed in the shop, but as Flex Ible says, every time you draw something on the plate or drawing board some principle of these subjects is used. It should be the aim of every ambitious young man employed in the boiler shop to get a good understanding of these principles and their application to the development of practical laying out problems.

Some will say that they have not the opportunity. This, however, is not so, because there are on the market many books which treat on the subjects of laying out, boiler construction, etc., also technical magazines and correspondence schools which give instruction in this class of work. So there is no need to offer a flimsy excuse of this kind. What was good practice in the early days for a boiler maker is practically obsolete to-day. The coming boiler makers have better opportunities by the use of the available instruction just mentioned. To rise from the ranks of the average mechanic means personal work and effort, and the sacrifice of spare time to the study of subjects that are of importance in this work.

It should be an incentive for young men to forge ahead and not complain of their lack of chances, when it is considered that the old-timers in the boiler-making business had so few opportunities to obtain a knowledge of the various details in boiler work. It is evident that with more knowledge of the business, better work will naturally result. Boiler making is a scientific industry. If boilers were made otherwise they would soon blow up.

Subjects such as heat and steam, elementary mechanics, strength of materials, boiler construction, descriptive geometry, etc., enter into the matter of proportioning a boiler strong enough to meet certain requirements. The boiler maker and apprentice should not feet satisfied until they have gained an understanding of the above subjects. A man who is satisfied will not advance very far. An ambitious person is never satisfied until he realizes the fulfilment of his efforts and succeeds. He always finds plenty of room at the top of the heap. The excuse often heard is the one on lack of opportunity. Opportunities are rising every day, but the question is, "Are you prepared to meet them?" The trouble with most people is that they have not the will power to sacrifice of few of their worldly pleasures and use some of the spare time so expended to the building up of a better knowledge of subjects which are of vital importance to them and their welfare.



Easy Lesson in Laying Out for the Apprentice

One reason that the boiler maker is looked upon as a person who does only the laborious work of his trade is due to the fact that he does not have the understanding of the theoretical principles involved in his work, and consequently he is not consulted on important questions. To secure the recognition due the men employed in the boiler making industry will require that the mechanics obtain for themselves the theoretical education they need in order to keep up their end. Some old-timer will say that he has been building boilers, tanks, etc., for the past thirty or forty years, and up to this time he has seen no need of a theoretical education. He reasons that what is good enough for him should be good enough for Jack, Pete and Tom and the other apprentices that are serving their time. That is a poor stand to take, as it only tends to hinder the younger man from pushing himself forward. It should be his aim to help the apprentices secure a firmer foundation for the essentials in their trade, and also point out the means whereby they will obtain a technical education of the subjects included in the boiler business.

In my opinion, the layer out is the most important man in the shop. His responsibility is great. He must have enough work laid out to keep the plant busy, and his knowledge of the subjects of geometry, trigonometry, mathematics, practical projection and triangulation must be of such a high standard that accurate and well-fitting patterns will be the result. He should within the bounds of reason receive more consideration than he does. His compensation for the services rendered is small when you compare his work with others employed in the trade. Sufficient interest should be taken in these men to see that they are rewarded for their efforts in endeavoring to advance themselves, as thereby the interests of the firm will unquestionably be advanced. This interest would be doubly repaid.

Apprentices should make the most of their present opportunities and prepare for advancement. They should study all they can. Anyone who is ambitious need not take a back seat and watch the other fellow get all of the good things. Training is essential to success. Ability, courage and persistence are good qualities and are necessary, but alone they will not pave the way for a successful career. To succeed you must study and keep up-to-date. Every boiler maker and apprentice should subscribe for a trade journal. All ambitious persons who have not obtained an education should do so, as there is no excuse with all of the means now at their disposal and within the reach of all.

C. B. Linstrom,
Asst. Principal, School of Boiler Making, I. C. S.

Two Easy Lessons for the Apprentice

Figs. 1 and 2 show the plan and elevation of an article oblong in shape with large and small ends somewhat similar to the body of a sheet metal bathtub.

To lay this out, divide the half circle on the plan into equal parts, as shown at 1, 2, 3, 4 and 5. On the left side of Fig. 1 set a straight edge to the points *R* and *S*. Also strike a perpendicular through the plan and elevation. Set trammels to the points *O* and *R* and carry the distance to Fig. 3. Strike off the arc as shown and set the trammels to *O* and *S*, Fig. 1; transfer the distance to Fig. 3 and strike the arc from point *O* as shown. Set dividers to one of the spaces on Fig. 2 and set off on each side of the center line at Fig. 3, the same number of spaces as there are in the plan. Set a straight edge to points 5 and *O* and draw in line 5-5, which will give the half pattern for the conic section. Set a square to the line 5-5 and draw line 5-6, making it equal in length to half of the side of the article at the top. Square off the bottom distance in the same way and draw in line 6-6, which completes the half pattern of the article to the rivet lines. The laps should be allowed outside of this. In setting out the plan for this layout all lines must be drawn to the neutral axis of the material.

Figs. 4 and 5 show the plan and elevation of a raised cover for an oblong tank. To lay this out, divide one quarter of the plan into equal parts numbered as shown, connect the points to point *O* in the center of the plan. Take these different lengths and set them off from the point *H*, Fig. 4, along the base, numbering them to correspond with similar points in the plan, and connect them with lines to the point *S*.

Draw the line *S*-1, Fig. 6, and from the point *S* set off the length of 1-*S* taken from Fig. 4. Set dividers to one of the spaces in the plan and strike an arc on each side of point 1. Take the length of the line 2—*S* from Fig. 4 and set this off from point *S*, Fig. 6, intersecting the arc at point 2, on each side of the center line. The lengths of the other lines are set off in the same manner until points 5 are reached. Take the distance 5-6 from the plan and strike arcs from the points 5, Fig. 6; then take the distance *S*-6 from Fig. 4 and, with *S*, Fig. 6, as a center, strike arcs intersecting the arcs at points 6. Draw in the lines to these points and the pattern to the rivet lines is complete except for the lap and flange which must be added. JOSEPH SMITH.

Lorain, Ohio.

Layout of Dished Head

To layout a dished head in sections, draw first a profile of the dished head to the neutral line of the material, as shown in Fig. 1. In this case the material consists of plates ¾-inch thick joined with lapped seams. Butt-strapped joints would probably be better on such thick plates, but they are costly to construct. Eight plates of the shape shown in Fig. 3, together with the top piece shown in Fig. 2, will complete the head. A plan view of the head, showing the eight plates and the top of the center piece, is shown in Fig. 4.

There are four outside and four inside plates. Between the flanges of the four inside plates and the shell of the tank should be placed ¾-inch fillers. There should also be ¾-inch fillers between the top center piece and the inside plates. There should be no scarfing on the dished head, but the fillers should be made a close fit up against the outside sections, so that the calking can be done properly.

The writer has made globe boilers which were 12 feet in diameter in the shape of a ball made with twelve segment plates and two dished end plates. The plates were ⅝-inch thick and ⅝-inch fillers were placed under edges of the plates.

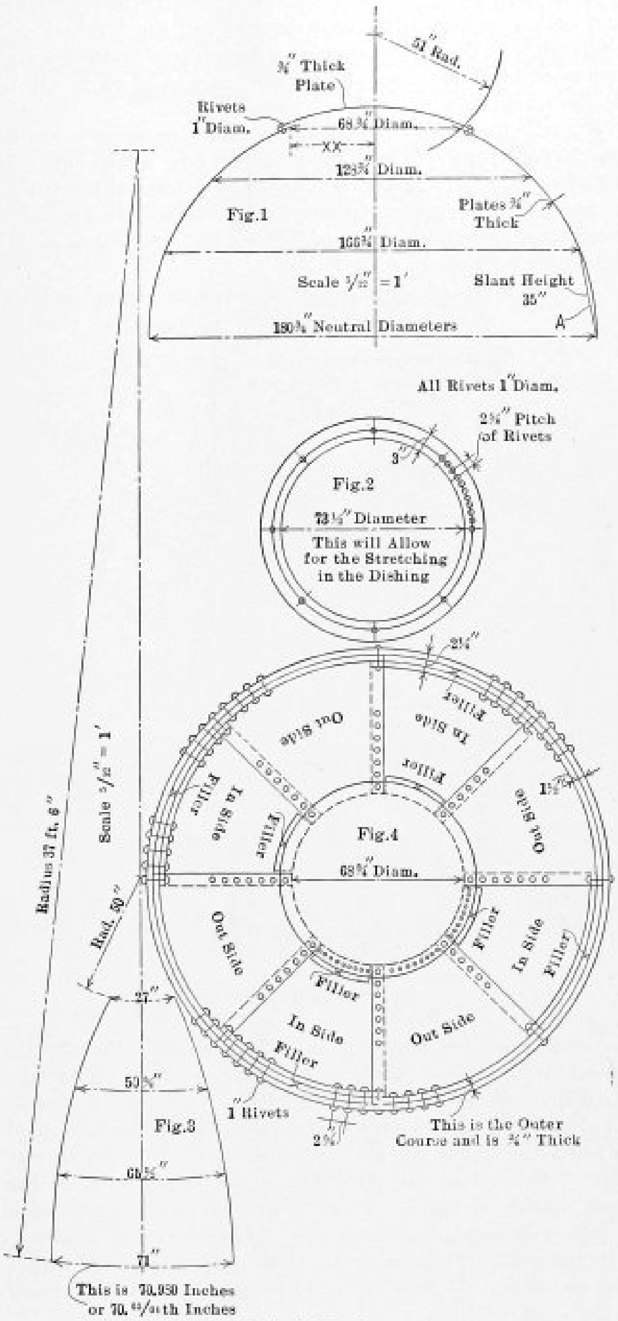
To the pattern shown in Fig. 3 all laps and flanges should be added. The four outside segments can be scarfed at four corners of each segment, but the scarf should be made very long and thin, although even then the job would not have the appearance of being properly done.

It is imperative that anyone who undertakes to layout sectional dished heads of this kind should have not only experience in laying out, but also experience in the drawing and contracting of hot plates when they are set to dies. Any experienced layerout can figure out the sizes of the plates when the radii are given. The radius at the small end is obtained as follows:

Take one and one-half the length at *X*, Fig. 1, and this will give the radius. The radius at the large end is obtained by multiplying the slant height, *A*, Fig. 1, by half the diameter of the large end of Fig. 1 and dividing that by one-half the difference of the two bottom diameters, Fig. 1. In this case 180 inches is the diameter of the large end and 166 inches the diameter at the next division. The difference is 14, and one-half of 14 inches is 7 inches. The radius at the large end is 37 feet 6 inches, and the radius at the small end 50 inches. The slant height of *A*, Fig. 1, is 35 inches.

HENRY MELLON.

Boston, Mass.



Dished Head

How He Tipped the Flue

Not many years ago I was an instructor in forging in a small Western college. It was my duty to show youngsters how to draw out, upset, weld, harden, temper, etc. But it wasn't my duty to teach flue tipping. I never tipped a flue in my life, and I guess I never will, especially now that I am all out of practice.

Among other students that attended that college was a crowd of young fellows, who stayed there only long enough to learn to run a traction engine—in other words, a threshing engine. And since it is of value for engineers of this type to know how to make all sorts of repairs on the engine and boiler, as well as to know how to run the infernal machine, it was deemed advisable to have them learn the elements of blacksmithing, and, of course, it was up to me to do the teaching.

I taught to the best of my ability, but it never occurred to me that each one of them should know how to tip flues. If I had thought of it I, perhaps, would have learned how to do it myself, before trying to show others how. At welding I considered myself "pretty good," although I never was an expert, by a long shot.

It occurred to the gentleman who taught engine practice, however, that flue tipping should be a part of the regular course, and, without asking me whether or not I would take the matter in charge, he requested that I loan him the use of the forge room for a Saturday afternoon, stating that he wanted to teach flue tipping and that, inasmuch as it was not a regular part of the course, and inasmuch as he proposed to do the work outside of regular school hours, he would charge each embryo engineer a half-dollar for knowledge thus imparted. I thought it a strange procedure, but consented to his wishes just the same. He said he would be glad to have me present at his demonstration.

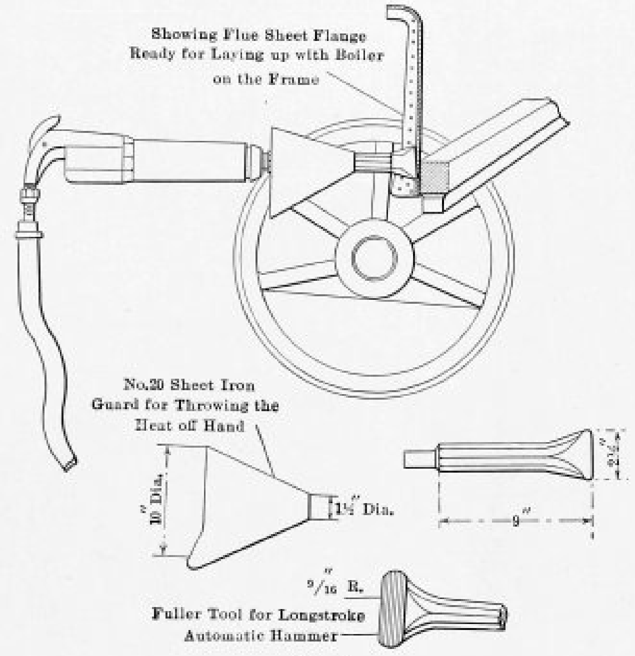


Fig. 1

I was present. But in spite of my presence the lesson was a decided failure. He scarfed the two pieces all right. It doesn't seem to be so very difficult to do that, because one needn't be so very particular about heats. Tipping, you see, was the problem—not scarfing. It wouldn't tip. I could see with half an eye that he never once had the flue heated to a welding heat, but, being a mere onlooker, I said nothing. I did nothing. He used five pounds of borax, but even that didn't do the trick, except that he once thought it was welded when the solidified flux held the tip in place for an instant—until touched by a pair of tongs.

He worked at it until he had holes burned through the flue in several places, all of which gave him an opportunity to crawl. "The flue is too old and rusty," he said. "However," he added, "you will easily be able to tip a flue by following these methods."

The lesson ended there, but I will say this much to his credit—he didn't ask each student to divvy up fifty cents.

N. G. Near.

Shop Kinks

Fig. 1 is a sketch showing an arrangement for laying up flue sheet corners or flange patches. The laying up of flue sheet corners, where the boiler is on the frame with the driving wheels in place, is a job that often causes a fight between the boiler maker and his helper, for the reason that it is a difficult place for a boiler maker to hold a fuller so that a helper can strike it with a sledge. The helper very often misses the fuller and breaks the handle. By this time the heat on the corner of the flue sheet is gone, so that it will be necessary to spend anywhere from fifteen minutes to half an hour taking another heat. The arrangement shown in Fig. 1 is such that anyone can easily lay up the corner of the sheet with one heat, as he can handle the automatic hammer in five minutes' time, which is certainly an advantage as compared with the old methods, on account of the difficulty of holding a fuller on a round flange in close quarters so that anyone can strike at it.

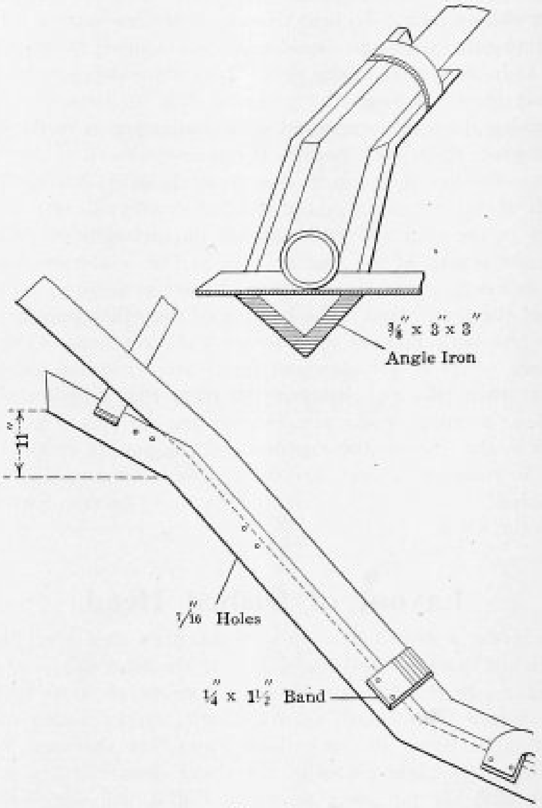


Fig. 2

On account of the many hard blows which the writer has received from fullers flying off the handle, the writer believes that this arrangement deserves the dignity of being called a "Safety First" device.

Fig. 2 shows a quick, practical method of bending water bars. This device keeps the bar from getting out of round and different marks can easily be made along the edge of the angle and a piece of iron ¼ to 1½ inches placed at these different marks in the water bar for different bends. As a rule, in different shops for bending water bars they place the bar across the anvil or block in order to bend it to the necessary angle. This is neither a quick nor a practical method, as the bar often gets out of round. By using the device shown in Fig. 2 anyone can quickly bring the bar down to the angle that is needed in a few minutes' time.

Harry Lacerda.

Schenectady, N. Y.

Selected Boiler Patents

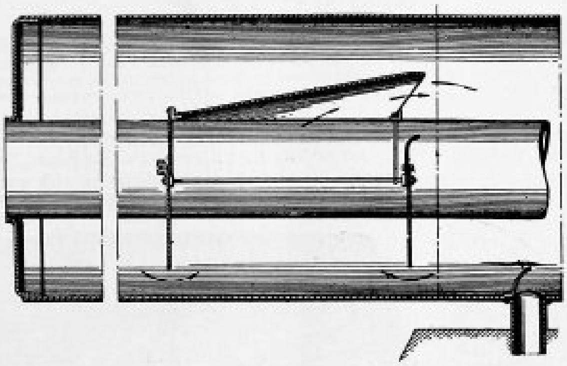
Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,
Millertown, N. Y.

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

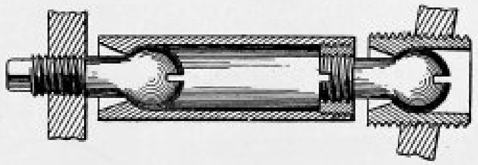
1,083,281. CIRCULATING MEANS FOR BOILERS. ROBERT D. JEFFREYS, OF NEW WINDSOR, NEW YORK, ASSIGNOR TO HARRY SCHOFIELD, SIDNEY J. ROSS, AND OLIVER PRESCOTT MACFARLANE, ALL OF LONDON, ENGLAND.

Claim 1.—In a boiler having internal flues, a knockdown circulator-housing comprising in combination a pair of suitably shaped plates extending substantially across the boiler and embracing the flues at one end of the housing, said plates extending to a point well below said flues, suitably shaped plates embracing said flues at the opposite end of the housing, suitable stays uniting the two sets of plates, a top plate attached to the upper portion of said first named set of plates, and extending across said flues and inclining upward therefrom over the top of the housing in a longitudinal direction. Two claims.



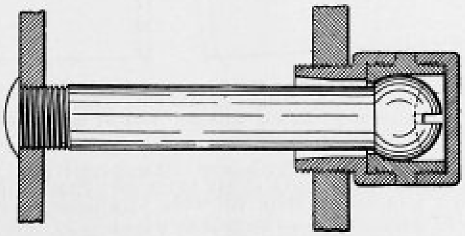
1,086,144. STAYBOLT. ETHAN I. DODDS, OF CENTRAL VALLEY, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—A flexible staybolt comprising a hollow shank, and a connector at each end of the shank and connecting the latter with the walls of the boiler, each connection being rigidly secured at one end to one of said parts, and having a universal joint connection at its other end with the other of said parts, whereby the bolt is free to give or yield at either end to accommodate itself to the movements of both walls of the boiler. Five claims.



1,086,737. FLEXIBLE STAYBOLT. RALPH G. TAYLOR, OF DAVENPORT, IOWA.

Claim 1.—The combination with a staybolt having a rounded head, of a supporting sleeve having an externally threaded inner end and an enlarged outer end forming a shoulder, of a socket member detachably secured to said sleeve and bearing against its outer end and said shoulder and having an annular seat adapted to engage the rounded head of said bolt, and a cap detachably secured to said socket member. Nine claims.

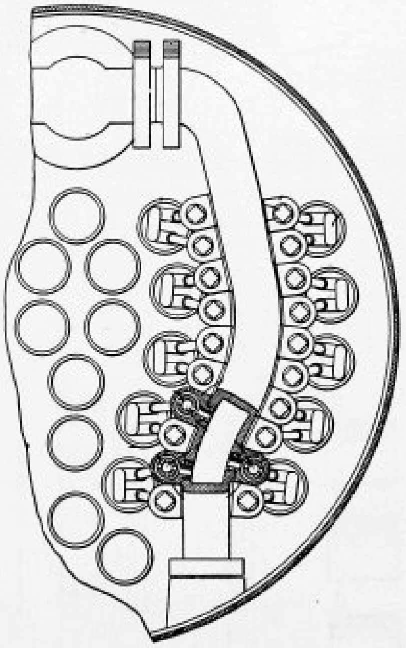


1,083,540. SMOKE CONSUMER. WILLIAM KELLY, OF MEMPHIS, TENNESSEE.

Claim.—The combination with a furnace, of thimbles extending through the furnace wall and communicating with the fire box, a manifold arranged on the exterior of the furnace and provided with diametrically opposed series of air inlet nozzles and discharge nozzles, the latter extending into the said thimbles, a steam supply pipe arranged within the manifold and provided with steam injection nozzles projecting into the discharge nozzles of the manifold, means for controlling the supply of steam to said pipe, and an air supply pipe extending parallel with said manifold and provided with outlets telescopically engaging the air inlet nozzles of the manifold. One claim.

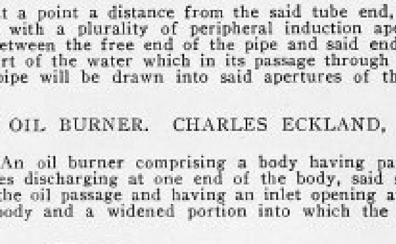
1,086,807. COUPLING FOR SUPERHEATERS. FREDERICK CONRATH, OF ST. PAUL, MINN., ASSIGNOR OF ONE-HALF TO GEORGE H. EMERSON AND ONE-HALF TO HENRY YOERG, BOTH OF ST. PAUL, MINN.

Claim 2.—A superheater header having saturated and superheated steam chambers formed therein and projections thereon having pockets communicating respectively with said chambers, said projections having sockets to receive the ends of a superheater tube, gaskets interposed between said ends and the bottoms of said sockets, and plugs fitting into holes in said projections and having threaded connections with said tubes and provided with passages communicating with said tubes and said pockets. Eight claims.



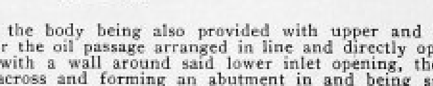
1,087,480. WATER-CIRCULATING SYSTEM FOR BOILERS. ANDREW EMANUEL AXLUND, OF VALLEJO, CAL.

Claim.—In a water-circulating system for boilers, in combination with a boiler head and water tubes communicating therewith, an injection pipe connected to a source of pressure higher than that in the boiler which has its free end extending into an end of one of said tubes and terminating at a point a distance from the said tube end, said pipe being provided with a plurality of peripheral induction apertures which are located between the free end of the pipe and said end of the tube, whereby a part of the water which in its passage through the tube surrounds the pipe will be drawn into said apertures of the pipe. One claim.



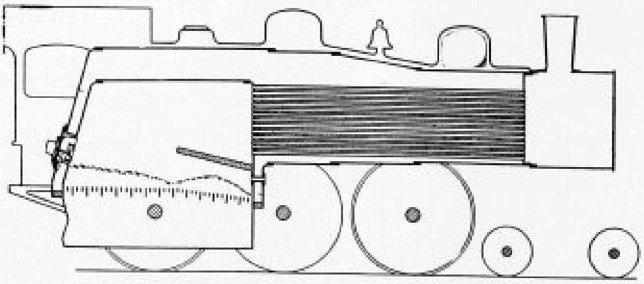
1,087,741. OIL BURNER. CHARLES ECKLAND, OF STOCKTON, CAL.

Claim 2.—An oil burner comprising a body having parallel oil and steam passages discharging at one end of the body, said steam passage being below the oil passage and having an inlet opening at the opposite end of the body and a widened portion into which the inlet opening discharges; the body being also provided with upper and lower inlet openings for the oil passage arranged in line and directly opposite each other and with a wall around said lower inlet opening, the said wall extending across and forming an abutment in and being spaced from the sides of the widened portion of the steam passage to cause steam to divide and pass around opposite sides of said abutment while traversing said steam passage. Two claims.



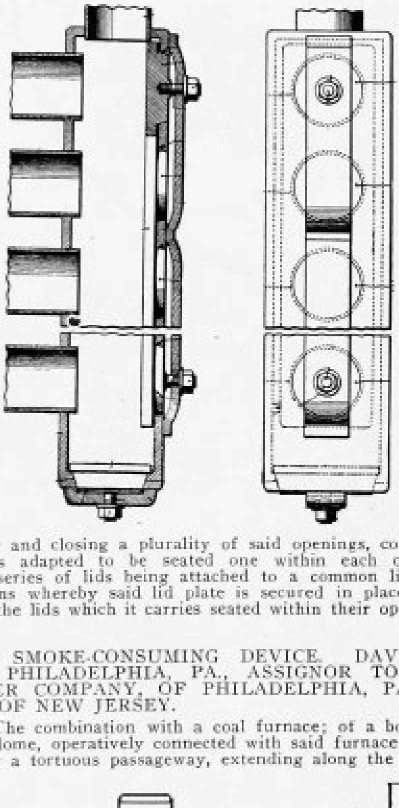
1,088,136. SMOKE PREVENTER. BENJAMIN F. B. FAIRBROTHER, OF KEENE, N. H., ASSIGNOR TO CHARLES K. DARLING, OF CONCORD, MASS.

Claim 1.—In a furnace, the combination of the combustion chamber with its grate, an arch extending rearwardly from the front of the combustion chamber over the grate and spaced therefrom and a fan in the rear part of the combustion chamber and so arranged as to draw the gases to the rear, mix them and project them back into the chamber so as to pass out over the arch. Four claims.



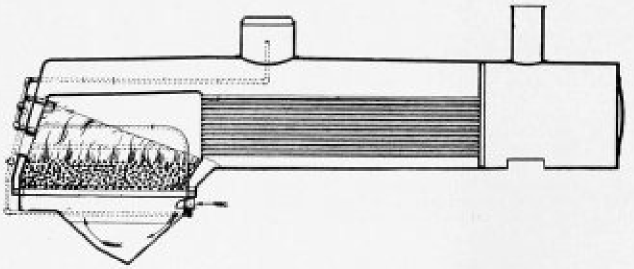
1,088,224. HEADER FOR STEAM GENERATORS. ALEXANDER STANLEY HAY, OF PHILADELPHIA, PA.

Claim 1.—A header for a steam generator receiving water tubes and provided with corresponding openings opposite said water tubes, said openings being provided with interior lid seats, means for simultaneously opening and closing a plurality of said openings, consisting of a series of lids adapted to be seated one within each opening from within, said series of lids being attached to a common lid plate; and securing means whereby said lid plate is secured in place from without, with all the lids which it carries seated within their openings. Two claims.



1,088,639. SMOKE-CONSUMING DEVICE. DAVID TOWNSEND, OF PHILADELPHIA, PA., ASSIGNOR TO CORNELL ECONOMIZER COMPANY, OF PHILADELPHIA, PA., A CORPORATION OF NEW JERSEY.

Claim 2.—The combination with a coal furnace; of a boiler comprising a steam dome, operatively connected with said furnace; flat retorts, each inclosing a tortuous passageway, extending along the opposite side walls of said furnace; an angle iron extending along the lower edge of each of said retorts, preventing their lateral displacement; vertical angle irons preventing tilting of said retorts; a conduit connecting the passageways in said retorts; a conduit connecting one of said retorts with said steam dome; a burner extending across the rear wall of said furnace and comprising a straight horizontal series of jet orifices arranged to direct a plane sheet of gas to the tube sheet, above the coal and below the boiler tubes; and a conduit connecting the other retort with said burner. Seven claims.



1,082,996. SECTIONAL BOILER. JOHN B. BERNHARD, OF SYRACUSE, NEW YORK.

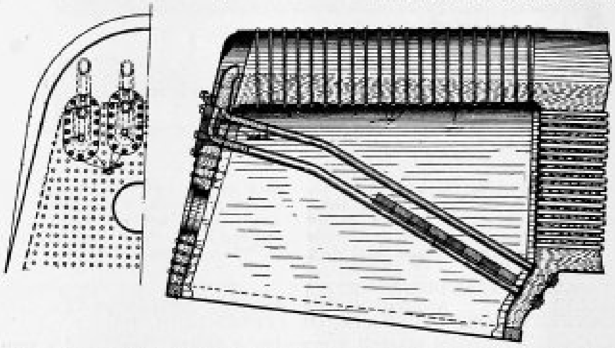
Claim 2.—An intermediate section for sectional boilers, comprising a substantially horizontal top member and a wide rear member which communicates with the top member and is composed of a substantially vertical rear water leg, an inclined front water leg, a more inclined intermediate water leg which divides the space between the front and rear water legs into two transverse flues which are located one behind the other, and a pedestal with which the lower ends of said three water legs are united—the front water leg being reduced in width near its upper end to form a passageway for the products of combustion from the fire-box into the front transverse flue, and a plurality of inclined water legs which extend between the top member and said front water leg—each of said inclined water legs being wider than the one next below it. Three claims.

1,088,794. FLUE-CLEANER. GEORGE F. PIERCE, OF KANSAS CITY, MO.

Claim.—In a flue cleaner, a tube having a nozzle on its front end, a hollow head having a substantially cone-shaped front portion, the free end of which abuts the nozzle and also having a substantially cone-shaped rear portion, the free end of which engages about the tube, a substantially conical hollow head spaced from the first named head and having its smaller end engaged about the tube, cutting means connected to the heads, and means secured about the tube and which engages the inner circumference of the second-named head adjacent the smaller end of the latter to prevent lateral movement of the second-named head. One claim.

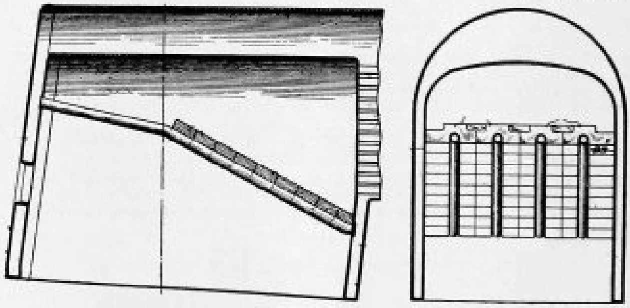
1,089,666. LOCOMOTIVE-FIRE-BOX CONSTRUCTION. LE GRAND PARISH, OF NEW YORK, N. Y.

Claim 2.—A locomotive fire-box comprising in combination with water walls, a pair of circulating tubes communicating with a water wall, and a common delivery member communicating with the discharge ends of the tubes and extending toward the normal steam space. Three claims.



1,090,891. LOCOMOTIVE-ARCH CONSTRUCTION. ENOCH P. STEVENS, OF CHICAGO, ILL., ASSIGNOR TO LOCOMOTIVE ARCH BRICK COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

Claim 1.—In a locomotive having a firebox therein, the combination of a plurality of arch tubes extending through said firebox, a plurality of rows of bricks supported on said arch tubes, each of said rows being supported on a corresponding arch tube, said brick having recesses in their lower surfaces for the reception of said arch tubes, and a plurality of rows of locking bricks engaging adjacent rows of bricks and filling the space therebetween. Three claims.



1,089,317. GRATE BAR. GEORGE E. CAMP, OF UTICA, N. Y., ASSIGNOR TO INTERNATIONAL HEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—In a revolving grate bar a shaft triangular in cross section, journals on said shaft, triangular wings projecting from the surfaces of said shaft and all slanting toward the same end of said shaft and having their outer faces each adapted to form substantially flat fuel-supporting surfaces. Three claims.

1,088,833. FURNACE GRATE. DOUGAL J. McKENZIE, OF CHICAGO, ILL., ASSIGNOR, BY MESNE ASSIGNMENTS, TO CHICAGO TITLE AND TRUST COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

Claim 1.—In a device, a bar having holes therethrough, transverse fuel supporting members mounted thereon, and bolts through the holes engaging the said members, each of said members having a socket to receive a nut to coact with the bolt, said socket being surrounded by a flange. Two claims.

THE BOILER MAKER

JUNE, 1914

Failures of Heavy Boiler Shell Plates*

Causes of Heavy Boiler Plate Failures Disclosed by Extensive Investigations and Tests Made During the Past Fifteen Years

BY SIDNEY A. HOUGHTON†

In spite of the fact that the knowledge of the manufacture and science of steel making increases year by year, as shown by the *Journal of the Iron and Steel Institute,* it is unfortunately true that failures of plates which have passed the usual tests are not yet eliminated. That this should be the case with the lower grade descriptions of mild steel would not give cause for criticism, but that they should occur with the heavy boiler shell plates used in marine boilers, which are made from the highest class of mild steel, and generally from special charges, is a matter which is worthy of special investigation. The only paper on the subject seems, however, to be the able one by Mr. J. T. Milton, chief engineer of Lloyd's Register, on "Fractures on Large Steel Boiler Plates," which is given in the *Proceedings of the Institution of Naval Architects.*[1] This paper is of considerable importance, but practically deals fully with only one case, which was investigated by Professor Arnold, though four or five others are described.

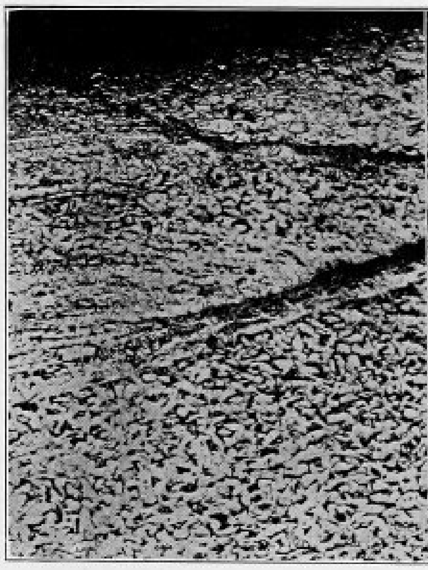


Fig. 1

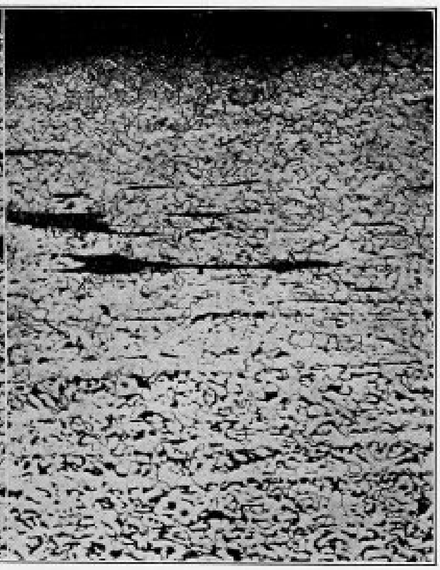


Fig. 2

The importance of failures of this nature has long been recognized, and careful investigations have been made by the Board of Trade and the classification societies into fractures discovered in the boiler shops, but as financial questions often arise between the steel maker and the boiler maker it is not as a rule possible to publish the results at the time, and indeed in some instances the actual causes have not been definitely ascertained.

The cases described in the present paper are selected from those which have come under the author's notice during the last fifteen years. Some of the plates were not under Board of Trade inspection, but through the courtesy of Lloyd's Register of Shipping and the British Corporation for the Survey and Register of Shipping, facilities were afforded for testing and examining the plates in conjunction with their surveyors.

It should be stated here that the plates had all been tested in the usual way, at least one tensile and two bend tests being taken from opposite corners, and in some instances from each corner, and that the results were satisfactory; also that the plates were bent cold in the rolls to the necessary radius, and that all rivet holes were drilled in place.

The principal details of the failures described are stated in the form of a table, and a short description of the circumstances attending them is given before considering the causes of failure as a whole. It must be understood that the opinions as to the causes of failure are those of the author,

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* A paper read before the Iron and Steel Institute, London, England.

[1] Vol. xlvii (1905).

† Assoc. Mem. Inst. C. E. (Glasgow). Ship and Engineer Surveyor, Marine Department, Board of Trade.

and are not necessarily those of the Board of Trade or of the registration societies concerned. In some instances the conclusions arrived at cannot be fully verified, but the author hopes that by thus publishing them it will be possible to obtain criticisms and suggestions which will lead to the discovery of the correct ones.

All the plates were made by the acid open-hearth process with the exception of plate C4, which was made by the basic open-hearth, and all the sections of which photographs are shown were cut longitudinally; that is, in the direction of the greatest length of the plate, unless otherwise stated. These sections were therefore at right angles to the cracks, which were all transverse ones. Practically all the sections were etched with a solution of picric acid in amyllic alcohol to which a few drops of nitric acid were added. Picric acid by itself is hardly sufficiently powerful to distinctly mark out the ferrite crystals in mild steel, but with the addition of a little nitric acid these are shown clearly without discoloration, while the picric acid blackens the pearlite suitably for photographic purposes. In all cases complete sections of the plates were examined, and in dealing with material of this nature this is absolutely necessary. This is mentioned because some metallographic workers appear to use sections only about ⅜ inch square or even less; the author has experienced no difficulty in preparing sections ¾ inch or ⅞ inch square, and with these dimensions the thickest shell plate can be examined in two parts only. If the sections are protected by a cover-glass secured by Canada balsam in the usual way, and then mounted on a glass slip with white lead, they will keep indefinitely and will be available for examination at any time.

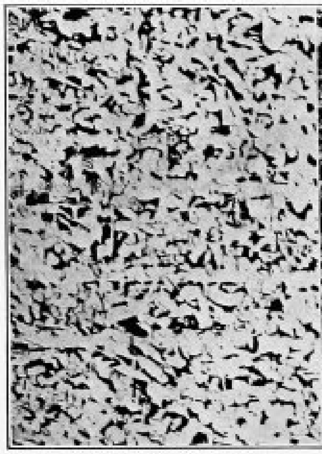
Fig. 3

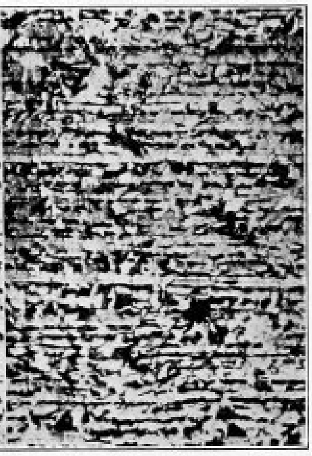
Fig. 4

All the photographs were taken at a magnification of 50 diameters, except Figs. 17 and 18, so that they are easily comparable.

A few of the analyses given cannot wholly be relied on, at any rate so far as those elements liable to segregation are concerned, as the drillings were not taken right through the plate. It is always advisable in dealing with heavy plates to take at least two analyses, one from the two outer quarters of the plate and one from the inside half, thus indicating if segregation exists.

The cases considered are not dealt with in chronological order, but are divided into three classes, as follows:

(*A*) Plates in which partial cracks only have occurred.

(*B*) Plates which have cracked right across in the boiler shop.

(*C*) Plates which have failed under the hydraulic test.

Class A—In most of the plates of this class the cracks have occurred in dressed portions, and hammering has been one of the chief causes of failure, though many plates are abnormal in some other characteristic. It is hoped that this list of failures may help to prevent the use of this obnoxious practice in future.

A1—This plate had some well-marked surface defects, as shown in Fig. 1, accompanied by an absence of carbon near the surface, possibly due to the slab being burnt in the soaking pit; it will be noticed that this part is sharply defined from the normal structure. As can be seen in the photograph the surface has been well hammered, and it is not surprising that the steel in this part gave way when bent. The structure near the center was very coarse (see Fig. 3), and is in great contrast to that on the outside, which may be due to the slab not being uniformly heated. There is considerable difference between the original tests and those in the vicinity of the fracture, and as the analysis does not agree with the latter, it is probable that the drillings were taken from another place and that the plate was far from uniform in composition, though it should be mentioned that there is no sign of segregation in the sections examined.

A2—Both the sulphur and phosphorus were very high in this plate, and the latter formed some carbonless bands near the surface, thereby helping to cause roughness and conferring extra brittleness on the part which was hammered. This metal contained a great number of blow-holes, which increased towards the center, and it may be remarked that in several instances an excessive number of blow-holes appear to indicate an inferior quality of metal, though at first sight there seems no reason why any material difference should be noticeable if the metal is stressed in the same direction as that in which it is rolled. The general structure is very lamellar in character, which it is suggested may be produced if the slabs are soaked too long, especially when the phosphorus content is high.[3] The failure of this plate was due to hammer-dressing on surface defects produced by the minor segregations of phosphorus.

A3—The primary cause of the failure of this plate was probably the large carbonless area shown in Fig. 2, due possibly to the surface of the slab being burnt or decarbonized in parts; there are also some carbonless bands below caused by phosphorous segregations. The structure towards the center of this plate is of a lamellar character, with a moderate number of blow-holes and some compound crystals, which would indicate that the finishing temperature was high. The author calls "compound crystals" those which are composed of several separate ones of ferrite and pearlite, and which, in fact, constitute the entire structure of mild steel heated to a temperature of 1,000 degrees C. There were no signs of hammer-dressing on this plate.

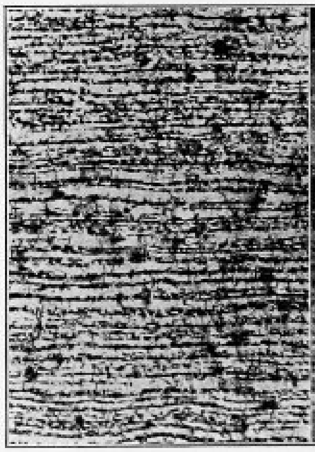
Fig. 5

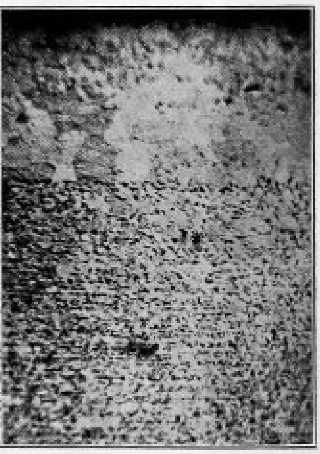
Fig. 6

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[3] See also "Crystallization and Segregation of Steel Ingots," by Dr. J. E. Stead; *Proceedings of the Cleveland Institution of Engineers*, 1905-1906, p. 163.

A4—The structure of this plate was extremely lamellar, as shown in Fig. 4, and there were an excessive number of blow-holes which could be better seen before etching. The phosphorus was quite high enough, and there was a considerable amount of arsenic; the plate was also hammer-dressed, but there were no signs of segregation near the fracture.

Fig. 7.—Surface Section

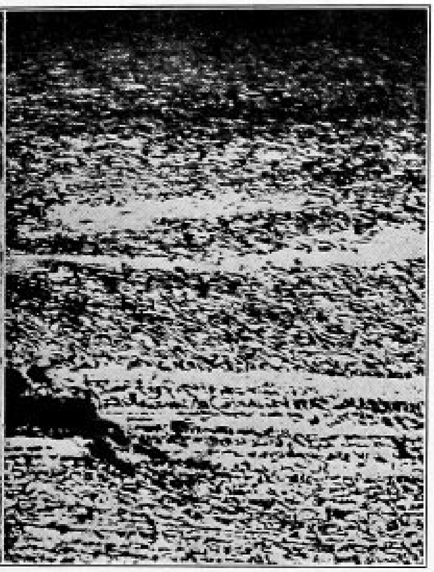

Fig. 8

A5—This plate shows a structure considerably different from the preceding cases; it was said to have been annealed, but if so the annealing was very inefficient. The general structure was very fine and mostly lamellar, as shown in Fig. 5; it is, in fact, too small to be produced by annealing, and the plate must have been finished at a very low temperature, thereby setting up internal stresses. Near the surface are some good examples of phosphoretic minor segregations, as shown in Fig. 6, where it will be noticed that the crystals in these parts are of huge size compared with those of the steel itself. Fig. 7 is a horizontal one at the surface, showing the evil effect of these segregations, and it is evident that they afford a good starting point for a fracture. The outlines of the phosphoretic iron crystals can be seen also in this photograph.

A6—The defect in this plate was only found under the hydraulic test when a leak was observed near a rivet hole; and on further examination it was seen that there was a crack starting from the rivet hole in a dressed part. This crack did not go right through the plate, and was only shown by the water passing around the rivet itself. The length of the crack was 17½ inches and the depth 1⅛ inches, and it was of the "bubble" description. The tensile tests were satisfactory; but the structure shows that the plate was finished at a high temperature, probably not less than 800 degrees C., and that the plate had been hammered in the dressed part to conceal a surface defect.

A7—This plate was partly riveted into the boiler, when it was found that there was a transverse crack 13 inches long extending from one of the rivet holes, this being in a part of the plate which had been dressed. The tensile tests taken near the crack gave satisfactory results, with the exception of one which failed with an extension of only 4 percent, due to a concealed surface defect. The bend tests were similarly good, except one taken alongside the crack which failed from a surface defect. The analysis gave nothing unusual, though the phosphorus was somewhat high; while the microscope showed that the structure was fairly normal, but that the surface had been severely hammered to conceal surface defects arising from the outside of the slab being overheated.

A8—This plate had been curved to radius when an irregularly shaped crack, about 8 inches long, was noticed in a

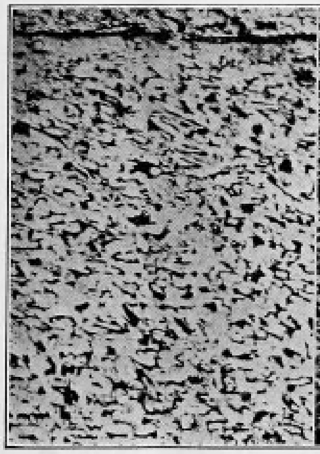

Fig. 9

Fig. 10

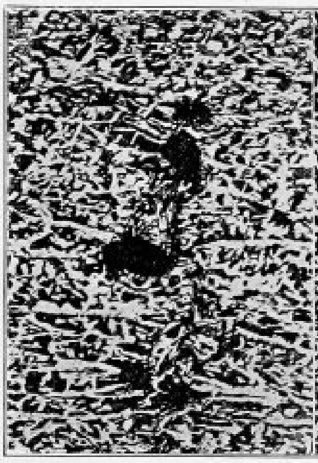

Fig. 11

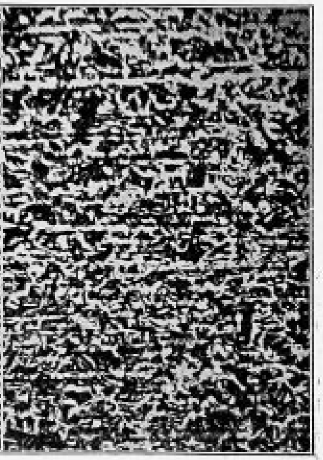

Fig. 12

dressed part. On the piece containing the fracture being broken, the crack was seen to be very uneven in character, extending to about half the thickness of the plate. The tensile and bend tests were satisfactory, except bends made from the dressed portion, which failed at a small angle. Analysis showed that while the carbon decreased towards the surface the phosphorus increased, and this latter condition showed itself as usual as carbonless bands. There were also some blow-holes at the surface which had been severely hammered (see Fig. 9). The internal structure differed considerably from that at the outside, being of a marked lamellar character, and was decidedly coarse for the thickness of the plate.

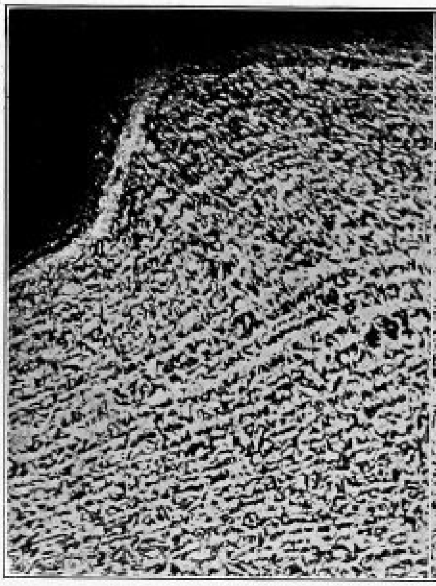
Fig. 13


Fig. 14

A9—This plate had also been curved to radius before a crack 4 inches long was found in a dressed part near one side. No tensile tests were taken, but bend tests were made from the dressed portion. These all failed at a comparatively small angle, and it is evident that this test is a simple and efficient one for disclosing surface defects which have been hammered. The analysis is fairly normal, but the microscope showed some large flaws and carbonless bands near the surface. The latter had been hammered apparently with a flogging hammer, judging by the distortion produced, as shown in Fig. 8; and it was a foregone conclusion that a plate so treated would fail when bent.

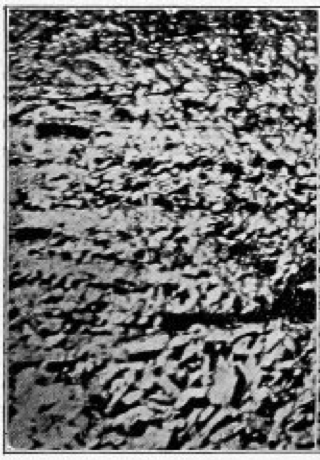
Fig. 15


Fig. 16


Fig. 17

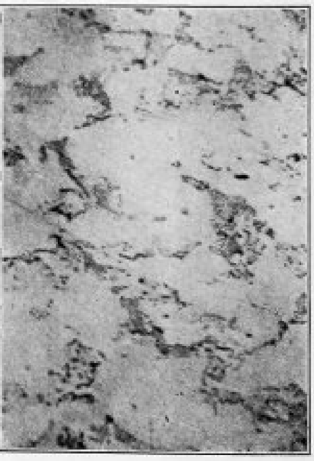
Fig. 18

A10—Two cracks in dressed portions of this plate were observed after it had been bent to radius, one being near the end and the other about midway along one of the sides, the latter crack being exceptional in that it was of a rectangular character, one part being transverse and the other longitudinal. Bend tests from the dressed portion failed, and a section near the rectangular crack revealed the nature of one of the defects which it had been attempted to hammer down. This was evidently caused by some foreign substance which had been rolled in, and produced the depression shown in Fig. 13. It will be noticed that the structure is deformed by hot work, and also that the top surface has been hammered. There were in addition some carbonless bands and flaws near the surface, and, though it sounds paradoxical, there was an increase of carbon towards the surface, there being no signs of segregation.

A11—The cracks in this plate were not discovered till the boiler was ready for the hydraulic test, when two were seen, one 8¼ inches and one 9 inches long, in dressed parts not far from the middle of the plate. After the plate had been removed a portion was cut off and broken through the 8¼-inch crack, which was then seen to be of the "bubble" description. The tensile tests gave varying results, and showed that the plate was segregated, but all the bend tests were satisfactory. The analysis showed excessive carbon and phosphorus, and indicated that the material was unsuitable for a shell plate. In preparing the sections for the microscope it was noticed that the metal was soft and powdery to the file, similar to that of a steel casting, and, on examining the structure, this was found to approximate to that of an imperfectly annealed casting (see Fig. 10), showing that the plate had been rolled at a grossly excessive temperature. Fig. 11 is taken from the center of a tensile test-piece near the point of fracture, and shows the form of segregation and also the manner in which the metal gives way at this part, owing to its want of ductility. At the fracture this is shown by the familiar white line caused by the crystalline break of this part of the metal. This plate was also hammer-dressed, possibly in order to hide defects due to the surface being burnt. The following abnormal features occurred in this plate: Excessive rolling and finishing temperature, excessive carbon and phosphorus, hammer dressing and central segregation, so that its failure was not a matter for surprise.

A12—When this plate was being bent in the rolls a tinkling noise was heard, and on examination two cracks were found in a dressed portion, one 3⅛ inches and the other 1½ inches long. This part of the plate was cut out and broken, when it was seen that the principal crack was of the "bubble" description, so that it would seem that this form of crack can be produced by bending the plate. The transverse tests taken in the vicinity of the cracks all gave poor results, and some failed with a square fracture and a white line indicating segregation. The structure of the plate shows a large number of minute sulphide or manganese flaws, which increased towards the center, both in size and quantity; it seems that the fissures shown on the fractured surfaces are due to this and not to piping. The general structure is rather lamellar, with carbonless bands near the surface, which had been hammered in the dressed portion. This is clearly shown in Fig. 13, which illustrates a good example of a phosphoretic band, the boundaries of which are clearly marked, and also of the effect of hammering the plate. The heavy central segregation in this plate is shown in Fig. 12, where the carbon would amount to about 0.5 percent. From the microscopical examination it is probable that the amounts of carbon and sulphur given in the analysis are under-estimated.

A13—In this instance a crack about 8 inches long was found in a dressed portion of the plate near the center. The analysis obtained was normal and the mechanical tests were satisfactory. The structure showed heavy blow-hole and surface flaws, with carbonless bands near the surface (see Fig. 15), which had been hammered. The general structure was very coarse, indicating high temperature of rolling and slow cooling, and possibly this plate had been piled.

Class B—The failures in this class are in some respects of a more important character than those already considered, as the plates failed by cracking right across in the rolls, giving the impression of extreme brittleness.

B1—This plate had only partially been bent to the required radius when it broke nearly across, there being two cracks in approximately the same line, which were only separated by a small web of metal. The tensile tests from this plate all gave good results, and the chemical analysis is not abnormal, except that the quantity of phosphorus is high and greater at the outside than in the inside. The structure of the steel showed an excessive number of blow-holes (see Fig. 16), so that before etching the metal looked in parts more like wrought iron than steel. As might be expected from the analysis, there were also considerable local segregations of phosphorus at the outside, and, considering their amount and well-known want of ductility, they probably constituted the principal cause of failure. The plate was also rolled hot on one side, and on examining the sections at the fracture after light etching, lines were seen on the ferrite crystals which were at first thought to be slip bands, but on examination at higher power were found to be Neumann's lines (see Fig. 17). This plate and B4 are almost the only ones in which the author has seen these lines, and in both cases the metal was hard to the file, more so than would appear from this analysis. It is suggested that the ferrite contained arsenic or some other hardening constituent which was not analyzed for.

B2—This plate cracked right across in the rolls during the first pass. It had been cross-rolled so that the longitudinal axis of the ingot was the transverse one of the plate. The metal generally was of excellent quality, but from the fact that some segregation showed on one side of the plate and blow-holes at the other, it is evident that too great a portion of the ingot was used. The number of these blow-holes was very considerable, and the structure on this side of the plate was of a coarse crystalline character, indicating it had either been overheated when being annealed and possibly piled afterwards, or that annealing had been insufficient to break down the rolling structures; on the whole the former would appear to be the correct opinion. Also at this side the effects of shearing had not been entirely removed by planing, but the structure only appeared to be distorted on the inside of the plate, as the edge had been beveled as usual. A noticeable feature about this plate was the increase of pearlite on the outer surfaces, and it is suggested that this might be due to the effect of an excessive amount of composition on the ingot mold. In this connection it may be mentioned that heavy carbonization of the surface may take place in large steel castings when certain carbonaceous coatings are given to the molds, which fact does not seem to be so widely known as is desirable, and it is worthy of careful consideration by the users of such castings. The increase was comparatively slight in this instance, but would produce an appreciable effect when the plate was being bent. The most striking feature revealed by this case was the great importance of uniform annealing at a correct temperature.

B3—The carbon content of this plate was too much, indicating that little work was given to the steel; the finishing temperature was very high, and there was considerable difference between the structures on opposite sides. There was also segregation in the center of the plate and a large number of blow-holes near the surface, so that altogether the metal might be described as unsuitable for the purpose for which it was intended.

B4—This plate broke completely across when being passed through the rolls for the first time, the fracture being of a coarse crystalline character. The tensile tests were on the whole satisfactory, only two of the transverse tests showing segregation, which, however, did not reduce the elongation below 24 percent. The analysis shows high carbon and phosphorus, both being in excess of the amount suitable for mild steel. In preparing the sections it was noticed that the metal was very hard to file, and the structures revealed were found to be of an unusually interesting kind. Towards one side of the plate the ferrite crystals were of a large rounded form, while the pearlite was of a very ropey nature, some of it being in the form of cementite. This is shown in Fig. 18, the section being etched with boiling sodic picrite, which, as is known, blackens cementite and only shades the pearlite. This structure has been shown some years ago by Dr. Stead and more lately by Dr. Rosenhain to be formed when mild steel is kept at a temperature between 600 degrees C. and 700 degrees C., the structure thus produced being of a brittle nature. In this instance the effect was obtained in the annealing furnace, owing to the pyrometer being out of order. On the other side of the plate this formation did not exist, but the structure was very coarse and angular, and indicated that the plate was rolled too hot, and that the temperature of the annealing furnace was insufficient at that side to break it down. In the sections examined from the first-mentioned side, many of the crystals near the fracture showed well-marked Neumann's lines (see Fig. 17) similar to those in plate B1. It may also be mentioned that in one section there were signs of "cupping" in the center of the plate. The segregation was not excessive, and was exactly in the center of the plate, so that it was not at first discovered in examining the sections, as it was removed by the saw when cutting the complete section in half. The chief causes of failure appear to be the formation of a brittle structure combined with unequal annealing and high phosphorus. (*To be continued.*)

Heavy Plate Developments

BY C. B. LINSTROM*

The drawings in connection with this article illustrate two representative boiler shop problems very often met with.

When objects are made of thick plates, such as ¼ inch and up, the thickness must be taken into consideration in working up the plate, as when flanging and rolling it. The plate in the up-take, Fig. 1, is ⅜ inch thick, the outside diameter at the top equals 3 feet 11⅜ inches, and the height of the piece above the cylinder (*C*) is 20⅞ inches. The slope of the side *dd'* was given as 12 inches in 12 inches, hence it is at an angle of 45 degrees with the horizontal or vertical planes. Part (*B*), owing to its taper, is a transition piece running from an elliptical base to a round top. To develop (*A*) and (*B*), work from the neutral layer of the plate, and find where the lines of construction in the neutral plane intersect the outer surface of the connecting cylinder (*C*).

PLATE ALLOWANCES FOR ROLLING

It is evident that at the neutral layer the plate does not contract or stretch during the process of rolling. The outside and inside of the plate undergoes a change in form; the inside gathers and the outside stretches, but the inside takes up more than the outside stretches, therefore it is necessary to allow for these features, which in a shop term is called the "takeup" in rolling.

Some boiler makers in determining the length of a sheet for a given inside diameter, multiply the diameter by 3.1416, and to this result add three times the plate thickness for the loss in rolling the plate. Others work from the outside diameter by multiplying it by 3.1416, and from the result thus obtained subtract three times the plate thickness for the stretching or gain in the length of the plate.

To show the difference between the two methods in plate length, consider a cylinder 40 inches inside diameter and plate ½ inch in thickness. Then for the stretch-out in a plate to be rolled to an inside diameter we have 40 × 3.1416 = 125.66 inches; ½ × 3 = 1½ inches, plate to be added. Then 125.66 + 1.5 = 127.16 inches, length of plate required.

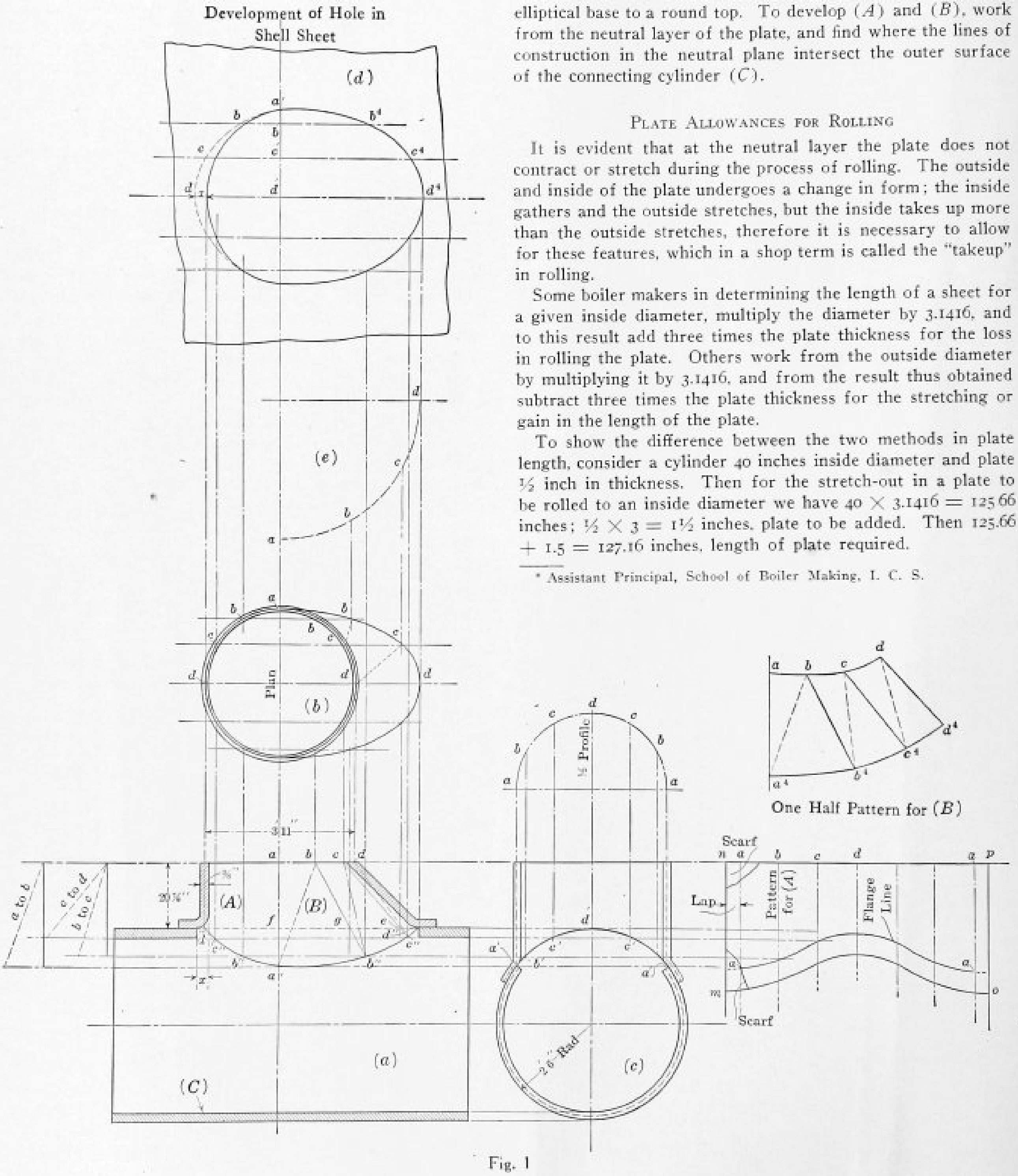

Fig. 1

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Working from the outside diameter we have $40 + \frac{1}{2} + \frac{1}{2} = 41$ inches, outside diameter.

$3.1416 \times 41 = 128.81$ inches.

$\frac{1}{2} \times 3 = 1\frac{1}{2}$ inches, length of plate to be taken away from 128.81 inches.

$128.81 - 1.5 = 127.31$ inches, length of plate required.

$127.31 - 127.16 = 0.15$ inch, say 3/16 inch difference between lengths.

Using the neutral layer to find the stretch-out gives the exact result. The neutral diameter equals $40 + \frac{1}{2} = 40\frac{1}{2}$ inches, then $3.1416 \times 40\frac{1}{2} = 127.235$ inches, length of plate needed.

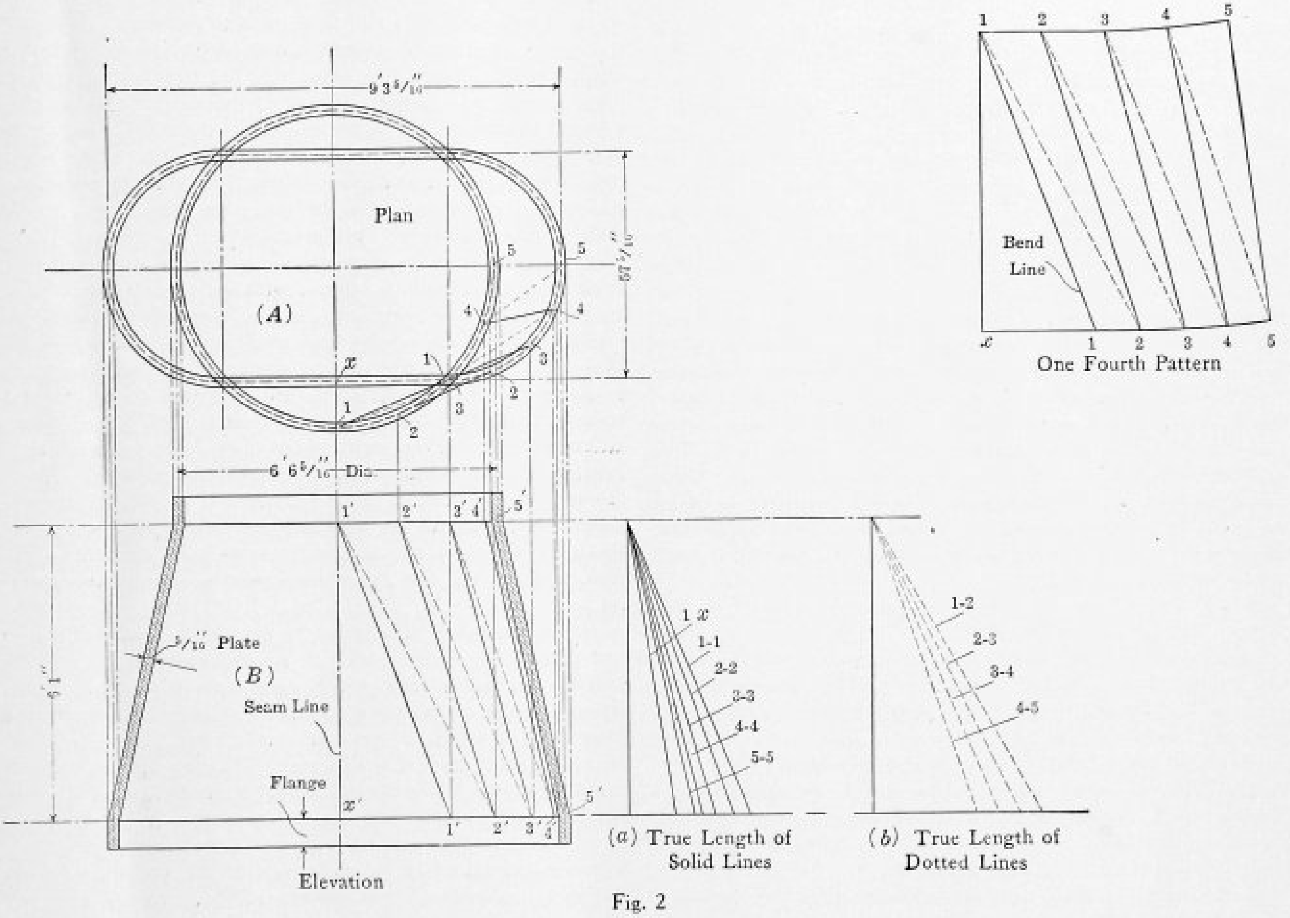

Fig. 2

DEVELOPMENT OF FIG. 1

Draw the center lines in views (a), (b) and (c), and about them lay off the parts (A), (B) and (C) to the required dimensions. First find the line of intersection between (A) and (C). This is established by dividing the neutral circle of view (b) into a number of equal parts, as at a, b, c and d. In view (c) locate the profile shown. Upon it place a, b, c and d to correspond in relation with the same points in (b). From the profile in (c) draw horizontal lines to intersect the outer circle of pipe (c) in points a', b', c' and d'. Erect perpendiculars therefrom to intersect the corresponding lines drawn from points a, b, c and d of view (b), thus producing the points through which the miter line between (A) and (C) is to pass.

Before the connecting line between (B) and (C) can be determined, some preliminary constructions must be made. Considering the shape of part (B), it is a transition piece, having a base where it joins (C) in a plane d'' and f elliptical in form. The width through f equals the neutral diameter of the semi-cylinder. The major dimension equals $f\ d''$. To show the shape through $f\ d''$ of (a), first draw the quarter circle (e) with distance $f\ d''$ as a radius. Divide it into the same number of spaces as are in one quadrant of circle in (b). By construction complete the ellipse, which is readily done as follows:

Draw from points a, b, c and d of view (e) horizontal lines to intersect the corresponding lines drawn in view (b). Next find the true positions of lines d-d, c-c, b-c in view (a). Locate on line $f\ d''$, which represents the outer edge of the plate for (c), the points g and e. Through g draw line g-b, then draw e-c. Where the radial lines g-b and e-c intersect the perpendiculars drawn from (c), as at b'', c'' gives the remaining points for drawing the miter line between (C) and (B).

PATTERN FOR (A)

The pattern for (A) is laid off by parallel lines. Make the stretch-out line a-a equal in length to the

$$\frac{\text{neutral diameter at } A \times 3.1416}{2}$$

Divide the line into the same number of equal spaces as contained in the semi-circumference of the circle in view (b). By projection draw lines from (c) to intersect the corresponding lines in the pattern. Allow material for laps on sides a-a, a-a and metal for the flange. Scarf the ends indicated so as to provide for a good fit, and allow no gaps between parts (A) and (B) in the joint.

DEVELOPMENT OF HOLE IN SHELL SHEET

The width of the spaces in the hole (d) equals the arc distances between a', b', c', d' of view (c). Hence lay off these distances as shown. From (b) draw horizontal lines to intersect the perpendiculars drawn through a', b', c', d', thereby locating points a^4, b^4, c^4, d^4. Owing to the arc in the flange in pipe (*A*) an allowance must be made in the opening between (*A*) and (*C*). Inspecting view (*a*) it is shown that the flange takes an additional space at *x*. Lay off from *d* in view (*d*) this distance and draw in a curved line to *a*, as shown by the dotted line. This is the required cut-out line.

PATTERN FOR *B*

This development is made by the triangulation system. Little time is involved in this case in doing that way, as lines *a-a*, *b-b*, *c-c* and *d-d* are shown in their true length in the elevation of view (*a*). The plan shows these lines parallel to the vertical plane, and as a result their vertical projections are their true lengths. The dotted lines are oblique to all of the principal planes, and are as a consequence shown foreshortened in the plan and elevation. Their true lengths are obtained by erecting right-angle triangles. For example, the true length of *c-d* is found as follows:

Lay off a line equal to the dotted distance *c-d* of the plan. Erect a line at right angles to it. Upon this perpendicular lay off a height equal to the horizontal distance between c'' and *d* of view (*a*). The hypotenuse is the required line. The true length of these dotted lines are shown above (*a*). With these lines and the solid lines between points *a-a*, *b-b*, *c-c* and *d-d* of view (*a*), and the distances between points a-b^4, b^4-c^4, c^4-d^4 of (*d*), lay off the half pattern (*g*) as shown. Allow for rivet lap and flange. Scarf plate so that there will be a proper connection between *A* and *B* and the pipe which these pieces join. In view (*c*) no seam line is indicated in the shell. The practice is in boiler work to have the seam as far above the fire as possible. In tubular boilers they are usually placed at an angle of 45 degrees with the center line of the boiler and above it. Adjoining sections are made so that the horizontal seams will not come together.

CONSTRUCTION OF FIG. 2

The object represented is a transition piece tapering from a wash-boiler opening to a round one. The dimensions are given to the neutral layer of the plate. In this development the plate thickness must be taken care of as was done in Fig. 1, therefore lay off the plan (*A*) and elevation (*B*) to the neutral dimensions as shown. The object, owing to its irregular form, necessitates the triangulation system of development for securing its patterns. The drawings illustrate clearly the application of this method.

As the bases of the object are symmetrical about their respective center lines, only one-quarter of the views (*A*) and (*B*) need be developed in practice. Divide the quarter circles of the top and lower base into any desired number of parts, as 1 to 5, inclusive, shown in the plan (*A*). Connect points 1-1, 2-2, 3-3, etc., with solid lines and 1-2, 2-3, 3-4, 4-5 with dotted lines. By doing this one is enabled to follow definitely the steps in the construction. The elevation in practice need not be drawn; it is shown in this case to bring out the relationship between the views (*A*) and (*B*) and the true lengths of the construction lines at (*a*) and (*b*).

Find in the usual way the true length of the solid and dotted lines by constructing right-angle triangles, as explained, for the lines used in connection with the development of (*B*), Fig. 1. In this object they are all of the same height, as the bases of the transition piece are in horizontal planes parallel with each other.

DEVELOPMENT OF PATTERN

Draw line 1-*x* equal to 1-*x* of the triangles. From *x* lay off a distance equal to *x*-1 of the wash-boiler profile. With 1 as a center, and with line 1-1 of the triangles, draw an arc cutting the arc just drawn from *x* in the pattern. Then set off from point 1 at the top and at the bottom, the arc distances between these two points, which are taken from the respective arcs of the bases in the plan. Complete the development in this way by using the true lengths of the lines (*a*) and (*b*) and the spaces between 1-2, 2-3, 3-4, 4-5 on the two bases. Allow for rivet lap, flange, space off rivet centers and the pattern is complete.

Superheat

BY E. J. NICHOLSON[*]

No scheme or device of recent introduction into railroad work in this country is looked upon with as much favor as is the use of superheated steam. It was adopted by the railroads of this country about five years ago and now we have about 8,000 engines so equipped. Those of the railroads which have adopted this principle are adapting it to their heavy power as fast as it goes through the shops for repairs. Some roads have even equipped switching locomotives with superheaters, so one can readily see that the roads are very much pleased with results obtained. This practice had its origin in England some eighty-five years ago, when it was attempted in a crude way on stationary engines with very gratifying results. In Belgium twenty years later, it was tried experimentally on locomotives, but the results were never published and it is unlikely that any appreciable saving was effected, owing no doubt to the nature of the device, which consisted of an annular space surrounding the smoke box and stack. The designer attempted to arrest the waste gases and thus increase the temperature of the steam before it entered the cylinders. Many attempts had been made on stationary and locomotive engines from that time until the year 1898, when the Prussian State Railways equipped two locomotives with Dr. Schmidt's design, which is the one now most generally used in this country.

Steam generated in a boiler is known as saturated steam and remains as such so long as its temperature remains the same as the water from which it is generated. Superheated steam is steam reheated to a higher degree of temperature than that at which it was generated, after it has been cut off from direct contact with water. Thus by passing through the superheater it absorbs additional heat, increasing its temperature and volume, but not its pressure. It has been determined that when maximum power is obtained upon a locomotive using saturated steam, it requires the burning of from 120 to 130 pounds of coal per square foot of grate area per hour, whereas when superheated steam is used and when approximately the same power is developed, only from 85 to 90 pounds of coal per square foot of grate area is burned. This difference in coal consumption, while operating with saturated and superheated steam respectively, represents about a 25 percent saving in coal. The efficiency of the cylinders at 100 pounds and 200 pounds is practically the same, so that it is possible to decrease the pressure to 160 pounds and get the same hauling power with a superheated engine that can be gotten with a saturated engine carrying 200 pounds pressure. The efficiency of the power is also considerably increased with an increase of superheat and the higher degrees of superheat are obtained when the engine is traveling at high rates of speed and under heavy load, on account of the increased activity thus produced on the fire.

The Schmidt superheater consists of several large flues located in the upper part of boiler and containing a system of tubing known as the superheat units. These units are suitably connected to a header which is located in the smoke arch of the engine. The superheater flues are seamless steel tubes extending from back to front flue sheets. The flues vary in size from 4½ inches at the back to 5⅜ inches at front flue

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[*] Foreman boiler maker, Chicago & Northwestern Railway, Milwaukee, Wis.

sheet. This enlargement begins about 6 inches from back flue sheet and is provided for the purpose of allowing the superheater units to rest therein. The superheater flues are situated within the upper one-half portion of flue area, which enables them to derive the greatest amount of heat from the fire. The superheater units which are contained within the superheater flues are each a set of independent tubes 1½ inches in diameter, with a double return, each having an outlet and an inlet from a common header which is connected with the dry pipe in the boiler and thus with the stand pipe and throttle box.

The steam header is so arranged by webs or walls on the interior that each and every unit is connected at one end with the opening from the thottle and to the outlet passage to the steam pipes and valves at the other end. The saturated steam admitted by the throttle to the superheater travels through the double return 1½-inch pipes contained within the superheater flues, and is reheated from about 330 to 600 degrees by the absorption of the heat of the gases passing through the superheater flues. It is in these units then that the superheating of the steam takes place.

Great care must be taken with regards to keeping the superheater flues clean, as any unburned coal, cinders or other foreign substances very easily collect in them, owing to the obstructions of the superheat units, which retard the passage of the gases through the flues, and when such obstructions are formed, they prevent the superheater units from performing their functions and they also interfere with the free steaming of the engine. Care should also be taken with regards to shaking grates violently while the engine is working, for by so doing cinders and foreign substances are more apt to lodge about the units, further hampering the steaming qualities as stated before. If one or more flues become stopped up the effect would be that of saturated steam mixing with superheated steam at the outlet of the header, thereby reducing the temperature of the superheated steam before it enters the cylinders.

The forward ends of the superheater units, as well as the outlets from the superheater flues, are enclosed by a box-like form of construction in the front end. The passage of the gases through this box is controlled by means of a damper operated by the admission of steam to a small cylinder attached at one side on the exterior of the smoke arch. The action of the superheater damper is controlled automatically and operates in harmony with the engineer's throttle in the cab, since, by opening the throttle, steam enters the valve chamber and in turn passes through a ¼-inch copper pipe which makes connection with the damper operating cylinder attached to smoke arch. The necessity of enclosing the forward ends of the superheater units and flues in this manner arises from the fact that in drifting with an engine not so equipped the superheater units would become so hot that there would be danger of burning them. Also from the fact that by attaining so great a degree of heat, there is danger from the sudden influx of saturated steam when the throttle is again opened. This would cause contraction and would result in a tendency to rupture the unit pipes or open the joints at the header, and would without a doubt cause engine failures.

The superheater units are connected to the header by means of clamps and bolts; the connections on recent locomotives being ground ball joints, which are a great improvement over the flat joints containing copper and asbestos gaskets which were tried a few years ago. Though the ground ball joint is an improvement it does not always entirely eliminate the leakage at the header-unit joints, and very often when an engine is not steaming it is possible to trace the cause to the leaking of these joints. These leaks serve to overcome the vacuum that is required in front end to produce the draft, and also, as is often the case, blow back into the firebox and prevent the engine from burning a bright fire, but cause a dull red one instead, indicating that the heating value of the coal is not being fully realized.

The lubrication of superheater engines is of vast importance. As there is no moisture in superheated steam to assist in lubrication, it is generally necessary to use a little more oil than with saturated steam, and owing to this there is, or seems to be, a tendency on the part of some engineers to use too much oil. The results of this practice are that there is trouble from the carbonization of the oil on the cylinder heads, on the pistons, and in the steam passages. The carbon also diminishes the life of the piston rod packing. Because of this feature in superheated steam, enginemen should never shut off entirely, but should keep the throttle open, enough at least to overcome atmospheric pressure and to supply a measure of lubrication while drifting. It is always advisable to use a good grade of mineral oil having a high flash point. Some roads use oil with a flash point as high as 585 degrees. One can readily see that this is necessary, as superheated steam sometimes attains a temperature of 600 degrees. Enginemen must always know that the oil feed to the valves and cylinders is constant. Where the cylinders are equipped with an independent feed, about 75 percent of the oil should be fed to the valves and 25 percent to the cylinders. When cylinders are not equipped with independent feeds and all of the oil is delivered in the steam-way or to the steam chests, no reduction should be made in the total amount of oil used.

Another feature of importance is boiler feeding. A superheater engine consumes about one-third less water than does a saturated engine doing the same work and the engineer should regulate his boiler feed accordingly. Water should never be carried so high that it will be drawn over into the superheater pipes, as they would then become merely an auxiliary boiler and deliver only saturated steam instead of superheated. Water should never be too high when starting, as, under this condition, the engine is very slow in getting under way. The location of the water should be ascertained very closely before taking the engine out, as water is quite frequently carried very high owing to the fact that engine house forces are sometimes inadequate, and the engine watchers do not dare to take too many chances with low water.

Reports should always be made by enginemen when the damper fails to work or when any other condition arises that may indicate something wrong in the front end which retards the steaming of the engine. Cases have been known where very bad conditions have existed in the front ends without appearing to have bad effects on the steaming qualities of the engines. Should the superheater damper become disconnected while on the road, it can be tied up, and whenever this is necessary care should be taken when going into stations that the throttle is not entirely closed for the reasons previously stated. Enginemen should bear in mind that the application of the superheater serves to materially increase the boiler capacity, as a result of which the superheater locomotive can be worked much harder than is possible with the saturated steam-engine, as, for instance, in going up heavy grades.—*Railway Review.*

LARGE REPAIR JOB.—An unusual boiler repair job was carried out recently by the Western Welding & Cutting Company, Milwaukee, Wis., at the plant of the Beloit Boxboard Company, Beloit, Wis. Sixteen large cracks in the firebox of the largest boiler in the plant were welded and the boiler was placed in service again within 48 hours' time. Only two men were required for the entire job.

CHANGE OF NAME.—The Grimm Boiler Works, Quincy, Ill., will hereafter be known as the Illinois Manufacturing & Supply Company. The reorganized company will put on the market a new line of manufactured articles, including machinists' supplies.

Master Boiler Makers' Annual Convention

Discussion of Electric and Oxy-Acetylene Methods of Welding and Kindred Subjects Brought out at Eighth Annual Meeting of Master Boiler Makers

The eighth annual convention of the Master Boiler Makers' Association opened at 2 o'clock Monday afternoon, May 25, at the Hotel Walton, Philadelphia, Pa., with the president of the association, Mr. T. W. Lowe, general boiler inspector, Canadian-Pacific Railway, Winnipeg, Canada, in the chair. After an invocation by Rev. C. Lee Gaul, of the Tioga Methodist Episcopal Church, the chairman introduced Mr. W. H. S. Bateman, chairman of the entertainment committee of the Master Boiler Makers' Association, who in turn introduced Hon. Rudolph Blankenburg, Mayor of Philadelphia.

Mayor Blankenburg extended a most hearty welcome from the city of Philadelphia to the members of the association and their guests. He addressed them not only as members of a great organization but in the broader sense as citizens of the Republic, pointing out that civic righteousness is the foundation of the Republic and its institutions, and that the first duty of every man and woman is to help maintain the highest standard of civic righteousness. He emphasized the power of the ballot in the emancipation of communities from political domination in municipal affairs, and showed that in order to secure good municipal government partisan politics should be kept out of the government, just as it is kept out of the organization of successful manufacturing concerns.

Members and Guests of the Master Boiler Makers' Association at the

Mr. M. O'Connor, past-president of the association, responded to the Mayor's address, after which the chairman introduced Mr. S. M. Vauclain, vice-president and general manager of the Baldwin Locomotive Works in Philadelphia.

Abstract of Mr. Vauclain's Address

After pointing out that Philadelphia is undoubtedly the mechanic's home, Mr. Vauclain referred with pride to the phenomenal growth of Philadelphia, its manufacturing facilities and its educational institutions. No less remarkable, however, has been the growth of locomotive boilers from the time when the "Ironsides," with only a few hundred feet of heating surface, was built down to the present time, when boilers of several thousand square feet of heating surface are being turned out by the thousands each year. More essential than the making of the boiler, however, he maintained, is the care of the boiler when it is placed in service. After the boiler has been turned over to the owner it requires the supervision of men of experience, who are resolute, and who can call a halt on the use of anything which is not in proper repair, or which would endanger human life. In referring to the difficulty of getting good boiler makers, Mr. Vauclain pointed out that the portion of the locomotive which requires the greatest amount of thought, skill and dexterity is the boiler. Huge plates must be rolled into shape, their nature must be studied, and the boiler maker must know the amount of heat that can be applied, the method of turning a flange so as not to destroy the material, and a thousand other things that must go into the handling of the material which goes into a boiler, coupled with a thorough knowledge of the mechanical side; how to calculate stresses and how to correct the mistakes which draftsmen are constantly making in the designs of the boilers. In spite of the disinclination of young technically-trained men to enter the boiler-making business, he strongly advised that such men should take a course in the boiler shop and spend at least one year of their apprenticeship in studying this important work.

Mr. C. P. Patrick, fifth vice-president of the association, responded to Mr. Vauclain's address.

The next speaker was Mr. Ivy D. Lee, chief executive assistant to the president of the Pennsylvania Railroad.

Abstract of Mr. Lee's Address

After welcoming the members of the association to the convention city, as a railroad officer Mr. Lee gave some interesting figures about the Pennsylvania Railroad. It has about 25,000 miles of track, and in good times employs ten men for every mile of track, making 250,000 men on the pay rolls. The Pennsylvania Railroad takes in and spends out each year more than double the expenditures and receipts of the government of Spain. A problem which this railroad has earnestly dealt with is that of "Safety First." The chief trouble which railroads have encountered in this direction is man failure rather than machinery failure. Expenditures for safety are justified only as they will procure an economical result. In England, for instance, where all the passenger cars are of wood, there is to-day no movement on to substitute steel cars for these "bandboxes," and the reason for this is frankly given—that the great cost is not warranted. To meet some of the requirements which are being sought, through legislation at Washington, on the plea of "Safety First," Mr. Lee maintained that the railroads would be burdened with immediate expenditures that they would not be able to face. He insisted that the fact should be kept in mind that there is an economic limit as to what can be done, and that the principal energy should at all times be directed toward the cultivation of the man. He took exception to the law recently passed by Congress authorizing the Inter-State Commerce Commission to establish an arbitrary factor of safety for locomotive boilers, showing that during the past two years only six locomotive boiler shells have exploded out of 63,000 locomotive boilers in use in the United States—an average of three a year, or about one in 21,000. On the Pennsylvania Railroad there has not been a boiler explosion since 1880, and yet if the factor of safety now proposed becomes a law it will necessitate changes in about 5,000 locomotives on the Pennsylvania Railroad at very great expense. In closing, Mr. Lee urged upon the members of the association that, in addition to providing proper rules for the scientific and mechanical conduct of their work, there is a larger responsibility for them, and that is, to work for the man as well as the machine.

Works of the Parkesburg Iron Company, Parkesburg, Pa., May 27

Mr. George W. Bennett, past-president of the association, responded to Mr. Lee.

The President's Address

In the course of his presidential address, Mr. T. W. Lowe declared that one of the principal duties which the master boiler makers should perform is to observe the construction of boilers and note when they go into service where they could be improved. The first information, he stated, they were in honor bound to furnish to their employers, otherwise they would jeopardize their personal welfare, and could not expect to be consulted as to suggestions for new designs. While this means that many of the topics which are brought before the convention are individually second-hand, they are nevertheless discussed by master boiler makers collectively for the first time, and for this reason he urged the members to participate freely in the discussion of the topics. With reference to the success and progress of the association, which is related from year to year, he suggested that in future the association either have fewer topics for discussion or else devote more time to the discussion, making it the aim of the association to dispose of all topics yearly except those which are carried forward from lack of sufficient information. He suggested, further, that means be adopted whereby all papers which are disposed of at the convention should reach the heads of the railways or firms which the members represent, such as the master mechanics and the manufacturers' associations.

Special Committees

The following committees were appointed to serve during the convention: On the president's address, J. J. Mansfield, C. L. Hempel, George Wagstaff; auditing, G. W. Bennett, J. T. Goodwin, J. A. Doarnberger; resolutions, M. O'Connor, C. P. Patrick, Andrew Greene; memorials, P. J. Conrath, J. B. Tate, J. H. Smythe; award of prizes in Champion competition, Frank Gray, W. H. Laughridge, E. W. Rogers.

TUESDAY MORNING SESSION

The second session of the convention convened at 9:30 Tuesday morning, with President T. W. Lowe in the chair. The first speaker was Mr. S. G. Thomson, superintendent of motive power of the Philadelphia & Reading Railroad.

Abstract of Mr. Thomson's Address

The care and maintenance of the locomotive boiler, declared Mr. Thomson, means co-operation and patience. Besides co-operation with the railway officials the care and maintenance of boilers requires co-operation with the government inspectors. The government inspector is an experienced man in his line. He has been around and has had experiences which the average master boiler maker has not had. He has traveled over other roads and has met other conditions. In the course of his official duties he has assimilated a lot of information that will be of advantage to the boiler maker, so that he can tell at first hand what other boiler makers are doing. This is important for every master boiler maker, and he should cooperate in every way with the government inspector to get the benefit of his experience. In referring to the difficulty of getting good boiler makers to take charge of the boiler work at various points along the railroads, Mr. Thomson stated that apprentices are very scarce. It is hard to induce them to come into this line of work, and the reason for this he attributed to the compensation. There are two kinds of compensation—physical and mental. Physical compensation covers the actual money received for the services performed, while mental compensation is the reward of success. The knowledge of success for having done the work well is a valuable compensation, but in return for this it is expected that a boiler maker should improve himself, and besides making a business of boiler making he must make boiler making a business, which are two very different things. To make a business of boiler making a man must learn his trade thoroughly; he must develop his mind and get out of the old ruts; he must keep thoroughly up to date, and be conversant with the new ideas and developments which are met in the construction and maintenance of boilers. On the other hand, to make a business of boiler making requires men that will make the boiler pay the railroad company; for this are required men that will use their intelligence; men that will give the boiler proper repairs, and men that will be interested in the boiler as a business proposition. The railroad officials want the boiler maker to show whether a boiler needs a new firebox immediately, or if the old firebox will be good for another year's service. If the railroad can get interest on the money that would be required for the renewal of the firebox for another year, they want to do it; that is what makes a business out of boiler making, and it is something which both the railroads and the government are interested in.

T. W. Lowe, Retiring President

Mr. E. W. Young, of the executive board, responded to Mr. Thomson's address.

The next speaker was Mr. Frank McManamy, chief boiler inspector, Inter-State Commerce Commission.

ABSTRACT OF MR. MCMANAMY'S ADDRESS

I am going to differ a little with one of the speakers who addressed this convention. The statement was made yesterday that resources of railroads could be wasted in promoting safety. I do not believe that. I believe that the most important duty that the railroads have to perform is to promote safety, not only among their employees, but among the travelers, and even among the trespassers, if you please, who have no right on their right-of-way. The government inspection service has only one excuse for being in existence—that is to promote safety.

When the locomotive boiler inspection law was being formed it was very strongly opposed by the representatives of the railroads, the same as practically every other law that has been passed along those lines. The statement was freely made, as it was made here yesterday, that most all of the accidents and injuries and boiler failures and so forth were due to man failure. I am going to admit that too many of them are due to man failures; but if they are due to man failures the first year's experience with the locomotive boiler inspection law reduced the man failures 60 percent in the matter of causing loss of life. In other words, there was a reduction of 60 percent in the number killed by boiler failures during the first year the law was enforced. The second year that the law was enforced has not yet passed, but the first nine months of it, in comparison with the first nine months of 1913, show a reduction in the number killed of 48 percent. I don't care whether the loss of those lives was due to man failure or to boiler failure; if we can reduce the number of killed and injured due to either we are accomplishing the purpose for which we were created, and I am going to say that we are not a bit ashamed of our record.

No railroad employee is more anxious for co-operation to improve locomotive equipment than all government employees, and no railroad official or employee will go farther than we will go to get co-operation. As a matter of fact you are the government inspectors. The law does not provide that the United States Government shall inspect all of these locomotives. It provides that the railroad company shall inspect at regular intervals. Therefore you do that work or supervise it. The law provides that the railroad company shall make repairs of all defects disclosed by any inspection before the boiler or boilers or appurtenances thereof are returned to service. You are in charge of those repairs.

The law was not necessary because railroad men were not capable of taking care of locomotive boilers. The law was not necessary because you men were not anxious to do your work. The law was necessary because you were not always given proper facilities to do your work and because the locomotives were not always allowed to remain at terminals long enough for you to do your work.

We had some discussion yesterday in the matter of a proper factor of safety. After two and a half years of experience and investigation, a meeting was called a short time ago in Washington for the purpose of discussing with representatives of the railroads what would be a proper factor of safety for boilers now in service. It was found at the time that there were locomotive boilers in service with a factor of safety below two. There were 212 locomotive boilers in service with a factor of safety below two and a half. There were 1,224 locomotive boilers in service with a factor of safety lower than three. There were 2,371 in service with a factor of safety lower than three and a quarter; there were 4,524 with a factor of safety below three and a half; there were 7,254 with a factor of safety below three and three-quarters, and there were 12,043 with a factor of safety below four, and there isn't an authority in the world to-day that will say that a factor of safety of four is too high, not one. That is the reason why it becomes necessary to amend the rules and fix a proper factor of safety for locomotives.

We have no desire to interfere with the transportation of the country by tying up traffic; therefore our agreement with the committee representing the railroads in the matter of increasing the factor of safety to four gives seven years to bring all those boilers up to a factor of four. Now, if that is not co-operation to the fullest extent, if it is not leniency on behalf of the employees of the government, who are not only permitted to enforce the law and bring about safety conditions, but are required to do so, I don't know what you can ask in that direction. Instead of this factor of safety costing the railroad an immense amount of money, the rules are so arranged that it will all be done when the locomotives go through the shops. In the matter of strengthening them and increasing the stress on braces, we permitted the locomotives to be operated not only until a new firebox was supplied, but until a new firebox and wrapper sheet was supplied. Could you go further in the method and manner of co-operating with railroad officials?

In the matter of these locomotive boiler inspection rules, they are simply your rules. The satisfactory results of the locomotive boiler inspection law do not come from any innovations in the way of rules, but simply from a reasonable enforcement of the rules which were in existence at the time the law was passed. To show the result of the law and enforcement of the rules, I will read the complete results showing the reduction of the killed and injured since the law became effective.

The records show that during the first year the law was enforced, 856 accidents due to failure of locomotive boilers or their appurtenances occurred, resulting in 91 killed and 1,005 injured, or a total of 1,096 casualties, which is an average of 71 accidents and 91 casualties per month. During the second year there were 820 accidents with 946 casualties, or an average of 68 accidents, resulting in 79 casualties per month, which is a reduction of 13 percent in the number of killed and injured. During nine months of the present fiscal year for which the records are complete there have been 452 accidents, resulting in 523 casualties, or an average of 50 accidents, resulting in 58 casualties per month, a reduction of 26½ percent in the number of killed and injured, or a total reduction since the law became effective of more than 36 percent in the number of killed and injured by failure of locomotive boilers and their appurtenances.

There is one thing, though, that I want to touch on which I believe this convention should thoroughly understand. We are frequently asked why we are requiring the staying of plugs more than 1¼ inches in diameter in firebox sheets, and we are frequently told that that plug is applied from the water-side and cannot blow out. We know that, but it can be driven in, and we frequently investigate an accident where one or more boiler makers are seriously scalded by just that thing. It is only a short time ago where a plug in a flue hole that was only half covered by a patch was driven into the boiler with steam pressure on the boiler by men calking the seam. Those things happen right along. Don't get the idea that these laws were passed to protect engine men. We want to enforce the law to bring the greatest measure of protection to all men engaged in the work of operating, maintaining or testing locomotive boilers, and if there are any conditions which are causing accidents to men engaged in repairing locomotive boilers, it is just as important that those conditions be remedied as it is to prevent failure on the road.

Mr. John B. Tate, fourth vice-president, responded to Mr. McManamy's address.

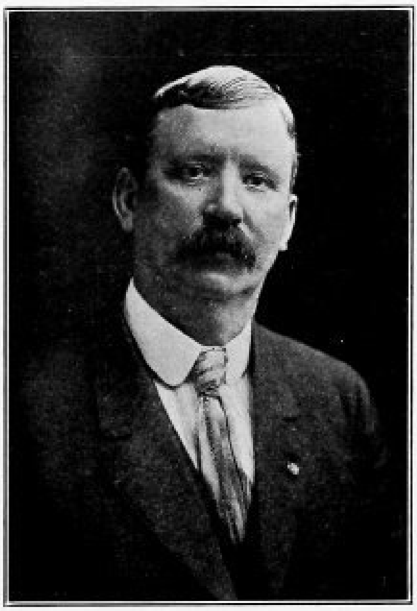
REPORTS OF THE SECRETARY AND TREASURER

The treasurer's report showed a balance in the treasury on April 31, 1913, of $441.67. The total receipts for the year were $1,652.67, and the total disbursements $894.01, leaving a balance in the treasury at the present time of $758.66.

The secretary's report showed that the total number of members of the association in good standing at the opening of the convention was 419. The secretary complimented the men who had served on committees during the year upon the prompt and thorough manner in which they handled the work entrusted to them. For the first time in the history of the association every committee report scheduled was ready and mailed at the appointed time preceding the annual convention. This desirable result is attributed largely to the fact that the work was carried on during the past year by smaller committees than heretofore. The secretary reported the deaths of two members of the association during the year as the result of accidents: David Martin-Yule, Somerville, Mass., and C. H. Smith, Vineland, N. J.

The Advantages and Disadvantages of Oxy-Acetylene and Electric Welding Processes for Use in Boiler Maintenance*

From various papers the chairman has received on welding and cutting by oxy-acetylene, the latter seems to me more satisfactory in results and in more general use. Cracks in firebox sheets of all kinds have been welded with the acetylene process and some very good results have been obtained. One report shows that cracks 15 and 20 inches long have been welded with acetylene, and have given eighteen months' service without trouble, also half-side sheets have been successfully welded. Much trouble has resulted, however, from sheets cracking adjacent to the welds, or in the welds themselves, due to the unequal stresses placed upon the sheet when cooling. For reinforcing thin plates in sheets, such as at wash-out hole openings, the oxy-acetylene is of value.



James T. Johnston, President

HEATING

Acetylene is found to be serviceable in heating sheets for laying up, in the fitting of boiler work; also in straightening crown sheets where same have been damaged by low water, as the heat can be localized and thus not injure adjacent sheets. It has been found dangerous to make welds adjacent to riveted seams and staybolts, as both are prone to leak after such treatment when the boiler again is placed in service.

CUTTING

Oxy-acetylene has been found extremely valuable in cutting boiler sheets, engine frames, etc., and in some cases is used preparatory to welding. For use in emergencies, such as on wrecking trains where time is a big factor, the acetylene outfit has proved its worth as a cutting agent. In the salvage of broken parts of rolling equipment and of shop machinery considerable savings are reported.

ELECTRIC WELDING

Electric welding, as its predecessor, is past the experimental stage and its value is unlimited. One very important thing

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* Abstract of committee report by Frank A. Griffin.

in connection with electric welding is that it is not dangerous to the operator, or those coming in contact with it, as there is nothing explosive about it and the voltage is low. Electricity has been used to some extent for cutting, but its greatest value is in welding. Cutting is done with a carbon, using it in the holder the same as the iron rod is used for welding. This method of cutting is not a fast one, but it can be used where it is difficult to get with a pneumatic hammer. As welding has become much more extensive than cutting we will therefore consider the possibilities of the former.

Side sheets, half-side sheets and patches, firebox sheets, are found to be very successfully applied, using the welder in making the seams join the sheets the same as in a butt joint. Experience has shown that the more crooked the seam the more efficient the welding is; that is to say, the sheets should be cut in an irregular outline so that the weld will not be in a straight line. In regard to patches, the same holds true, the more irregular the patch the better the weld.

Andrew Greene, First Vice-President

From various papers received by the committee the opinion in regard to the manner in which sheets should be fitted to make a good weld seems to be general. The best results have been obtained by placing the sheets about 3/16 inch apart, and beveling them from the fireside about the same as a sheet is beveled for calking. This allows the metal to burn through into the water space, filling the opening entirely. The welded seam should not be more than 1/16 inch thicker than the sheet that is welded.

Reinforcing the sheet with welding metal is found to be poor practice. Welding of broken mud-rings is an item of saving, and is done as follows:

The firebox sheet should be cut away with the fractured mud-ring. All the broken parts should be removed to give ample room for the welding. The welding should be done by filling in the opening, welding the firebox sheet and ring together.

Door-opening flanges are repaired by setting in patch, or in many cases by applying a collar completely around the opening. This class of repairs is of great value, as in many cases the door-opening flanges give trouble when the remainder of the firebox is in good condition. A large number of door-opening patches and collars are reported to have given good service for the past two or three years.

One of the most frequent questions asked in connection with electric welding is what success is obtained by welding over old seams that are damaged by fire-cracked sheets, and old patched seams likewise damaged? In most cases it is found that it is a very uncertain way of making repairs, as in many cases the welding fractures and continues to give trouble. There have been cases, however, where this kind of repairs have held fairly well.

Welding Broken Flue Sheet Bridges

From reports received we find very few cases of welded bridges giving satisfactory service. The most serviceable way to do this kind of a job is to remove the two flues adjacent to the broken bridge, placing a 3/16-inch plate in the water-side of the sheet, so that both flue holes are covered. The metal of the broken bridge is cut away, and the sheet welded into the opening formerly occupied by the bridge and its two adjacent flues. New holes are now drilled ¼ inch smaller than the original, so as to allow as large a bridge as possible. The flues are now swedged down on the firebox end to fit. This gives a very successful weld.

Cracks extending from flue hole to top knuckle of flue sheet flange can be successfully repaired in the same manner. Vertical cracks in firebox sheets are repaired by cutting the crack out, making the opening the same as in patching or applying sheets, removing all staybolts that come in the line of the crack, and filling them entirely, making sure that the weld reaches clear through. Holes are then drilled and bolts applied in the usual manner. This type of repair has given little trouble, but frequently the cracks open and have to be rewelded.

Welding Flues in Flue Sheet

The committee finds that the best method is to first apply the flue in the usual manner; place a layer of metal around the calking edge of the flue bead, being careful not to put it on too heavily, and hammer it while it is at a white heat. If proper care is taken in hammering this while at a white heat it will leave the metal smooth and will not require turning up. Flues applied in this manner can be tightened in the sheet in case of leaks from the weld giving out, same as in the ordinary way. In many cases flues have been known to give double the mileage when welded in, and in all cases show a decided improvement over the former way.

Applying new ends to tubes by the electrical process is being experimented with at the present time, and the results thus far obtained seem to be superior to those obtained by the former. The welding is very smooth and stands well under test.

The miscellaneous uses of the electric welder are also many, such as repairs to shop machinery, etc.

Discussion

Mr. Powell: I would like to ask whether, in welding superheater flues, anybody has had trouble with old flues breaking back of the weld after they have been in service for two or two and a half years, due to excessive expansion? We have found that such flues, which were electrically welded, cracked longitudinally back of the weld; in some cases they would break half-way around; so we have decided that we won't weld any flues electrically in sheets that are over twelve or fifteen months old. I would like to know if anyone else has had the same experience?

Mr. Griffin: We have found that pieces of the tube were known to break off directly back of the bead, practically in the center of the setting of the sheet. In some cases the piece was re-welded in with the electric welder and the flue was renewed. I would like to ask in connection with this the difference of opinion on electrically welding vertical cracks in fireboxes, and whether the staybolts were removed in the cracks or whether they were left in and welded to them?

Mr. Patrick: We still find it profitable to use the electric welder, but we have changed our method of electric welding since our last meeting. We follow now the practice on the Lake Shore; in other words, we apply the flues in the ordinary manner, put in coppers, prosser them, roll them and bead them, then cement around the edges with the welder. Our former practice was to project the flues through the flue sheet about one-quarter to three-sixteenths of an inch and fill in around the edges with the welder and then dress it off with the tool. We have abandoned that method. We have found in regard to patches that the oval patch welded in is less likely to break than a rectangular patch. Mr. Lucas mentioned putting in the side sheets and putting in the bolts, riveting the seams next to the door sheets and next to the flue sheets, and doing the mud-ring last, and then riveting the staybolts. We have never tried that, but I expect we will. Our practice has been to leave the mud-ring holes blank and drop the corner an inch and a half, and then the constant contraction would draw that up so that we would have about enough lap in the hole.

Mr. A. N. Lucas: I have had oxy-acetylene since 1910, and have now six oxy-acetylene plants in operation, and with new developments it has reached a point where they can be used every day to good advantage and with a big saving. We have not riveted a half-side sheet in since 1910, and we have not had a failure in the longitudinal seams. In applying the side sheet I have heard so much about leaving it loose and leaving it down an inch and a half, and this way and that, but I have never found any advantage in that in the least. I get out my half-side sheet and rivet it to the flue sheet and the door sheet; then I apply all my staybolts, not breaking them off or cutting them off, and put the bolts in the mud-ring and leave that loose, then I do my welding and cut off the staybolts and drive the mud-ring rivets, and the job is complete; and we have had no bad effects from that whatever.

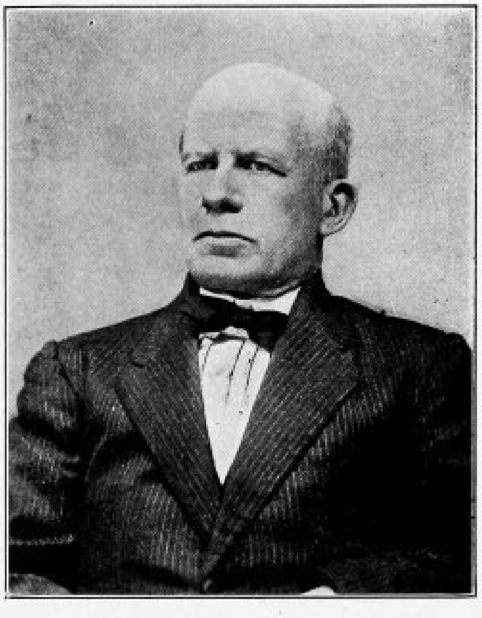
In applying patches of different designs I find that the round patch has given good success. We have had very little trouble from the weld breaking. We have had a few give way after seven or eight months' service for a short distance, but we rewelded them and they are still doing good service. I had an engine in service with oblong or oval patches when I was at the last convention, and those patches are still in service. They are 18 inches wide, about 40 or 45 inches long, with ends rounded. They have given perfect satisfaction.

We do not weld our superheater flues in, or have not welded them in. We haven't any trouble with our large superheater flues, but our superheater units gave us trouble where they used the cast end and threaded them and screwed them in. We did away with that, and three years ago we applied a set of superheater units welded at the end. At that time we had a square end where we mortised a piece in the end, and as they went along in service, the contraction and expansion of the pipe, one getting hot quicker than the others, broke them across these square corners, so that we had some little trouble in that line. Then we advanced the idea of giving the pipes a slight bend at the end and sawing it off and mortising it at the end where they come up together, making one weld and then putting a slip across to support the weld. We have had these in service over two years and haven't had one failure.

The field for the oxy-acetylene is growing every day and I don't know what we would do without it. We find some new use for it every day.

Mr. Thomson: On the Santa Fe we use the oxy-acetylene process, and we have done all kinds of patches and have had failures, but in the last six months we have adopted the principle of putting the patch in just as though you would have a butt joint, beveling both the firebox and the patch and welding from the inside. We have a man on the outside with a long blowpipe, so that he can put it through the staybolt hole and gradually follow about half an inch behind the welder, and it makes a weld that you can't tell what side it's welded from, and I believe it is going to be a perfect job when we do that class of work. We leave no draw of any kind and put in as little metal as possible to fuse the old and the new sheet, and we haven't had a failure of that kind. We have had them break on the vertical prior to this welding of both sides, but we have had no horizontal seam crack. We have welded the door sheet top and around the fire-door hole and mud-ring corners, ash boxes, sections taken out and put in, and we have not had any failures at the present time other than six in about seventy-five welds.

Mr. Hempel: I will try to answer the question that Mr. Griffin asked. He asked if we left the staybolts out or applied the staybolts before electric welding. In electric welding we leave out the staybolts when proceeding to weld a crack extending on either side of the bolt. The bolt is entirely removed. The hole is countersunk at an angle of 45 degrees or more, about half-way through the sheet. The entire staybolt hole is welded up and the crack extending from either side is also welded, and then a new staybolt hole is drilled and a new bolt applied. That is the only way that we have found that we have been able to weld cracks successfully. We could not expect these cracks to last as long as the original plate. If the original side plate will crack in from six to twelve months, we could reasonably expect a re-welded crack to last only from three to five or six months. The more circular you weld your patch the less expansion you have. If you weld a patch on four sides, the last side that you weld would naturally have the most stress; the plate would move on the other three sides sufficient to give while the metal is cooling.



John B. Tate, Third Vice-President

In regard to electric welding, possibly the first machine you get that you think would meet your requirements will be a 200-volt machine; after a short time service you find that you need a 500-volt machine. We have recently installed a 500-volt machine, and find it is not sufficient at the present time for our service. We should have a 1,500-volt machine, for the reason that with anything below a 500-volt machine you can't cut and weld at the same time.

Mr. Gray: I would like to ask a question in regard to welding cracks in the top of back flue sheet; that is, cracks that run cross-ways. We have been using an electric welder a matter of eight months, and have welded several of those cracks, and while quite a percent have been successful several have not, especially where the crack was about 30 inches long across the top of the flue sheet. We experimented in several ways by cutting out a small V and cutting out a wider one.

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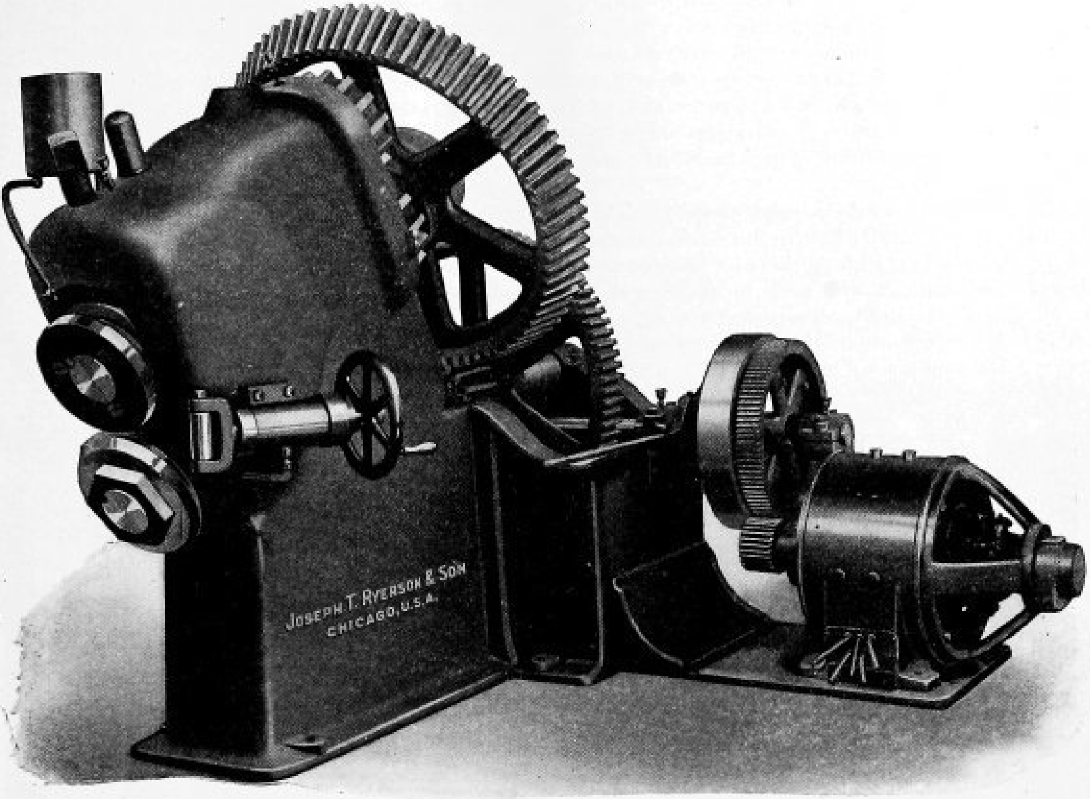

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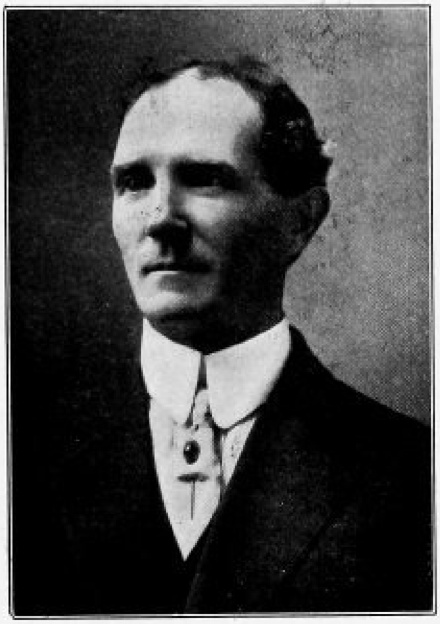
SEATTLE
DETROIT

We cut them from the water side and welded from the water side; but we had better success by cutting a very light gap and putting in lots of metal with the electric welder than when we first cut a small V, so that it just left an opening of about an eighth of an inch. Where we cut the opening at the top it would be a matter of an inch and a quarter and at the bottom about five-eighths of an inch, and so far we have got the best results out of that. If any of you have had different experience I would like to hear it.

Mr. Tynan: In order to weld a patch properly, take the patch and put all the holes in it; fit it to the place, and drop it on one end an eighth of an inch to the foot, and as you go along and weld that patch it will work up there and work right to its place, and you will have a perfect job of welding.

Mr. Harthill: We have both electric and acetylene welding, but we have not had any success in welding large cracks with the electric welder. If you weld a large crack, either with the electric or acetylene welder, you will probably get six weeks to two months' service out of it, but eventually you will always get a poor job. Now, since Nov. 1, 1910, in the Calumet shops, we have welded 163 side sheets, 152 door sheets, 5 crown sheets, mud-rings, corners, 794 patches, and 132 large patches. My failures up to Oct. 1, 1912, were 290. We started our new system of welding our side sheets and haven't had a failure since Oct. 1, 1913; but I think if we drive our mud-ring rivets in and put our mud-rings in, we would have 45 or 50 percent of failure. I can't weld sheets that way. I have had fourteen failures in almost 250 sheets. By hanging the sheets in loose and dropping them down on one end according to the speed of your welder—my welder welds fast enough to drop a sheet down an inch and 3/16, and I leave the holes out of our mud-rings and down the side; we see that we have a perfect fit before we start, and drop the sheet down and fasten it with a clamp. We use acetylene for building up corners around the wash-out plugs, to build up holes and in numerous ways on machinists' work. We saved $2,800 last month on machinists' work alone with acetylene welding. We use the electric welder for welding flues. You take a short crack, and you can weld that with acetylene or the electric welder; but when you get a 14-inch or 20-inch crack you will have a failure in six or eight weeks. I have talked with people on other roads; but they tell me they keep the engine in service and keep on re-welding. We have great success with the electric welding of flues, and I attribute our success entirely to cleaning the sheet before we start to weld the flue. I had occasion to go down to Dunkirk two weeks ago to weld three engines there, and the grease on the sheet was about half an inch thick; it took us two days to get it cleaned off, and as we were welding the oil would bubble out from under the bead. I cut out all oil in prossering and beading in my shops, and on the flues, and use linseed oil and put gasoline on the sheet, and in fifteen minutes it is all burned out and perfectly dry, and I have fine success.



C. P. Patrick, Fourth Vice-President

Mr. Stewart: On the Atlantic Coast Line, in 1910, applying side sheets, we burned the side sheets off at each end behind the rivets and welded the rivets to the flue sheet. Why take the time to rivet those ends? Why not weld them up? We have been doing that three years with good success. We put in our staybolts and put in one row all around next to the weld. Putting in 2/3 door sheets we weld to the side sheets and the back head, and never have any trouble. Putting in half-front flue sheets we weld through the bridges successfully. I don't think there is so much in all this dropping sheets down and going to all that trouble when you can put your sheets up there and fit them up and put all your staybolts in and weld your sheets on both ends to the door sheet and flue sheet, and drive your bolts and drive your mud-ring, and that's all there is to it.

Mr. Nau: I would like to know if there is any man in the room that has welded flues without a copper ferrule? I have tried that on one engine and she has made 9,000 miles and is O. K. up till now.

Mr. Bennett: I would like to ask if any of the members have had experience in welding in fire-door holes, eliminating the riveting entirely? I have seen several of them welded in, and they have been in service about a year and there are no indications of any leak.

Mr. Griffin: In connection with Mr. Nau's question on welding flues without copper ferrules, we have welded seven sets of flues without copper ferrules, accidentally. A boiler maker—the foreman boiler maker—was misled and misunderstood the instructions, thinking they meant to omit the copper from the flues, and put in seven sets before we caught him, and those flues made from 7,000 to 9,000 miles until they had to be renewed. During the time they were in service it was necessary to work the flues repeatedly. The longest any of them ran was a little over 9,000 miles before a part set was applied on the whole seven sets, which made a very poor showing without the copper.

Mr. Hershey: I have had a little bit of experience with the electric and acetylene machines, and I have had success and some few failures. In putting in a half-side sheet we rivet the flanges and mud-ring, leave out the staybolts, and after the welding is done we apply the staybolts and rivets. In welding flues we have engines that have been running twenty-two months, we have now welded the flues, and some of those have been running ten months, but don't give us any trouble, which will answer the question in regard to old flues being welded. With the acetylene machine we have very good success, but I have never been able to weld a solid sheet successfully with the acetylene machine. In putting in a side sheet with the acetylene machine we lower it one-quarter of an inch in twelve, and by doing that we have engines in service two years that have never given us a particle of trouble. We put the sheet up solid, and put in all the bolts and all the rivets. We have been unable to make the seam hold on a vertical crack between staybolts. To overcome that we have taken the top of the patch and run it down in a V shape to the mud-ring, 12 or 14 inches, and have had very good success in that. We are now starting to weld all our flues, put our flues in, prosser and bead them the same as we always do, then weld the bead with the electric machine. I consider the electric machine for all welding in the boiler shops better than the acetylene welder.

Mr. Henry Rapps: In regard to welding a fire-door, we have done that very successfully. We have about eighty, and they haven't given any trouble except those welded on the inside of the firebox; that has a sleeve, and we have had three of those give trouble and they have had to be rewelded, but where they were welded on the outside of the boiler they don't give any trouble whatever. We don't put any plugs in or rivets. In regard to dropping the side sheets, we found it pretty hard to determine on the proper amount of drop of sheet; one welder would want a drop of ⅛ inch to the foot, and another would want 3/16, so we came to the conclusion to bolt our sheets in the same as for rivets, and if they crawl up a little chip them out. We do our welding and then put the bolts in and rivet the sheets in afterwards.

Mr. Doarnberger: We know the contraction that takes place in acetylene welding, and we have abandoned that and do all our cutting with acetylene; it is indispensable for that, but we weld our work exclusively by the electric method. In putting in side sheets I have had them riveted to the mud-ring, calked, the staybolts tapped and riveted up and calked before the operator came along to weld the seam. I have done the same thing with patches and we have had remarkable success.

Mr. A. N. Lucas: In regard to welding fire-door holes, we have about forty welded under the head sheet with perfect success. Our first one we welded eighteen months ago, eliminating all patch bolts, plugs, rivets and calking, and it makes quite a saving over the old method. We welded in a side sheet, putting all the staybolts in, and in one case putting mud-ring rivets in. After three months that crack opened up and we tried to reweld it, but in the end we applied a patch. We have done a whole lot of good with acetylene welding, and are still learning there's a whole lot of good that can be done.

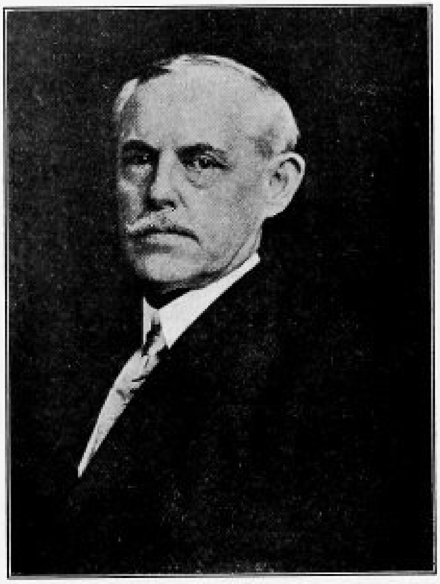
Mr. Artist: We have a Seaman-Wilson outfit, and in addition to the operations mentioned we are also welding locomotive frames. We have welded a total of seventy-one frames to date, and had a failure of nine, which makes about 12½ percent of failures. We are also welding flat spots and locomotive tires with great success, and are welding flues and patches.

Mr. Holt: First I went into the acetylene business for eighteen months. I am sorry to say it's a failure; I have proven it out. Then I got hold of the electric welder, and I took one of the old acetylene jobs that I had, with 176 inches of cracks in the corrugated side sheet; cut the whole acetylene job out, and went over it with the electric and got twelve months' service out of that engine.

Mr. Patrick: Mr. Young has requested me to get up and explain something about the welding of buttonhead staybolts, and preliminary to that Mr. Young mentioned that we should avoid welding up cracks or pits in barrels of boilers or mud-plug openings, which I think is very good. It is not our practice on the Erie Railroad to do that. We sometimes have a buttonhead staybolt that is badly calked—calked like a door-knob. You have all seen them, you have got them on your various railroads, and we are talking on the electric welding. I want to give you the experience that we have had. The Inter-State Commerce Commission took exception to our welding buttonhead staybolts in the crown sheet.

I made half a dozen tests, some with new bolts applied to new sheets, pushing them up. In every instance they proved far stronger than the new bolt. I don't mean to imply that we ought to weld in new bolts, but when you get to a point when it is badly calked, and the Inter-State Commerce Commission takes exception to it, this electric welding is a relief to carry the engine through till she comes into the shop for general repair.

The water condition in both types of welding is important, as I know, because I have both good and bad water in the territory I cover. It is natural to suppose that if the scale will adhere to the firebox, that naturally there is more contraction when you go to wash that boiler out or in cooling down, and Mr. Stewart, who spoke on welding side sheets, joining them to the flue sheet and door sheet without riveting them—the plan never struck me before, but if we can weld in a rectangular patch, why shouldn't we do that? But it is my impression that he is in good water. We have one or two divisions on the Erie Railroad that I cover where that wouldn't hold a moment. I don't believe we could weld it. On our east end—that is, on what we call the Meadville division—we can weld in rectangular patches, and they will give longer service than otherwise, but my recommendation and my experience is that patches should be made oval or rounding in either type of welding.



Harry D. Vought, Secretary

The discussion was closed and it was voted to carry the subject over for another year.

TUESDAY AFTERNOON SESSION

What Benefit Has Been Derived from Treating Feed Water for Locomotive Boilers Chemically, etc.? *

C. N. Nau: We had used soda ash for a number of years until Feb. 24, 1913, when we started to use polarized. When using soda ash our engines ran from four to seven days between wash-outs, and we had to keep close watch in order to see that the engines were properly handled as far as blowing off is concerned. We had considerable trouble on account of engines foaming, and with boiler checks, injectors, cylinder packing and throttle packing. We also had trouble with leaky superheat units. While not blaming soda ash for all of these troubles we nevertheless felt that this had something to do with it. Soda ash is a fair boiler treatment if it is properly handled and the engines are properly blown off.

When we started using polarized it gave excellent results as far as cleaning the boiler was concerned. It brought the scale down in large quantities, and until after a period of about six weeks we experienced no leaks. After that our flues, staybolts, radial stays, mud-ring corners, boiler seams and wash-out plugs gave much trouble and caused engine failures. Arch pipes began to sag and bag and had to be removed. Arch tubes, which formerly ran from twelve to eighteen months, had to be removed in from thirty to ninety days, and in several

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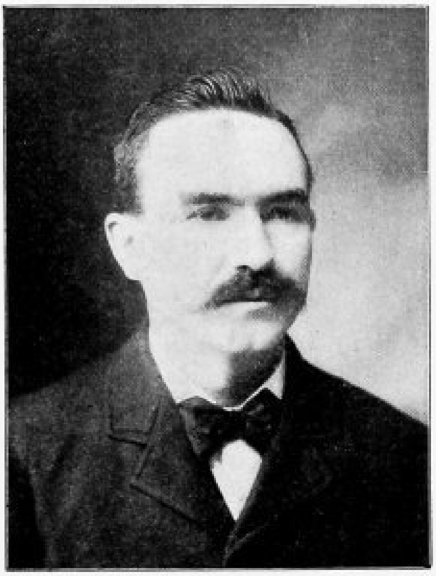
* An abstract of this report is printed on page 195.

cases they ran from only one wash-out to another, on account of the formation of very hard scale, which adhered to the sheet. After the old scale was brought down there was a formation of new scale that accumulated on the flues and outside wrapper sheets. On engines with new flues using polarized treatment in less than six months a coating of scale running from 1/32 to 1/16 inch thick formed on the flues. Where the flue came in contact with the firebox sheets, and for about 18 to 20 inches along the back end of the tube, it was free from scale, while the front end of the flue, next to the flue sheet, would corrode almost solid. This trouble was attributed to water conditions that the polarized treatment could not overcome. We then began to use Dearborn compound, and after that had no more trouble with these engines.



Frank Gray, Treasurer

The Dearborn compound did away with leaky staybolts, radial stays, wash-out plugs, mud-ring corners and boiler seams, and it has also stopped leaky superheat units. We feel that the Dearborn treatment has eliminated our troubles to a great extent. Detail figures are given showing the actual cost and savings effected by these different treatments.

Mr. Bury: We have for some time been using the polarized. We have not been in favor of any compound at all, as far as that goes. The first time we got the polarized compound we had good results, but later we have not been getting as good results. I looked the matter up, and in my opinion the mercury is not polarized the same as it was when we first got it, and I have asked the question, is there any way that polarization could get out of the mercury by any chemical action or otherwise? How long will the polarization stay in that mercury? I agree with that report to a certain extent, but I don't agree with it in all things, and that has been our trouble lately. As far as I can see the polarization is not in the mercury the way it was in the first place.

The Chairman: I don't really know whether there are others here that have had any larger experience with polarized mercury than the Canadian-Pacific Railway (Western lines). On the Saskatchewan division, which ends about 28 miles west of Winnipeg, and embraces a mileage of probably 800 miles, we have had this material in use during the last seventeen months. On one occasion where we had a continuous treating system of water tanks at the wayside tanks, treated in the same manner that I find on the Northwestern and on other roads in the United States which I have visited, we have cut out that treatment, even though the company had gone to very great expense in erecting them, some of them costing $25,000 and $30,000, and we tried polarized mercury. By doing so we have made very material savings for the company. It is the first material that we ever used on our Western lines with which we could show up a profit for the Canadian-Pacific Railway. Now, there is nothing injurious in connection with the use of it which will harm the boiler, which will harm the checks or which will interfere with the operation of the engine whatever. We have used it for that length of time, and during the most trying and critical periods of the year, during our severe winters, we went through and made a comparison of what we accomplished the previous year, when we had treated water in the wayside tanks, and we have been able to show something miraculous with regard to the actual boiler conditions of the railway company. The use of polarized mercury lengthened our period between washouts and enabled us to double our mileage, and in some cases to multiply our mileage three times between washouts. In every way that you could imagine we have been able to show a very large profit.

Mr. A. N. Lucas: Does it do away with foaming?

The Chairman: With a reasonable period between the wash-outs we are not troubled with foaming, although we use a foaming compound during the winter, when the water conditions are different.

Mr. A. N. Lucas: Do you blow out more when you lengthen your wash-out period?

The Chairman: Quite frequently, yes; not immediately after the application. The application is made, of course, at the time of the wash-out, just before we close out the boiler, and we have men delegated to see that it is applied and keep a regular record of the amount of material that is used, the mileage between the wash-outs and all the particulars that are necessary to enable us to compute the savings from month to month. The company insists upon our making a monthly statement showing just what we really accomplish.

Mr. Johnson: Do you have any trouble with failures due to foaming?

The Chairman: Not now. We sometimes have to set off a car or two, to reduce our tonnage on account of an engine foaming, but we have a foam-reducing proposition which can be used in connection with it to enable us to run as long as we can and not make the boiler suffer, but where our duties come in is to see that we do not exceed the proper time, and we have got to watch that closely, due to the changed conditions that pass over the district during the year.

Mr. Nau: Is there any anti-leak connected with the treatment?

The Chairman: No, not with the polarized; it's a separate application.

Mr. John B. Smith: Do your flues pit any with this polarized system?

The Chairman: No, we have no trouble with pitting.

Mr. J. B. Smith: In using this polarized method of treating your water do you have much scale on your flues?

The Chairman: No.

Mr. Courtney: It depends a good deal on the water. We have used the polarized treatment in our Yankton and Sioux City division, putting it in when the engines got new flues, and it didn't do a bit of good; they scaled just the same, it didn't help them a bit. Then we put in treating tanks, and now we get better results.

A Member: We tried polarized treatment on the Pittsburg & Lake Erie for six months, and at the end of six months we took two engines, one that was not treated and one that was, and you couldn't tell a bit of difference between the two flues.

Mr. Powers: I think Mr. Kelly will bear me out in what I am going to say. Some three years ago we had the same trouble you have experienced on our Iowa divisions, due to foaming and scaling. We had the wayside treating plants the same as now, but there wasn't any system; nobody followed it up; there wasn't any system of blowing off, and I want to tell you that when you put soda ash in the boiler you have got to get it out or you will have trouble. Mr. Kelly, I believe, was the originator or starter of the systematic blowing-off of locomotives on the Iowa division, which afterwards became a standard on the Northwestern Railway. We either have the wayside treating plant or soda ash, and blow our engines once every mile if possible, or at least once between every station.

Mr. Neff: I think the use of any kind of water treatment enters a whole lot into the human element; in other words, the engineer, fireman and round-house employees. You take soda ash, for instance, and I don't know of a round-house foreman or any other employee that won't kick at the use of soda ash, and after some experience on the line we naturally have quite a lot of water, and I find that by using soda ash we had about as much trouble as when we didn't use it; in other words, the appearance of the locomotive was worse than when we didn't use anything. We had the sediment coming out around the staybolts, wash-out plugs and so forth, which made the engine look bad. My experience with this new method has been very limited, but I will say that with the use of the Dearborn compound it has eliminated at least 50 percent of our troubles at the outlying points where we couldn't get hold of the boiler to wash it out at given periods, like we can on a main trunk line. We have divisions on the Baltimore & Ohio where we keep the engine in service as long as we can within the limit of the law; in other words, get as much as we can out of the locomotive between washouts, and I found that with the use of the Dearborn compound we have had very good results, and did not need to depend on the engineer blowing the boiler out, didn't need any extra mechanical devices to blow the boiler down, but kept the boiler in service a reasonable length of time, which is an economy I think we are all looking forward to.

Mr. Howe: I have been in the Pittsburg district now about three years, and we have been using the Dearborn compound, both anti-foam and anti-leak, and up to the time we commenced using this we had a great deal of trouble on account of foaming; had to set off trains. But since we have used this Dearborn compound we have no trouble at all and have cut out failures completely. We are blowing our engines out now and have not been using any compound for the last four months, but where we are using the Dearborn compound we don't blow our engines and don't have to blow them, and during all our experience with the Dearborn compound we have got good results.

Mr. Powers: What do you do with all the sediment that goes in the boiler? What becomes of that if it is not blown out?

Mr. Howe: We wash out the boilers in that district every seven days.

Mr. Powers: Then you don't increase the periods of washouts?

Mr. Howe: No.

Mr. A. N. Lucas: I would like to ask if you have any mud burn on the side sheets just above the grate due to burning of the mud-ring?

Mr. Howe: No.

Mr. Cannon: I find there are two things in all compounds—they contain either acid or alkali. If your water has alkali, you have got to put in an acid to neutralize it; it makes no difference what compound you take, it's either acid or alkali in one form or another. If you get the proper amount in there, why, it won't hurt your boiler or anything else and will dissolve the scale, but if you get too much in there your boiler will pit. I think it is all governed by the kind of water you have got, and what applies to one part of the country would not apply to another; in fact, what applies to one water tank would not apply to another, and unless a man can tell you what his water contains I don't think you can get very much information from the results he gets.

The discussion was closed and it was voted to continue the subject for another year.

Mr. C. A. Conde, of Camden, N. J., a mechanical engineer, addressed the convention, briefly, on superheated steam.

What Can the Association Do to Get a Uniform Rule Regarding the Load Allowed on Staybolts and Boiler Braces? *

The load on boiler braces is fixed by the rules of the several State and inter-State boards, the stress allowable being something less than 12,000 pounds per square inch of cross section, which is correct and regular. The allowable load on staybolts is about 8,000 pounds or less per square inch of section, or a factor of safety of 6 or more. It is the opinion of the committee that the smaller the bolt the greater flexibility it has, but in order to get the benefit of the experience of the members of the association a form is submitted covering questions for each member to answer, these answers to form a report for 1915.

The paper was received as information and the committee continued until 1915.

What Shape and Size Head of Radial Staybolt in Crown Sheet of Oil-Burning Engines Give the Most Efficient Service?†

It is found that the screw crown bolt and radial stay, with a taper of ¼ inch in 1½ inches riveted over on the fire side of sheets, give the best service. Where crown bars are used an extra heavy wrought iron pipe thimble should be used between the sheet and crown bar. Where radial stays are used they are to be riveted over in the same manner as where crown bolts are used. Some roads are using a taper nut on the bottom end of radial stays over the crown sheet on coal-burning engines. This is also thought to be beneficial on oil-burning engines.

The Advantage or Disadvantage of Combustion Chambers in Large Mallet or Pacific Type Engines Other Than a Shorter Flue‡

Mr. Gray: I would like to ask Mr. Lucas if he has any trouble with stays breaking in combustion chambers any more than in ordinary firebox side sheets?

Mr. A. N. Lucas: We had a few stays break in combustion-chamber boilers, not to any great extent; in some localities they seem to break more than in others. The first row from the flue sheet seems to give some trouble, and it is our recommendation on our line where a staybolt breaks in a combustion chamber to apply a flexible staybolt, which gives an opportunity to get the old bolt out.

Mr. H. J. Wandberg: In regard to stays breaking in combustion chambers where the air pump was placed directly over the combustion chamber we had that moved off, and it remedied the difficulty.

Mr. Johnston: I would like to ask Mr. Lucas what trouble he had with seam brick, and to what extent, on the oil-burning engine?

Mr. A. N. Lucas: Almost five years ago we put in service twenty Mikado type locomotives in the oil service. They were built in the Milwaukee shops and sent to the Coast Line, and have been in service continually, and we have applied but one firebox in those twenty engines, and that was due to a low water gage. We cover our seams with special brick

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* Abstract of committee report by Chas. P. Patrick, Andrew Greene and J. J. Mansfield.

† Abstract of committee report by C. L. Hempel.

‡ An abstract of this report is printed on page 188.

made for that purpose. We have applied a number of back flue sheets, otherwise we have had no trouble to speak of in that class of boiler.

Mr. Johnston: What amount of heating surface will you take away from your firebox by the seam brick? Does that deprive the engine of some of the heating surface?

Mr. A. N. Lucas: In an oil-burning engine we cover from the bottom up, 18 or 20 inches in some cases; we cover the seam with a narrow brick 5 or 6 inches wide, the full length of the box; sometimes we have to use those bricks on the top of the door sheet seam and also on the inside of the seam, but we have had no trouble at all maintaining seams.

Mr. Clark: We have practically 70 percent of all our power in combustion chambers. I find that the flue failures are considerably less with the combustion chamber than they are without. The question arises about the washing out of the boiler. As a natural consequence it is a little more difficult to wash out, but I do find that we have practically 150,000 to 200,000 miles' service out of the flues. As far as the staybolt breakage is concerned we have very little trouble; in fact, we have practically all the combustion-chamber engines equipped with flexible bolts. We did have trouble before that equipment was made, but at the present time I am safe in saying that practically all combustion-chamber engines are equipped with flexible bolts, eliminating the staybolt breakage. I think all the members who have written papers are thoroughly familiar with the merits of the combustion-chamber engine, and those who have had them, as Mr. Lucas says, find they have been of great benefit; but would like to ask Mr. Lucas what method he employs in applying the flexible bolt to the crown sheet of the combustion-chamber engine?

Mr. A. N. Lucas: We apply a sleeve in the roof sheet the same as the regular practice, and our practice and general practice throughout our system is eight middle rows in all crown sheets. The bolt comes down through the crown sheet about ¾ inch, and a steel nut is screwed up against the crown sheet. The bolt is then held on and driven; if it is a radial on the topside, a cap is placed on the same.

Mr. Charles Zietz: We have a considerable number of combustion-chamber engines on the south end down in Colorado, and I find that we have considerable trouble up on the wings of the throat sheets on account of the inside burning and giving us considerable trouble. This is a coal-burner. Now I don't know whether I am right or not, but nevertheless I believe we use a different kind of coal entirely to what some of the Eastern roads do. It is some of the hardest coal in the country to burn, and I believe that has a whole lot to do with the condition of the firebox.

Does the Method of Flue Cleaning or Rattling Have Any Effect on the Further Scaling Up of Flues? *

When flues are properly cleaned in the rattler there is no material difference in the amount of flue mileage obtained, nor the amount of scale on the flue, than when the flues are new.

There are certain makes or designs of flue cleaners of the rotary type which leave small crevices in the body of the flue, which cause the scale to accumulate very rapidly. Flues cleaned in this manner accumulate and hold the scale more rapidly, and accumulate a greater amount of scale in the same length of time than when the flues are new or cleaned by the rattling process. The new or rattled flues are absolutely cleaned on the inside, as compared with the flues cleaned by the above method.

The rolling of dirty tubes in a dry rattler or in water rattlers, or on the chains of an ordinary rattler, seems to be the best form of cleaning, as it not only gives a smooth, polished surface on the outside but loosens and cleans out all the dirt from the interior of the flue. If the flues are properly cleaned in the above-mentioned manner they will not scale any more rapidly than new ones when the same kind of waters are used in the boilers. The amount of scale accumulating on the flues depends almost entirely upon the amount of impurities or chemical properties contained in the water used. It has also been noticed that the chemical properties found in the water in one district will dissolve and remove scale when the engine is running in other water districts. So that if we want to prevent the accumulation of scale and keep our flues in good and serviceable condition at all times, we will have to turn our attention to an improved and treated water system, and also to see that our boilers are carefully and systematically washed at regular intervals.

If the flues are cleaned properly and smooth on the outside surface with a flue rattler, either by the dry process or in water, and the replaced or pieced flues are free from scale with a surface smooth as that obtained with a new flue, the thickness of the body of the flue does not create a condition which accelerates scale formation, although becoming thinner with age. We have never been able to get more flue mileage out of a new flue than out of a rattled one, if the flues were cleaned properly and smoothly when the engine was operated in the same district and under the same conditions and received similar attention.

Mr. W. J. Murphy: In rattling flues, I find that in some places they rattle them through water and in other places they rattle them dry. My experience has been that we rattle them dry. I would like to hear what advantage there is in rattling through water.

Mr. A. N. Lucas: I cannot answer the question as to rattling them through water, although I think it makes less noise and saves some time, but we have a dry rattler and it makes a whole lot of noise, and I find in a good many cases that some of the foremen boiler makers don't see fit to put a regular man on the rattler, but they will let him go over and charge the rattler and take him away to do other work. The rattler goes on forever, and after five or six hours he happens to think of it and goes over and takes the flues out, and they are polished, and some of them are hammered up pretty badly and the material don't seem to be right. I think a great many would save some flues by watching the rattler a little closer. I don't believe we ought to rattle a minute longer than necessary. If there is a little scale left on knock it off with the hammer. I told them to sort them out and put the scrap flues in one bin, the next shorter ones in one bin, and the good ones in a third. At one time they were scrapping too many good flues, and there is a place where a boiler maker or foreman could check up and save some money for his company.

Mr. Gray: I presume what brought this subject out is that there is a mechanical cleaner that, when the flue is run through a machine with a number of corrugated wheels, it kind of cuts a thread on the flue—just presses the scale all up. There are several wheels, and part of them, the corrugations, run around them and other corrugations run crosswise, the same as a gear wheel, and the flues going through there, of course, have got to exert a good deal of pressure to get the scale off, and these corrugations will cut threads in the flue and, of course, that will make the flue slightly rough and possibly give the scale a little better chance to adhere. We have cleaned flues that way, have used the dry process, and at the present time we are using the water rattler. As far as the scale adhering to the flue, I can't say that there is any difference in any of the methods in our particular kind of scale. We have got some that is very hard, and I guess it will hang on to anything it gets hold of.

The Chairman: I would like to hear some of our members from oil-burning districts say something with reference to the internal cleaning of the flue; that is, if they have found any greater trouble in loosing oil and getting rid of the gath-

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* Abstract of committee report by B. F. Sarver, H. R. Mitchell and M. J. Guiry.

ering that is formed on the internal parts of the flue which might interfere with the welding up of the flue later, or if they are using anything different in their rattlers to get rid of that condition.

Mr. Johnston: We have something like 400 engines equipped with oil, and have yet to find any trouble due to the cleaning of the internal portion of the flue. We use the wet rattler, put the flues in there, and while they are not as clean as the dry rattler, we have no trouble with our scale forming on those flues which some of you gentlemen would call partly cleaned. They have a light scale. On the coast lines of the Santa Fe I advocate the wet rattler. The internal part of our flue is kept clean by the sanding out of the engines at intervals while in service. We experience no trouble whatever by any stoppage of the flue.

Mr. Cannon: Speaking about firetubes getting stopped up in oil-burning engines, I wish to say that I worked for a railroad not very long ago that uses oil burners, and every once in a while they would get a lot of salt in the oil and the flues would stop up and we would have to almost drill them through; that's the only way we could clean them, but that would only last for a while, and the oil cleans itself afterwards, and we wouldn't have any trouble for some months.

Mr. Murphy: I would like to ask how many revolutions per minute the rattlers should run to get good results? At one point on the road they found flat spots in them, they were running the rattlers at about 75 revolutions a minute; in our place we were running at 22 revolutions per minute.

Mr. Zietz: We are running our rattler about 15 revolutions per minute; 250 flues in the rattler.

Mr. Gallagher: We run about 18 revolutions a minute.

Combustion and Fuel Economy*

This report deals with the composition of bituminous coal, which is the principal fuel used in locomotives, and gives the proportions and physical properties of the various substances of which it is composed. The process of combustion as described, and the chemical reactions which take place in the locmomotive firebox by the combustion of fuel, are explained in detail.

It is possible for eleven reactions to be taking place in the firebox at the same time, and the gases passing out of the firebox might contain free carbon, hydrogen, oxygen, carbon monoxide and the volatile hydrocarbons, in addition to the inert nitrogen and the products of complete combustion, carbon dioxide and water vapor. In such a case the heat loss would be high; but it could be easily prevented by bringing these combustible substances into intimate contact (mixing them) in the presence of a sufficient quantity of heated air and giving them time to burn. This in turn calls for an efficient baffle (or arch), an excess of heated air above the fuel bed, and sufficient flame-way (or distance between back of arch and flue sheet) to allow the burning gases (or flames) to be completely consumed before entering the flues.

At atmospheric pressure and a temperature of 60 degrees, it takes about 13 cubic feet of air to weigh a pound, so the minimum theoretical air requirements would be $13 \times 11.54 = 150$ cubic feet per pound of carbon burned. A modern locomotive burning 3 tons of coal per hour would require from 20,000 to 25,000 cubic feet of air per minute, or say six boxcars full per minute. If the significance of these figures is grasped, large ash-pan openings and correctly designed grate bars will follow.

On the Central of Georgia we have an arch that is placed in perpendicular form, with air ducts extending from bottom upward to top of arch, distributing oxygen to the gases as they arise from the coal mixing with the gases as they arise, and pass into the combustion chamber. With this appliance on engines so equipped, the coal consumption has been materially reduced. If too much air is admitted it will reduce the temperature in the firebox so much that the gases will not ignite, or, if it is admitted in strong currents to regulate those air currents, dampers can be applied, and by proper adjustment of these dampers, supplying the gases with proper amount of air, almost complete combustion is obtained.

Various appliances have been designed and patented for the distribution of the various elements for perfect combustion. These in their places are excellent, and have reached the end to a very large extent for which they were designed, but with all the appliances of the age, and all the designs, the thought and energies which men have expressed are of very little service unless those who handle these devices have some knowledge of what they are for, and of how they may be used.

Tons of coal are annually wasted by neglect of tank and engine decks. To overcome this loss engine decks should be kept perfectly coal-tight at all times. Tanks should not be overloaded, so when the engine is in rapid motion coal will not be blown or shaken off. In this connection, also, the draft appliances should be maintained at all times so as to give the proper draft equally on all parts of the fire. If this is done, and the engine is burning a level, bright fire, then we know that we have gone the limit with draft appliances. The next step then would be to either increase or decrease the nozzle as the case may require. So it is evident that the engine is not getting sufficient draft to burn fire freely enough to make steam as fast as the engine is using the same.

Clean flues, clean arch, clean grates, proper adjustment of draft rigging, sufficient opening below grates and proper size of nozzle are essential to good combustion. Unless these are maintained at all times there will naturally be a waste of fuel.

The introduction of the electric welding process for boiler work, especially for flues, should be carefully considered from a fuel standpoint, especially in bad-water districts. The welding of old flues which have been in the boiler long enough to become heavily coated with mud or scale, or both, would require more fuel to heat these foreign substances, and the cost of fuel consumed by these obstructions would overbalance the cost of removing and cleaning flues and boiler.

The Proper Inspection of a Boiler While in Service*

Periodical Inspection of a Stationary Boiler Under Steam Pressure or a Service Inspection.

1. Examine the gage cocks and water-glass. See if they are open and in good working order with plenty of water.
2. Apply a test gage to prove the steam gage, and to see that the safety valves blow at the allowed pressure.
3. Try the injectors, feed pumps or other water-feeding apparatus to see if they are in good order and in good condition to deliver the maximum or any quantity of water.
4. Examine the boiler settings, all steam and water connections for leaks or signs of distress.
5. Let the fire burn down to allow as much examination as possible through the fire, soot and front end doors of the firebox sheets, flue sheet, bridge walls, flues, blow-off pipe, ashpit, etc.
6. Examine breeching, dampers and smokestack, to see if they are kept clean and free of air leaks so the boiler can give its best work.

A locomotive service inspection would be very similar, but should be made each trip or at each end of the road.

1. Examine gage cocks and water-glass to see if they are in good order with plenty of water.
2. Try the injectors to see if they work properly and feed into the boiler.
3. See if the blow-off cock is tight and in good serviceable condition.

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* An abstract of a committee report by C. F. Petzinger and R. W. Clark.

* Abstract of committee report by Charles E. Fourness and J. L. Fahey.

4. Examine the ash-pan and grates.

5. Examine the outside of the boiler for leaks or signs of distress.

6. Examine the front end to see that everything is in place.

7. After the engine has cooled down sufficiently, the firebox should be examined thoroughly inside for defects to the sheets, leaky flues, staybolts, etc. See that the flues are open and the brick arch (if there is any) is clean and in good condition.

MINORITY REPORT*

1. When an engine is taken into the engine-house the steam should be blown off and the water let out of the boiler, and a thorough inspection of all firebox sheets made, such as staybolts pulling through sheets, cracks, crown sheet safety plug and flues.

While all staybolts are drilled with tell-tale holes, the jacket is seldom removed, only when engine is in shops for repairs; therefore, all staybolts should have a hammer test, and defective bolts, if any, removed. The outer sheets should be inspected as well as possible for distress of any kind.

2. All grates and ash-pans should be inspected and the front end should be opened and inspected.

3. Gage cocks and water-glass columns should be removed and cleaned from all corrosion. Steam gages should be tested by a regular machinist assigned to this duty with a test gage.

4. The boiler should be filled up and fire applied and the required working steam pressure be raised on the boiler, and the safety valves tested to carry not more than 2 to 4 pounds over the regular working pressure. It is necessary also to examine all outer sheets for defects after the engine has raised the amount of working pressure.

While this inspection is necessary every thirty to ninety days, a rigid inspection of all staybolts and firebox sheets is necessary three or four times a month. This applies to locomotive boilers only. A boiler in service is at all times in service until taken out for repairs or stored. It is never necessary to take a boiler out of service for inspection.

THURSDAY MORNING SESSION

At the opening of the final session of the convention on Thursday morning President Lowe introduced Mr. Henry J. Hartley, superintendent of the boiler department of William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.

ABSTRACT OF MR. HARTLEY'S ADDRESS

While my work in the boiler line has been of a general character, yet the greater portion of it has been for marine services, dating from the old drop-flue class of boilers to the present types of Scotch and watertube boilers. The former drop-flue class is used at the present exclusively for river boats, while the latter (the Scotch and watertube types) are used for sea-going vessels. In this connection I beg to call attention to the phenomenal evolution that has taken place in steam boilers of all types within the last half century, in regard to weight, power and steam pressures.

In the way of comparison, I call to mind data of some types of marine boilers built by the I. P. Morris Company (a subsidiary of the William Cramp & Sons) within my recollection, which as far as I know are still in use on the steam ferryboats *America* and *Merchant,* lately plying the Delaware River between Philadelphia and Camden. The *America's* boiler is of the two-furnace, return-flue and steam chimney type, 18 feet in diameter, 30 feet long, carrying an average steam pressure of 25 pounds, with a ratio of heating surface to grate area of 26 to 1. The *Merchant's* boiler is of the two-furnace, straight-away tubular type, 7 feet 6 inches in diameter, 21 feet long, carrying an average steam pressure of 30 pounds, with ratio of heating surface to grate area of 38 to 1. The average evaporation in both cases is about 7½ pounds of water to 1 pound of anthracite coal, cutting off steam at one-third of stroke of piston. The engines are of the walking-beam, paddle-wheel type. In this connection I will state as a piece of ancient history, previous to about 1870 the largest transatlantic ships were equipped with similar low-pressure boilers, such as the steamships *Atlantic, Pacific, Baltic* and *Arctic*—pioneers of what is now the great White Star Line—their lengths on deck not exceeding 286 feet, with a tonnage of 2,700. Each of these ships contained four iron boilers of the square water-bottom type, having eight arched furnaces and 2-inch vertical watertubes, carrying a steam working pressure of 14 pounds. The ratio of heating surface to grate area was 57 to 1, and the evaporation 7½ pounds of water to 1 pound of coal; paddle-wheel engines. Also many vessels of the United States navy, as late as 1875, were equipped with the above-described type of boiler, made entirely of copper, such as the *Susquehanna, Powhattan, Mississippi, Sarnac* and *San Jacinto,* all of which did good active service during the Civil War, and afterwards were re-boilered with iron ones of a more modern type, known as the Martin boiler, at a cost of about the value of the copper contained in the old boilers. However, those of the Martin watertube type were short-lived on account of the tubes fouling.

It is a remarkable fact that all data obtained in regard to the efficiency of the different types of boilers of the before-mentioned period agree as to the quantity of water evaporated per pound of coal, viz.: about 6½ minimum and 7½ maximum for both anthracite and bituminous coal, which, in comparison with the present evaporation obtainable, is very low, considering that 9 pounds is about the average for the Scotch boiler and about 11 pounds for the watertube boiler, while as high as 14 pounds of water per pound of fuel oil has been obtained.

It is needless to say that but few of the foregoing described styles of low-pressure boilers are now in use, having been superseded by the Scotch and watertube types of higher steam pressure capacity. Where the Scotch type is preferred in the newer transatlantic and other sea-going vessels, the steam pressures have gradually but steadily increased to 235 and 250 pounds.

The company with which I am connected has recently completed three ships for the Pacific trade, via the Panama Canal, each equipped with three Scotch boilers of 3,000 horsepower, 15 feet 9¼ inches in diameter, each containing four corrugated furnaces, 3 feet 7½ inches in diameter, to carry a working steam pressure of 223 pounds per square inch under oil fuel. There are 39 feet of heating surface to 1 of grate surface. The plates composing the shells of these boilers are 12 feet wide, 12 feet 4 inches long and 1 11/16 inches thick, each plate weighing 11,000 pounds. The finished weight of each boiler is 74 tons. The total weight of these boilers is 669 tons, exclusive of all fittings, such as up-takes and stacks, which equal 115 tons. On account of the size (in width) of these plates it was necessary, I regret to say, to have them imported, and they were made by David Colville & Sons, Ltd., of Motherwell, Scotland.

We have also made for the Southern Pacific Company two ships equipped with heavy Scotch boilers of the double-ended type, each of 7,500 horsepower, 15 feet 4 inches in diameter, 21 feet 6 inches long of plate, 1 11/16 inches thick, containing eight corrugated furnaces, 3 feet 1½ inches in diameter, to carry a working pressure of 235 pounds per square inch. The plates composing the shells of these boilers are 5 feet 8 inches wide, 25 feet long, 1 11/16 inches thick. Each of the shell plates in the circumference of the shell weighs 9,500 pounds, making the total weight of each completed boiler 120 tons. The width of the plates in these boilers was such as could be rolled in this country, and were therefore made by the

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* By L. Borneman.

Lukens Iron & Steel Company, of Coatesville, Pa. The total weight of the boilers for each ship is 480 tons, exclusive of up-takes and stacks, the weight of which is 67 tons. This, coupled with the fact of their being the heaviest and highest pressure marine Scotch boilers ever made in this country, constitutes their main features.

Likewise the changes in size and weight of the locomotive boiler since the first made, such as the *Rocket* and other types experimental of the earliest period, have been equally as varied, excepting in external form so established as better suited for railroad conditions generally, which has remained about the same. Since about twenty-five years ago, however, the average weight of locomotives has gradually increased from that of, say, 30 tons to about 75 tons, and it is still increasing—a fact of which we were reminded yesterday while visiting the Lukens Iron & Steel Company's plant, where there was a monster locomotive weighing as much as 114 tons.

Topics for Report and Discussion at Convention of 1915*

Your committee begs leave to recommend the following topics for committee reports for the next annual convention in 1915 in addition to those that may be carried over this year:

1. (a) Best Method of Scaling a Boiler when All Flues are Out. (b) When is a Boiler Properly Scaled? (c) When is the Best Time to Locate a Crack in the Interior of the Boiler; that is, Before or After Being Scaled?

2. What Should be the Standard Slope for a Crown Sheet in a Locomotive Firebox; its Advantages or Disadvantages?

3. Best Method to Determine the Reduced Percentage of Strength in the Shell of a Boiler Occasioned by Pitting or Corroding.

4. Best Method of Staying the Back Heads of Locomotive Boilers so that they may be Inspectable in "Service" Engines.

5. What are the Advantages of Cross Stays Above the Inside of Firebox? Has their Introduction Brought About Failures at Other Locations, and, if so, Where?

6. Where the Back Flue Sheet Braces, Joining the Tube Sheet to the Shell, have Been Omitted, has it Resulted in Better Service from the Lower Tubes? If so, what Results have Been Obtained Compared to the Original Method of Staying with Braces?

7. What is the Best Method of Cleaning Out Clinkered and Clogged Superheater Tubes in Round Houses? What are the Proper Tools to Use?

8. Which is the Most Economical Method of Removing and Replacing New Fireboxes in Wide Firebox Locomotives—Taking Out the Head or Cutting Back End off at the Connection, or Taking Boiler off the Frames and Removing Old Box and Replacing New One Without Removing Back Head or Connection?

9. Is the Welding of Superheater and Small Tubes in Back Flue Sheet Successful, and, if so, what Method Gives Best Results?

10. What Method of Driving Staybolts and Radial Stays Gives the Best Results and Service in Locomotive Boilers?

11. What is the Most Economical Method for Constructing New Locomotive Tanks, and what Advantages have the New Designs Over the Old Style of Tanks?

12. Law.

13. To Recommend Topics for Committee Reports at the Annual Convention in 1916.

14. Best Method of Drilling Tell-Tale Holes in New Staybolts and Opening Up Old Tell-Tale Holes in Staybolts in Locomotive Boilers.

15. Which Firebox Steel Gives the Best Results in Locomotives in Service—the "Basic" or the "Acid"?

Election of Officers

The following officers were elected for the ensuing year: President, J. T. Johnston, foreman boiler maker, Santa Fe System, Los Angeles, Cal.; first vice-president, Andrew Greene, general foreman boiler maker, Cleveland, Cincinnati, Chicago & St. Louis, Indianapolis, Ind.; second vice-president, D. A. Lucas, general foreman boiler maker, Chicago, Burlington & Quincy, Havelock, Neb.; third vice-president, J. B. Tate, foreman boiler maker, Pennsylvania Railroad, Altoona, Pa.; fourth vice-president, Charles P. Patrick, foreman boiler maker, Erie Railroad, Cleveland, Ohio; fifth vice-president, Thomas Lewis, general foreman boiler maker, Lehigh Valley Railroad, Sayre, Pa.; secretary, Harry D. Vought, 95 Liberty street, New York; treasurer, Frank Gray foreman boiler maker, Chicago & Alton, Bloomington, Ill. Messrs. Winterstein, Weldin and Powers were elected members of the executive board, succeeding Messrs. Doarnberger, Rogers and Schaule, whose terms of office expired this year.

Officers of the Supply Men's Association

The Boiler Makers' Supply Men's Association elected the following officers for the ensuing year: President, J. C. Campbell, Chicago Pneumatic Tool Company; vice-president, D. J. Champion, Champion Rivet Company; secretary-treasurer, George Slate, The Boiler Maker, New York.

The new members of the executive board elected were as follows: W. O. Duntley and George Seavey for a term of one year; B. E. D. Stafford and J. W. Faessler for a term of two years; W. H. S. Bateman and Le Grand Parish for a term of three years.

Officers of the Ladies' Auxiliary Association

The following officers for the Ladies' Auxiliary Association were elected for the coming year: Honorary president, Mrs. John McKeown, Galion, Ohio; president, Mrs. B. F. Sarver, Fort Wayne, Ind.; first vice-president, Mrs. J. W. Kelly, Chicago, Ill.; second vice-president, Mrs. Frank Gray, Bloomington, Ill.; third vice-president, Mrs. J. T. Goodwin, Plainfield, N. J.; fourth vice-president, Mrs. George Bennett, Albany, N. Y.; secretary and treasurer, Mrs. C. L. Hempel, Omaha, Neb.

Registration at the Convention

S. B. Adams, Asst. Chief Insp., Hartford Steam Boiler Insp. & Ins. Co., Philadelphia, Pa.
Thomas Aldcorn, Chicago Pneumatic Tool Co., New York.
Archie Allison, F. B. M., D. & R. G. R. R., Helper, Utah.
James T. Anthony, American Arch Co., New York.
L. C. Ardis, Foreman Boiler Dept., P. B. & W., Wilmington, Del.
Geo. Austin, G. B. Insp., A. T. & S. F. Ry., Topeka, Kansas.
H. J. Bailey, Hilles & Jones Co., Wilmington, Del.
R. M. Baily, Tyler Tube & Pipe Co., Philadelphia, Pa.
A. M. Baird, Asst. Supt. Shops, A. T. & S. F. R. R., Topeka, Kan.
L. Balsbaugh, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. L. Balsbaugh, Philadelphia, Pa.
Geo. A. Barden, Chicago Pneumatic Tool Co., Philadelphia, Pa.
Mrs. G. A. Barden, Philadelphia, Pa.
John Barnes, Bird-Archer Co., New York.
Mrs. J. M. Barnes, Philadelphia, Pa.
Richard Bate, Wm. T. Bate & Son, Conshohocken, Pa.
W. H. S. Bateman, Parkersburg Iron Co. and Champion Rivet Co., Philadelphia, Pa.
Mrs. W. H. S. Bateman, Philadelphia, Pa.
C. J. Baumann, F. B. M., N. Y., N. H. & H. R. R., New Haven, Conn.
Mrs. C. J. Baumann, New Haven, Conn.
H. S. Beale, President, Parkesburg Iron Co., Parkesburg, Pa.
John F. Beck, F. B. M., G. R. & I. R. R., Grand Rapids, Mich.
Miss Carrie Beck, Grand Rapids, Mich.
G. Bennett, F. B. M., Pennsylvania R. R., Verona, Pa.
Mrs. G. Bennett, Verona, Pa.
George W. Bennett, Dist. Insp., I. C. C., Albany, N. Y.
Mrs. George W. Bennett, Albany, N. Y.
R. W. Benson, American Flexible Bolt Co., New York.
Frank E. Berrey, F. B. M., Erie Railroad, Cleveland, Ohio.
Mrs. Frank E. Berrey, Cleveland, Ohio.
John Berry, Boiler Insp., G. T. R. R., Toronto, Ont.
Mrs. John Berry, Toronto, Ont.
W. F. Besant, F. B. M., I. C. R. R., Centralia, Ill.
Mrs. W. F. Besant, Centralia, Ill.
Mr. Best, P. & R. R. R., Reading, Pa.
Mrs. Best, Reading, Pa.
Matthew Billington, F. B. M., B. R. & P. R. R., E. Salamanca, N. Y.
P. B. Bird, Bird-Archer Co., New York.
Mrs. Thomas Bird, Brooklyn, N. Y.
W. S. Bitting, National Tube Co., Philadelphia, Pa.
Mrs. W. S. Bitting, Philadelphia, Pa.

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* Abstract of committee report by W. W. Wilson and J. B. Tate.

L. Borneman, F. B. M., C. St. P. M. & O. R. R., St. Paul, Minn.
Mrs. L. Borneman, St. Paul, Minn.
H. R. Bovie, National Tube Co., Philadelphia, Pa.
L. P. Bowen, F. B. M., C. & R. R., Covington, Ky.
Wm. G. Bower, F. B. M., C. & N. W. R. R., Chicago, Ill.
Chas. Bourgeois, Balwin Locomotive Works, Philadelphia, Pa.
Mr. Chas. Bourgeois, Philadelphia, Pa.
Geo. R. Boyce, A. M. Castle & Co., Chicago, Ill.
Mrs. Geo. R. Boyce, Chicago, Ill.
John A. Brandt, N. Y. O. & W. R. R., Middletown, N. Y.
W. E. Brooks, Supt. Boiler & Structural Dept., Tennessee Coal & Iron Co.
Arthur E. Brown, G. F. B. M., L. & N. R. R. Shops, New Albany, Ind.
H. H. Brown, THE BOILER MAKER, New York.
J. M. Burns, Baldwin Loco. Works, Philadelphia, Pa.
Mrs. J. M. Burns, Philadelphia, Pa.
Jas. Byrnes, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. Jas. Byrnes, Philadelphia, Pa.
G. H. Calbreath, F. B. M., C. & O. R. R., Russell, Ky.
John C. Campbell, Chicago Pneumatic Tool Co., Chicago, Ill.
W. J. Cannon, Boiler Insp., Pere Marquete R. R., Detroit, Mich.
S. M. Carroll, F. B. M., C. & O. R. R., Huntington, W. Va.
J. H. Casanave, Chicago Pneumatic Tool Co., Philadelphia, Pa.
R. M. Casey, F. B. M., C. & O. R. R., Clifton Forge, Va.
J. E. Chamberlin, Phila. Dist. Mgr., C. & C. Electric & Mfg. Co., Garwood, N. J.
D. J. Champion, Champion Rivet Co., Cleveland, Ohio.
Mrs. D. J. Champion, Cleveland, Ohio.
J. H. Chastain, F. B. M., N. C. & St. L. R. R., Atlanta, Ga.
A. J. Christy, Ingersoll-Rand Co., New York.
Chas. J. Clark, Sr., Gang Leader, Penn. R. R., Philadelphia, Pa.
Mrs. Chas. J. Clark, Philadelphia, Pa.
Miss Marie Clark, Philadelphia, Pa.
James C. Clark, F. B. M., P. R. R., Reading, Pa.
Mrs. James C. Clark, Reading, Pa.
J. E. Clark, Boiler Insp., Southern Ry.
R. W. Clark, F. B. M., N. C. & St. L. R. R., Nashville, Tenn.
B. A. Clements, Worth Brothers Co., Chicago, Ill.
J. F. Cockburn, J. F. Corlett & Co., Cleveland, Ohio.
H. S. Coleman, Lukens Iron & Steel Co., New York.
Mrs. H. S. Coleman, New York.
Albert H. Conley, F. B. M., Penn. R. R., Olean, N. Y.
Mrs. Albert H. Conley, Olean, N. Y.
P. Conniff, Supt., B. & O. R. R., Baltimore, Md.
James Connor, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. James Connor, Philadelphia, Pa.
Shelby V. Conrad, F. B. M., L. H. St. L. R. R., Cloverport, Ky.
P. J. Conrath, National Tube Co., Chicago, Ill.
Mrs. P. J. Conrath, Chicago, Ill.
B. F. Converse, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. B. F. Converse, Philadelphia, Pa.
E. C. Cook, Mgr. Ed., Railway Journal, Chicago, Ill.
James E. Cooke, F. B. M., B. & L. E. R. R., Greenville, Pa.
Mrs. James E. Cooke, Greenville, Pa.
Miss Mildred I. Cooke, Greenville, Pa.
Ray E. Cooke, Greenville, Pa.
Alfred Cooper, G. F. B. M., St. Joseph & Grand Trunk Island Ry., St. Joseph, Mo.
Mrs. Alfred Cooper, St. Joseph, Mo.
J. H. Cooper, Dearborn Chemical Co., Chicago, Ill.
Mrs. J. H. Cooper, Chicago, Ill.
R. S. Cooper, Independent Pneumatic Tool Co., New York.
J. F. Corlett, Lukens Iron & Steel Co., Coatesville, Pa.
P. E. Cosgrove, G. F. B. M., Joliet & Eastern R. R., Joliet, Ill.
J. A. Costlow, F. B. M., T. & P. R. R., Big Spring, Texas.
M. S. Courtney, Gen. Boiler Insp., Gt. Northern R. R., St. Paul, Minn.
Geo. W. Cravens, C. & C. Electric & Mfg. Co., Garwood, N. J.
Miss Sue Crawford, Philadelphia, Pa.
Thos. F. Crawford, Ingersoll-Rand Co., Philadelphia, Pa.
Jasper C. Crisp, Fed. Boiler Insp., Los Angeles, Cal.
R. J. McCucan, F. B. M., Wabash & Pittsburg Term. R. R., Wilkensburg, Pa.
E. Curtis, F. B. M., I. C. R. R., St. Louis, Ill.
John J. Daly, F. B. M., P. & R. R. R., Reading, Pa.
W. H. Damon, F. B. M., L. R. R. R., Richmond Hill, L. I., N. Y.
Mrs. W. H. Damon, Richmond Hill, L. I.
J. J. Davey, Gen. Boiler Insp., Northern Pacific R. R., St. Paul, Minn.
Mrs. J. J. Davey, Minneapolis, Minn.
E. Tyler Davis, Tyler Tube & Pipe Co., Washington, Pa.
W. H. Deen, F. B. M., C. & O. of I. R. R., Peru, Ind.
Mrs. W. H. Deen, Peru, Ind.
H. J. Dickman, F. B. M., Atlantic Coast Line, Florence, S. C.
J. L. Didier, F. B. M., Southern Ry., Salisbury, N. C.
Geo. Diehl, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. Geo. Diehl, Philadelphia, Pa.
H. N. Dinsmore, THE BOILER MAKER, New York.
A. C. Dittrick, Gen. Boiler Insp., Soo Line, Minneapolis, Minn.
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Daniel A. Stark, G. B. Foreman, L. V. R. R., Sayre, Pa.
W. F. Stauch, G. B. Insp., B. & O. R. R., Newark, Ohio.
H. E. Steever, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. H. E. Steever, Philadelphia, Pa.
L. M. Stewart, F. B. M., Atlantic Coast Line, Waycross, Ga.
Mrs. L. M. Stewart, Waycross, Ga.
Miss Lillian Stewart, Waycross, Ga.
M. W. Stokes, F. B. M., Texas & Pacific R. R., Marshall, Texas.
Jos. Sullivan, F. B. M., N. Y. C. & H. R. R., Buffalo, N. Y.
Mrs. Jos. Sullivan, Buffalo, N. Y.
E. A. Sumner, M. M., P. R. R., Overbrook, Pa.
Mrs. E. A. Sumner, Overbrook, Pa.
George Suraud, Ross Schofield Co., New York.
T. J. Talbot, F. B. M., R. F. & P. R. R.,
J. B. Tate, F. B. M., P. R. R., Altoona, Pa.
Mrs J. B. Tate, Altoona, Pa.
M. K. Tate, American Arch Co., New York.
C. A. Thomas, F. B. M., Southern Ry., Birmingham, Ala.
Geo. Thomas, 3d, Parkesburg Iron Co., Parkesburg.
E. H. Tredinnick, F. B. M., Erie R. R., Buffalo, N. Y.
S. W. Tredinnick, F. B. M., Erie R. R., Scranton, Pa.
B. H. Tripp, Chicago Pneumatic Tool Co., Chicago, Ill.
Mrs. B. H. Tripp, Philadelphia, Pa.
G. A. Troutman, F. B. M., H. & B. T. R. R., Saxton, Pa.
John Troy, F. B. M., Pere Marquette R. R., Saginaw, Mich.
Joseph Troy, Clerk M. M. Office, P. M. R. R., Saginaw, Mich.
W. M. Tucker, F. B. M., Illinois Central R. R., McComb, Miss.
John J. Turner, F. B. M., Chicago Terminal Transfer Ry. Co., E. Chicago, Ind.
Mrs. John J. Turner, East Chicago, Ind.
J. B. Tynan, F. B. M., W. & L. E. R. R., Massillon, Ohio.
E. C. Umlawf, F. B. M., Erie R. R., Susquehanna, Pa.
Geo. B. Usherwood, Supv. Boilers, N. Y. C. & H. R. R., Syracuse, N. Y.
Mrs. Geo. B. Usherwood, Syracuse, N. Y.
R. J. Venning, Cleveland Steel Co., Cleveland, Ohio.
Harry D. Vought, Secretary, M. B. M. A., New York.
Mrs. Harry D. Vought, Montclair, N. J.
George Wagstaff, American Arch Co., New York.
F. G. Waldis, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. F. G. Waldis, Philadelphia, Pa.
C. E. Walker, Mgr. Rwy. Dept., Chicago Pneumatic Tool Co., Chicago, Ill.
J. H. Walker, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. J. H. Walker, Philadelphia, Pa.
Herman L. Walter, F. B. M., L. V. R. R., Easton, Pa.
H. J. Wandberg, F. B. M., C. M. & St. P. R. R., Minneapolis, Minn.
Mrs. H. J. Wandberg, Minneapolis, Minn.
J. A. Warfel, Superior Oxygen Co., Pittsburg, Pa.
Mrs. Kenton Warne, Philadelphia, Pa.
R. Warner, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. R. Warner, Philadelphia, Pa.
Philip Weiss, Ingersoll-Rand Co., New York.
H. F. Weldin, F. B. M., Pennsylvania R. R., Philadelphia, Pa.
Mrs. H. F. Weldin, Philadelphia, Pa.
Franklin Weldin, Asst. F. B. M., Pennsylvania R. R., Phila., Pa.
Mrs. Franklin Weldin, Philadelphia, Pa.
Jos. R. Wetherald, Parkesburg Iron Co., Parkesburg, Pa.
Mrs. Joseph Wetherald, Philadelphia, Pa.
M. J. Wharton, F. B. M., Pennsylvania R. R., Renovo, Pa.
F. P. White, F. B. M., Baltimore & Ohio R. R., Baltimore, Md.
A. W. Whiteford, Lukens Iron & Steel Co., Coatesville, Pa.
John Wick, F. B. M., Northern Pacific R. R., S. Tacoma, Wash.
R. M. Williams, Dist. Insp., I. C. C., Rocky Mount, N. C.
Mrs. R. M. Williams, Rocky Mount, N. C.
Miss Fannie Williams, Rocky Mount, N. C.
G. C. Wilson, Independent Pneumatic Tool Co., New York.
J. T. Wilson, Boiler Insp., C. M. & St. P. R. R., Sumatra, Mont.
Mrs. J. T. Wilson, Sumatra, Mont.
Frank E. Wilson, Asst. F. B. M., Florida East Coast Ry., Fort Pierce, Fla.
John Winterstein, Dist. Insp. I. C. C., Philadelphia, Pa.
Mrs. J. Winterstein, Philadelphia, Pa.
Wm. H. Wood, Media, Pa.
G. H. Woodroffe, Baldwin Locomotive Works, Philadelphia, Pa.
Mrs. G. H. Woodroffe, Philadelphia, Pa.
W. C. Wortman, F. B. M., C. & N. R. R., Fond du Lac, Wis.
Miss Gladys M. Wortman, Fond du Lac, Wis.
Bernard Wulle, Asst. F. M. B., Big Four R. R., Indianapolis, Ind.
Mrs. Bernard Wulle, Indianapolis, Ind.
Frank Yochem, F. B. M., N. P. R. R., Fort Scott, Kansas.
Mrs. Frank Yochem, Fort Scott, Kansas.
E. W. Young, Gen. Boiler Insp., C. C. M. & St. P. R. R., Dubuque, Iowa.
Mrs. E. W. Young, Dubuque, Iowa.
Chas. Zietz, F. B. M., D. & R. G. R. R., Denver, Colo.
Mrs. Chas. Zietz, Denver, Colo.
Miss C. Zietz, Denver, Colo.
E. M. Zwing, Chicago Pneumatic Tool Co., Chicago, Ill.

ENLARGED PLANT.—The Superior Boiler Works Company, Marion, Ind., has moved into a new and enlarged plant, and is in a position to handle all classes of boiler and tank work.

Master Boiler Makers Visit the Plants of the Parkesburg Iron Company and the Lukens Iron & Steel Company

On Wednesday, May 27, the members of the Master Boiler Makers' Association and their friends visited the works of the Parkesburg Iron Company, Parkesburg, Pa., and of the Lukens Iron & Steel Company, Coatesville, Pa., as guests of these corporations.

The party left Philadelphia shortly after 9 o'clock on a special train, and went directly to Parkesburg, where they were entertained by the officials of the Parkesburg Iron Company. The ladies of the party were escorted to the Parkesburg Opera House, where a motion picture show was provided for them, while the boiler makers were taken on a tour of inspection through the plant of the Parkesburg Iron Company. The visitors were shown through the works by the officials of the company and guides competent to explain the various processes used in the manufacture of charcoal iron tubes. In addition, signs were erected throughout the plant designating the various operations which were being carried out in the shops.

After a two-hour inspection of the Parkesburg Iron Company's plant the party boarded the special train again and were taken to Coatesville, where they were entertained at luncheon by the Lukens Iron & Steel Company. Luncheon was served on the lawn of the home of Mr. A. F. Huston, president of the Lukens Iron & Steel Company, where an immense open tent had been erected. The tables were tastefully decorated with flowers, and at one end of the tent was a platform upon which was stationed the Lukens Band.

THE MENU

Grapefruit
Radishes Olives Celery
Cream of Celery Soup
Rasped Rolls
Deviled Crabs Sweet Bread Pattie
Sherbert a la Lukens
Filet of Beef, Mushroom Sauce
New Potatoes New Asparagus
Ice Cream and Ices
Mixed Cake Cut Cake
Salted Nuts
Coffee

The programme for the concert which was given during the luncheon by the Lukens Band, under the direction of J. H. Vanderslice, was as follows:

March—National Emblem	E. E. Bagley
Overture—Primrose	E. Brespant
Characteristic—A Day in the Cottonfield	Zublin
Air Varie—Old Home Down on the Farm	F. P. Harlow
Baritone Solo, A. H. Long	
National Overture—Land of Liberty	Barnhouse
Characteristic—Forest Whispers	Losey
Overture—The Golden Crescent	Miller
Indian Intermezzo—Nokomis	Leach
American Patrol	Meacham
Waltz—Language of the Soul	Scouton
Overture—Inspiration	Hays
Overture—Amateur	Hays

Following the luncheon the ladies were left to enjoy another band concert, while the men were taken through the plant of the Lukens Iron & Steel Company, and shown in detail the manufacture of boiler plate. The party returned to Philadelphia on the special train in the afternoon, leaving Coatesville about 5:30.

Prize Papers in the Champion Competition

Methods of Heating Rivets Discussed in Three Papers Awarded Prizes by a Special Committee at the Boiler Makers' Convention

During the Master Boiler Makers' Convention in Philadelphia, May 25 to 28, a special committee appointed by the president of the association, consisting of Mr. Frank Gray (foreman boiler maker of the Chicago & Alton, Bloomington, Ill.), Mr. E. W. Rogers (general foreman boiler maker of the American Locomotive Company, Schenectady, N. Y.), and Mr. A. E. Brown (general foreman boiler maker of the Louisville and Nashville Railway, New Albany, Ind.), passed judgment upon the papers submitted in competition for the prizes offered by Mr. D. J. Champion, vice-president and general manager of the Champion Rivet Company, Cleveland, Ohio, for the best essays on "How to Heat Rivets Satisfactorily."

Three prizes were offered, the first, $50; the second, $35, and the third, $25. The following are the papers for which these prizes were awarded:

How to Heat Rivets Satisfactorily*

BY J. B. BECKER †

The writer has had considerable experience in various lines of boiler and metal construction work requiring large quantities of heated rivets. The best, most satisfactory and economical way of heating rivets where large quantities require heating is accomplished with a fuel-oil forge or furnace with fan blast, which carries a high, soft, uniform heat, always under control of the operator. This method of heating rivets is indispensable in connection with pneumatic or hydraulic power riveting machines. In such a furnace the rivets are always in plain sight, and are quickly heated to a soft, uniform heat.

Where the facilities for fuel oil heating are not at hand, the best method for heating rivets is in a soft coal fire having sufficient coal banked on the forge around the fire. The fuel should be composed of small lumps, to be fed gradually into the fire as it is consumed.

The rivets should be stuck into the fire head first, so that portion of the rivet will become heated in advance of the body of the rivet, owing to the greater amount of material in the head than any section of its diameter. When red-hot, turn the rivet and lay it in a horizontal position in the fire so that it will become thoroughly heated, covering same slightly with coke, which in the meantime has formed from the coal around the edge of the fire. By so doing a soft, uniform heat is insured throughout the entire rivet.

Heating of Rivets ‡

BY W. R. MORGAN

To produce the best results in heating rivets I have found the following practice to give good results: Put just the right number of rivets in the furnace to keep the gang going. By putting too many rivets in the furnace there are too many hot rivets at one time, and they form a heavy scale. In heating the rivets place the rivets in the furnace with the points in. The points of the rivets should be made hot, to a fusing point if necessary. The head of the rivet should not be allowed to come to the fusing point, but it should be made hot enough to do its part of upsetting and make it solid in the rivet hole.

The heat of the rivet may vary according to the way the rivet is driven. Heavy machine riveting does not require such hot rivets, although the same rule will apply to the heating, *i. e.*, the head of the rivet should not be as hot as the point. The cause of rivet heads dropping off when other conditions are normal, is on account of making the rivet head hotter than the point. In driving a rivet heated in this way it will pull apart at the neck. When the men complain of rivet heads dropping off I trace it to the improper heating. By correcting the heating as above stated, successful results are obtained.

Too many rivets of different sizes should not be placed in the furnace unless they are driven in a reasonable time after they become hot. Some rivet heaters overdo this and should be corrected. The number of rivets placed in the furnace should be sufficient to give them time to come up to the proper heat in order to make the proper delivery to the riveter when ready.

In my estimation fuel oil is superior to any other fuel for heating purposes, as it contains no element that is injurious to the rivets. For economy and rapidness there is nothing equal to it. The even distribution of heat in an oil furnace will give the rivet heater every opportunity to heat a perfect rivet. The rivet can be seen and handled without any inconvenience.

Summing up the above: Place the rivets in the furnace points in. Do not put too many in the furnace at one time. Do not heat the head of rivets as hot as the point. Heat the rivet as hot as you like, but never heat the head to a fusing point. Do not allow your rivets to remain in the furnace too long. Reduce or increase the number in your furnace according to demand. The sooner the rivet is driven after it is heated the better the result. Do not heat the rivets too hot for heavy machine work. Always heat the point of the rivet hotter than the head. Short and small rivets, when driven with an air hammer or by hand-riveting or machine, can be heated evenly to a white heat with good results, as they cool off much quicker than larger rivets.

How to Heat Rivets Satisfactorily*

BY W. WRIGHT

In my opinion the best way to heat rivets is with an oil furnace, for the heat is more uniform, one always has perfect control, and the rivet is always in full view.

First start the furnace and allow it to become well heated, then shut off the oil and throw about 12 or 20 rivets, depending upon their size, into the furnace. See that they do not lie in a heap but are spread out on the bottom. Then start the furnace steadily and you will get that batch of rivets all to a good uniform heat, so that when they are driven they will thicken up and fill the hole, and the head and back will form squarely over the rest of the rivet. Being uniformly hot, the iron is left in good condition and the pull is evenly distributed all through the rivet, making a good steam-tight job.

As the rivets are being used, keep taking them from one-half of the furnace bottom, and when that half is clear put another six or ten rivets into the space and let them lie while you use the other half. By that time the last lot will be as hot as the first, and so on, till the job is done. By this means all of the rivets in a seam will be uniform in pull, for there will be no burnt or unevenly-heated rivets. As we know that a seam is only as strong as the weakest spot in it, it is of the utmost importance that all rivets should be got to the same heat so that there will not be a weak one among them.

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* Awarded first prize.

† General foreman boiler maker, Southern Pacific Railroad shops, San Francisco, Cal.

‡ Awarded second prize.

* Awarded third prize.

Some Boiler Shop Leaks

A Few Pointers on Cost Systems—What They Are For and What They Should Do

BY JAMES FRANCIS

"Going to start an accounting office, Mr. Superintendent, or what are you getting all those forms, slips and cards for?"

"No, Mr. Francis, I'm just putting in a little cost system, so we can tell what things cost us without having to guess at it."

"A cost system, eh? Well, I know just one thing about the average cost system and have suspicions of a lot of other things concerning such a system."

"Well, what's the thing you are so cock-sure of?"

"Why, it is that the main thing about a cost system is the cost of keeping that system. It does cost like fury to put in and run a cost system, and I reckon that is why they call it by the name."

"Oh, I don't know. Many concerns run cost systems and they can tell at any minute exactly what any thing has cost for work, material, expense, etc. In fact, they can give you right off the reel the data regarding each and every operation carried out in the shop. They have in sight all the time each operation performed on regular work, the tools and operations required for and in that work, and they can give you the time and material used on each operation performed."

"Well, Mr. Superintendent, what good is the system after they have got it to working? How does it cheapen production any and how does it increase the quality of work turned out by the shop? Also, how does a cost system increase the amount of work the factory can get and do?"

"It looks this may to me, Mr. Francis: A good cost system makes it possible for the manager or superintendent to keep tabs on the work which is being done. If one job comes through the factory at a higher cost than a similar job, then he can look into the matter and see who is to blame. He can analyze the several cost items and cut out those which do not aid in improving output or lessening production cost."

"Good enough, Mr. Superintendent, but before you fool yourself in that direction just go to some boiler shop where they are running a cost system; go all over the whole business; stay there a week and dig down deep into what they have got, what they do, and what they gain by so doing, and then estimate carefully and honestly whether or not the system is actually of any practical benefit to the shop. If so, find out how and where. Then you will be in a position to decide whether or not it will pay you to saddle your shop with the expense of a so-called "cost-system." Just make sure—don't guess at it as you are doing now—but make sure before you go into it. And then, if you still decide to install a cost system, start it 'from the ground up,' and put in one which is as simple as possible, but which is still worth while and which is an actual cost system and not a joke."

"Say, Mr. Francis, are you in favor of a cost system, or are you opposed to it? Wish you would tell me exactly how you stand in regard to that matter?"

"No, Mr. Superintendent, I am not opposed to cost systems in general, but I am opposed to some so-called 'systems.' Perhaps I am in the position of the late Josh Billings, who once remarked: 'Yes, I believe in the universal salavation of man, but I want to pick the men.' And it is much the same regarding cost systems—I want to pick the system!"

"Why is one system better than another, Mr. Francis?"

"Why, to judge a cost system just ask a couple of questions and base your opinion of that system upon the manner of the answer received. These two questions may be: 'Is the cost system costing too much?' and 'Does it give all the information it should?' If both these queries are answered in the affirmative, then the cost system is a good one, and you may install it to advantage in your shop."

"But how am I to know whether or not the cost system is costing too much, and whether or not it is giving all the information it should? It seems to me those are two pretty big questions?"

"They are big questions, and they require big answers, too. Furthermore, it takes a big man to answer those questions properly. But after all what is a cost system for, anyway? For what purpose are you about to put one in your shop?"

"Why, to keep the cost of production of course. To tabulate items of expense so I can tell at any time just what it costs to do certain operations or to manufacture certain articles, such as boilers, stacks, etc."

"Oh, come now, Mr. Superintendent, just guess again and see if you can hit the correct one. Why, you don't care what it costs as long as it costs as little as possible. Isn't that right?"

"Well, yes, I believe it is. I only want to know that it is not costing too much, and that one job does not cost much more than another similar job."

"Well, then, why don't you speak right out in meeting, and say that the only thing the cost system will be good for is to detect leaks? That is all that a cost system is good for, and when it shows you all the leaks then you are sure that the cost system is giving you all the information it should. Is that not so?"

"I believe that's what, Mr. Francis; but I sure never realized before that a cost system was nothing but a leak telltale."

"That's just what it is, Mr. Superintendent. Let's make the cost system itself answer the first question, viz., 'Is the cost system costing too much?' Now, if the system is good enough to give you 'all the information it should,' then it will answer the question as to its own cost and whether or not that amount is too great. Just ask the question of the system, and it will give you an answer which may be compared with the cost of other systems in boiler shops.'"

"But after that is all done I don't see where the answer is coming from to the question, 'Is my cost system costing too much?'"

"Why, to be sure! The answer comes from where the answer comes when you ask the cost system, 'Is flanging a 72-inch head costing us too much?' There you get the data from your cost system, don't you? And make up the answer to the question after comparing the data of costs for several flanging jobs on 72-inch heads. Isn't that the way you do it?"

"Yes, I believe it is; but I always had the idea that a cost system was something which you could look over when you were figuring a new job by contract, and find what similar work had cost in order to make a price therefrom for new work."

"That's one thing the cost system is good for—if it is good for anything—but the main purpose, as stated, is the finding of leaks. And once they are found the best cost system in the world will not stop the leaks. You have to work out and apply a cure from other sources than the cost system."

"Can you tell me how to work a cost system so as to get the information from it that will stop the most leaks?"

"Mr. Superintendent, now you are asking me a mighty big question, and to answer it properly would require a good deal of study of your shop from the standpoint of the general manager. To put the information required into such condensed form that it can be given in the limited space available here, I believe I can do no better than to quote page 113 in Kent's new book, 'Investigating an Industry' (New York, John Wiley & Sons, 1914), which says that the general manager, together with the sales manager and the factory expert (leak hunter), should at all times consider the following matters:

"Products; design; quality; method of making.

"Material—quality specifications and tests; requisitions; seasonable purchasing prices; storage; handling; scrap; byproducts.

"Designing; drafting; estimating.

"Superintendents, foremen; foremen's committee; purchasing agent.

"Blacksmith shop, foundry, pattern shop and storeroom.

"Boiler shop; machine shop; equipment; arrangement of machines; handling of work in progress; interior transportation; care of tools.

"Power plant; engineering tests; friction; lubrication; boilers and boiler appliances; means for improving economy; engines; condensers; dynamos; motors; power transmission; fuel handling and storage; ash handling.

"New machinery for new or old products.

"Load factor, means for increasing.

"Shall certain small parts be purchased instead of made?

"Inventory of machines, age, cost, depreciation.

"Items in scientific management of factory; tool room, tool grinder, messenger service; storeroom; standard sizes and shapes of tools and parts of product; planning room; routing; moving; cars, cranes, trucks, elevators; functional foremen; speed and feed boss; disciplinarian; time, motion and fatigue study; standardizing operations; instruction cards; graphical daily balance; plotting of results; effect of methods upon cost; planning ahead for work to be done in the coming months."

"Great Scott! Why, Mr. Francis, do you mean to say that we have got to take a hand at all those things if we put in a cost system? Why, it would take the general manager, the superintendent and all the office force all the time, and more too, to keep up with that list of red tape twisters. Why, where would there be any time for getting work out of the shop?"

"There would be more time available with a good cost and leak-stopping system in operation, Mr. Superintendent, than there is now, when you don't know what you are doing or how you are doing it. By classifying all the boiler shop work under the heads named above, a man is able to put his finger right on the point which needs attention. The cost system will give the information necessary, and you can put your finger right on the string you want to tie a knot in. Then you can do the trick and be off about something else in far less time than it would require without a cost-system, leak-stopping arrangement, to find where you were at and what you want to do."

"But it would take all the time of the general manager, my time, the draftsmen, shop foremen, all hands and the secretary and treasurer to watch that list of 'things to do' and keep tabs on them."

"All right, Mr. Superintendent, let it go at that, except that the secretary and treasurer don't have any finger in this pie. Their business is to rustle the accounts, the information and statistics, labor, sales and new development. Those two shouldn't come into the factory matters at all, except to help the general manager with the classification and records of workmen (to quote again from 'Kent'), length of service, promotions, wages, premium bonus, piece-work, changes desirable, apprentices, apprentices' school, methods of training workmen, pensions, old age and disability; accident insurance, prevention of accidents; first-aid hospital, welfare work, sanitation; workingmen's houses; workmen's committees, complaints and suggestions by workmen."

"Great derricks! And the general manager has all this to look after, too?"

"Yes, with the help of the secretary."

"Well, say, how does the general manager find time to eat?"

"By classification of work, Mr. Superintendent, which puts things where he can hit them instantly without stopping to look for what he wants. That's what the list is for, and it does the work, too. Fits right in with the cost system and works along with it."

"Well, that general manager certainly will be a busy man when he gets all that red tape tangled up!"

"Hold on there! 'red tape' don't get tangled. It is not red tape when 'red tape' means everything running well and all matters straightened out. You haven't got any red tape in your shop now, and that's the reason everything is tangled up, and you can't tell the cost of anything without digging it out of a mass of records, and perhaps overlooking part of the cost at best."

"Well, maybe. But it seems to me that the general manager is as busy as a hen with one chicken, and I see where I get my great big share of it, too. Hanged if I realized what was coming to me when the cost-system, leak-finding system was brought up. The general manager won't have time to take a vacation this year, will he? Got to stick to that list all summer, tight as mud to a cart-wheel?"

"Not a bit of it, Mr. Superintendent. In fact the general manager is going to have more time than ever after the system is in working order. And then he will have time to take a look-in at the sales department, the new development department, and also to be a member of the president's finance committee. So you see that although the general manager has his work cut out for him by the new method, of which the cost system will be a part, the general manager also has a whole lot of his present work done for him by 'the system,' thereby leaving him time for more important things."

"Well, I'm only 'superintendent,' yet suppose if I ever become 'general manager' I'll find some way to do the work—perhaps I can invent some 'system' which will do it all for me? But just tell me, Mr. Francis, does the cost system really help any in detecting leaks?"

"Sure! It doesn't detect leaks of itself, but it enables you to detect them. For instance, a man goes for washers to use on job B1673. He has ten washers, ½-inch cut, charged to that job. You know that it only requires five washers, so you get right after the man who played that old workman's trick of taking twice the stock needed, leaving four washers on the floor and throwing one at a stray dog. It is the same with the time-cost, too. You detect the leaks by the systematized lists placed before you by the cost clerk. The system doesn't find the leaks, but it gives you a chance to find them, and at the same time relieves you of all the labor of hunting up the records of that job. It lets a cheaper man do that much of your work and gives you that much more time to understudy the general manager's job. See?"

Safety in Pennsylvania Railroad Shops.—One of the results of the "Safety First" movement, which was instituted by the Pennsylvania Railroad in September, 1910, is that $99,753 has been spent for safety guards—mainly in shops. Practically all machines and dangerous conditions are now guarded. But the real result is that serious accidents to shop employees have been reduced from 5.4 per 1,000 employees in 1911 to 3.2 in 1912. In 35 out of 46 shops, where more than 500 men are employed, the number of serious accidents per 1,000 men has been reduced from 5 to 70 percent. One of the results of the original attention to the subject, and the keeping of detailed statistics, is that when one shop does not show a satisfactory improvement, special inquiry is made with a view always to improving conditions.

The Advantages and Disadvantages of Combustion Chambers in Large Mallet or Pacific Type Engines Other Than a Shorter Flue *

The Chicago, Milwaukee & St. Paul Railroad has at the present time about 605 engines equipped with combustion chambers, consisting of Mallet type, Mikado type, Pacific type and Prairie type, all being equipped with arch tubes and arch brick.

The first of this class, the Prairie type, freight engine, was put in service in 1907, which gives nearly seven years' experience, and I believe is ample time to demonstrate the benefits derived from a combustion chamber boiler or any weak points or faulty construction. The depth of these combustion chambers is from 32 inches in our Prairie type to 76 inches in our Mallet type, which you can readily see would increase the amount of firebox heating surface to a considerable extent. When you consider Prof. Goss' report on recent tests showing the value of firebox heating surface to be better than 6 to 1 over heating surface derived from flues, this cannot but help to give a good free steaming engine.

The lengths of flues in our engines are as follows:

Praririe type, 13 feet 4 inches; 2 inches diameter.
Pacific type, 19 feet; 2 inches diameter.
Mikado type, 17 feet 7 inches; 2 inches diameter.
Mallet type, 24 feet; 2¼ inches diameter.

From our Prairie type we have service records of more than 185,000 miles between flue settings, in our Pacific type better than 196,000 miles, in our Mikado type better than 90,000 miles, and from our Mallet type better than 86,000 miles.

We have 195 of the Prairie type K-1 class, and during the past seven years these engines have been in service pretty much all over our system. While a great many of them are in bad-water districts, our flue records show that we have better than three years' service from the majority of these engines, and from many of them we obtain fifty, sixty and seventy months' service. Twelve of these engines are still in service with the original flues now having sixty months' service. In this class we have applied no new fireboxes except where we have had a couple of low-water cases. We have applied a number of side sheets, door sheets and back flue sheets, but have applied only two inside throat sheets and one combustion chamber to date.

We have had but little trouble with seams leaking. In some cases where we have had trouble with seams leaking on top of the inside throat, we found it necessary to scarf the sheet down and apply new rivets or bolts; but where this work had been done originally in a proper manner the seams did not give much trouble on account of leaking.

The only trouble discovered at all was broken braces from the bottom of the combustion chamber to the bottom of the shell. We believe that the cause of these braces breaking is due to temperature strain. With the method of applying these braces on the Great Northern there is a flat surface on the inside throat, and the brace extends from the inside throat to the bottom of the shell, and is made flexible by running braces through a hole in a lug on the bottom of the shell and applying a nut on the back end of same. The Northern Pacific's method of applying these braces involves a plate, flanged Z shape, riveted from the bottom of the shell to the bottom of the combustion chamber, which takes the place of staybolts as well as the braces used in the other methods.

This method is good; but it might be possible that scale would gather and fill up around these braces more readily than it would around staybolts. Where there are eight or ten rows or more of staybolts along the length of the combustion chamber, and where the inside throat is constructed with the large radius, it is impossible to apply the ordinary throat stay. We could do away with these stays, especially so when they are applied from the bottom of the combustion chamber to the shell.

In our Pacific type passenger engine we are getting very good service, the firebox sheets standing up well. We have applied a few side sheets and a number of back flue sheets. We are getting better than thirty-six months' service with one setting of flues and with but very little trouble on account of flues leaking.

As to the Mikado type, the first twenty were built at the Milwaukee shops and put in service the first part of 1909. The engines were equipped for burning oil and have been on the Coast Extension since 1909. From these engines we average better than thirty-six months' service for one setting of flues. We have applied but one firebox on account of low water, and have also applied a few back flue sheets. In all classes of oil burners we have had to cover seams with brick made for that purpose.

In our Mallet type so far we have had better than thirty-three months' service for one setting of flues. We renewed no firebox sheets with the exception of a few back flue sheets and one side sheet.

We have not been having a great deal of trouble with our combustion chamber fireboxes. In some cases we found broken staybolts in the combustion chamber, some of these being on the top rows, also around the front row of the combustion chamber, but not to any great amount. We have overcome this by applying flexible staybolts. Where we have found broken bolts in combustion chamber boilers we have also found some trouble in getting out the old bolt from the leg of the boiler; but where we applied a flexible staybolt in place of a broken bolt in the combustion chamber we had no trouble in getting out the old bolt.

We wash all classes of our boilers from the front end. All front flue sheets are applied with four to six wash-out plugs, and in washing the shell of the boiler we use a long nozzle that will extend to the back flue sheet or in a combustion chamber boiler to the inside throat. After the boiler is washed an inspection is made with a long rod with a light to make sure that there is no accumulation under the combustion chamber.

What we term a few of the disadvantages of the combustion chamber are:

1. Increased cost of construction.
2. Breaking of throat stays.
3. Difficulty of removing broken staybolts from the bottom of the combustion chamber.
4. The occasional leaking of seams on inside throat sheets.
5. The cleaning out of the combustion chamber occasionally, due to not keeping bottom flues open.

To offset this we have the following advantages:

1. A good, free steaming engine, caused by better circulation and more effective heating surface.
2. Less calking of flues, longer service, as shown by record, less cold air striking the flues.
3. Each renewal cost of flues less on account of shorter flue.
4. Increased life of back flue sheet, due to less flue work.
5. Decreased cost of renewal of back flue sheet on account of smaller sheet, less labor to apply, no staybolts, no arch tubes, no mud-ring, easy to hold on.
6. Increased life of arch brick on account of not having to knock out the arch when renewing or working the flues.
7. Due to increased combustion space above the fire, the combustion of the coal is improved and the smoke nuisance is greatly reduced.

(Concluded on page 195)

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* Abstract of committee report by A. N. Lucas, P. F. Gallagher and R. A. Pearson, presented before the Master Boiler Makers' Association, Philadelphia, Pa., May, 1914.

The Boiler Maker

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Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

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NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

According to the opinions expressed in the papers on Rivet Heating, submitted in the Champion Prize competition, the best results are invariably obtained by using an oil forge or furnace. Such a furnace insures a high uniform heat; it requires less care than a coal-fired forge or furnace, and is always under control of the operator. As the rivets are in plain sight and the fuel contains no elements injurious to the rivets, such troubles as partially heated, heavily scaled or burnt rivets are practically eliminated. Heating rivets in a coal fire, on the other hand, requires more attention on the part of the operator. Success with a coal fire depends upon the skill of the rivet heater in building up and maintaining a proper fire, and in manipulating the rivets in the fire. It is evident that much better results will be obtained if a skilled man is placed in charge of the work, rather than an inexperienced helper or apprentice.

The three papers which were awarded the Champion prizes by a special committee at the Master Boiler Makers' convention, are published elsewhere in this issue, while a number of the other papers submitted in the competition which are of special interest will appear in later issues of THE BOILER MAKER.

Discussion at the Master Boiler Makers' convention centered chiefly around the topics of electric and oxy-acetylene welding and the chemical treatment of feed water for locomotives. That other important subjects were passed over with little or no discussion, can hardly be laid to the fact that the members of the Association were not familiar with the reports, because practically all reports were prepared in ample time for printing and distribution well in advance of the date of the convention. There was, however, only a limited amount of time for discussion of the reports, as the entire programme of committee reports was crowded into a single day, which seems rather a small proportion of a four-day convention to devote to the serious discussion of technical topics.

Some confusion was occasioned in the discussion of welding methods on account of the different procedures requisite for successful results with oxy-acetylene and with electric welding. Both methods have found much favor among boiler makers, although each method is particularly suited to a certain class of work which cannot be accomplished successfully with the other method. Good results have been obtained with the oxy-acetylene process in welding cracks and firebox sheets of all kinds, and for welding in half-side sheets. Oxy-acetylene apparatus is particularly suited for cutting and for laying up and straightening damaged plates. Electrical welding appliances, on the other hand, have given good results in welding in side sheets, half side sheets, patches and flues. In welding in flues, the usual operations of rolling, prossering and beading are performed, and then the beads are cemented around the edges with a welder. Difficulties are frequently encountered in welding in square or rectangular patches, so that for good results oval or round patches should be applied. In putting in half side sheets some found it necessary to put the sheet in loose with an allowance for contraction during the welding, while others, especially with the electrical apparatus, riveted in the sheet, tapped and riveted up the staybolts, finishing the entire job with the exception of welding the seam, which was the last operation performed, leaving no allowance for the movement of the sheet due to expansion and contraction. Aside from the regular boiler repair work, both the oxy-acetylene and electric welders have been found of great value for miscellaneous uses, such as repairs to shop machinery, locomotive frames, tires and other castings and forgings.

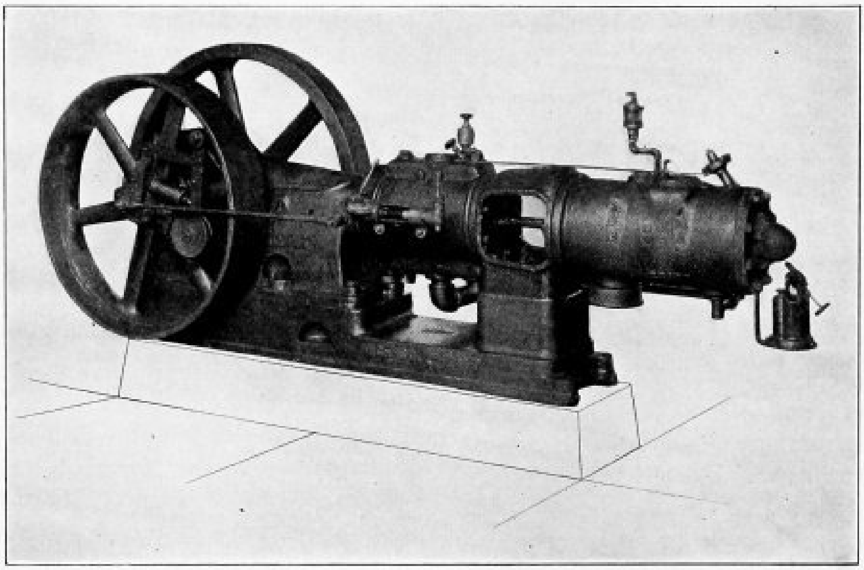
The value of the chemical treatment of feed water seems to depend very largely upon local conditions, especially as to the kind of water used and the kind of service in which the motive power is engaged, as well as upon the systematic attention given by the enginemen and roundhouse employees to such matters as blowing off, cooling down and washing out the locomotive boilers. On account of the variety of conditions encountered, a comparison of different methods of feed water treatment led to no definite conclusions. Each case must be carefully studied by itself.

Engineering Specialties for Boiler Makers

Oil-Engine Driven Air Compressor

The increased use of low-grade oil fuel for power purposes has led to the design, by the Ingersoll-Rand Company, New York, of the oil-engine driven air compressor illustrated on this page. This is of the direct-connected straight line type, and somewhat resembles in this respect, as well as in the design of the air end, the company's standard line of small compressors. The main frame is designed for a splash system of lubrication; it is of the wholly enclosed type and provided with removable covers.

The feature of greatest interest in this machine is the design of the driving end. This, as can be seen from the illustration, consists of a single oil-engine cylinder set behind the air cylinder, and directly connected, by means of an extended piston rod, to the air piston. It follows in general design a type known as the hot-bulb engine, which is really a development of the Diesel engine, and combines a high thermal efficiency with great simplicity of construction and far less complication in details of design, there being an entire absence of auxiliary air compressors, etc. This, combined with a lower working pressure, makes an ideal type for compressed air service.



The power cylinder is of the single-acting, two-cycle type. It is water-jacketed and provided with an efficient system of lubrication, and is of sturdy design. It is supported by a heavy distance piece, reaching to the foundation and bolted to the air cylinder. It is fitted with a torch for heating the ignition bulb preliminary to starting. After the compressor is under way this torch is dispensed with.

The fuel is automatically injected into the combustion chamber by means of a small pump on the side of the frame, operated by the main shaft. It enters in the form of a finely atomized spray, and is immediately ignited by the hot bulb, dispensing entirely with electric sparking devices, batteries, etc. The stroke of the fuel pump is regulated by a centrifugal governor located in the fly-wheel, thus regulating the amount of fuel injected into the cylinder in proportion to the loads. This is supplemented by a regulating device on the in-take to the air cylinder of standard design.

The operation of this machine is accompanied by none of the losses common to the average two-cycle gasoline engine, in which part of the incoming charge follows the exhaust gases through the outlet ports and is wasted. This is due to the fact that the fuel is not vaporized by an outside agency and introduced with the air used for scavenging, but is injected directly into the cylinder, at the end of the compression stroke, as already mentioned.

This means that pure air is used during the scavenging period of the stroke, consequently the inlet and outlet ports can be so arranged that more thorough scavenging is afforded without any loss of fuel. The absence of carburetor, with its needle valves, springs and delicate adjustments, which have to be constantly changed to suit atmospheric conditions, is an advantage which cannot be overestimated.

A feature of this engine is the introduction of a small quantity of the water from the cylinder jacket into the combustion space. This water performs the function of regulating the temperature in the cylinder, thereby preventing an undue rise in temperature of the piston, etc., causing dissociation of the fuel. It reduces the maximum pressure in the cylinder, at the same time slightly increasing the mean effective pressure, making a smooth running and highly economical machine. The amount of water injected is regulated according to the load on the compressor.

The whole machine is compact and self-contained; it is at present made in but one size, with an actual capacity when running at 325 revolutions per minute of 66 cubic feet of free air at 100 pounds pressure and 73 cubic feet at 80 pounds pressure. The fuel consumption at this speed, and under average operating conditions, is about 2.2 gallons of kerosene per hour. It is adapted to run on either kerosene, fuel oil or distillate. Its weight complete is 3,000 pounds, and the floor space is 8 feet 10 inches by 2 feet 5 inches.

Results from Service Tests of Eckliff Boiler Circulators and Purifiers

Trouble from scale formation led to the recent installation of seventeen circulators and purifiers manufactured by the Eckliff Automatic Boiler Circulator Company, Detroit, Mich., in a number of Scotch and fire-box boilers on dredges and tugs owned by the Great Lakes Dredge & Dock Company of Chicago. Before the installation of these circulators the heating surfaces of the boilers were coated with a heavy accumulation of scale, which greatly impaired the efficiency and economy of the boilers. After the circulators were installed the scale gradually peeled off until the heating surfaces were practically clean and, by the operation of one blow-off valve on each boiler for a period of 30 seconds every 6 hours, it was found that no further scale formed on the heating surfaces and that the boilers could be operated indefinitely without washing. In addition to the above results the consump-peeled off the furnaces and tubes. The boiler was then closed and operated continuously for six weeks before a sufficient quantity of hard scale had again accumulated to interfere with the automatic removal of the soft residue in the bottom of the boiler. At that time a thorough examination of the tubes and furnaces was made and they were found to be almost entirely free of any scale formation.

During the first 30 days following the installation of the circulators and purifiers the average fuel consumption was only 1,240 pounds per hour, or 9 percent less than before the circulators and purifiers were installed. As the balance of the scale continued to peel from the heating surfaces, the fuel consumption was further reduced so that the last records available show a reduction of 15 percent.

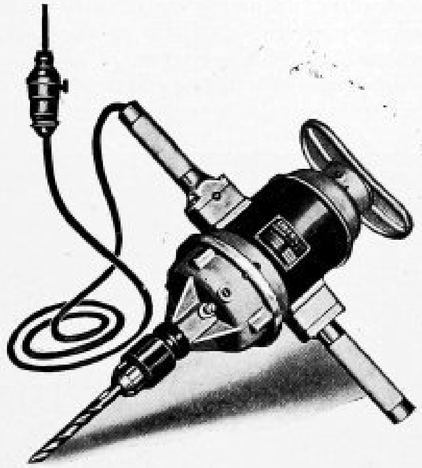
The Eckliff system of circulators and purifiers is totally independent of all feed pipes and any other connections on the boiler. The results obtained were accomplished without the use of any chemical or mechanical means, and the removal of the scale from the tubes and furnaces was brought about solely by the conditions created inside the boiler by the circulators. Scale formation on the heating surfaces of a boiler equipped with Eckliff circulators and purifiers, it is claimed, is positively prevented because the feed water is purified inside of the boiler below the level of the grates, and all of the solid residue contained in the feed water is precipitated to the bottom of the boiler away from any heating surfaces, where it remains in the form of soft sludge until automatically blown out of the boiler.

In the case of the tug *J. McCarty*, the feed water was taken directly from overboard and delivered to the boiler without having passed through any exterior feed water purifiers and was heated only in an exhaust heater to a temperature not exceeding 190 deg. F. Immediately following the installation of the circulators and purifiers this boiler was filled with water at a temperature of 70 deg., and within 45 minutes after the fires were lighted in the three furnaces the steam gage indicated 120 pounds pressure. The thermometer, which was attached to the boiler so that the mercury bulb was between the bottom of the combustion chamber and the boiler shell, and completely surrounded by the water contained in the boiler, indicated a temperature at the extreme bottom of the boiler of 337 deg. F. Fifteen minutes later the steam gage indicated a pressure of 165 pounds and the temperature of the boiler under the combustion chamber was 368 deg. F. Considering the fact that the ordinary Scotch boiler must be fired very gradually from 12 to 24 hours before steam is allowed to generate, this test indicates the rapidity and positiveness of the circulation induced in a boiler equipped with the Eckliff system of circulators. Owing to the fact that the temperature of the contained water is equalized at all times throughout the boiler, this rapid firing can be done without injury to the boiler, as the strains due to unequal expansion and contraction are entirely eliminated. It is also found that through the equalization of temperatures throughout the boiler pitting, grooving, corrosion, breaking of staybolts and the formation of furnace cracks are prevented, while the girth seams of the boiler remain dry and tight.

As the result of the test in the tug *J. McCarty* the Eckliff system of circulators and purifiers has been installed in one fire-box and thirteen Scotch boilers on other dredges and tug boats owned by the Great Lakes Dredge & Dock Company.

New Type ½-Inch Electric Breast Drill

The Stow Manufacturing Company, Binghamton, N. Y., has on the market a new type of electric breast drill with a capacity for ½-inch holes in iron or steel and ¾-inch holes in hard wood with Jennings bit. The drill is furnished in two types, one for alternating current of 100 or 220 volts, 60 cycles, and the other for direct current of 120 or 220 volts. The first machine is 5¾ inches diameter, 13 inches high without the chuck and weighs 22 pounds. The other machine is of the same diameter, but has a height of 13½ inches without the chuck and weighs only 20 pounds. The manufacturers claim that these weights are as light as it is practicable to use with this size of drill. All parts of the drill are equally balanced, making it an easy tool to handle. The reduction gears are so designed that power is transmitted equally from the opposite points on each gear.



Westinghouse Arc Welding Apparatus

The subject of arc welding is receiving a great deal of consideration at the present time by railways and industrial concerns because of the many advantages it possesses for certain kinds of work. In locomotive shops, metal pencil welding is used extensively in firebox and boiler repairs, flue welding, repairing steel locomotive frames, building up mud-rings and general work of this character. A large amount of equipment that would have to be scrapped can thus be repaired with the electric arc, and a large saving in money, time and labor effected. In electric railway shops arc welding can be used to special advantage in repairing broken armature shafts,

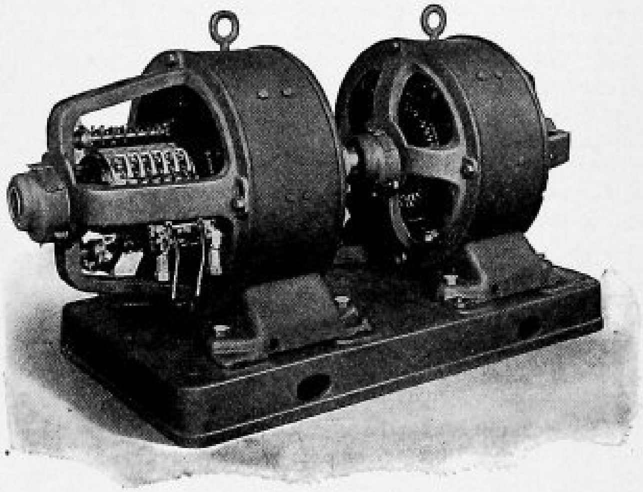


Fig. 1.—Welding Motor-Generator Set

axle brackets and motor frames. In track equipment, the repair of broken frogs, cross-overs and other work of this nature can be done with excellent results.

Realizing from past experience the practical value of the electric arc for general welding purposes, the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., has developed a standard line of electric arc welding equipments. The equipments comprise standard apparatus. They are simple in construction and easy to operate. Complicated relay schemes for automatically inserting resistances are eliminated. Ample protection is secured, it is claimed, by circuit breakers and special arrangement of the resistance. The outfits are furnished complete in the four following sizes: 200, 300, 500 and 800 amperes.

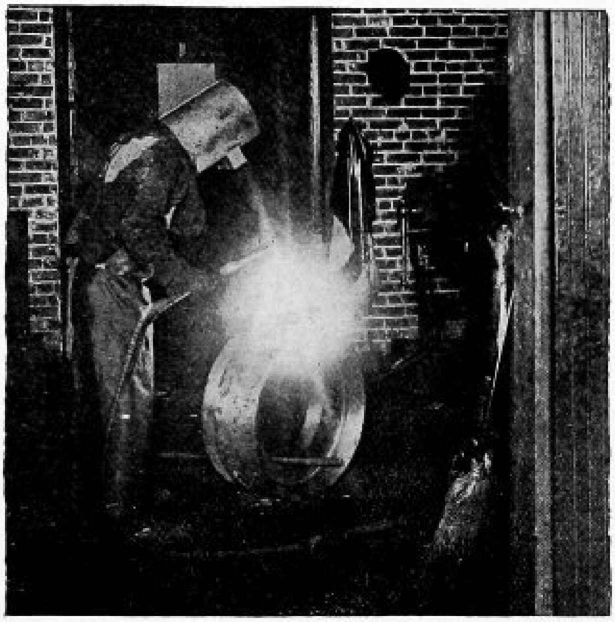


Fig. 2.—Welding Operation

Each equipment includes a welding generator, or a welding motor-generator set, switchboard, control and all necessary accessories. The welding generator consists of a special 75-volt, commutating-pole, direct-current machine, either belt or motor-driven. The instrument and control panels are composed of two sections. The upper section contains the indicating instruments, protective apparatus and switches arranged for regulating the welding current, and the lower section contains the starting and protective equipment for the motor-generator set. It is often desired to have several welding circuits connected to one generator. For this arrangement a control panel is provided for each circuit. Each panel can be located at the most desirable place. Metal or carbon pencil welding can be done from any of these panels independent of all others, and one or more arcs can be operated simultaneously.

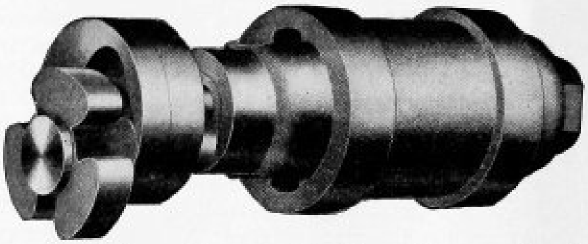
The accessories furnished consist of a carbon holder and a hood for protecting the operator, together with a shield and a metal pencil holder for each welding circuit.

A New Turbine Cleaner for Fire Tube Boilers

The illustration shows a new type of air or steam turbine-driven vibrator knocker head for dislodging scale from the outer surfaces of tubes in return-tubular boilers. This cleaner also removes the soot from the inner surfaces of the tubes. The soot is loosened by the vibrating knocker, and is blown out of the tube ahead of the cleaner by the steam or air exhausting from the front of the turbine.

The knocker head is made of three parts—a cylindrical body somewhat smaller in diameter than the boiler tube, and an eccentrically pivoted lever carrying a clover-shaped knocker on a stud at its free end. The lever fits flush into a triangular recess in the forward face of the main body, the free end swinging in an arc through the center of the head.

The three hammer faces of the knocker are shaped to fit the inner circumference of the boiler tube, thus giving a greater area of contact with the tube than is possible with former types. This advantage permits the hammer being made heavier and a firmer blow struck without injury to the tubes. The extra weight and force of blow is proving successful in loosening stubborn scale.



The head is driven at high rotative speeds, the eccentrically-pivoted lever carrying the knocker is thrown from side to side, and the knocker caused to revolve on its axis at each contact with the tube, giving a resultant gyratory motion to the knocker, causing it to hit all points of the interior circumference of the tube.

The cleaner is fed into the tube by the flexible rubber hose furnishing the air or steam pressure, the revolving motion of the head eliminating the necessity of turning the cleaner by twisting the hose.

The motor for driving the head is intended for either steam or compressed air, and is of the rotary engine type. The air or steam strikes upon radial paddles, giving a high rotative speed to the shaft. The paddles themselves are continually held out by the air or steam, which is admitted to a chamber behind the paddles so that they always form a tight fit with the case. The motor has four paddles, two of which are always under pressure, making it impossible for the motor to stall.

All wearing parts are made of high-carbon steel, carefully tempered and ground to fit. The wear is very slight, but as all parts are machined to jigs, they can be easily replaced.

A specially designed oiling device, which is furnished as an extra for these motors, mixes the oil with the air or steam supply, thoroughly blowing it into all the bearings and rubbing parts.

This new turbine tube cleaner is one of the many types of cleaners manufactured by the Lagonda Manufacturing Company, of Springfield, Ohio.

Plans for Reception and Entertainment at the Boiler Manufacturers' Convention

A meeting of the Supplymen's Association of the American Boiler Manufacturers' Association was held at the Waldorf-Astoria Hotel, New York, May 12, to discuss plans for the reception and entertainment of the Boiler Manufacturers' Association at their twenty-sixth annual convention, which will be held in New York September 1 to 4, with headquarters at the Waldorf-Astoria Hotel. Thomas Aldcorn, of the Chicago Pneumatic Tool Company, vice-president of the Supplymen's Association, presided at the meeting, and urged the local boiler manufacturers and supplymen to work together and extend to the visiting boiler manufacturers a rousing New York welcome. F. B. Slocum, of the Continental Iron Works, secretary of the association, presented a list of the various committees that will be formed.

Letters from Practical Boiler Makers

Smoke-stack Calculations

A mistake that is all too frequently made in steam plants is in having the smokestack too small. In plants newly established this mistake is generally avoided, although not always, but in plants where new boilers are being added or in replacing old ones whose capacity was too small, the manufacturer too often thinks that the old chimney or stack, which was not any too large to give proper draft for a small boiler, is plenty large enough for the new boiler, which may be twice the capacity. By making this error, although he may not realize it, he is wasting more money every year than a new stack would cost, as to obtain the best results from fuel or the greatest economy it is necessary to have a stack of proper size.

If the owners of the steam plants would pay a little more attention to methods which will give them an accurate idea of how the proper proportions for engines, boilers, stacks, etc., are obtained, they will readily see that there are fixed laws in regard to these things which must be followed, or the neglect to do so will have to be paid for continually. The paying for the same may not be quite as apparent as though they were called upon for so many dollars and cents, but the account is charged up to coal bills, and were the plant in proper shape these coal bills would be so much less in many instances as to cause surprise at the amount of money that was being saved.

The area of a stack should, of course, be larger than the combined area of all the tubes or flues in the boiler, and as such a thing as too much draft is practically unknown, where there are proper dampers, to make the stack one-third larger than the required area is keeping within safe limits. To determine the proper area for a stack, therefore, the following rule may be used:

Rule: Multiply the area of cross section of all the tubes or flues in the boiler by 1.3; the product will give the required area for the stack.

To find the area of the cross section of a tube it is, of course, necessary to multiply the square of the diameter of one tube by .7854. This will give the cross section area of one tube.

Multiplying this by the number of tubes will give the combined cross section area of all the tubes in the boiler; multiplying this by 1.3 will give an area of stack large enough to furnish proper draft for the boiler. To ascertain the proper diameter of a round stack to give this area the following rule is used:

Rule: Divide the required area of the stack by .7854 and extract the square root of the quotient. CHAS. MILLER.

Albany, N. Y.

Talks to Young Boiler Makers—and Old Ones

Those who read THE BOILER MAKER can rest assured that its management is glad to give both sides of any question which is of interest to the art and trade. In its last issue, Mr. Basford made some very interesting remarks on a subject of vast importance, and I am going to take exceptions to his utterances.

He states that "the apprentice problem is very simple," and he then proceeds to tell how difficult it is. Now I ask any boiler maker or man who understands the trade, who has gray hair on his head, or no hair at all on it, whether or not he can remember the time when there were plenty of boiler maker apprentices to be had? My memory stretches back a good, long way, and I can recall no time when there was not the disposition to say that there were no more apprentices, and that when a few more deaths took place, incidentally that of the speaker, all the good boiler makers would have departed this life.

The boiler maker's trade is no pink tea affair; the work is arduous; it is not carried on usually in comfortable surroundings; it is so noisy as to produce irritation and often the discomfort of deafness results from it. When compared with, for instance, the machinists' trade or pattern makers', it is hard to understand why any young man prefers it to either of the trades named where physical effort is practically unknown and where the surroundings are usually comfortable. It can only be accounted for by the personal desire of the young man.

Mr. Basford, it seems to me, is not aiming at having the boiler makers' trade taught only, but proposes to develop character to an extent which so far our schools and churches have failed to accomplish. I am quite well aware that some of my boiler acquaintances and old-time friends have on occasions, in fact many occasions, disregarded keeping the peace and have proceeded to thump each other's noses most vigorously and in other ways, perhaps, have not lived up to the highest ideal of citizenship, but they were bully boiler makers all the same. I agree with Mr. Basford that a good citizen is an advantage in a boiler shop as elsewhere, but I cannot agree with him that it is a wise thing to attempt to make a perfect man while teaching him the boiler makers' trade. It's quite a job to undertake the latter alone.

I can see no disadvantage in a young man learning his trade in an "old-time" boiler shop; that is, in a shop where all modern appliances are not provided. In fact, if I had a boy who wanted to learn the boiler makers' trade, I would try to find a boiler shop where they made boilers instead of manufacturing them.

Mr. Basford's idea, if carried out, it seems to me, would attempt to provide foremen instead of tradesmen. You can teach many young men to be good boiler makers, but you cannot teach men to be foremen; that is, good ones. That is a natural gift. We have the assertion that "a prophet has little honor in his own country," and promoting men from workmen to foremen has to my certain knowledge often proved this to be true. It is a difficult position, and unnecessarily so, to be made foreman of a gang with which you have worked, but it is a fundamentally correct idea to have workmen understand that they have a chance of promotion when worthy of it.

I think that all will agree with me on this, that the system of pay for workmen is unfair. There is not a foreman going who does not feel down in his heart that the poor boiler maker is getting too much pay and the really good one too little. If the foreman was allowed to grade the pay he would probably have plenty of trouble when he started the job, but after a while fairness and justness would prevail.

No one can believe more thoroughly in trade schools than I do, and no man can be more appreciative of education than I am. I have run trade schools and have had every advantage in the line of education, yet I am free to say that trade schools have far too great a tendency to get into the head of the scholars the unfortunate idea that a trade is only to be learned and then as quickly as possible abandoned for managementship. That education has for its object discontent—not the discontent that makes for true advancement, but that which looks down on pure manual work.

If a trade school teaches a trade, and this is absolutely possible, it has gone as far as it legitimately should. It is not to be expected that in doing this all the virtues desirable in a human being should likewise be taught. Orderly conduct, application and reasoning, are all part and parcel of an apprentice's work. Honesty, truthfulness, sobriety and ambition are taught from example, and are to be found, I am glad to say, in the great majority of American young men.

In America we are handicapped by the fact that there is no way to indenture or hold a young man who comes to learn a trade. He can leave the job when he pleases and go to some town where he is not known and work as a journeyman; in other words, do what we call "steal" his trade. Some of the best boiler makers I have known got their trade in this way. Perhaps in a railroad system Mr. Basford's plan might work out to a certain extent, but just commercial boiler shops would be somewhat loath to educate apprentices who will be stolen by rival concerns at the first opportunity.

Let it be thoroughly understood that I welcome anything which will produce more good boiler makers, but I do deprecate the tendency which runs through Mr. Basford's article, namely, that it is an advantage to try to teach the boiler trade with far less effort on the part of the apprentice. It is an unfortunate tendency in education to do away with close, hard application. It starts in the kindergarten, where play is substituted for study, and results in the child getting into its head the idea that anything it has to learn must be made enjoyable and pleasing.

Skinned knuckles, blisters and smashed fingers are a part of learning the boiler trade—not enjoyable, of course, but most instructive. To place in the apprentice's hands all up-to-date boiler contrivances is questionable. We appreciate only from experience. When we breast drill a few holes we then appreciate the value of an air drill. As a sailor is a better one who learns his business in a sailing vessel, where he has to watch tide, wind and position of sails, so a boiler maker is a better one who learns his trade where makeshifts have to be often resorted to, and where first-class work is the result of his own manual skill, instead of using the products of the hydraulic press and bending machines.

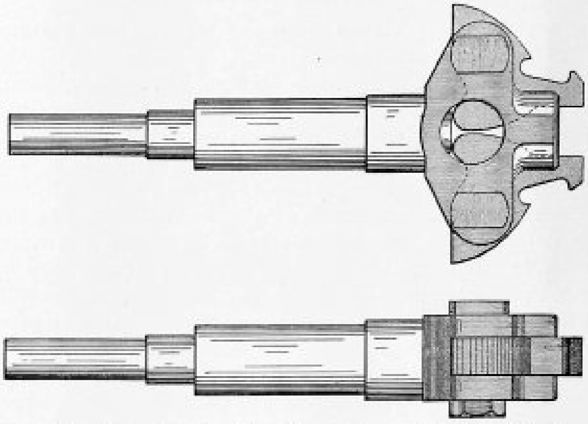
It would be instructive and entertaining to hear from some of the other readers of THE BOILER MAKER on this subject.

New London, Conn. W. D. FORBES.

Combination Flue Expander, Prosser and Beading Tool

E. E. Stillwell, general foreman boiler maker of the Ferrocarril Mexicano, Orizaba, Mexico, has invented a combination flue expander, prosser and beading tool, the details of which are shown in the illustration. The invention provides in a single tool means for performing quickly and efficiently the operations in setting boiler flues which commonly are done by three different tools, that is, the roller expander, the prosser and the beading tool. The combination tool is operated by either a small air hammer or an electric hammer. It is claimed that the tool can be operated by any boiler maker or apprentice who has had brief experience in a boiler shop, and that the tool is especially adapted for repair work. The tool illustrated is suitable for use with 2¼-inch flues, but it can be made in any size desired for flues up to 6 inches in diameter.

The tool comprises a cylindrical outer casing and a plunger or piston. At the end of the outer casing are projections to which are attached the expanding elements. The combined expanding and beading member is of triangular shape, with cam surfaces at the inner point. The outer ends of the members are shaped to conform with the expanded and beaded portions of the tube. As the plunger, or piston, rests against the cam-shaped surfaces of the expanding and beading elements, it is only necessary to strike the end of the plunger and the cam surfaces will be forced outwardly against the inner wall of the boiler flue, expanding the tube against the flue sheet; at the same time the beading elements engage the outer end of the flue and flange same outwardly, performing the beading operation.

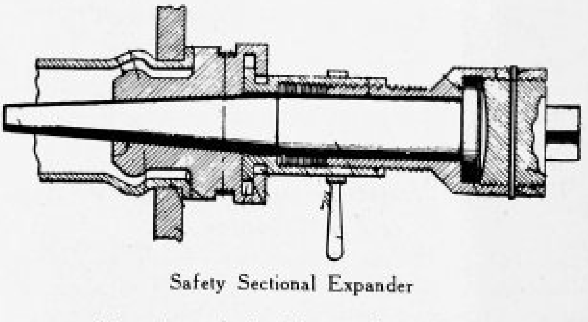


Stillwell Combination Flue Expander and Beading Tool

Changes may be rapidly made in the combination and proportion and arrangement of the tool as may be desired to suit a particular boiler or flue on which the tool is used. It is claimed that in actual tests the tool has accomplished twelve times as much work as by the ordinary method, using separate tools for the different operations. The tool has been patented in the United States, and patents have been applied for in Great Britain, France, Belgium, Germany and Canada.

A Safety Sectional Boiler Flue Expander

A safety sectional boiler flue expander, which is operated with a reversible air motor instead of an air hammer, has been invented by F. W. Frank of Rocky Mount, N. C., who has applied for patents for the invention. As can be seen from the illustration, the expanding elements are of the usual prosser type, which are forced out against the tube wall by a tapered mandrel. Instead of driving the mandrel into the expander by means of a hammer, however, the mandrel is forced into the expander by a threaded sleeve, which is turned by a reversible motor. A shoulder on the end of the mandrel, which engages with a shoulder on the threaded sleeve, serves to extricate the mandrel when the motor is reversed.



Safety Sectional Expander

It is claimed that with this tool only one man is required for expanding the flues, and that all flues are expanded exactly alike. The danger of flying steel by the breakage of the mandrel is eliminated, while the work is much more easily performed than is the case with a long-stroke air hammer.

Advantages and Disadvantages of Combustion Chambers

(*Concluded from page* 188)

8. With a combustion chamber boiler we get the shorter flue, making a saving on the original cost. With this class fewer flues are applied, making another saving. We also get a better flue sheet, due to a wider bridge and better spacing, therefore a better circulation.

Of these combustion chamber boilers, 301 are equipped with superheaters, a large number being put in service in April, 1912. To date we have had no flues out of these boilers, and we feel that with any of our combustion chamber boilers receiving proper care we can get thirty-six months' service from one setting of flues, at which time it would be necessary to take them out to meet the requirements of the Federal Law. In this class of boiler, with the service we get from the flues, it would not be necessary to talk about welding in flues. At the same time there may be localities where we could not get this service from flues, due to the poor water conditions and pitting of same, and flues would have to be renewed on account of the pitting, but not on account of the poor condition of flues in back flue sheet.

Mr. David Van Alstyne, when mechanical superintendent of the Northern Pacific Railroad, read a paper before the Northwestern Railway Club, highly commending the benefits of combustion chamber boilers which they had been testing out. He also stated at that time that the trouble with leaking flues was 75 percent less on a combustion-chamber engine compared with the same design of locomotive not so fitted and worked under identical conditions. He also mentioned as an advantage not to be overlooked the opportunity to work flues without removing the arch brick, and recommends a comparatively wide bridge, stating that 1 inch or more would be desirable for large boilers.

He also makes another good point in pointing out the importance of the proper care of boilers, such as regular and thorough washing out and blowing off, washing out and filling up with hot water, feeding, working the injector as far as possible when engine is working, and expanding the flues in an intelligent manner. We all know just how much damage can be done to flues and flue sheets while expanding them. This is due to too much pounding, too heavy hammering and too much calking. Good water and water treatments will give the results looked for.

What Benefit Has Been Derived from Treating Feed Water for Locomotive Boilers Chemically?*

A great deal of our boiler trouble is due to poor water. Some of its bad effects are the burning of firebox sheets, leaky flues and staybolts, foaming, and a much greater expense in upkeep. This is due to the fact that boilers have to be washed oftener and flues and staybolts worked more frequently to keep them tight. That feed water can be treated successfully, if a well organized method is adopted, and that wonderful results can be obtained, is a recognized fact, but to treat it in a half-hearted way, without following it up to see that instructions are carried out, is a waste of money.

The first consideration in getting a supply of water for locomotive use is to get the best water possible. This remark may sound absurd, but there is sometimes a great difference in the quality of water within a radius of a few miles. Where good water cannot be obtained it is economy to install treating plants.

While the initial expense of installing treating plants is considerable, varying according to the size and kind selected, they will more than pay for themselves in a short time in the results obtained. The cost of maintaining treating plants will, of course, vary according to the price of chemicals used, which are generally lime and soda-ash; this being the cheapest. There is no additional cost of labor, as the pumper can attend to the plant with his other duties.

These treating plants should be well organized and under the head of some department, with a man in charge to see that the water is properly treated, and that samples are sent to the chemist at regular intervals to be analyzed if the best results are to be obtained.

Where treating plants are not installed, good results can be obtained by putting soda ash into the tanks of locomotives, the amount per thousand gallons to be determined by the chemist after an analysis has been made of the water. But in either case the method of using must be well organized and blow-off cocks on locomotives must be used systematically. Blow-off cocks should be applied to locomotives so they can be operated from either side of cab by engine men without getting off the seat box.

One of the reasons soda ash has been condemned by some railroads is because the claim is made that it causes locomotives to foam and that it cuts out valves and packing. This is true if blow-off cocks are not used. The reason soda ash is put into boilers is to soften the scale or turn it into a sludge or soft mud. This should be removed with the blow-off cocks. The use of blow-off cocks will prevent foaming and tend to keep the boilers clean and extend the time between wash-outs, as it is the opinion of the writer that it is a detriment to the boiler to cool it down, and that the longer the wash-out period can be extended the better it is for the boiler. With the use of treated water from treating plants, or using soda ash direct into the tank of locomotives, the wash-out period can be extended and the changing of water, in most cases, is unnecessary, provided the blow-off cocks are used.

On the C. & N. W. Ry. the engines are fitted up with a blow-off cock on each side of the engine on the outside sheets near the front corners of mud-ring, and these can be operated from the cab by the engine men without getting off the seat box. Our instruction relative to the use of blow-off cocks is to blow the engine into blow-off tanks when leaving the round-house, and to use blow-off cock every few miles on the road, or at least once between every station. This is followed up very closely by road foremen and master mechanics; also to blow the engine on arrival at the round-house.

When blowing the engine off on the road, the blow-off cock is only opened from three to five seconds. This does not mean a great loss of water, as practically all that comes out of blow-off cock in that time is mud. A very good demonstration of this is to open blow-off cock on an engine that has steam off but that the water is still hot. You will find that all that comes out of cock for the first few seconds is mud, then clear water, showing that it is the first few seconds that gets the mud. Another way to show that the short blowing gets the mud is to open a blow-off cock against a snow bank or fence; it will be spotted in one place only.

On one 150-mile division of the C. & N. W. Ry. using treated water, a few years ago it was necessary to either change water or wash the boiler at each end of the road. Now with the same water engines are making 1,050 to 1,500 miles between wash-outs, and are having no trouble on account of foaming, and when plugs are removed there is not over 2 inches of mud on mud-ring. This improvement has been accomplished by systematic use of the blow-off cocks, as described above.

Summing up the benefits derived from treating water with soda ash and lime, in treating plants or putting soda ash direct into locomotive tank where blow-off cocks are used, they are as follows:

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* Abstract of committee report by T. F. Powers, presented before the Master Boiler Makers' Association, Philadelphia, May, 1914.

1. Failures from foaming are practically unknown.
2. Wash-out period is extended.
3. Changing of water not necessary.
4. Better circulation, making better steaming engines.
5. Boilers are kept clean, burnt and buckled side sheets are very rare.
6. Leaky flues and side sheets are avoided. (This is a big item.)
7. Engines are run longer between shopping for flues because scale is softened and removed by blow-off cock in form of mud.
8. Decrease in expense of upkeep in round-houses.
9. Better feeling among men running engines, because engines are not failing on the road due to leaking and foaming.

It would not be fair in saying that all the benefits mentioned above can be derived unless the boiler work in the round-house is done properly. Flues must be expanded when needed, and when the locomotive is washed all plugs must be removed and the boiler washed until thoroughly clean of mud and scale, which can only be determined by inspection of a competent foreman or boiler maker before the plugs are replaced in the boiler.

SUPPLEMENTARY REPORT*

During the past twenty-four years the Western lines of the Canadian-Pacific Railway have experimented with many different methods of water treatment. The chemicals used were principally lime, soda ash and caustic soda, and although all of them mixed up with the water in various ways before entering the boiler only one of them took care of the sludge. The latter consisted of agitating and settling chamber tanks, with means for removing the sludge before the water entered the boiler. This was very satisfactory at times, and prevented heavy scale formation, providing sufficient caustic soda was used to take care of the majority of the sulphates of lime and magnesia, but when treated sufficiently to do this the engines foamed so badly that we were obliged to resort to round-trip wash-outs. When the quantity of caustic soda was reduced to alleviate foaming, a hard, flinty scale developed around the tubes at the back tube sheet end, rosettes and stockings of scale accumulated around the staybolts, together with a formation of it on the firebox plates.

The life of tubes and firebox plates was lengthened over what was obtained with crude water, or with any other class of treatment, although it was not determined whether it was more profitable to renew the tubes and fireboxes at intervals to prevent boiler failures or treat the water as described.

During the past eighteen months over the Saskatchewan division, and about one year over the Manitoba division, the treating of water by the above means has been discontinued and a polarized metallic preparation substituted. The results of the applications of this material are that it is possible to keep the boilers clean with sufficient and proper washing-out to run between No. 1 repairs without removal of any tubes and without failures because of leakage. In no case has it necessitated more frequent washing out than with other methods of treatment. It has in all cases permitted 100 percent more mileage between wash-outs, and in many cases it is possible to run 200 percent. So far as we have been able to discover, pitting or corrosion does not follow from application of this treatment. It does not aggravate foaming. Its action on the removal of old scale and new formation appears to be more mechanical than chemical, in that it does not create a pasty sludge next to the fire-plates and tubes, which is common with other treatments and which prevents the water getting into proper contact with the plates, being most difficult to wash off, thus producing overheating of the plates and tubes, which frequently results in boiler failures.

Polarized treatment is not productive of such evils. Therefore, by correctly regulating the period between wash-outs, with a strict observance and performance, accompanied with good water pressure, it is possible to do better than we have heretofore experienced, inasmuch as the reduction in boiler maintenance and washing-out expense has been greatly reduced, together with economy in water consumption, rubber hose, boots, etc., and less general wear and tear on the tool equipment for boiler washing and boiler making. There is also a large saving in coal and lighting up material because of boilers being hot, due to less washing out, together with increased earning power of the locomotive, because it is available many times without boiler washing or boiler making than we have heretofore experienced.

Taking into consideration the many advantages herein described I feel quite satisfied in saying that it is more profitable from a mechanical standpoint than any other treatment experimented with during my practice. It is very conveniently applied after each wash-out, being distributed in bars over the crown and tubes, or arranged to suit what the inspection exposes to be the proper place to locate it, according to the condition and design of boiler.

It is too early in our experience to say what percentage of saving is effected in boiler maintenance and boiler repairs, because it takes several years to arrive at an intelligent estimate of its use compared with what was formerly obtained. However, I feel confident in saying that my experience with it so far demonstrates the fact that it is the greatest innovation for saving money for a railway company that has yet been introduced in this line.

Personal

C. W. CROZIER, of Baltimore, Md., widely known as a boiler maker and a boiler manufacturer, has been appointed a boiler inspector with the Fidelity & Casualty Company of New York.

JOHN FIELD has been appointed acting foreman boiler maker of the Minneapolis & St. Louis Railroad at Marshalltown, Iowa, succeeding P. H. Maley.

D. J. GRACE, formerly foreman boiler maker of the Colorado, Midland Railway, Colorado Springs, Colorado, has been appointed foreman boiler maker of the Santa Fe Shops at Albuquerque, New Mexico.

THOMAS PURCELL, foreman boiler maker of the Atchison, Topeka & Santa Fe Coast Lines at Winslow, Arizona, has been transferred to Richmond, Cal., as foreman of the boiler shops at that point.

ALEXANDER B. SCULLY, president of the Scully Steel & Iron Company, Chicago, Ill., died early Thursday morning, May 7, at his home in Chicago. He was born in Chicago, November 29, 1856, and received his education in the public schools of the city. After leaving school he became a messenger boy for the Western Union Telegraph Company. In the year 1875 he entered the employ of Joseph T. Ryerson & Son and remained there until 1885. In 1886 he formed the W. S. Mallory Company, a business which was sold out to Joseph T. Ryerson & Son in 1890. In 1891 he formed the Scully-Castle Company, which later became the Scully Steel & Iron Company, a firm of which he was president up to the time of his death. Mr. Scully is survived by his wife and two sons, Alexander Clifford and James Stewart Scully.

WILSON B. CHISHOLM, president of the Champion Rivet Company, Cleveland, Ohio, died May 10, aged 65 years. He was born in Montreal, Canada, and when a boy his father, Henry Chisholm, moved to Cleveland. He father became one of the founders of the Cleveland Rolling Mill Company, and Wilson B. Chisholm was vice-president and manager of this company for about fifteen years. He was also interested in the Chisholm & Moore Manufacturing Company, Cleveland, of which his brother is president. Mr. Chisholm had been in poor health for a number of years following a stroke of apoplexy, and during that time had practically retired from active business.

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* By H. W. Armshaw.

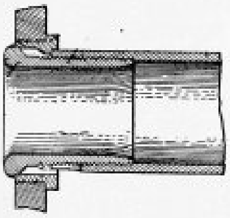
Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
Millertown, N. Y.

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

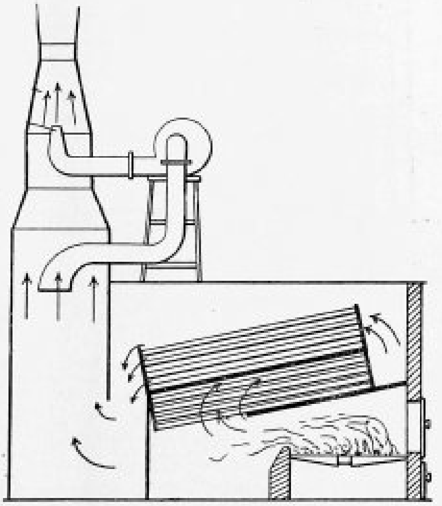
1,089,970. BOILER-FLUE-FASTENING MEANS. FREDERICK SCHMITT, OF OAKLAND, CAL.

Claim 1.—In combination, a flue sheet provided with a bearing, a flue seated in said bearing, and a clamping and securing member connected with the flue and coacting with the flue sheet to hold the flue against its bearing, said clamping member being spaced from the flue sheet and the adjacent end of the flue being formed with passages permitting water to enter the space between the clamping member and the flue sheet. Two claims.



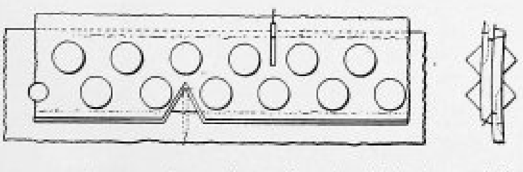
1,089,827. INDUCTION DRAFT APPARATUS. ADELBERT FISCHER, OF PHILADELPHIA, PA.

Claim.—The combination with a furnace, of a passage for the discharge of the combustion gases from the furnace comprisinig a portion having the form of a Venturi tube and including a converging part, a jet nozzle set to discharge into said converging part of said portion of the discharge passage, and means for supplying under pressure to the jet nozzle a part of the combustion gases taken from a point between the combustion chamber of the furnace and the jet nozzle. One claim.



1,091,847. METHOD OF FACILITATING THE DETECTION OF STEAM-BOILER SEAM-CRACKS. SHERWOOD FRANK JETER, OF HARTFORD, CONN.

Claim 2.—The method of providing for the detection of seam cracks in the plate of a boiler shell which consists in reducing the thickness of the plate by cutting an oblong recess adjacent to the seam in the surface of the plate opposite to the surface in which the crack is liable to first occur and transversely of the probable path of development of the crack, whereby the crack will open into the recess and become apparent before it extends completely through the plate. Seven claims.

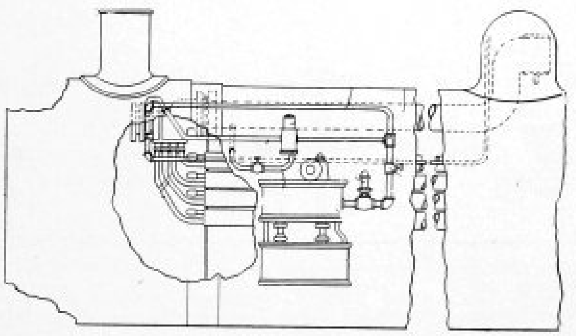


1,089,843. FURNACE-CASING. CHARLES AVERY KENNEDY, OF COATICOOK, CANADA.

Claim.—A furnace casing comprising a plurality of hollow sections, a flange on the edge of each section forming a rabbet, the edge of one section resting in the rabbet of the adjacent section, the flange of said first section, and a grooved strip secured to the flange of the second section, and a grooved strip secured to the flange of the second section and embracing the flange of the first section. One claim.

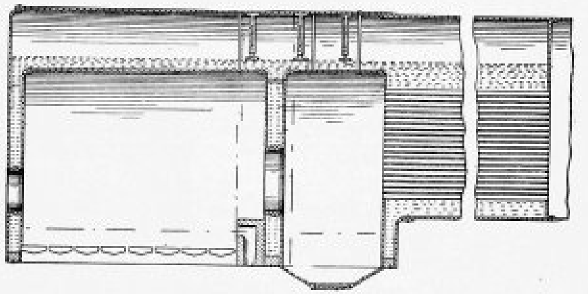
1,089,807. LOCOMOTIVE SUPERHEATER APPARATUS. CHAS. D. YOUNG, OF ALTOONA, PA.

Claim 2.—In combination in locomotive superheater apparatus for supplying a portion of the superheated steam to the steam cylinder of an air pump, a main superheater for supplying steam to the locomotive cylinders, a supplemental superheater, a connection from the supplemental superheater to the said air pump steam cylinder, a communication from the supplemental to the main superheater, and controlling means therein operated by supplying and cutting off the supply of steam to the main superheater for opening and closing the said communication. Seven claims.



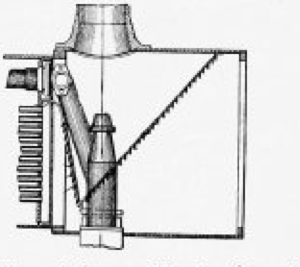
1,089,758. BOILER. LEWIS D. FREEMAN, OF PITTSBURG, KANSAS.

Claim.—The combination with a boiler having flue sheets and flues therein, of a primary combustion chamber, a secondary combustion chamber, a water partition dividing the secondary and primary combustion chambers and having a plurality of ports therein, the combined area of which is greater than the combined area of the flues, and air inlets leading into the primary combustion chamber adjacent the partition. One claim.



1,090,754. LOCOMOTIVE DIAPHRAGM AND SPARK-ARRESTER. EDWARD M. ROBERTS, DECEASED, LATE OF ASHLAND, KENTUCKY, BY ANNIE C. ROBERTS, ADMINISTRATRIX, OF ASHLAND, KY.

Claim.—The combination with a tubular locomotive boiler having a smoke box at its forward end, the front wall of which is vertical, of a perforated draft plate disposed in front of the fire tubes of the boiler and extending forwardly and downwardly therefrom, hoods projecting downwardly from the rear face of said plate and overlying said perforations, of a perforated spark arrester secured to the top of the smoke box near the front thereof and extending rearwardly and downwardly therefrom and terminating at a point near the lower edge of the draft plate, downwardly extending hoods on the forward side of and overlying the perforation in the spark arrester and disposed in plane as substantially parallel to the plane of the front wall of the smoke box, whereby cinders in the outer portion of the vortex developed by the flow of the gases are deflected from said perforations inward to the inner portion of the vortex, to be precipitated by the latter. One claim.

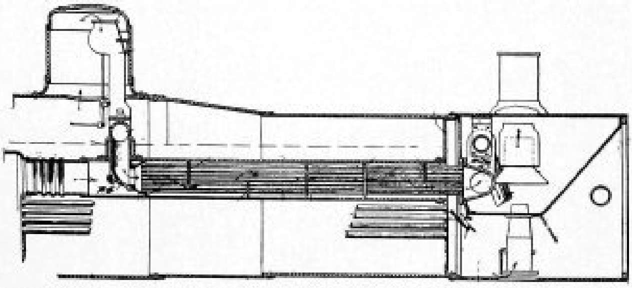


1,088,772. MECHANICAL STOKER. WILLIAM M. DUNCAN, OF ALTON, ILL.

Claim 2.—The combination with a mechanical stoker having a traveling grate, of a cylindrical water back at the rear of said grate, water conducting connections to which said water back is journaled, and means for rolling said water back back and forth to vary the gap between the grate and barrier. Two claims.

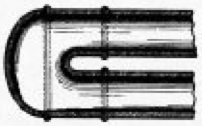
1,090,688. STEAM-SUPERHEATER FOR BOILERS. MILLARD F. COX, OF LOUISVILLE, KY.

Claim 2.—A steam boiler having a plurality of flue tubes of small diameter extending from the firebox to the smokebox, a cylindrical combustion chamber of relatively large diameter also extending from the firebox to the smokebox, baffle plates positioned in said combustion chamber to compel the combustion gases to take a helical course therethrough, a self-contained superheater within said combustion chamber, a duct leading the generated steam to said superheater from the dome of the boiler, a collector in the smokebox for collecting the steam from the superheater and conducting it to the engine cylinders; said duct comprising an elbow pipe within said combustion chamber, and a standpipe extending through the cylindrical wall of said combustion chamber and opening into the dome of the boiler, and a throttle valve for closing said opening and means for regulating said throttle valve, said standpipe having double walls forming a water jacket around said standpipe. Two claims.



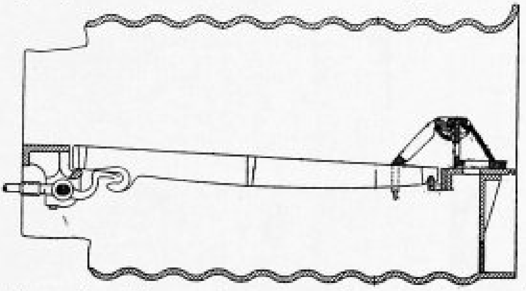
1,090,551. MANUFACTURE OF SUPERHEATER UNITS. COLUMBUS K. LASSITER, OF RICHMOND, VA.

Claim.—The improvement in the manufacture of superheater units which consists in forming a return bend body and a return bend cap, in separate sections having matching end surfaces, electrically welding each of the lines of pipe to a matching surface on one end of the return bend body, removing inward projetions of metal at the welds by the application of a cutting tool, and thereafter electrically welding the cap section to the matching surface of the opposite end of the return bend body section. One claim.



1,090,273. MARINE-BOILER AND OTHER FURNACE. RICHARD CAMPBELL, OF LIVERPOOL, ENGLAND.

Claim 1.—In a furnace, the combination of a flue; a main grate therein; a longitudinally-movable fire-bridge at the back thereof having a laterally disposed internal space; and an auxiliary grate in front of said bridge, said auxiliary grate, together with the main grate and the bridge wall inclosing a space in front of said wall. Thirteen claims.



1,087,358. SMOKE-BURNING DEVICE. FREDERICK T. FARNUM, OF CHICAGO, ILL., ASSIGNOR OF ONE-HALF TO JAMES W. McCLEARN, OF CHICAGO, ILL.

Claim 1.—In a smoke-burning device, a hollow metal casing disposed across the upper and forward edge of the bridge wall of a furnace, the walls of which are contracted and extended downwardly from the body of said casing and are perforated, tubular members extending forwardly from said casing and down into the bed of said furnace, said members being likewise perforated, and means for conducting air to said casing and members. Two claims.

1,091,166. CHAIN-GRATE STOKER. JAMES H. ROSENTHAL AND CHRISTOPHER S. DAVY, OF LONDON, ENGLAND, ASSIGNORS, TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

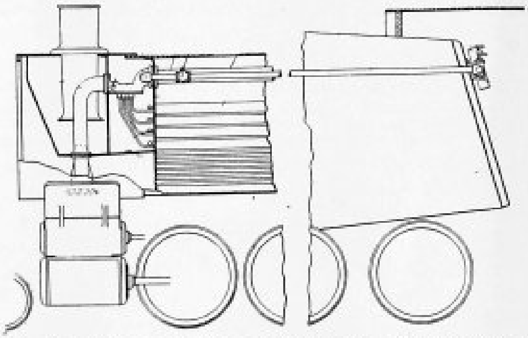
Claim 1.—A chain grate stoker comprising a plurality of transverse supporting bars having heads to receive and to prevent the grate bars being disengaged, and grate bars each having an open recess, the wall of which corresponds to said head, and the opening thereinto of less width than the diameter of the head, but of sufficient width to permit swinging of the grate bars on the supporting bars. Six claims.

1,090,947. STEAM-BOILER SETTING. MINOTT W. SEWALL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 2.—A boiler setting comprising side walls having one section lined with water tubes, front and rear manifolds into which said tubes are expanded, and another section lined with water tubes, front and rear headers, into which said latter tubes are expanded, and means to permit the movement of said manifolds and headers with their connecting tubes in opposite directions without distortion of the walls. Ten claims.

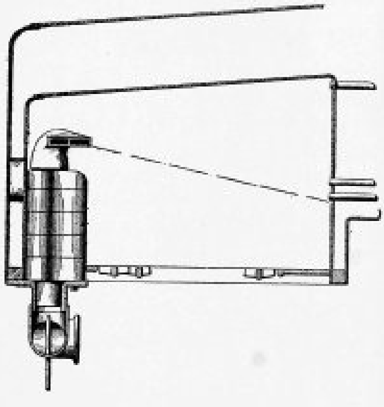
1,091,178. STEAM-LOCOMOTIVE. GEORGE W. WYMAN, OF WILMINGTON, DEL.

Claim 2.—In a steam locomotive, a boiler, steam chests and cylinders, a superheater, a dry pipe delivering steam to said superheater, steam pipes from said superheater to said steam chests, an auxiliary pipe from said boiler to said superheater, a reducing valve in said pipe, and a check valve in said pipe between said reducing valve and said superheater, said pipe and valves arranged to receive steam at high-pressure from said boiler and deliver it to said superheater at a reduced pressure. Three claims.



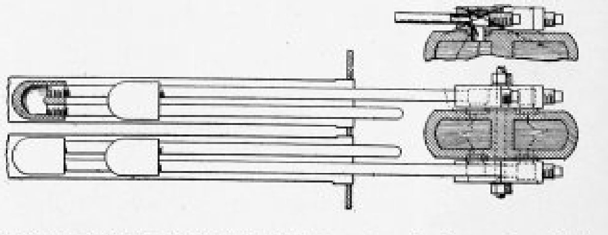
1,092,853. FURNACE AND AIR-INJECTING NOZZLE THEREFOR. JOHN H. PARSONS, OF RIDLEY PARK, PENNSYLVANIA, ASSIGNOR TO PARSONS ENGINEERING COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

Claim 1.—In combination with a nozzle, having grooved portions, a protecting facing for the front portion of the nozzle consisting of a plurality of adjoining sections flanged to engage said grooved portions at the opposite edges of the facing, and at a point intermediate said edges to slidably interlock the sections with the nozzle. Eleven claims.



1,093,954. STEAM-SUPERHEATER. MAX TOLTZ, OF ST. PAUL, MINNESOTA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO LOCOMOTIVE SUPERHEATER COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

Claim 1.—In a steam superheater, a pair of headers arranged one in front of the other across the smoke box and with their sides in substantially the same plane, a superheater element or loop having a short and a long end, an elongated integral connector having a pair of independent wholly separated elbow passages one at each end, one pair of corresponding ends of the two passages going to the different headers and the other pair of ends having the aforesaid long and short element ends joined respectively thereto, and means for fastening the connector to the leaders. Six claims.



1,092,840. TOOL FOR SPREADING THE TUBES OF WATER-TUBE BOILERS. JOHN KEERS, OF BROOKLYN, NEW YORK.

Claim 1.—A tool for spreading the tubes of water-tube boilers, embodying a carrier comprising two main parts, one of which is slidable lengthwise of the other, a pair of tube-spreading members secured respectively to said carriers, one of which members is pivoted to its carrier to swing relatively to the other tube-spreading member, and means for moving said tube-spreading members toward and from each other. Six claims.

THE BOILER MAKER

JULY, 1914

Flanged and Pressed Work in Boiler Shops

Types of Furnaces Used for Heating Boiler Plates—Hydraulic Presses and Flanging Machines—Design of Flanging Dies

BY F. A. GARRETT

Although the production of pressed plates forms one of the most important branches of boiler making, yet it is not often referred to in the technical press; at least not in sufficient detail to enable anyone to obtain a thorough grasp of this comprehensive subject. It is impossible to treat the subject at any length in the scope of a short article like the present one, but it is proposed to outline as briefly as possible the whole subject, which includes furnaces, machines, flanging dies and dies for punching steel plates without heating.

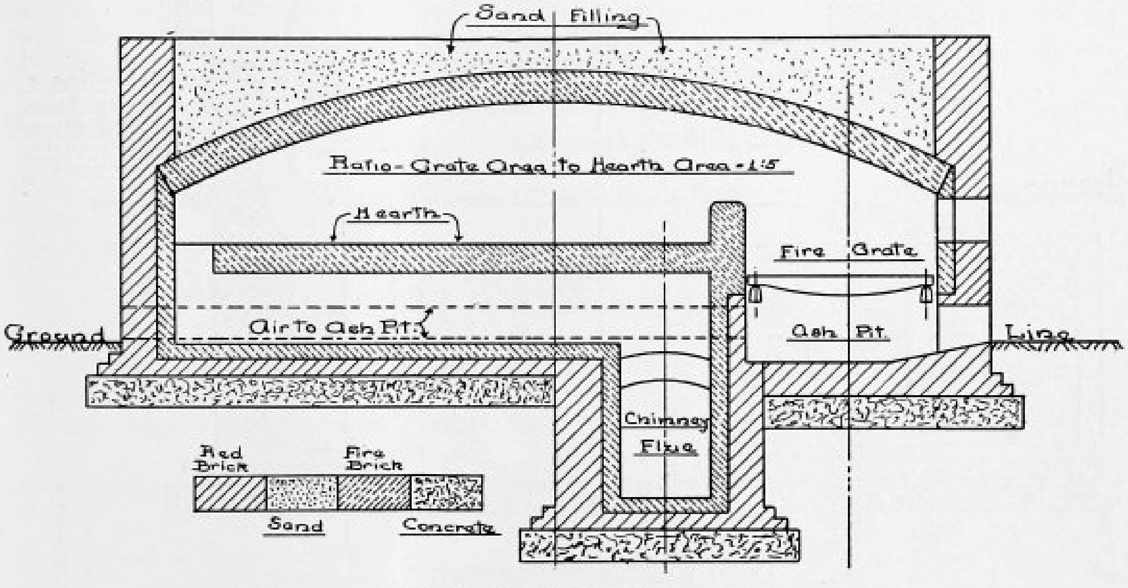


Fig. 1.—Reverberatory Furnace

As is well known, hand work on boiler plates is very objectionable; first, because the work is not so good as when done in the press, and, second, because of the higher cost when compared with machine work. Hand work often costs dollars where machine work with proper dies will reduce the cost to cents. More especially do the advantages of machine work show up when large quantities of a single article are required and where the manufacturer is really desirous of turning out the very best work possible for the least expenditure.

HEATING APPLIANCES

There are, generally speaking, four distinct types of heating appliances in use as follows:

First. Reverberatory furnaces using coal or other solid combustible as fuel. These are made in various sizes and particular designs, varying in detail. In Fig. 1 is given an outline showing a typical arrangement of such a furnace, the drawing being self-explanatory. Good results will be obtained with a proportion of grate area to hearth area of about 1 to 5. It will, however, be found in practice that good results are obtained with widely varying proportions, the length and width of hearth and the arrangement of fire grate, together with the working temperature required, being important considerations. With the ordinary type of this furnace it will be found practically impossible to obtain an even heat over any considerable surface of hearth. This, together with the excessive amount of scale generally formed (due to the excess air passing over the plate when heated), renders this type of furnace unsuitable for turning out high-class work at a low cost.

Second. Gas-fired furnaces using producer gas as fuel. These divide themselves up into furnaces fitted with air reversing regenerators and those fitted up on the Weardale principle, as in Fig. 2, the latter giving a comparatively moderate amount of heat to the air required for combustion. These furnaces are coming more into general use, as the advantages to be gained thereby are being realized more and more by manufacturers.

The advantages of this type of furnace are very marked when compared with coal-fired reverberatory furnaces; first, because plates may be heated much quicker, with an exact means of regulating the temperature in the furnace to suit the work in hand, and, second, because of the economy of fuel, with practically an absence of scale on the plates. This last item is obtainable because it is possible to regulate the air required for combustion to a nicety, making it possible to get complete combustion of the gas with a minimum excess of air over and above the theoretical amount. With these furnaces we can regulate the air supply so as to give either an oxidizing, neutral or reducing flame. An oxidizing flame has an excess of air over and above that required to cause complete combustion of the gas; therefore when the plate which is in the furnace gets hot, the oxygen which is present in the excess air combines with the steel and forms oxide, which is scale, hence the term oxidizing flame.

With a more exact regulation of the air supply, we find that the quantity of scale formed will decrease in amount until there is very little formed at all, the action of the flame on the plate having become neutral. If now we curtail the air supply still further we get what is known as a reducing flame (one which will abstract oxygen from certain substances when brought into contact with it), this action being very powerful at high temperatures. In practice we do not use this flame for furnace work, because it is, generally speaking, wasteful of gas and there are no advantages gained. What we do aim at is a neutral flame, which gives us the highest temperature obtainable with a minimum amount of gas and a good, clean plate practically free from scale.

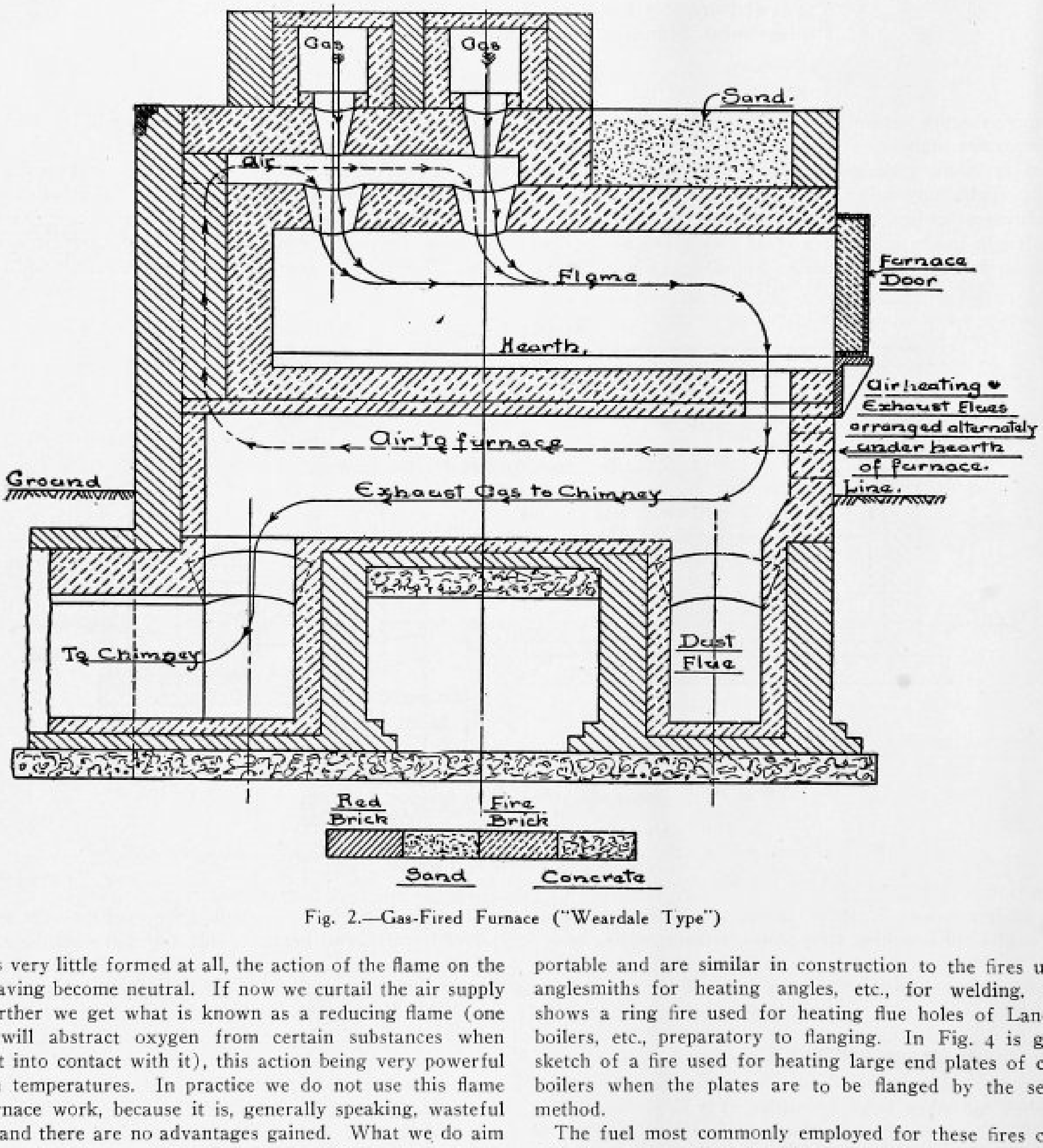


Fig. 2.—Gas-Fired Furnace ("Weardale Type")

It should be pointed out here that with these furnaces the temperature should not be too high, and the plate should be taken from the furnace directly the flanging heat is obtained. If the plate is allowed to lie in the furnace for any length of time when hot, a very small amount of excess air will soon cause scale to form. Also, if the plate is much hotter than actually required for flanging, scale will rapidly form after the plate is taken from the furnace, although it will not be so hard as when formed in the heating operation.

Third. Furnaces using crude oil, which compare very favorably with gas-fired furnaces when the oil can be obtained at a very low price. The ratio of the cost of oil compared with coal for producer gas, other things being equal, will have to be about 3.25 to 1 for equal running cost from the fuel standpoint. These furnaces admit of very quick high temperature heats being obtained, but are not used to any large extent for plate heating in England.

Four. The principal types which come under the fourth heading are fires of the "box" form. These are generally portable and are similar in construction to the fires used by anglesmiths for heating angles, etc., for welding. Fig. 3 shows a ring fire used for heating flue holes of Lancashire boilers, etc., preparatory to flanging. In Fig. 4 is given a sketch of a fire used for heating large end plates of circular boilers when the plates are to be flanged by the sectional method.

The fuel most commonly employed for these fires consists of coke with a plentiful supply of air blast.

HYDRAULIC MACHINES

There are three different types of hydraulic presses generally used for boiler work. In Fig. 5 a machine of the column type is shown, while in Fig. 6 is shown a machine of the overhung type. Fig. 7 is an illustration of a sectional flanger. Fig. 5 can be used for a very great variety of work, but is generally used for flanging purposes. Fig. 6 is more suitable

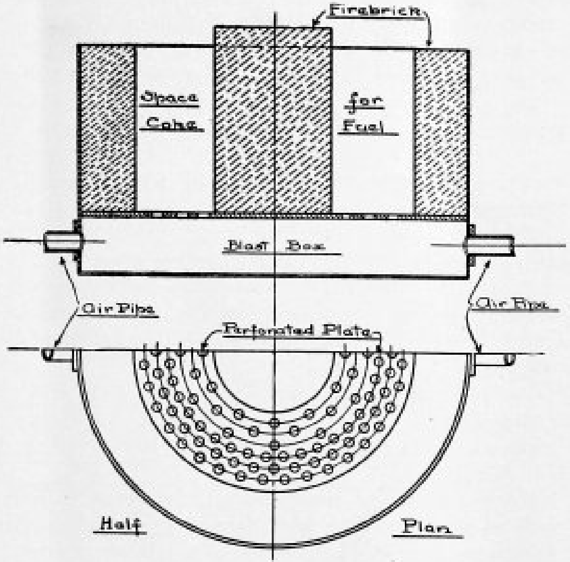


Fig. 3.—Ring Fire for Flue Holes

for punching, both hot and cold, being more rigid than the machine shown in Fig. 5. This is important, because a very little vibration is liable to make the punch come down foul on the die, with disastrous results to the hardened steel faces. This machine is also useful for a variety of comparatively small flanging work. The sectional flanger illustrated in Fig. 7 can also be used in the same manner as the overhung press shown in Fig. 6 by simply coupling the two top rams to a common table.

The working of this machine when used for sectional flanging is as follows: A bottom block made to the radius of the flanged plate required is bolted to the table directly under the outermost top ram. A plain, flat block being fixed to this ram, so that the plate, after being heated in a fire similar to the one shown in Fig. 4, may be gripped between these two blocks. Another block is bolted to the inside top ram, having about 3 inches radius at the bottom corner, where it folds the plate down over the block which is fixed to the bottom table. After the plate has been flanged down in this manner, a small, flat-faced block, attached to the horizontal ram shown in the illustration, finishes the work off.

The above method saves the expense of making large dies, and is the only practical method for flanging large diameter plates such as those required for cylindrical marine boilers.

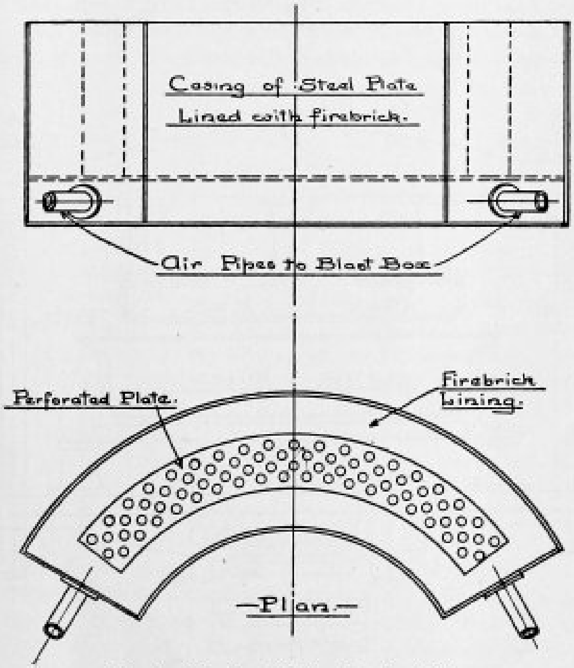


Fig. 4.—"Sectional" Fire for End Plates

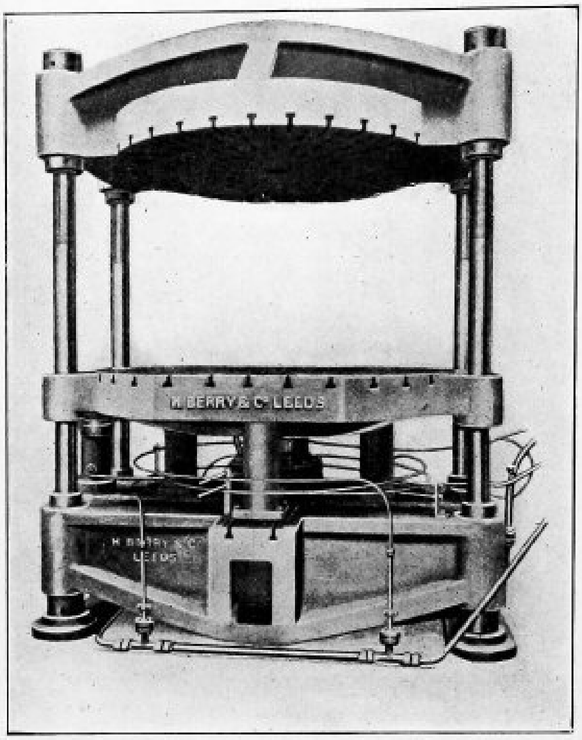


Fig. 5.—Column Type Flanging Press

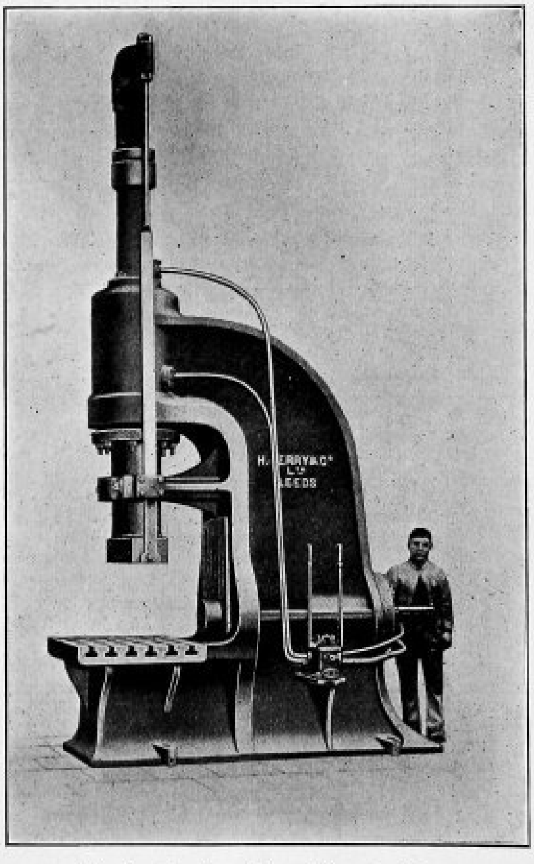


Fig. 6.—Overhung Type Flanging Press

There are also many other jobs which may be done to advantage on this machine, and it will be found a most useful tool for a shop doing a large variety of work.

Flanging Dies

Upon the design of the blocks used in the press depends the success or otherwise of any specific operation, and much thought is often needed to insure this success, many failures having been caused by an insufficient comprehension of the points involved. It is the writer's intention to give some rules and data and to enumerate some difficulties which he has encountered from time to time, and also to include some examples of dies which have given the results expected of them.

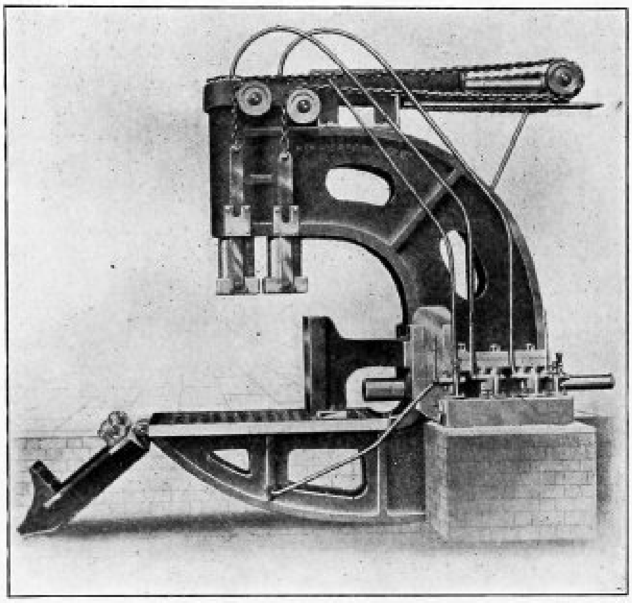


Fig. 7.—Press Used for Sectional Flanging

One of the first things which has to be determined when designing dies is the best method of doing any given operation, and the one aim should be to eliminate all hand work on the article when it has passed through the dies. The plate should then be ready to be built up into a boiler or other structure. When a plate is heated it expands, so that the dies have to be made larger than the required finished size of the plate. By means of a series of experiments the writer has found that the expansion of steel plates at flanging heat, which is about 1,800 degrees F., is equal to one-sixteenth inch in every 9 inches. For example, suppose we have a plate which has to be 3 feet 7½ inches diameter, finished size over the flange; we should have to make the female die 3 feet 7½ inches, plus $\frac{43.5}{9}$, which equals, say, 3 feet 7 13/16 inches diameter. The expansion expressed by formula is:

Expansion when at flanging heat, in sixteenths of an inch, equals $\frac{l}{9}$ where l = dimension in inches when cold.

Another important consideration for good work is the clearance between the male and female blocks; this should not exceed:

Thickness of plate, plus 1/32 inch, for plates up to one-half inch thickness.

Thickness of plate, plus 1/16 inch for plates over one-half inch in thickness.

The above applies to cases where the material is gathered in, such as plates with the edge flanged up at right angles to the remaining portion. In the case of a job where stretching of the plate occurs, as in holes flanged outwards, no clearance whatever should be allowed.

There are two designs for flanging dies in general use. One as shown in Fig. 8, where we have a top block, a holding-up block resting on four vice rams and a female block. The plate is gripped between the top and holding-up blocks, while the ring block is brought up over the plate, thus completing the flange. The plate can then be stripped off the top block by releasing the vice rams and allowing the female block to travel downwards.

The other design consists of a top block and a solid bottom block, as shown in Fig. 9, the plate being pressed into the bottom one by raising the lower table. Although there are a great number of plates pressed by this second method, it has the following disadvantages when compared with the former: *First.* It does not allow of a very small clearance between the two blocks, for if this is made too small the plate will invariably hang on the top block and shrink thereon before it can be removed. *Second.* The design does not allow accurate fitting up of the blocks when making same, and they are more difficult to produce generally. *Third.* There is more material in both pattern and casting, and they are, therefore, more expensive. *Fourth.* Due to the third defect they are more clumsy to handle when fixing in the machine.

Many boiler makers uphold this design because of its ap-

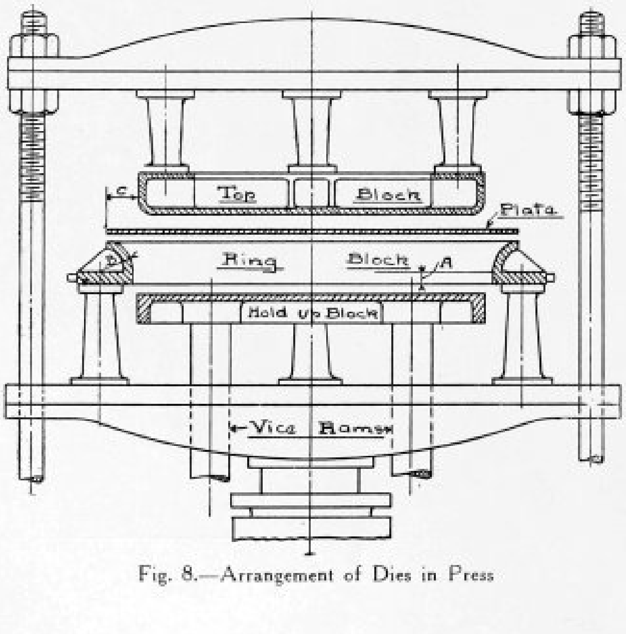


Fig. 8.—Arrangement of Dies in Press

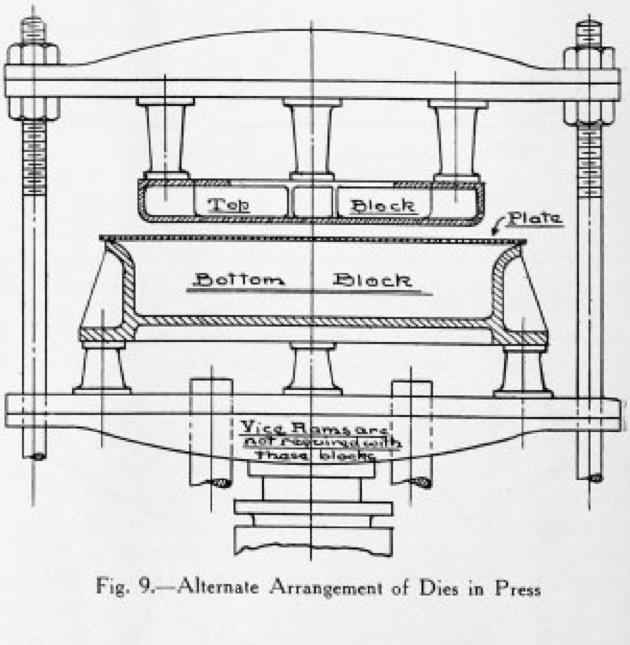


Fig. 9.—Alternate Arrangement of Dies in Press

parent simplicity (it certainly does not use as much hydraulic power as the other design), but experience has taught the writer that the first method, mentioned above is the best one to adopt wherever possible. The length of time that a set of blocks will produce accurate work depends upon the amount of flat, as at *A*, Fig. 8, this should in no case be less than 1½ inches, and should be more when circumstances will permit. The amount of radius shown at *B*, Fig. 8, should equal the amount of plate which has to be flanged up as *C*.

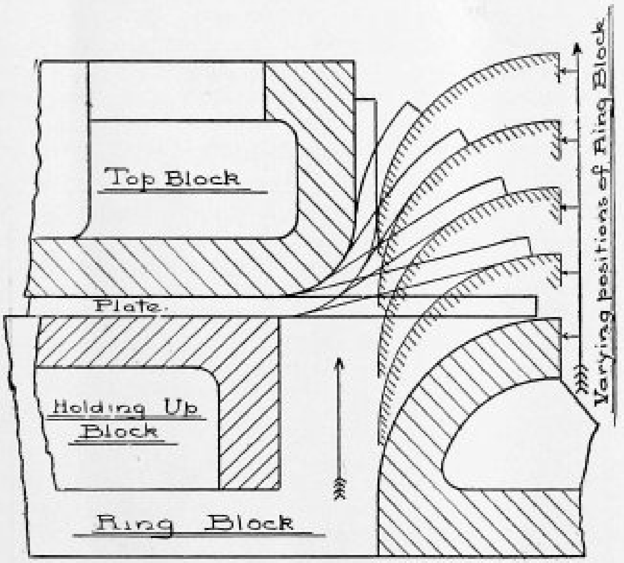


Fig. 10.—Action of Ring Block on Plate Flange

Fig. 10 shows how the plate clings round the radius of the female block. It will do this more readily than buckle, which means that the metal is more evenly gathered in than when a very large radius is used. With a large radius the buckling of the plate is very much more pronounced. More especially does this apply to thin plates with sharp radii in the corners, but the different effects produced in the two cases are quite apparent with thick plates and large radii.

In the case of a plate having flanges in opposite directions, as in Fig. 11, it is usual to employ a press with a cylinder fixed to the top table for one of the operations. The dies are generally arranged as shown in Fig. 11, although it is most usual to make the top ram a fixture to the cylinder ram, thus making it necessary to draw the top ram back through the plate before same can be removed from the dies. With this arrangement exactly what happens is that when the ram has passed through the plate and flanged it outwards the material immediately commences to contract, due to the cold metal of the ram coming into contact with it. When the ram is drawn back the plate clings very tightly to it, thus causing the radius of the plate at *X*, Fig. 11, to become smaller than it was intended to be. To get over this difficulty the ram should be so arranged that, having flanged the hole, it can be released from its supports, thus enabling the plate to be withdrawn from the dies without it being necessary to pull the ram back through the plate. Fig. 11 shows an arrangement which will allow of this being done. Fig. 11 also shows a typical arrangement of dies suitable for flanging in opposite directions, and the manner in which they are worked is as follows:

Block *A* is fixed to the top table of the press and the ram *B* is fixed to the ram of the top cylinder. The cutter *C* and the holding-up block *D*, together with the female block *E*, are supported from the bottom moving table, it being possible to support the holding-up and female blocks *D* and *E* on the four vice rams *F*. The heated plate is now put between the dies, the bottom table is brought up, partially flanging the outside of the plate; the top ram *B* now travels downwards, thus cutting out a portion of the plate against cutter *C*, the ram being passed right through *D*. The four vice rams *F* are now brought into operation so as to support *D* and *E*, supports *G* are removed from *E* and the bottom table is brought up again, passing *E* up over the plate and completing the flange. The top ram *B* having been released from its supports, the vice rams *F* are lowered and the bottom table travels downwards sufficient to strip the plate off the block *A*, which enables the plate to be withdrawn.

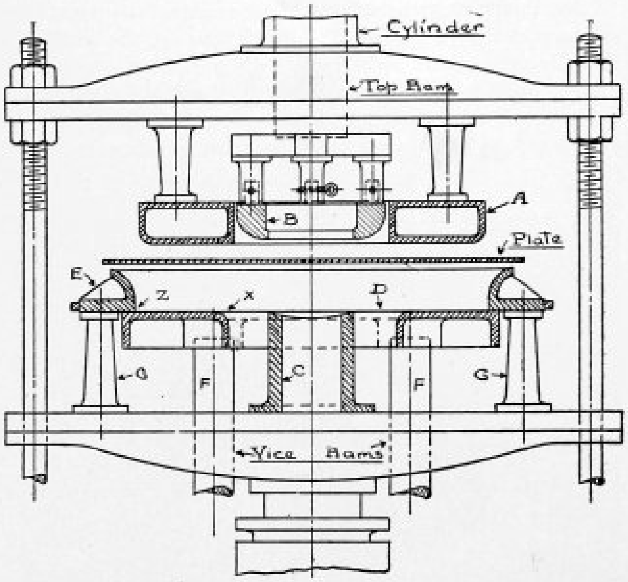


Fig. 11.—Arrangement of Dies in Press for Flanging Plate in Opposite Directions

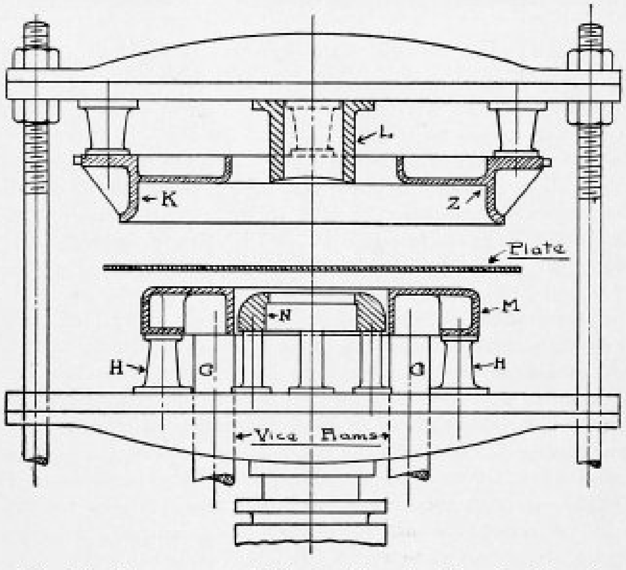


Fig. 12.—Arrangement of Dies in Press for Flanging Plate in Opposite Directions (No Top Ram On Press)

Fig. 12 gives a design which enables a plate similar to the previous one being flanged in a press where no top ram is available. Blocks *K* and *L* are fixed to the top table, while *M* and *N* are supported on the bottom moving table, it being possible to support *M* on the vice rams *G*. The heated plate having been placed in the dies the bottom table is brought up, thus pressing the plate between *K* and *M*. The vice rams now hold *M* in position while supports *H* are removed, which allows block *N* to complete the other flange, *N* being passed completely through *K* and supported thereon while the plate is being taken from the dies.

It should be noted here that it is quite unnecessary to make the profile of a block agree with that of the plate. I refer to such points as *Z* in the last two illustrations; this simple principle, properly put into practice, often saves a great deal of labor in the making and fitting up of dies. It may always be assumed that a plate will "drag" between the radius of the male and female blocks.

There appears to be much diversity of opinion with regard to the extent of machining necessary on flanging dies to insure accurately finished plates. There are certain parts which must be machined if trouble from breakage is to be avoided; for instance, it is necessary to face up the top or bottom surface of a casting where is will be bolted to the supports in the press; this enables an even bearing to be obtained on all the supports, thus doing away with any risk of breaking the die when the pressure is applied. It is also advisable to machine any surfaces between which it is desired to level the plate.

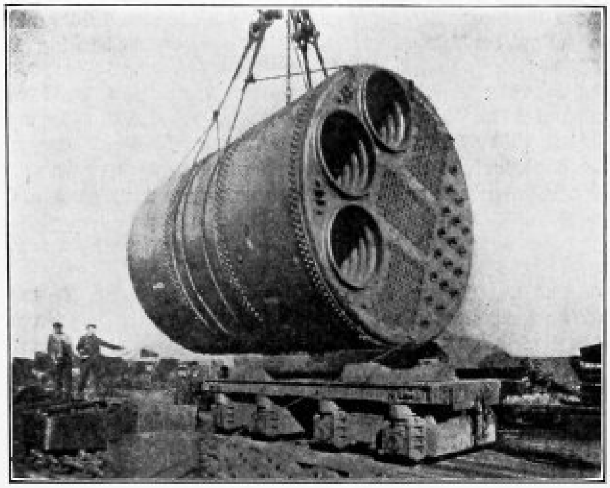


Fig. 1.—One of the *Britannic's* Boilers

Careful pattern making and molding will go a long way toward eliminating a considerable amount of machining which will otherwise be necessary, and it is surprising how the cost of making a set of dies may be reduced by paying careful attention to these points. It is generally argued that, as only one casting is required off each pattern, it does not pay to spend much time on the pattern. Although this holds to a certain extent it must be remembered that patterns can be made accurately without being elaborately finished. If castings are made so as to avoid machining, the cost will be less and the dies will last longer, because the skin of the casting is much harder than the interior, and it will also reduce considerably the time required to complete a given set of blocks.

Sufficient attention is not generally given to the design and maintenance of flanging dies in a great many cases, and it strikes one very forcibly the difference in the quality of work which is turned out from a shop where the dies are not so good as they should be and another shop where every attention is paid to this subject. Although the work turned out in the second case does not cost any more, but often less, than that turned out of the former shop, yet there is no comparison between the finish of the work in the two cases.

(To be concluded)

Boilers of the White Star Liner Britannic

The new White Star liner *Britannic*, which is now being fitted out at the yards of Messrs. Harland & Wolf, Belfast, Ireland, will be equipped with 29 Scotch boilers, 24 of which are double-ended, 6-furnace boilers, the other 5 being 3-furnace single-ended boilers. Each of the double-ended boilers is 21 feet mean length and 15 feet 9 inches mean diameter. The single-ended boilers are of the same diameter as the double-ended boilers, but only 11 feet 9 inches mean length. The heating surface of each of the double-ended boilers is 5,702 square feet, and the grate area 130.8 square feet. The heating surface of each of the single-ended boilers is 2,852 square feet and the grate area 65.4 square feet. There are thus in the whole boiler plant on the ship 159 furnaces, 150,958 square feet of heating surface and 3,461 square feet of grate area, making a ratio of heating surface to grate area of 43.6 to 1. All of the furnaces are 3 feet 9 inches inside diameter and in the double-ended boilers the furnaces at each end opposite to each other lead into a common combustion chamber.

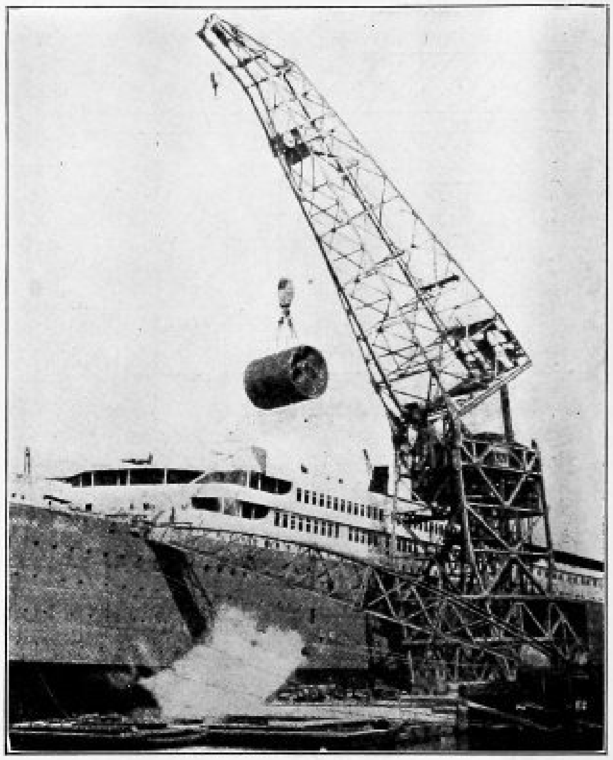


Fig. 2.—Placing Double-Ended Boiler on Board the *Britannic*

Boiler Makers' National Convention.—At the eleventh biennial convention of the International Brotherhood of Boiler Makers, Iron Shipbuilders and Helpers of America, held in San Francisco, Cal., in June, the following officers were elected: International president, J. A. Franklin, Kansas City, Kan.; first vice-president, A. Hinzman, Kansas City; second vice-president, Thomas Nolan, Portsmouth, Va.; third vice-president, J. P. Marrigan, Montreal, Can.; fourth vice-president, Louis Weyand, Cleveland, Ohio; fifth vice-president, John P. Down, New York; sixth vice-president, William Atkinson, Los Angeles; seventh vice-president, M. A. Maher, Portsmouth, Va.; eighth vice-president, Joseph P. Ryan, Chicago; ninth vice-president, John F. Schmitt, Columbus, Ohio; secretary-treasurer, Frank R. Einemeyer, Chicago; editor of *Journal*, James B. Casey, Kansas City.

Power from Mercury Vapor

A novel departure in apparatus for the development of power has been proposed by W. L. R. Emmet, consulting engineer of the General Electric Company, whose theories and experiments are described in recent issues of the *General Electric Review*. Mr. Emmet proposes to use a mercury boiler in which mercury vapor is produced in a manner similar to the production of steam in a steam boiler. The mercury vapor after being utilized in a simple form of turbine is condensed in a steam boiler, the steam produced in condensing the mercury vapor being used to drive other turbines or power apparatus.

In a thermo-dynamic process, such as a steam power plant, the theoretical limit of efficiency is determined by the ratio of the temperature range embraced by the process to the maximum absolute temperature used. The lower limit is fixed by the temperature of the cooling water available and is, therefore, not susceptible of variation. The possible upper limit is the temperature which can be produced by the fuel used when burned with air, which in practice is about 2,700 degrees Fahrenheit. While the theoretical efficiency of steam power plants can be increased by using higher pressures, nevertheless for any rise of temperature the increase of pressure is very rapid; and since the steam turbine has limitations in the efficient use of high pressures, the prospects of gain in this direction are not very attractive.

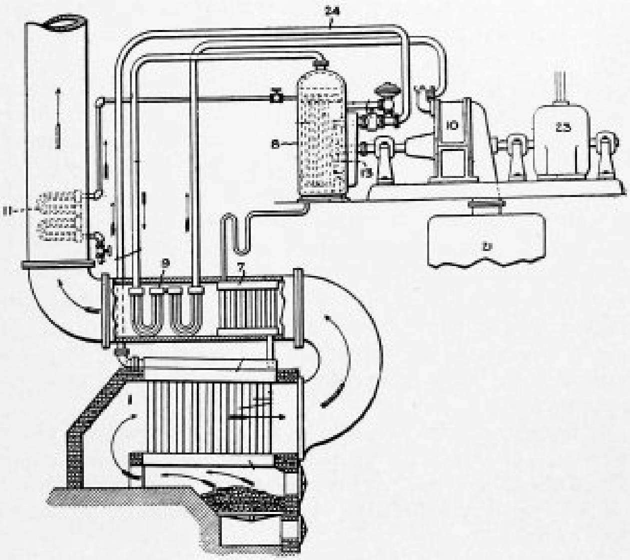
Mercury boils at 677 degrees Fahrenheit at atmospheric pressure and condenses in a 28-inch vacuum at 457 degrees Fahrenheit. It is, therefore, well adapted, at least by pressure and temperature conditions, for use in a temperature cycle above that now used by steam. Its use to greatly increase the temperature range available and so to increase efficiency is the object of the development here described.

The method applied in this process, stated briefly, is as follows: Mercury is vaporized in a boiler heated by a furnace of ordinary type. From this boiler, it passes at a pressure near or not much above the atmosphere to the nozzles of a turbine which drives a generator or other utilizer of power. From this turbine it passes to a condensing boiler, where it is condensed on the outer surface of tubes which contain water, and this water is vaporized by the heat delivered, and the steam produced is used to drive other turbines or for any other purpose. This condensing boiler is preferably placed at a level above the mercury boiler, so that the condensed liquid will run back into the mercury boiler by gravity without the aid of a pump. Since the mercury vapor is much hotter than the steam, the gases will normally leave the mercury boiler at higher temperatures than they have in leaving a steam boiler. To utilize this excess heat in the gases, it is proposed to convey them, first, after leaving the mercury boiler through a heater which raises the returning liquid near the boiling point; second, through a superheater which superheats the steam delivered by the condensing boiler, and third, through an economizer which heats the feed water for the condensing boiler and so reduces the gases to the lowest practicable flue temperature.

By careful study and experimental development, means have been devised for reducing the amount of mercury used, for effectively preventing its loss or dissipation, and for immediately detecting any failure in such prevention.

The disadvantages of mercury for such a process are: First; that it is very expensive, its cost being about 60 cents per pound. Second; that it is poisonous and is capable of pervading the atmosphere in a very finely divided state in the neighborhood of places where the vapor can escape. Third; there are certain difficulties in confining both the vapor and the liquid, although these, with proper methods, are not serious.

Mercury's advantages as a thermo-dynamic fluid for the purpose desired are many. First; its boiling points at desired pressures are convenient. Second; its high specific gravity makes possible the use of gravity feed, sealing of valve stems, etc., by gravity and centrifugal sealing of turbine packings. Third; at the temperatures used it is completely neutral to air, water, iron, and such organic substances as it may come in contact with. Fourth; it carries nothing in solution which can adhere to or affect heating surfaces; consequently the interior of boiler is always perfectly clean. Fifth; its vapor density is so high that it gives a very low spouting velocity, and, consequently, a very simple type of turbine can be used. Sixth; it does not wet the surface of turbine blades and consequently gives apparently no erosion. It is believed that the action between the vapor with its accompanying liquid and the blade surface will conduce to a high economy in a turbine, although no positive data on this subject have yet been obtained. Seventh; its volume at convenient condensing temperatures is such that it can be used in turbines without excessive bucket heights. One of the greatest limits of design in steam turbines is the large area required for the efficient discharge of the low-pressure steam. With mercury vapor this difficulty does not exist. Eighth; delivering its heat at the temperature and in the manner which it does, the condensing boiler in which this heat is used to make steam is very small and simple as compared with a steam boiler. Steam boilers transmit an average of about 6 watts per square inch with an average temperature difference of about 1,100 degrees Fahrenheit. A surface condenser transmits 18 watts per square inch with 20 degrees Fahrenheit temperature difference. The mercury boiler is about equivalent in dimensious to a surface condenser, and since there is no high temperature involved there will be no possibility of scaling or burning.



1. Mercury Vapor Boiler
7. Heater for Liquid Mercury
8. Condenser Boiler
9. Superheater (Steam)
10. Steam Turbine
11. Feed Water Economizer
13. Mercury Turbine
21. Steam Turbine Condenser
23. Electric Generator
24. Mercury Vapor Pipe

Diagrammatic View of Apparatus to Generate Power from Mercury Vapor

Thus in this process we have low-pressure and a clean boiler interior at the hot end, and small and perfectly distributed temperature differences at the low-temperature end of the process where steam is made. High temperature, unequal distribution of heat, and the necessity for large heating surface constitutes the principal difficulties of boiler construction. All of these are overcome in this method of making steam.

Studies have indicated that if this process works out as expected, the apparatus described can, in many cases, be put into the building space now occupied by steam boilers, so that the act of changing existing steam plants to this process should retain in use most of the existing investment. By making the change in an efficient, modern power station, the same amount of steam can be delivered to the turbines at the same superheat, thus giving the same turbine output, and that in addition about 66 percent of the power so delivered can be delivered by mercury turbines, the fuel required being only about 15 percent greater than that which would be used with the steam alone. Thus the gain in capacity of an existing station would be approximately 66 percent and the gain of output per pound of fuel would be about 44 per cent. This calculation is based upon a mercury vapor pressure 10 pounds above the atmosphere and a vacuum of 28.5 inches at the steam turbine outlet.

About 10 pounds of mercury would be evaporated for each pound of steam produced, the steam pressure being about 175 pounds gage, superheat 150 degrees, and the final temperature after the gas leaves economizer being about 300 degrees. The vacuum in both steam and mercury turbines can be maintained by the same air pump, means being employed to separate all mercury vapor from the air in a suitable cooler. It is also obvious that where the mercury process is added where steam is less economically used than in modern power stations the gain will be relatively greater. The purpose of the process is to replace steam boilers wherever they are used and to obtain power from mercury turbines as a by-product.

It is expected that the gain in fuel economy of the above type of power plant over that of the best existing steam plants should be about 45 percent, and with the most efficient oil-fired mercury boilers the economy should be very near to that of Diesel engines.

Boiler Explosions in Great Britain*

In Great Britain, under the Boiler Explosions Acts of 1882 and 1890, every boiler casualty, no matter how trivial, even so small an occurrence as the leaking of a single rivet, becomes as much a case for official investigation as though accompanied by injury or death. The Board of Trade is required by this act to investigate fully every such accident and make a public finding as to its cause which must fix the responsibility for it. These inquiries extend not only to boiler accidents, but cover as well every type of steam-containing apparatus, including piping. They include also all accidents occurring on ships of British registry. The effect of this act is to reduce boiler accidents to a minimum, for all parties concerned, whether owners, operatives, manufacturers, designers, or those responsible for the inspection of the apparatus realize that the extent of their responsibility will be fixed without fear or favor.

The report of the Board of Trade for the year ending June 30, 1912, is particularly interesting, in that it gives in addition to the statistics for the years 1911-1912 comparative figures for the thirty years during which the act has been in force.

During the year ending June 30, 1912, there were 106 explosions. Of these 60 resulted in loss of life or personal injury. Thirty persons were killed and 75 injured. The 30 deaths were caused by 14 explosions, 9 on land and 5 on ships. In 20 out of 27 explosions aboard ship no one was injured, while in the remaining 7 accidents 13 were killed and 4 injured. The number of deaths for the year is above the average for 30 years (26.3 per year), but this is largely due to two explosions in each of which six were killed. It is interesting to note that out of a total of 10 accidents to heating apparatus, 9 were caused by the freezing of pipes.

Classification of the causes of explosions and the types of boilers which exploded 1911-1912:

Causes	Number
Deterioration and corrosion	29
Defective design and undue pressure	17
Water hammer action	8
Defective workmanship, material or construction	16
Ignorance or neglect of attendants	24
Miscellaneous	12
Total	106

Types of Boilers	Number
Horizontal tubular	15
Vertical	7
Lancashire and Cornish	4
Locomotive	2
Watertube	6
Tubes in steam ovens	10
Heating apparatus	10
Steam pipes, stop valve chests, etc	24
Hot plates, etc	4
Economizers	4
Calenders and drying cylinders	4
Steam jacketed pans	4
Rag boilers, kiers, stills	4
Miscellaneous	8
Total	106

STATISTICS, 1882-1912

Year.	No. of Explosions.	Personal Injuries		
		Lives Lost.	Injured.	Total.
1882-83	45	35	33	68
1883-84	41	18	62	80
1884-85	43	40	62	102
1885-86	57	33	79	112
1886-87	37	24	44	68
1887-88	61	31	52	83
1888-89	67	33	79	112
1889-90	77	21	76	97
1890-91	72	32	61	93
1891-92	88	23	82	105
1892-93	72	20	37	57
1893-94	104	24	54	78
1894-95	114	43	85	128
1895-96	79	25	48	73
1896-97	80	27	75	102
1897-98	84	37	46	83
1898-99	68	36	67	103
1899-00	59	24	65	89
1900-01	72	33	60	93
1901-02	68	30	55	85
1902-03	69	22	67	89
1903-04	60	19	45	64
1904-05	57	14	40	54
1905-06	54	25	21	46
1906-07	77	28	65	93
1907-08	73	23	50	73
1908-09	93	12	53	65
1909-10	103	14	62	76
1910-11	100	13	61	74
1911-12	106	30	75	105
Totals	2,180	789	1,761	2,550
Average for 30 years	72.7	26.3	58.7	.85

A Problem in Laying Out

To layout the surface of the object shown in Fig. 1, divide the object into three parts, *A*, *B* and *C*, and develop each part separately. It is hardly necessary to explain how *A* and *C* are laid out, as this is plainly shown in the illustration.

To layout *B* attention is directed to Fig. 4. For simplicity the line between *A* and *B* is drawn at 45 degrees to the vertical, so that the projection of the top of part *B* is a circle, as shown in the lower part of Fig. 4. Divide this circle into twelve equal parts, 0-11, and divide each of the two-semicircles at the base into six equal parts as shown, 0-6 and 6-0. Join the corresponding points between the top and the base with straight lines. These are shown in the figure as full lines and are called elements of the curved surface. The two triangles, 0-0-0 and 6-6-6, are flat surfaces. Now, by con-

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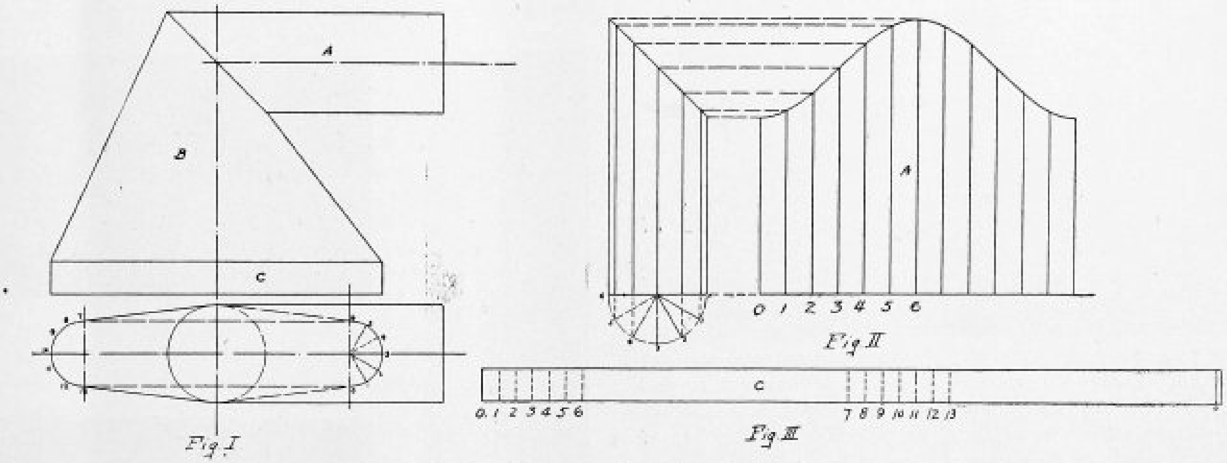
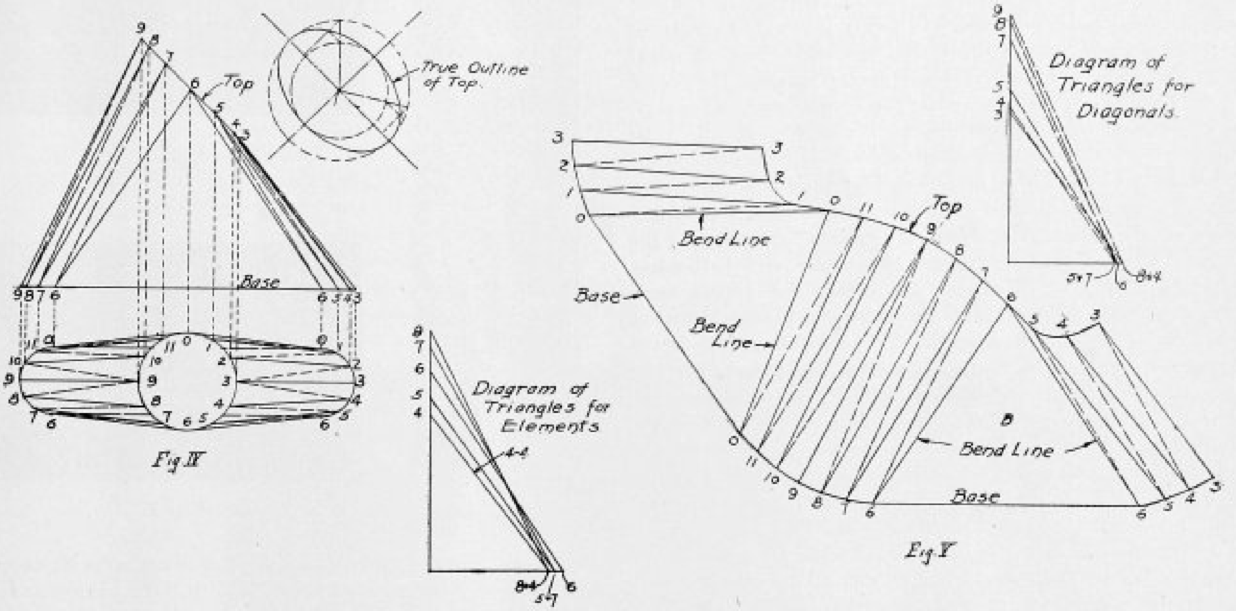
* From *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

necting 3 in the top to 4 in the base, 4 in the top to 5 in the base, etc., by dotted lines to distinguish them from the elements, we are able to layout the curved surfaces by triangulation.



Layout of Patterns for Sections A and C



Layout of Pattern for Section B

It is seen in the figure that on opposite sides of the elements 9-9 and 3-3 these dotted lines, called diagonals, slope in opposite directions from the elements 9-9 and 3-3. This is done for convenience in laying out, that is, it only becomes necessary, in the diagram of triangles, to layout one-half the total number of diagonals.

The diagrams of the triangles are constructed, as usual in this system of laying out, to obtain the true length of the elements (full lines) and the diagonals (dotted lines). It will only be necessary to explain the method of doing this for one line, as the method is similar throughout.

In the lower part of Fig. 4 measure the length of line 4-4, for instance, and lay that out from a vertical line on a horizontal as in the diagram for elements. Then measure the distance vertically from the base, in Fig. 4, to point 4 in the top and lay this up on the vertical of the same diagram. By joining these two points we then obtain the true length of that element as shown by line 4-4 in the diagram for elements.

The same is done for all elements and then for all diagonals. Now lay out the part of the base as 6-6, a straight line, in Fig. 5, and finish the triangle by using the length of the element 6-6 from the diagram of triangles. These are the bend lines.

Now, there are two more lengths to be found before we can proceed; namely, the true length between the equidistant points on the top and the same for corresponding points on the base. For the distance on the top, lay out the true outline, which will be an ellipse. This can be done in any convenient manner and most layer-outs have some system for doing it. Divide this outline into the same number of equal parts and find the true length of one part. Now do the same for the base, which is shown in its true form in Fig. 4. With these two lengths and the lengths of elements and diagonals lay out the surface by triangulation, as shown in Fig. 5. For instance, from point 6 at the right-hand end of the base, draw an arc with a radius equal to the diagonal 6-5, and from point 6 at the top draw another arc with a radius equal to the true length between equidistant points on the top. These intersect at point 5, Fig. 5. From point 5 at the top strike an arc with a radius equal to the element 5-5, and an arc from 5 at the base with a radius equal to the true length between equidistant points on the base of Fig. 4. These arcs intersect, giving us point 5 on the base, Fig. 5.

Continue this process of triangulation throughout and draw in the top and base by connecting the points thus formed by a continuous line. It will be seen that the figure is symmetrical about the element 9-9, therefore only one-half need be actually laid out. The other half may be spotted off and drawn in any convenient manner.

Throughout this whole solution no provision has been made for joining the parts together, as that depends entirely on the kind of material and the use to which it will be put.

Failures of Heavy Boiler Shell Plates*

BY SIDNEY A. HOUGHTON

Class C—The failures under this heading are the most serious of all, seeing that they imply that the actual factor of safety of the shell was less than two.

C1—In the first case to be considered the boiler was made with two strakes of plating, and the strake containing the manhole cracked right across through that part, near the minor axis, when the hydraulic pressure had reached one and three-fourth times the working pressure, although it is said that twice the working pressure had previously been applied. It was found that the width of the manhole on one side of the fracture was 1/8 inch greater than on the other side; but the manhole ring was intact, though the crack was open 1/8 inch on each side of the opening. The tensile tests all showed a tonnage below the original ones, and the transverse tests in line with the manhole showed a heavy central segregation which apparently extended to the manhole. The chemical analyses revealed a considerable difference between the center and the outside of the plate, and at the former part the quantities of sulphur and phosphorus are excessive, as might be expected from the segregation shown by the transverse tests. The amount of arsenic is also very high, and this has segregated with the phosphorus. An examination of the structure confirmed the chemical analysis, the carbon being low at the surface, where there were some blow-holes and carbonless bands (see Fig. 19). Towards the center there were some large compound crystals, and the structure became lamellar with increase of carbon, while at the center there was heavy segregation. In this plate the segregation must have been an important element in producing failure, but probably the principal factor was the presence of internal stresses in the plate. It is difficult to estimate what proportion of these was due to rolling and what proportion to the manhole riveting, but on the whole it seems not unlikely that they were about equal.

C2—In this instance the hydraulic test had reached about 40 pounds below the double pressure when the shell plate gave way at the manhole with a sharp report. The main crack extended from the manhole to one of the rivets in the circumferential seam, and was open 7/64 inch at the manhole and 1/16 inch at the seam. There was a small crack on the other side of the manhole extending only to the nearest rivet hole, and it was noticed that the calking of the ring was undisturbed. This ring was of the flanged description, which requires a considerably larger opening in the shell than the plain variety, and is more difficult to fit accurately, so that the author thinks that the opening of the plate after the failure was more due to stresses set up in riveting than to any resulting from rolling. It is also more difficult with this form of ring to arrange that the actual compensation approaches the theoretical. The longitudinal tests of this plate were satisfactory except that near one end they were below the specified minimum—30 tons; but the transverse tests, taken from the center of the plate, between the manhole and the other end, gave very inferior results, the elongation falling to 4 and 5 percent with a square fracture having a white line in the middle, which clearly indicated segregation. On examining a section this was found to be of a very fine typical character, and the author made the continuous photograph, Fig. 20, which shows the structure from the surface of the plate to the center (a distance of 13/16 inch), where the carbon must be fully 0.8 percent. It will be seen in the photograph that there are in places conglomerations of crystals which would not show at a moderately high magnification. Before etching a number of sulphide of manganese flaws were also evident at the center. It is clear that the plate contained the major segregate of the ingot, and as the weight of the plate is not heavy compared with that of the ingot, it is probable that the segregate would not have been included unless a larger amount than usual had been cut off the bottom of the ingot, possibly to clear some defect. The steel of this plate was evidently defective, yet in the author's opinion the causes of this important failure must be considered as largely mechanical, as the segregation did not extend to the crack itself.

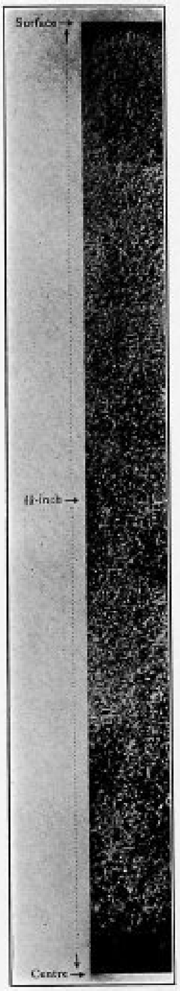


Fig. 20

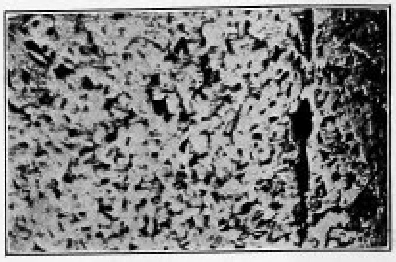


Fig. 19

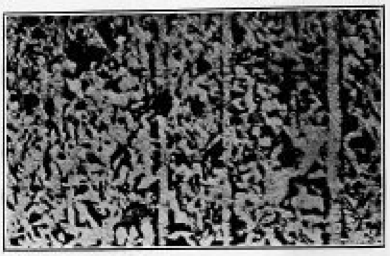


Fig. 21

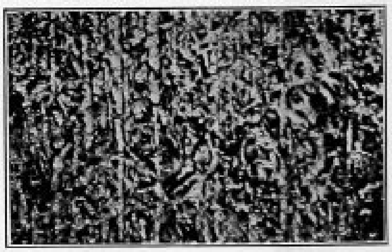


Fig. 22

C3—This case is of an exceptionally interesting character, as the plate fractured under the hydraulic test, not through the manhole itself but through the rivet holes at one end of the ring, the pressure at the time being at a little under twice the working pressure. There was only one strake of plating in the boiler, the manhole being rather near the back end, and it had a plain ring double riveted. The plate fractured from end to end, the crack passing through four rivet holes, at which place the edges were open 1 1/8 inches; this distance

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* Concluded from the June issue.

diminished gradually towards the ends. At the manhole the edges were also sprung outwards 2¼ inches. The analysis from the metal near the manhole showed nothing unusual, but as the microscope revealed a large structure with segregation at the center (see Fig. 21), it would seem that the drillings for the analysis must have been taken near the surface. Seeing that the manhole was not in the longitudinal axis of the plate, it is probable that the segregation at that part would be heavy unless the plate had been cross-rolled. One of the transverse tensile tests taken near the fracture broke with a very low tonnage owing to the presence of a small crack, and another gave only 18 percent extension in 5 inches owing to segregation; but the others gave satisfactory results, and the fracture itself showed no additional cracks. Some notched bar tests gave poor results—three and five blows—and on annealing the specimens with slow cooling this number increased to twenty-six and eighteen. On the whole, the tests and examination do not show that the metal was sufficiently inferior to cause failure, and it is therefore to a large extent a question of internal stresses, whether produced by rolling or riveting. The fact that the plate failed in a part near the manhole where the strength was but little reduced points to some cause arising from the riveting. The author is therefore inclined to believe that, as will be explained later on, the chief stresses in the plate were produced by riveting the end rivets, and then working from the other end of the ring towards the part where failure took place.

C4—This plate was made by the basic open-hearth process, and is the one referred to by Mr. Milton in his paper, the material of which was thoroughly investigated by Dr. Arnold, the report made by him being given as an appendix to the paper. The author only includes it here therefore for the sake of comparison, but as he had several pieces of it given to him by Mr. Milton, a few observations may not be out of place. It should be stated that this plate fractured right across through the solid metal under the hydraulic test. Dr. Arnold concludes that the plate had some abnormal thermal treatment in the mill which made it brittle; if, as would appear from his previous remarks, this was caused by overheating the slab, the author is in entire agreement with him, as many of the sections showed considerable amounts of compound crystals (see Fig. 22), and considering that the plate was only 1 inch thick it seems probable that as the finishing temperature was high the slab itself must have been grossly overheated. In some other sections examined by the author there were some carbonless bands a quarter of an inch from the surface—a very unusual place—and porosity at the center. The ferrite crystals were extremely soft, and in polishing the metal gave an appearance of slight porosity which was absent from the acid steels dealt with in this paper. As stated by Mr. Milton, the plate was compared with a similar one made by Messrs. Spencer & Sons, of Newburn. The author made the following simple experiment with a fatigue test-piece from each plate; the two pieces were placed close together and heated to a bright red, and then allowed to cool together. Figs. 23 and 24 show the structures thus obtained, the differences being remarkable. The causes of failure of this plate were not wholly defined by Dr. Arnold, and this exemplifies the great difficulty an investigator experiences when he is not able to see and select his own tests from the fractured plate. It may be added that the weight of the plate as cut was 67 percent of that of the ingot, so that it would probably contain the major segregate, which fact may explain the great differences Dr. Arnold found in a second piece sent him, and may have had an important influence in causing the failure.

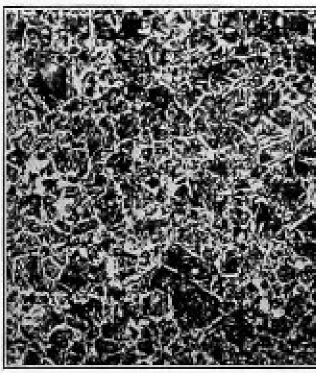
Fig. 23

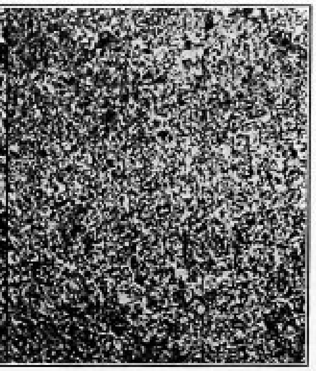
Fig. 24

It will be noticed that the longitudinal tensile tests, even when taken near the fractures, seldom revealed any abnormal features, while the transverse tests were far more successful, and so far as tensile tests go these are certainly the most valuable for ascertaining the inferior parts of steel plates. In nearly all the cases dealt with the bend tests were satisfactory, and at first sight it seems somewhat of an anomaly that a piece of a plate can be bent through 180 degrees while the whole plate fractures at a very slight angle. The conditions are, however, wholly different, as in a bend test the metal can flow with little restriction, while in the plate very little lateral flow is possible. Fig. 26 shows the distortion which takes place in an ordinary bend; it can be readily seen that the relative contraction and expansion of the two sides diminishes in proportion as the width of the bend is increased, and that in a plate the metal is subjected to pure stretch and compression. This fact is of special importance in considering the effect of hammer dressing, as though it is frequently possible to bend a strip of steel after being hammered on the outer surface, it does not therefore follow that hammering a wide plate would be equally innocuous.

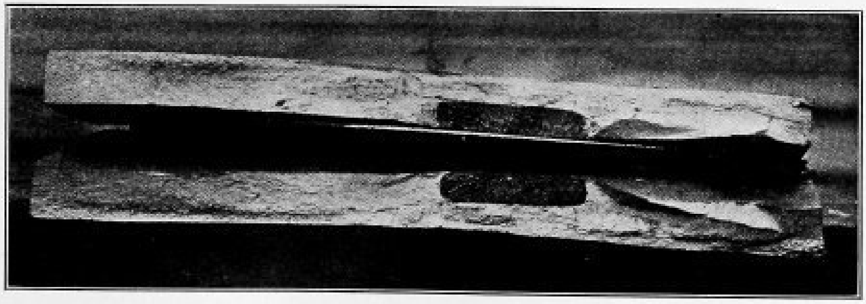
Fig. 25.—Piece of Shell Plate Broken Through "Bubble" Shaped Crack

In dealing with these cases it is essential to remember that one cause of weakness does not prevent others, and that in general it is the simultaneous occurrence of several defects which results in failure. For instance, it is not sufficient to say that a plate failed because it was segregated; there is little doubt that there are many more or less segregated plates in boilers; but they have not failed, as no other diverse conditions were present. A good plan in dealing with a failure is to estimate the percentage value of the different causes producing the fracture, and this has been done in Table I, but it will, of course, be understood that the values are only approximate estimates. When the total does not reach 100 it means that the author does not consider that all the causes have been ascertained.

In many cases hammer-dressing is given as one of the causes, and this is something which one might have hoped would have ceased long ago. Unfortunately, it frequently happens that a little hammering saves a good deal of chipping and buffing, and the temptation to use the first-mentioned tool is considerable. Moreover, it is almost impossible to detect it if the plate is buffed afterwards, and of this fact the loading bank staff are generally aware, so that very stringent orders and constant superintendence are necessary to prevent it being done. In point of fact the only certain method of detecting it is to examine a section of the plate after fracture occurs, when it is generally plainly evident. The surface defects which necessitate dressing may be only roughness caused by scale being rolled in, or they may be of a more serious nature, in the shape of laps, snakes, etc., or due to the local segregations of phosphorus which cause the "ghosts" in forging. The latter are probably the worst defects, and as can be seen in Fig. 7 must seriously reduce the ductility of the plate as regards bending; they may also tend to give a rough surface in rolling by sticking to the rolls, and will assist in causing corrosion when the plate is in the boiler. The nature and origin of these local segregations have been dealt with by Dr. Stead in a lecture on "Phosphides and Carbides in Iron," and it is to be hoped that steel makers will endeavor to produce ingots for such important plates with a minimum amount; probably the best plan is to keep the phosphorus content as low as possible.

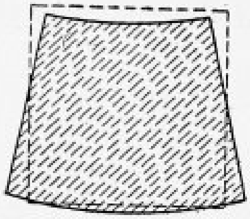

Fig. 26.—Section After Bending (Original Section Dotted)

Dressing plates as now done with an electrically-driven emery wheel, is *per se* generally supposed to produce no bad effect, and probably this is true if only the surface is cleaned. If, however, an extensive deep defect, produced, say, by scale being rolled in, is removed, it is quite conceivable that when the plate is bent local stresses are produced, seeing that the resistance to bending varies as the square of the thickness. These stresses may be serious in amount, and in some cases may be even one of the primary causes of failure.

It has been pointed out by Mr. David Colville and others that severe internal stresses may exist in heavy plates, as their stiffness prevents them from buckling in the manner that thin plates do when the rolls are not true, and there is little doubt that this cause is a factor, and possibly sometimes the principal one, in producing failure. Unfortunately, it seems scarcely possible to ascertain the amount of these stresses, or indeed to find out when they exist in a plate in most instances, but it has been supposed by some investigators that the bubble-shaped crack which so frequently occurs in defective plates is due to this reason. A typical example of this crack is shown in Fig. 25; it is a type which is nearly always at right angles to the direction of rolling, and perpendicular to the surface of the plate. As a rule the surfaces of these cracks are oxidized and are fairly flat, and their depth varies from one-half to three-quarters of the thickness of the plate. It would seem that, if they are the result of relieving internal stresses, the latter reach a maximum at some point below the surface.

In addition to the rolls being actually untrue or having become so when hot, there is also the risk of internal stresses being set up by the plate being subjected to rain through a leaky roof or from having other plates piled on it when hot. The latter must be considered a bad practice in every way, as very serious stresses may be caused through the plates only partially covering each other, so that one part of the plate is almost cold while the other is still at a red heat, and it is quite conceivable that this cause alone might be sufficient to produce failure. Even if the plate is wholly covered by another it is possible that it may be maintained at the dangerous temperature of 700 degrees C. for some time, thereby producing brittleness by partially turning the pearlite into cementite. Owing to the circumscribed space in some works it is difficult to avoid piling altogether, but it would be well that, if it is done, it should be confined to plates which will be afterwards heated in the course of manufacture. In any case, the author is of the opinion that the only satisfactory way to ensure that heavy plates are as free as possible from internal stresses is to anneal them. This will remove the effect of finishing at too high a temperature (see Fig. 10), or too low (Fig. 5), and also the results of slow cooling at an improper temperature (Fig. 18), and as these evils are not revealed by the usual tests it is the more important to ensure that they do not exist. Although it might seem a simple matter to anneal a mild steel plate, yet experience has shown that there are several pitfalls to be avoided. In the first place, the most suitable temperature has not been definitely settled; it is true that there have been many laboratory demonstrations, and that one or two practical papers, such as that by Mr. Campion, have been read, but it does not appear that the subject of heavy mild steel plates has been dealt with, or if so that it has come to the knowledge of at least some works. The author has seen the results of a series of experiments in this connection which have recently been made at a very progressive steel works, but these, being confidential, cannot, of course, be given in this paper; but it is to be hoped that perhaps one of the Carnegie scholars may find time to deal with this practical but comparatively simple subject. One point of importance may be mentioned, which is that mild steels containing a fairly high percentage of phosphorus require very much more drastic annealing than those with a small percentage; it is indeed remarkable how very persistent is the structure of a moderately high phosphorus steel. In the case of plate B4, in which the pearlite was partly in the form of cementite, even after annealing a small piece for half an hour at 850 degrees C. comparatively little difference was made in the structure.

It is also of great importance that the whole plate should be raised to the same temperature when being annealed, and although this should be the first axiom in annealing it is not altogether an easy matter to effect with large plates, and some of the older annealing furnaces are not free from suspicion in this respect. Plates B2 and B4 are prominent examples of the harm which can be done in this way, and the author has frequently seen others withdrawn from the furnace in which the color varied very considerably. Annealing may also be easily abused by soaking a plate to bring its tonnage down, and there are some people who apparently see no evil in this if the elongation is satisfactory, as it generally is, forgetting that certain forms of brittle material are quite satisfactory judged by the elongation. Owing to the readiness with which this measure of ductility can be applied it is in almost universal use, but the fact alone that bend tests are also required with steel plates should be an indication that it is not an absolute determination of the suitability of the steel.

Unquestionably the use of the pyrometer might be extended in dealing with the annealing of such important material, and it is difficult to believe that the trifling extra expense would not be soon repaid by the avoidance of expensive rejections.

In most of these plates the chemical composition is not abnormal, and would not be objected to for most purposes; that is, the sulphur and phosporus do not exceed 0.06 percent, or if they do it is only by a small amount. In large plates, however, where the work done on them is comparatively small, it is necessary for the metal to be exceptionally pure, and it must be remembered that both the major and minor segregations increase with large masses of steel. Phosphorus and sulphur unfortunately segregate so much that, although a certain percentage would be harmless enough if distributed evenly, it may produce failure owing to these segregations. For these reasons it is suggested that 0.05 percent should be the limit for phosphorus, especially if there is an appreciable quantity of arsenic present; the latter element is one whose bad qualities are not always fully realized, and it is a good plan, as adopted at at least one works, to add the quantity of it and phosphorus together in estimating the suitability of the steel, in which case the total should not exceed, say, 0.06 percent. It also appears that phosphorus has a strong tendency towards turning the pearlite into cementite, which occurs also if the plate is heated for some time at a temperature below 700 degrees C.

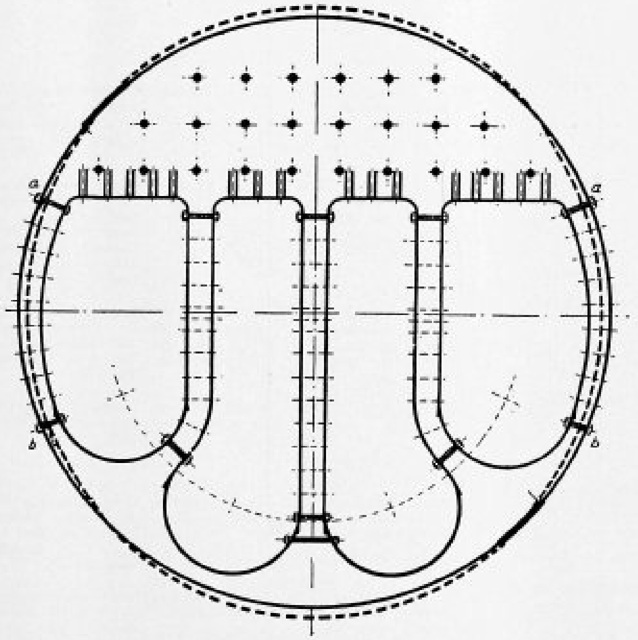

Fig. 27.—Section Through Combustion Chamber of Double-Ended Boiler, Showing Distortion by Pressure

It is sometimes urged that, owing to the progress of knowledge and increased skill in manufacture, the nominal factor of safety of marine boiler shells might be reduced. It is also argued that the joints themselves do not fail, and that the shell plate itself has a fairly large factor, *e. g.*, with a nominal factor of 4.5 for the joints and a percentage strength of 85 the theoretical factor of safety of the shell plates would be nearly 5.3. So far as the steel itself is concerned, the facts given in this paper should be a sufficient answer, but it is well also to remember that the calculation of the mechanical stresses in boilers is not so simple as is often supposed. The boiler shells themselves, though circular, and even when fitted with double butt-straps, are, as a rule, subjected to more additional stresses than pure tensile ones. For instance, in the case of many double-ended boilers the shell plates are tied horizontally only by the combustion chamber stays, with the result that when subjected to pressure they tend to become oval, or, more strictly speaking, of the form shown in Fig. 27. This movement is quite perceptible, especially when comparatively thin, high-tensile plates are used, and has caused distortion in the combustion chambers. It is evident, therefore, that the shell plates themselves must be subjected to somewhat complicated stresses at the points *a* and *b*. There is also a considerable barreling action, due to the ends of the shell being immovably fixed to the end plates, this being most severe in boilers in which only one strake of shell plating is fitted.

With regard to manholes, the conditions are much more severe in practice. The usual plan is to fit a doubling plate, the net section of which is equal to that of the plate cut out, but this is only a rough approximation, and there is little doubt that the factor of safety of the solid plate is reduced at these parts. It has been shown by Mr. John Smith, R. C. N. C., in his paper on "Stresses in Ships," read before the British Association in 1906, that the stresses around openings in plates approximate to those of the lines of flow of a stream of liquid flowing around a similarly shaped obstacle. In the case of manholes these increase greatly at the edge of the opening, and in manholes of the usual shape (Fig. 28) they are not necessarily at a maximum at the minor axis. Another and even greater reduction of strength at the manholes may be caused by the method of riveting the compensating ring. When these are of considerable thickness, such as are necessary with heavy shells, and especially when flanged rings are used, it is extremely difficult to make them accurately fit the curve of the shell plates. Consequently, when being riveted by the modern powerful hydraulic machine considerable creeping takes place, and it depends largely on the order in which the rivets are put in whether tensile stresses are or are not produced in the shell plates. Suppose, for instance, that riveting is begun at the ends of the major axis, rivets being alternately placed at each end, then as the riveting approaches the minor axis the compensating ring will tend to spring off and an enormous tensile stress will be produced in the shell plate, which stress, it must be remembered, will be in addition to that produced by the pressure of steam. This is about the worst result possible, but if not carefully done effects of the same nature can be readily produced by other methods of riveting. The proper manner to rivet is evidently to begin at the minor axis, and ream the rivet holes when creeping occurs. It may be observed that in plates C1, C2 and C3, where fracture occurred at the manhole, the edges of the plate remained open, and although it is impossible to prove how much of this movement was due to internal stresses and how much to the effect of improper riveting, yet it is probable, in the author's opinion, that the latter had in these instances at least as much influence as the former.

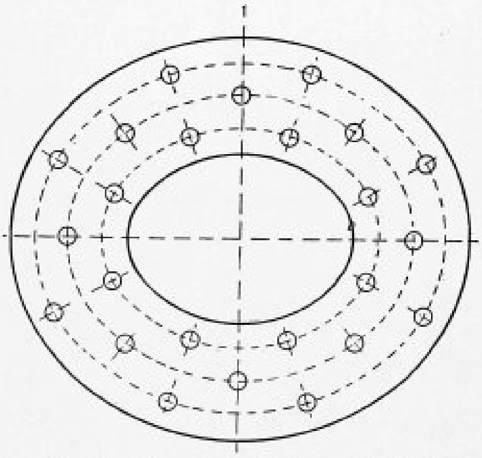

Fig. 28.—Compensating Ring for Manhole

TABLE I

Class and Number.	Thickness of Plate.	Weight of Plate.	Weight of Ingot.	Percentage Weight of Plate of Weight of Ingot.	If Annealed.	Tensile Tests.			Chemical Analysis.						Structure	Number of Photograph.	Nature of Failure.	Probable Causes of Failure, with Estimated Percentage Values.
							Tons per Sq. Inch.	Elongation in 8 Inches percent.	Carbon	Manganese.	Sulphur.	Phosphorus.	Silicon.	Arsenic.				
	In.	Tons. Cwt.	Tons. Cwt.															
A1	1⅝	4 5	7 10	56.6	No	Original At fracture	29.9 26.3	23 24	0.23	0.46	0.04	0.053	0.03	....	Carbonless bands and flaws at surface. No segregation. Slightly increased carbon towards surface.	1, 3	Crack 8 ins. long and ¾ in. deep, in center of plate when being bent	Hammer-dressing (35) on surface flaws (60); finished too hot (5).
A2	1⅜	......	......	....	No	At fracture, long. At fracture, trans.	28.4 28.5	30 18	0.19	0.5	0.067	0.065	0.037	....	Very lameller Large number of blowholes which increase towards center.	....	Crack 2⅝ ins. long.	Hammer-dressing (30); metal porous (15); phosphorus too high (20); surface defects (55).
A3	1 11/32	3 10	8 10	41.0	No	At fracture, long. At fracture, trans.	30.0 29.4	28 27	0.17	0.324	0.046	0.057	0.027	....	Carbonless bands at surface; lamellar in center. Moderate number of compound crystals.	2	Crack 9 ins. long near edge.	Surface defects (70); finished too hot (5).
A4	1 9/16	5 2	......	..	No	Original At fracture, long. At fracture, trans.	29.8 28.4 28.5	24 27 25	0.19	0.674	0.054	0.06	0.025	0.053	Very lamellar; large number of blowholes.	4	Crack 3 ins. long.	Hammer-dressing (50); lamellar structure (10); excessive phosphorus and arsenic (25.)
A5	1 17/32	6 2	11 0	55.4	Yes (?)	Original At fracture, long. At corner of plate, trans.	30.3 28.6 29.0	28 26 14	0.21	0.572	0.066	0.059	0.19	....	Fine lamellar, broad, carbonless bands at surface; segregation at center.	5, 6, 7	Crack 21 ins. long	Surface segregation (35); plate rolled cold, producing internal stresses (40); central segregation (15); lamellar structure (10).
A6	1⅝	4 16	7 15	62.0	No	Original At fracture, long. At fracture, trans.	31.7 30.9 29.9	27 30 28	0.22	0.545	0.028	0.054	0.047	....	Very coarse; large number of compound crystals, increasing towards center.	....	Boiler completed; crack 17½ ins. long from rivet hole.	Hammer-dressing (35) on surface defects (40); plate rolled at too high temperature (15).
A7	1 13/32	3 16	8 10	44.7	No	Original At fracture, long. At fracture, trans.	30.6 27.6 28.0	23 32 28	0.19	0.49	0.038	0.057	0.015	....	Fairly normal.	....	Crack 13 ins. long from rivet hole.	Hammer-dressing (60) on surface defects (40).
A8	1 13/32	2 2	8 10	24.7	No	Original At fracture, long. At fracture, trans.	30.0 28.7 28.6	23 23 27	0.155 0.2	0.463 0.49	0.03 0.04	0.054 0.047	0.027 0.013	....	Large; lamellar towards center; carbonless bands at surface.	9	Crack 8 ins. long near one side.	Hammer-dressing (30) on surface defects (40); plate rolled too hot (10); lamellar structure (5).
A9	1 13/32	3 16	8 10	44.7	No	Original	30.3	22	0.21	0.5	0.035	0.056	0.014	....	Large; lamellar towards center; many compound crystals.	8	Crack 4 ins. long near one side.	Severe hammer-dressing (50) on surface defects (45); plate rolled too hot (5).
A10	1 7/16	4 7	8 10	51.1	No	Original	30.1	23	0.2	0.54	0.04	0.058	0.011	....	Fine near surface, lamellar towards center; blowholes near surface.	13	Two cracks, 3 ins. long, one at end and one rectangular at side in dressed part.	Hammer-dressing (40). on surface defects (40).
A11	1 5/16	3 17	7 14	50.0	No	Original At fracture, long. At fracture, trans.	30.8 31.3 28.9	25 26 6	0.35	0.6	0.042	0.067	0.021	....	Very coarse; composed largely of compound crystals; segregation at center.	10, 11	Boiler completed two cracks found in dressed surfaces.	Excessive rolling temperature (40); excessive phosphorus (25); hammer-dressing (20) segregation (15).
A12	1 5/16	4 10	8 0	56.3	No	Original At fracture, long. At fracture, trans.	30.8 30.4 30.4 to 29.9	28 24 13 9	0.18	0.52	0.048	0.055	....	....	Large amount of sulphide of manganese flaws. Segregation of carbon, phosphorus, and sulphur.	14, 12	Two cracks in dressed part, one 3½ ins. and one 1½ ins. long	Hammer-dressing (35) on surface defects (35); segregation (30).
A13	1 9/16	3 11	6 10	54.6	No	Original	29.0	24	0.2	0.6	0.046	0.049	0.029	....	Very coarse; compound crystals towards center.	15	Cracked in center.	Hammer-dressing (25) on surface defects (40); rolled too hot, with slow cooling (20).
B1	1 45/64	5 6	7 18	67.0	No	Original At fracture, long. At fracture trans.	30.3 28.0 27.4	24 30 30	0.23 0.21	0.52 0.51	0.037 0.034	0.072 0.06	0.04 0.04	....	Fairly uniform, but abnormal amount of blow holes. Many carbonless bands. Neumann lines.	16	Cracked almost across in rolls.	Segregation of phosphorus on surface (40); excessive phosphorus (25); abnormal number of blowholes (20); high finishing temperature on one side (15).
B2	1 9/16	7 14	17 0	45.3	Yes	Original At fracture, long. At fracture, trans.	32.8 to 30.5 32.0 29.3	23 25 30 22	0.22	0.74	0.032	0.048	0.068	0.018	Increase of carbon at surface. Coarse angular structure on one side, with large number of blowholes.	....	Cracked right across in rolls.	Stresses produced by unequal heating (40); excessive rolling temperature on one side (20); increase of carbon at surface (15); blowholes (10); shearing effect (10); segregation (5).

TABLE I (*Continued*)

Class and Number.	Thickness of Plate.	Weight of Plate.	Weight of Ingot.	Percentage Weight of Plate of Weight of Ingot.	If Annealed.	Tensile Tests			Chemical Analysis.						Structure.	Number of Photograph.	Nature of Failure.	Probable Causes o Failure, with Estimated. Percentage Values.
							Tons per Sq. Inch	Elongation in 8 Inches percent.	Carbon.	Manganese.	Sulphur.	Phosphorus.	Silicon.	Arsenic.				
B3	1⅝	4 5	7 10	56.6	No	Original At fracture, long. At fracture, trans.	31.3 30.8 31.7	22.5 25 24	0.3	0.52	0.03	0.055	0.03	....	Heavy blowholes near surface Large number compound crystals; segregation.	....	Cracked right across in rolls.	Plate rolled too hot (15); and different temperatures at sides (40); segregation (20).
B4	1⁴⁵/₆₄	5 6	7 17	67.5	Yes	Original At fracture, long. At fracture, trans.	28.8 31.4 to 28.9 28. to 31.7	29 30 29.5 28 24	0.27	0.55	0.043	0.061	0.045	....	On one side pearlite, ropey, and partly changed into cementite; on the other coarse angular, Neumann lines; segregation.	17, 18	Cracked right across in rolls; fracture coarse crystalline.	Annealing at improper temperature (30); unequal temperature in annealing (20); rolling too hot (5); hrgh phosphorus (25); segregation (10).
C1	1¹⁷/₃₂	4 3	......	....	No	Original At fracture, long. At fracture, trans.	29.6 28.4 28.5 to 25.6	26 27 25 8	0.152 0.24	0.517 0.542	0.044 0.078	0.051 0.088	0.03 0.023	0.025 0.055	Carbonless bands at surface; carbon low at surface, segregation in center; many compound crystals.	19	Cracked through manhole during hydraulic test.	Internal stresses (35); stresses from riveting ring (35); segregation (25); rolled too hot (5).
C2	1⅝	4 10	9 18	45.4	No	Original At fracture, long. Near manhole, trans.	31.5 to 30.5 32.0 to 28.2 26.6	26 20 20 33 5	0.22 0.25 0.35	0.57 0.57 0.62	0.033 0.037 0.05	0.046 0.051 0.07	0.016 0.014 0.016	.... Outside Inside	Structure at crack fairly normal. Severe segregation bepond manhole	20	Cracked through manhole during hydraulic test.	Stresses from riveting-ring (55); internal stresses from rolling (20); segregation (25).
C3	1⁵/₆₄	4 14	......	....	No	Original At fracture, long. At fracture, trans.	29.2 28.6 27.7	29 27 18 in 5 in.	0.17	0.57	0.03	0.05	0.03	0.02	Considerable amount of compound crystals, central segregation, otherwise normal.	21	Cracked right across through manhole rivet holes during hydraulic test.	Stresses from riveting ring (55); internal stresses from rolling (25); segregation (15); rolled rather hot (5)
C4	1	4 1	6 2	67.0	No	Original Near fracture	28.3 30.6	25 28.7 in 2 in.	0.195	0.524	0.52	0.05	0.008	....	Many compound crystals. Carbonless bands ¼ in. from surface, porosity in center.	22, 23 24	Cracked through solid plate during hydraulic test.	Plate rolled too hot (30); segregation (30).

In connection with boiler shop work, it may be observed that the modern method of bending plates in a vertical roller press seems to be undoubtedly more severe on the plates than the old method of bending in the rolls. With the former method plates are sometimes bent in three passes, or even less, which would be impossible with the older apparatus.

The effect of shearing on the edge of the plate is another element which has to be taken into account in considering failures, and indeed in some cases the fracture has been attributed entirely to this cause. Though the author is of the opinion that this cannot be said of the instances quoted in this paper, yet it is undoubtedly true that the distance to which the deformation produced by shearing penetrates is not fully recognized by many boiler makers. The amount which should be removed will vary according to the state of the shears, but by testing some sections with Shore's sclerometer, Mr. A. McCance, of Messrs. William Beardmore & Company, Parkhead, has ascertained that the hardness produced by shearing extends to a distance of about half the thickness of the plate with the shears in average condition. This is considerably more than is usually assumed, an addition of only a quarter of an inch for shearing being a common allowance; it would therefore seem that this should be considerably increased. It has been suggested that the best remedy for this danger would be for the plates to be ripped to size once for all at the steel works, and undoubtedly this will altogether remove trouble from shearing effects, and would save expense, while at the same time the test pieces could be relied upon to be free from defects, it being well known that with thick plates these have to be made very wide or else cut out by the machine to avoid the prepared part being affected by the shearing. The chief disadvantage of the proposed procedure would be the difficulty of ascertaining if segregation existed in the plate, this being generally easily detected on the sheared edges, but is difficult to see if the plate is machined. In practice this is of importance, especially as segregation occurs, as a rule, away from the parts where the usual tests are taken; but this deficiency might be overcome by taking additional tests, and the balance of advantage would be in ripping the plates. It might be mentioned that this is occasionally done with very thick plates in some works, especially when the margin for test pieces is small, so as to avoid injury to the latter, but even then an allowance has generally to be left so that the boiler makers may take the responsibility of reducing the plate to its final dimensions.

As stated above the usual test pieces are taken from those parts where segregation is likely to be absent; they are also the parts which are never finished at an excessive heat, so that they will generally give better, or at least as good, results as any other part of the plate. It may be here mentioned that tests taken close to the edge can give a ton or more tensile strength than the body of the plate, a fact which is shown by many of the examples given in this paper. The position of the test pieces follows those made from iron plate, and in the early days of the use of steel, segregating was little heard of—at any rate by those outside the steel works. Moreover, the plates were small and thin, and trouble from this defect did not often arise. Certain inspecting societies have required cross tests as well as longitudinal ones, and although these, as a rule, are also taken at the corners, they do show to some extent whether the steel has had insufficient work on it, and whether it is fairly free from sulphur and blow-hole flaws, which defects produce little or no effect on the longitudinal tensile tests. The Board of Trade have, however, for some time instructed their officers, when the proportion of the ingot used is large, to take cross tests from the center of the ends of plates, with a view of detecting segregation, and experience has shown that this test is a very effective one. If the plates are cross rolled, so that the longitudinal axis of the ingot corresponds with the transverse one of the plate, these tests must obviously be taken from the center of the sides. A fair proportion of heavy plates have failed under this test, and this is undoubtedly due to the fact that the size of the ingots has not increased in proportion to that of the plates; indeed, in some works it is impossible to increase further, owing to the restrictions imposed by the cogging and rolling mills. Even if the mills are large enough, their strength may be inadequate, with the consequence that it is necessary to roll down the slabs at an excessive temperature, under which circumstances the segregate may be so fluid as to be squeezed out of the end of the slab.

It is sometimes suggested that segregation cannot be very harmful, as the inferior metal is situated at the neutral axis of the plate, but this argument does not take into account the stresses induced when removing any want of flatness in the plate. Moreover, if we consider the effect of segregation in the plate when being rolled, it will be seen that it may be of serious importance. Even if the segregate is not actually fluid it will be in a more pasty condition than the remaining metal, so that that part of the slab which contains it is somewhat in the condition of a box containing a more or less fluid interior. It will be seen that under these conditions the flow of metal becomes complex, and abnormal stresses may be set up by the rolling mill. Apart from this, the segregate is inferior and brittle metal, which should at all costs be kept out of such important articles as shell plates, and that it is harmful is shown sufficiently by the failures of plates C1, C2 and C3, through the manhole, so that it is not necessary to elaborate this point any further.

Although not mentioned in the heading, "Probable Causes of Failure," there is one which is, as it were, a master cause, and that is insufficient work on the steel due to the plates being made from too small an ingot. The exact proportions are not available in all the cases, but apart from the instances given in this paper the author has ample experience as to the evil effect of using too small ingots. In the first place, there is the risk of including part of the major segregate, the position of which varies, as is well known, but from experience it is found that if the weight of the plate as cut much exceeds 45 percent of the ingot, there is an increasing probability of including part of it, and with 60 percent the probability almost becomes a certainty. It must be understood that ingots of the usual proportions are considered, and that about 5 percent is cut off the bottom ends. If a larger proportion is cut off there will naturally be more danger of approaching the major segregate with the plate slab, and for this reason it is desirable to allow a fair margin with the percentage. With special methods of casting a higher proportion could doubtless be used, but this is a matter which rests with the steel maker. Even if this is done the objection still remains that insufficient work is put upon the material, and this is a point of the greatest importance. In the first place work removes to a large extent the deleterious effects of the minor segregations of phosphorus, and, secondly, it makes the material more reliable and ductile. This latter quality is unfortunately only partially measured by the elongation of the tensile test piece, for, as is well known, it is possible to get steel castings giving as good results, so far as strength and elongation are concerned, as rolled steel, yet no one would care to stand in front of a boiler under steam if the shell plates were made of cast steel. The percentage of reduction of area is a more reliable measure of true ductility, but to obtain the necessary particulars considerably more time would be required than is usually available.

To some extent the work put into the plate may be estimated by the chemical analysis. It is recognized in steel works that the carbon content must be increased with the thickness, which means that the work done on the material is reduced, even allowing for the fact that thick plates are generally finished at a higher temperature than thin ones. The author suggests, therefore, that a limit of carbon and manganese might be required for each tensile limit in the same way that the amounts of sulphur and phosphorus are restricted. Plates Nos. A11 and B3 may be quoted as examples of the want of this restriction; in these plates the carbon was 0.35 and 0.3 percent for a thickness of 1 5/16 and 1⅝ inches. These quantities approach those allowed for steel castings, and indeed the structure of these plates was similar to that material. The longitudinal tensile tests of these plates gave, however, quite satisfactory results, but both plates are typical of the use of too small ingots with a high finishing temperature.

To sum up, it would appear that in order to eliminate the risk of failure the following points should be complied with:

1. Large ingots; the proportion of the weight of the plate as cut not to exceed about 45 percent of that of the ingot.

2. Effective annealing, the pyrometer being always used, and a record kept of the temperature to which each plate was subjected as well as the length of time it was in the annealing furnace.

3. Low phosphorus, not to exceed 0.05 percent, or with arsenic 0.06 percent.

4. Inspection of all parts which require dressing by an independent inspector, no plate to be accepted at the boiler works which has been dressed, and has not been stamped by the inspector on the dressed part. (This has been done by the Board of Trade for many years.)

5. Occasional transverse tests to be taken from the centers of the ends or sides of the plates corresponding with the longitudinal axis of the ingot.

The Board of Trade have willingly given permission to use the official records for this paper, in the hope that the particulars given will help to prevent failures in future. The author desires to thank Mr. David Colville for granting the use of the fine photomicrographic apparatus at Dalzell Works, and Mr. H. J. Pinkerton, chief chemist at those works, for taking many of the photographs given in this paper.

How to Heat Rivets Satisfactorily

BY CHARLES MILLER

In my thirty-two years' experience as a boiler maker, layer out and foreman, I have seen and studied a good deal about the heating of rivets and claim that a rivet must not be overheated—a cherry-red gives the best satisfaction.

I have been laying out in a shop that turned out an average of about 120 boilers per year, and every boiler required from tow or three days' calking at the test. After I became foreman I tried my scheme and can state frankly that an average of eight rivets on a boiler didn't have to be calked. By heating a rivet at a lower temperature you not only get a clean and wholesome but an effective one.

The writer had an opportunity to visit a large locomotive plant and observed the method of heating rivets at a welding heat. On going into the test shop he observed a boiler under pressure, and it certainly did leak. If they had taken more pains in heating their rivets at a lower temperature they wouldn't have had any occasion for bad leaks.

The rivets in question were driven by a hydraulic riveter of about 125 tons capacity.

John and the Radius

Another Puzzling Question in Laying Out is Explained with the Aid of Geometry

BY JAMES F. HOBART, M. E.

"Mr. Hobart, how can a thing be so when you know it isn't so?"

"Never found things that way, John. Something must be the matter with your 'know.' What's the trouble, anyway?"

"Why, it's this radius business. Now, I know that a radius is just one-half the diameter of a circle, but I didn't know that it was one-sixth of the circumference!"

"It never used to be, John; and I don't think it has changed any lately."

"Well, Tug Stoker proved it, anyway. A little 36-inch boiler came into the shop to have a new head put into it, and I was trying to find the exact radius of that shell so as to mark out a blank to be flanged for the new head. I was measuring around the inside of the shell with a flexible rule, when Tug came along and gave me the ha! ha! He said I didn't know enough to pick a radius out of a shell without getting my feet tangled in it. I was just going to hand Tug a hot one, when I thought I would find out what he knew first, so I asked him to "show me," and he just took a pair of big extension leg dividers and opened them up; then Tug spaced around the shell, inside, of course, until the dividers were set so that just six steps brought them around to the starting point."

"Well, John, that gave you the radius of the shell, didn't it? About every boiler-shop kid knows, or ought to know, that a radius will just step six times around its circumference."

"Yes, I know. But why is it? Why should the radius reach around the shell just in six steps, more than in five or seven?"

"That, John, is one of the things which the wise men can't explain. It is a characteristic of the circle, made possible by its division into 360 degrees. Had some other system of degree division been used with the circle, then some other than a six-sided figure might have had peculiarities as marked as those of the equilateral triangle, six of which may be drawn inside any circle as shown at *G, A, B, C, D, E* and *F*."

"Yes, I know that each half of the hexagon, with its six sides at angles of 120 degrees with each other, contains three 60-degree triangles. But what I want to know is—how did they first work up this peculiarity of a circle, *i. e.*, that the radius would step exactly six times around the circumference?"

"That is one more of the things which can't be told. It is one of the things which, like the matter of which the earth and the universe is composed, never was created, but always existed. So the circle and its peculiarities always existed and never was created. We did not find them out for a long time, and probably there are things about the circle which we have not discovered yet, but those things never were made or created. They have always existed, and always will, same as time and matter, therefore, John, we will not worry about when these things started, but we will keep on trying to apply them to our needs, material and progressive."

"All right, Mr. Hobart, that brings us right back to that boiler shell. Tug stepped the dividers around a few times and adjusted them until they came out even. Then he struck out the head with the dividers, and when the blank was flanged right up to the line Tug drew the head was found just the right size."

"That's all right and proper, John; what's your trouble, anyway?"

"Why, only a couple of days afterwards the 'Old Man' gave me a section of 10-inch steam pipe, and told me to cut off a piece of ½-inch by 2-inch flat steel which would bend into a ring and just fit inside the pipe—and I got left bad in that proposition!"

"How was that? What was the matter?"

"I don't know. I have been trying ever since to figure out what the trouble was, and I haven't got it yet."

"What did you do? How did you get the length of the bar which would bend up inside the pipe?"

"Why, I just tried out Tug Stoker's rule on that ring, and—well, I fell down flat."

"What! Did you try stepping around the inside of the pipe with the dividers and then stepping off the six steps on a bar of flat steel?"

"Sure, that's just what I did, and it didn't come out within a row of apple trees!"

"No wonder, John. It couldn't possibly come out right measured in that manner!"

"I don't see why? The head came out all right, so why shouldn't a ring which fits inside the shell come out right the same as a head does?"

"Well, John, you still have that 'Ivory Dome,' haven't you? Some day I am going to have the boys drill a hole in it; drop in a pint of soup, and then you will have something which resembles brains, at least! Don't you see that spacing along a curved surface, as in Fig. 1, is a whole lot different from spacing along a flat bar? Don't you see that in the circle you space along the chord, straight from *A* to *B*, while on the bar of steel you have to space along the metal, as from *A* to *H*, to *B*? And spacing that way makes quite a difference, and your ring came out too short, didn't it?"

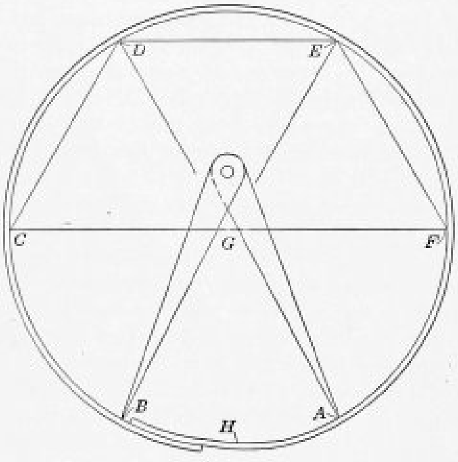

Fig. 1.—How "Tug Stoker" Spaced Around the Shell

"Yep. Too short at both ends, for neither end would reach to the other."

"Well, John, don't you begin to see the African in the wood pile? Don't you see that the radius can't be one-sixth of the circle, as you remarked at the beginning of our talk?"

"Yes, I thought I knew that all along; but Tug proved that I didn't know as much as I thought I did. He showed that the radius was just one-sixth of the circumference, didn't he?"

"No, he did not—not by a jugfull, and that is the place where you fooled yourself! When Tug spaced inside the head he stepped from *A* to *B*, didn't he? But when you spaced the bar of steel you stepped along the curve *A, H, B*, instead of straight across from *A* to *B*. Isn't that the way?"

"Yes, that's the way, all right!"

"Then, can't you see that when you step from *A* to *B* with the dividers in one step you are covering more shell than when you go around with the metal?"

"By thunder! So that's where I got twisted, is it?"

"Yes, John; and it isn't a bit to your credit that you didn't see it long before. Say! Do you see that if you set the dividers so they would contain twice the radius, you would "go around (across) the circle" in two steps instead of three? From *F* to *C* and back again. Also, if you set the dividers to reach from *A* to *C*, that you would go around the circle in three steps?"

"Yes, that's all good and plain."

"All right. And when you step along a bar with twice the distance *A C*, you get only two diameters of the circle laid off in the bar of flat steel instead of 3.1416 times, don't you?"

"That's sure, too."

"And when you step around with three steps, your piece of bar steel, when cut off and bent into a ring, reaches still further around?"

"Yes, that's so; and I see that when we step with the radius, which is the distance *A B*, that the ring is still longer—the steel therein is longer at least, and reaches nearly around the circle."

"That's the way, John. You've waked up at last, I see. And if we step around the circle circumference with the dividers set to the distance *A H*, the steel, after bending up, will reach further around, won't it? And, furthermore, if we shorten the space between the divider legs until they are very close together, indeed so close together that we can't see that the straight line (chord) is any shorter than the circumference between the points, then we will come out exact, and the same spacing laid off on the flat bar will fit inside the circle after the spaced piece has been cut off and rolled up, and proper allowance made for bending."

"Oh, yes, I see the whole thing now! Just space with so small steps that there is no difference between the chord and the arc, and I will come out all right, but I must add three thicknesses of the bar for take-up in the bending."

"But will you allow that much, John? Don't get thrown down again on that point. Do a little thinking about it first. Don't you remember that some time ago we looked to see where the "three thicknesses of plate" business happened to be right for the allowance made in bending? And don't you remember that we found that if we measured the length of sheet along a circle which represented the middle of the plate thickness, that no bending allowance had to be made?"

"Yes, I remember that; but won't I have to make the allowance here? We can't space along the inside of a pipe ¼ inch from the metal!"

"Of course we can't, John; but don't you see what I am getting at? If we bend up an outside ring we have to allow three thicknesses of sheet, don't we, or the bent sheet is too short? Then if we bend an inside ring, won't the sheet come of a different length than if placed outside? Won't have to make much if any allowance for bending, will you? How about this, John? Just figure it out and let me know, will you?"

"I'll do that, Mr. Hobart; but I want a little more about that chord and radius business shown by Fig. 1. Tug spaced around six steps, and the head came out the right size. Now how much shorter than the actual circumference is the spacing which Tug made?"

"That's very easy to figure, John. We will call it that the 10-inch pipe has an actual diameter of 10 inches (smaller sizes of pipe run larger than their nominal diameter, you know), and calling the diameter of circle in Fig. 1 10 inches, its circumference would be 31.416 inches, wouldn't it? And the dividers are set to 5 inches, aren't they—just one-half the diameter, which makes them 5 inches. Now, then, $6 \times 5 = 30$, and $31.416 - 30 = 1.416$ inches, the amount the bar falls short. But in bending this bar it keeps its length along its neutral axis, which is ¼ inch less on a side, ½ inch on the diameter, making the bending length of the ring $3.1416 \times 9.5 = 29.84$ inches; so you see, John, it is only .155 inch too short, and you don't have to allow three thicknesses of bar after all! What d'ye know about that?"

"Well, I'll be everlastingly thumped with a sledge handle, but if figures won't lie they won't always tell the truth! What is a fellow going to do to make proper allowance for sheet and bar thickness in bending?"

"Just use the neutral axis, John, in making calculations, and then you will come out pretty close; but even then you will 'fall down' when making very short bends. When you bend a piece of metal back upon itself—make a close bend, you know—then the stretch on the outside of the sheet or bar is more than the compression on the inside. That is, the neutral axis don't stay in the middle of the sheet or bar, but moves outward enough to spoil all bending calculations, however carefully they may have been made."

"Say, Mr. Hobart, is that what makes the difference when bending large circles and small ones? I find that while the three thickness rule comes very close on large work, that it don't answer very well when working thick sheets to very small diameters? Is that the reason?"

"That's one reason, John; and that one will make you all the trouble you want without looking for other reasons. But did it ever occur to you that with a certain thickness of bar steel the spacing around inside the pipe with a length equal to radius would come just right to make the ring fit?"

"No, I hadn't thought of that. Is it so?"

"Sure! You noticed that the ½-inch bar came within .155 inch of being long enough, didn't it? And if the metal had been a few hundredths of an inch thicker, the center, or neutral axis, would have moved inward sufficiently to have made the ends of the metal come fair together. See it now?"

"By ginger! I do see it. Say! Hold on a minute! I want to cut a strip of thin tin to six radius length, and try it inside the 10-inch pipe. Gee! But there it is, almost 1½ inches short! Say, what d'ye know about that?"

"You have to keep your eyes open, John, when working metal—sheet or plate metal, especially—or you will get thrown down. There are holes all around for a fellow to fall into unless he 'keeps his eyes wide open tight' all the time."

"I am finding that out pretty fast, Mr. Hobart; but there is so confounded much that a fellow don't know that it makes me feel sick sometimes to think of it. Well, I'll keep plugging along trying to study out things, if I do get bumped once in a while!"

"That's the spirit, John. If your horse throws you, jump up again as soon as possible; catch him, and try it again. A man knows more than a horse, don't he, and ought to win out?"

"Yes, if he don't break my neck first."

"Haven't broken yours yet, have you, John?"

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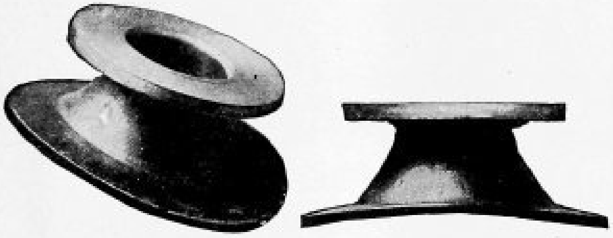

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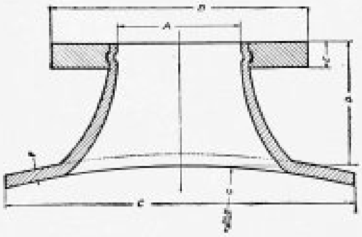

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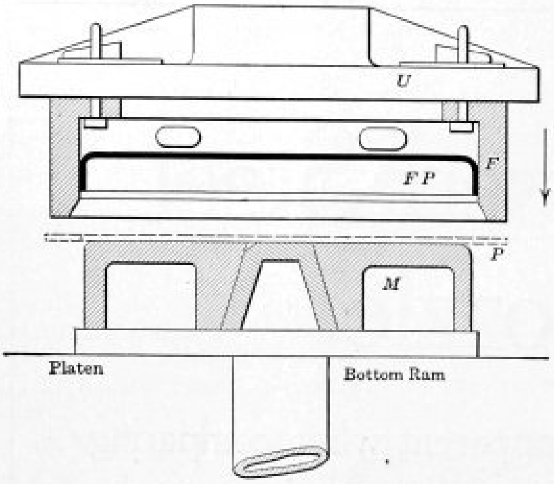

Fig. 10

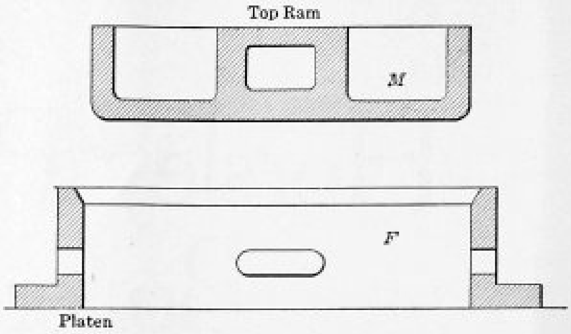

Fig. 11

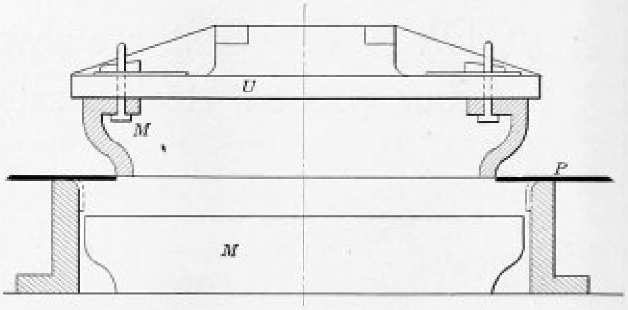

Fig. 12

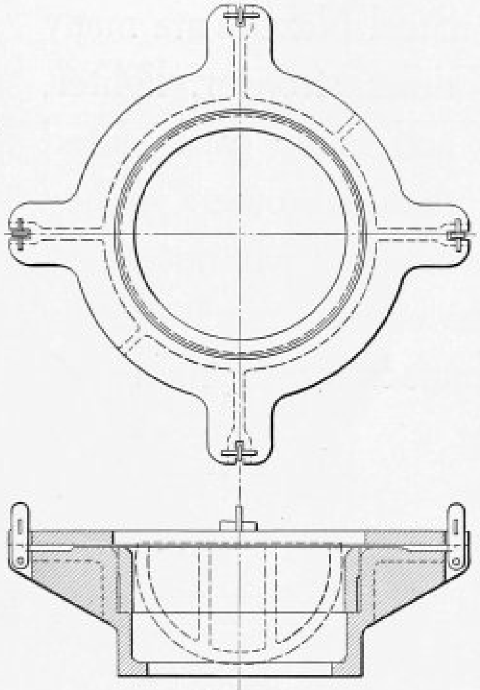

Fig. 13

Hydraulic Pressing—V

BY C. W. R. EICHOFF

In the last article on the subject of hydraulic pressing the writer mentioned a few simple operations which can be performed on the sectional flanging machine. The present article will show the variety of work of this kind that can be turned by this machine. In a well managed shop the flanging machines can be kept in operation most of the time during regular working hours, providing the general business conditions are satisfactory. The installation of a hydraulic plant, in fact, will prove a good investment, as the demand for pressed articles is growing daily, and these articles are rapidly replacing riveted articles.

It should be mentioned that the illustrations shown herewith are merely sketches indicating in a general way how the operations have been performed. The dies have to be modified to meet requirements and conditions prevailing in the shop and are subject to individual taste in regard to design.

In Fig. 10 is shown the arrangement of dies to flange a regular circular boiler head. In this case the matrix is fastened to the upper rams by a universal plate, to which the different sizes of dies can be bolted or keyed, as the case may require. The flanged head will usually stick in the matrix, but

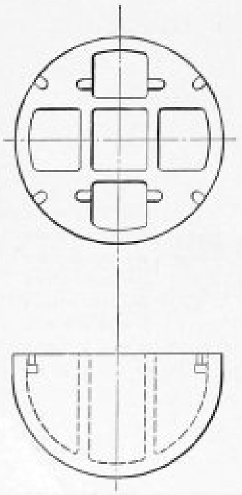

Fig. 14

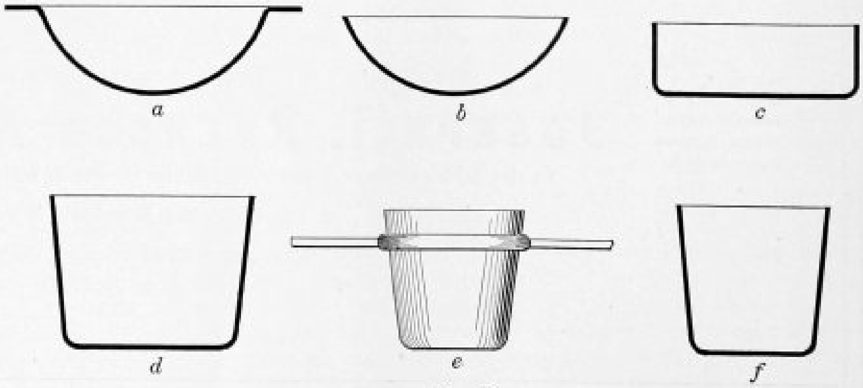

Fig. 15

as the hot head cools off it will shrink while the die expands, giving the head a chance to drop out.

One method of dishing heads is to place an additional former on top of the sectional male block, although the dishing of heads is more successfully performed on the four-column press, as will be explained in a future article. The male die in this sketch is of the sectional or universal type, the details of which will be described in a later article on operations on the column flanging machine. It is, however, a die which can be used on both machines if properly designed. Such universal dies are coming to the front more every day, saving money and also space. The latter is a very important item in many a boiler shop which is compelled to turn out a variety of work in these times of keen competition.

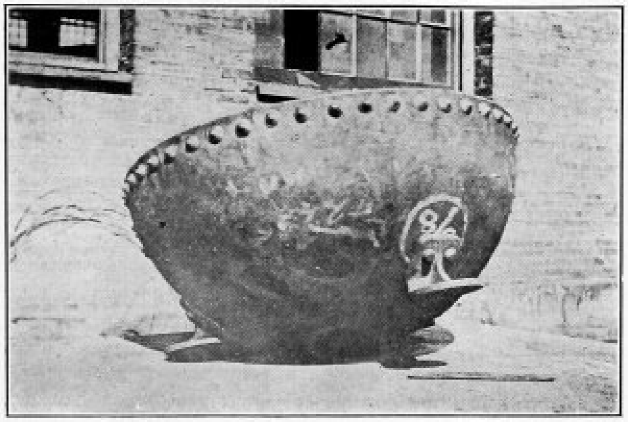

Fig. 16

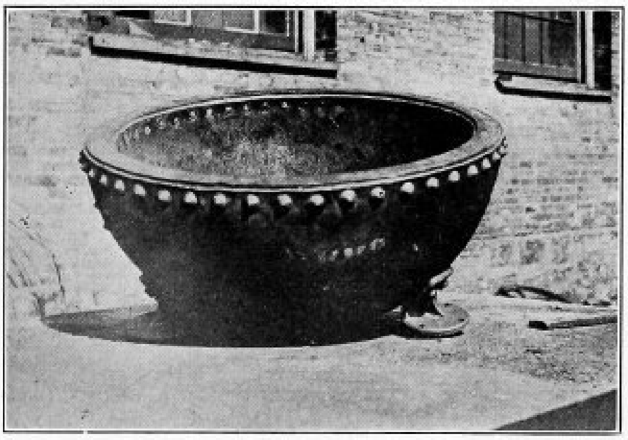

Fig. 17

The operation of the die is as follows: The plate *P* to be flanged is laid on the male block *M* resting on the platen of the machine; the matrix *F*, which is fastened to the universal plate *U* and the latter again to both vertical rams, descends downward over the die *M* forming the head. The finished product is shown in *F P*. When the top ram is down far enough and the head is just formed, some pressure is exerted to the bottom ram, if there is one on the machine. This slight pressure will press the male die against the inside of the flange and so produce a good, clean head. As soon as the pressure is released the finished head will easily follow the matrix and after shrinking can easily be removed from same.

Fig. 11 shows a male and female die to perform the same operation of flanging a regular circular head, but in this case the male block is fastened to the vertical rams and the matrix rests on the platen of the machine.

In Fig. 12 are shown the flanging dies for the furnace mouth of a head belonging to a Scotch marine or Clyde boiler. The male die *M* is fastened to the universal plate *U* by wedges and bolts. The die moves downward, forms the flange as shown by the dotted lines and after traveling far enough is loosened by simply driving the wedges out of the bolts or flats, when *M* will drop to the platen. The flanged head can be removed and after removal of same, *M* can be fastened again quickly to the universal plate, raised and the operation repeated. The dies shown in the sketch can be designed sectionally and arranged so they can be used for different openings, which one will often find when corrugated furnaces have to be inserted in the furnace mouth.

Figs. 13 and 14 show the blocks for forming hemispherical kettles on the sectional flanger, while the photographs, Figs. 16-17, show the finished product. These kettles are steam-jacketed. The available space to manufacture the product was only 42 inches on the machine; i. e., between the platen and the vertical rams in their highest position. The kettles are 36 inches outside and 30 inches inside diameter, the material being 5/16-inch and ¼-inch stock, respectively. The operation was performed on the same principle as explained in Fig. 12. The kettles were formed in one operation at a very low labor cost.

In Fig. 15 are shown some other forms or articles that can be fabricated on the sectional flanger if the machine is large enough and the dies are properly designed. Some, of course, require more than one operation.

The forms *A* and *C* are used in sugar work, *C* is in common use, and *D, E F*, are ladles for foundry use. In this product the annoying riveted joint is avoided, which is the cause of lot of trouble.

(To be continued.)

Tests of Locomotive Superheater Performance

In a paper read before the Franklin Institute, Philadelphia, April 30, 1914, by Mr. C. D. Young, engineer of tests, Pennsylvania Railroad, Altoona, Pa., the results from a series of tests made on various forms of the Schmidt fire tube superheater fitted to a locomotive boiler are described. The principal deductions that may be drawn from these tests may be summarized as follows:

(*a*) The standard superheater now in general use is found to give very satisfactory results with a possibility that some of the return portion could be eliminated with no detriment to the superheat obtained, and with an advantage in cost of material.

(*b*) Too much importance cannot be attached to the length of the superheater; it must extend as far toward the fire as practicable limitations will allow, considering the life of the elements in the hot gases.

(*c*) There is an advantage in the return portion of the superheater, but this part may be shortened, to what extent has not yet been finally determined.

(*d*) As the superheat is reduced, the evaporation of the boiler is increased within certain limits; in other words a boiler without superheater shows a larger maximum evaporation than one with a superheater. The power of the locomotive, however, does not increase with the greater weight of steam produced; on the contrary, the power is reduced with the reduction in superheat.

(*e*) Within the limitations of these tests, the highest superheat does not result in the lowest water rate; this is on account of the fact that to obtain the highest superheat the locomotive may be run at an increasingly long cut-off, the long cut-off increasing the water rate to a greater extent than is compensated for by the increase in superheat.

The advantage of superheating may be utilized in two ways; either in coal and water saved, due to a reduced water rate, or by burning the same amount of coal as would be required in the boiler where it is generating saturated steam and obtaining a decided increase in the power output of the locomotive. If we exclude conditions of starting, this would permit the superheater locomotives to haul heavier trains with a saving in transportation facilities and labor.

Another advantage in superheating which only recently is being given consideration is that by the application of superheaters small locomotives may be made to haul trains equal to those now hauled by saturated steam locomotives of greater weight, and this means that where traffic has outgrown the locomotive and the right of way conditions not permitting of heavier units of power being introduced, trains may be increased in weight by the adoption of superheaters.

How to Heat Rivets Satisfactorily

BY J. T. BRADBURY

The subject of "Heating Rivets" is one that appeals to boiler makers very strongly for several reasons; first, because of its far-reaching effect on the ultimate success of all work on which the use of steel rivets has so great a bearing and, secondly, because we can approach it with a feeling of confidence, due to the fact that we are treading upon familiar ground.

For many years the task of heating rivets in boiler shops has been done by boys just out of school, with no particular care taken to educate them as to the proper heat necessary or the bad results occurring from overheated or burnt rivets, the principal object apparently being to impress upon them the importance of getting rivets to the riveters as quickly as possible, so that no time may be lost on the job. As a result scrap piles reveal some queer assortments, if the trouble is taken to investigate their contents. If employers of labor would realize the importance of paying a higher rate of wages than is generally paid for this class of work, and if they would furnish an incentive to heaters to stick and become more expert at their particular line, better conditions would result.

From an economical standpoint a poor rivet-heater—that is, one who either underheats, overheats or fails to keep his crew supplied—is expensive at any price, as occasional periods of waiting, either from inability to furnish rivets fast enough or from overheated or burnt rivets not going in the holes, means a very heavy loss which soon runs into dollars, when one considers the high-priced labor of four and very often five men, to say nothing of fuel consumed to no purpose.

The writer well remembers his first experience at the fire using coal for fuel, working for a gang of hand riveters, long before pneumatic tools were introduced. An experienced heater was sent to explain the fine points, said fine points being to keep three rivets in the fire at once, always keeping the hot one in the center, and as each hot one was taken out the next hottest put in its place, a cold one taking the place of the one put in the center, and under no circumstances to keep the gang waiting.

The course of instruction lasted just two hours, the boss sending the instructor away to another job. On being left alone matters went along quite smoothly for about fifteen minutes and the writer had come to the conclusion that heating rivets did not require very much experience, congratulating himself on learning so easily, little dreaming of the rude awakening he was about to receive.

Presently he discovered the rivets were not heating no matter how much blast was turned on. The bottom of the fire gradually became black and dirty. The gang kept up an incessant rattling for rivets as all those taken to them had a dirty scale and were too cold to work. "Go back, clean your fire, and get a move on, you rotten fathead!" is a fair sample of some of the stuff handed out, with the addition of something extra, just to emphasize their feelings.

Every heater in the old days was, no doubt, familiar with the idea of punching holes in a piece of boiler plate somewhat larger than the size of rivet to be used, and laying it on top of the fire. This, in a way, was good for a green heater and only required keeping the fire in good shape, but it was very hard on the scrap pile, owing to the quantity of plate used. One good feature was the impossibility of losing rivets in the hot coals; but to offset this was the tendency to waste the rivets at the point and prevent their use where the work was of a steam-tight nature.

Another scheme was to bend a piece of five-eighth or three-quarter-inch square iron in the form of a slot about twelve inches long, to keep the hot rivet always at the inside end, and as each in turn was used shove the remainder inward, thus keeping the hottest ready for use. For the smaller rivets that did not require to be very hot, a good idea was to make a rough boiler plate box, about ten or twelve inches square by three or four inches deep, fill it with rivets, cover it with a piece of wood or iron and leave just enough opening to take out the rivets as wanted.

These methods served their purpose very well while coal fuel was in use, but since the introduction of gas and oil fuel furnaces they are considered very much out of date and are only mentioned in order to illustrate some of the ideas in vogue in the past.

No fixed rule can be given that will cover all the ground in heating rivets, as the conditions under which they are driven and the service they are required to perform, govern to a great extent the degree of temperature and how best to heat them. The writer is of the opinion that all rivets used for steam-tight work should be somewhat hotter, and consequently softer at the neck than at the point, as by so heating the center is expanded more readily and the rivet fills the hole better than it would if the point were hottest. This case is illustrated very clearly where both ends of the rivet are exposed to leakage, such as in mud-rings, door rings, front ends, o-gee flanges, etc., and if followed out as described would do away with a lot of unnecessary calking when testing, and prevent future leakage and resultant early destruction of boilers that would have had much longer service if more care were taken at those particular locations.

In the coal fuel furnace, even under the best conditions, it is only the heater of experience that gives satisfaction, as there are so many things to guard against, such as loss of time, cleaning fires, control of blast, quality of coal, losing rivets, etc., and on which the novice requires practical experience and information, otherwise something is bound to suffer and that something is always the employer's pocketbook.

In the oil or gas fuel furnace there is an entire absence of many objectionable features met with in the use of coal. As the rivets are not covered, but always in plain view of the operator, there is no possibility of overheating, provided, of course, that proper attention is given to the controlling value when the rivets are getting hot. No cleaning of fires, necessitating periods of idleness many times during the day, is required. No dirt or clinker is left to make the shop untidy, and there is an almost total absence of smoke and sulphur.

The writer believes the only answer that can be given to the query, "What is the best method of heating rivets?" is that all rivets heated should be brought to that mobile condition absolutely necessary to the proper working of the material, a condition which can be obtained only by heating to a temperature of from one thousand to eleven hundred degrees centigrade, with oil or gas fuel furnaces, which gives the maximum output for minimum fuel consumed.

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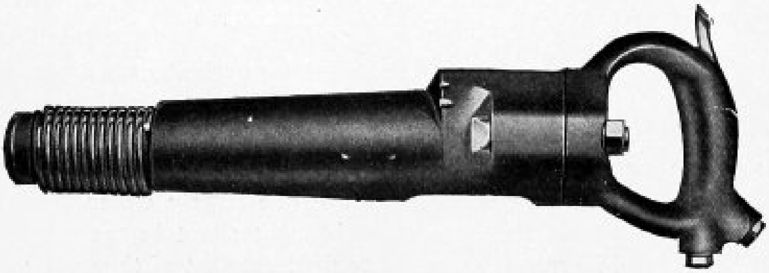
At the summer meeting of the American Society of Mechanical Engineers, held recently in St. Paul and Minneapolis, a resolution was passed authorizing a hearing in the rooms of the society at 29 West Thirty-ninth street, New York City, on September 15, for the consideration by all interests concerned of a preliminary report of a committee appointed some time ago by the society to formulate standard specifications for the construction of steam boilers and other pressure vessels and for the care of same in service. This committee has already prepared a tentative report suggesting a form of law which may be universally adopted and rules following closely those of Massachusetts and Ohio, regarding the design and proportions of steam boilers and other pressure vessels. About 2,000 copies of this tentative report have been circulated among engineers, boiler manufacturers, boiler inspectors and other specialists for criticism and suggestions. Those desiring to participate in the discussion of this report should present their criticisms and suggestions to the society in writing prior to August 15. By so doing it is expected that a comprehensive law and form for boiler specifications will be evolved which can be adopted as a basis for uniform legislation in the various States which are not now provided with boiler laws. The situation which boiler makers are now forced to meet demands different specifications in practically every State, with the result that the same boiler can hardly be sold in any two States, and it is practically impossible to manufacture boilers in stock for the trade on account of the variety of requirements to be met. As several States are now on the eve of enacting new laws covering boiler specifications, it is imperative that a satisfactory standard be adopted immediately which will be acceptable to the leading technical and engineering societies in the country and which will have the force of their approval to secure their universal enactment.

The paper on failures of heavy boiler shell plates by Sidney A. Houghton, which is concluded in this issue, brings to light much valuable information on a subject which is worthy of most careful study. As failures of boiler plate are due largely either to defects in the plate itself brought about in the course of its manufacture, or to the treatment of the plate by the boiler maker while it is being worked into the structure of the boiler, there are manifestly two classes of workmen who are responsible for the majority of such failures—the steel makers and the boiler makers. It is important, then, for boiler makers to note carefully the causes of plate failure which have been traced out by Mr. Houghton which can be overcome or eliminated in the boiler shop. It is true, of course, that for every plate that fails there are probably hundreds of other plates in use which have received the same mistreatment and which have similar defects, but which have not failed. Such a wide variety of conditions surround the manufacture and operation of any boiler that it is very difficult to single out any particular condition or defect which is the primary cause of a failure, especially when the investigator is confronted by hundreds of other examples in which similar conditions have produced no failure at all. It is safe to say, however, that any improper heat treatment to boiler plate or any form of construction which sets up internal stresses in the plate will have a serious effect upon its strength and may be a contributory cause of failure. A striking example of this was pointed out by Mr. Houghton in the case of riveting a compensating manhole ring to the shell plate. When the compensating ring is of considerable thickness, and especially when a flanged ring is used, it is a very difficult matter to make the ring fit accurately to the curve of the shell plate; consequently when the rivets are driven by powerful hydraulic machines considerable creeping takes place, and if the rivets are driven alternately at each end of the major axis, working towards the minor axis of the ring, the driving of the rivets will produce an enormous tensile stress, which must be carried by the shell plate in addition to the stresses produced by the pressure of steam and the expansion and contractions due to changes of temperature. Such causes of failure, of course, can and should be eliminated by the boiler maker.

Engineering Specialties for Boiler Makers

Safety First in Riveting

Following the recent "Safety First" movement, several States are drafting safety appliance laws, among the provisions of which are requirements that riveting hammers embody in their construction devices to prevent the accidental ejection of the rivet set from the nozzle of the hammer. To meet these requirements a novel rivet set retainer is now put out with the "Little David" pneumatic riveter, manufactured by the Ingersoll-Rand Company, New York.



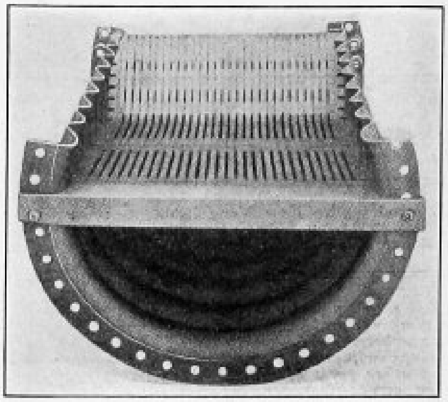
The retainer consists of but a single piece of heavy spring steel, closely wound into a spiral form. One end of this spring fits over the outside of the hammer nozzle and hooks over a projection integral with the nozzle. The other end is wound to a smaller diameter. Sets for rivets over ⅞-inch diameter are formed with a coarse thread and are simply screwed into place. Sets for rivets ⅞ inch diameter and smaller are formed with a shoulder and are slipped into the retainer while it is detached from the hammer, the shoulder holding it in place. The device is so effective it positively prevents the rivet set or piston from being driven out, even when the hammer is run free under 90 pounds of air pressure.

Other important improvements have been embodied in the "Little David" riveter. There is but a single ground joint between the handle and barrel and these parts are securely held together by two bolts, one on either side of the barrel. This construction eliminates the need of a vise in taking the tool apart for inspection, a feature of value to the structural worker as well as others who are not usually equipped with special facilities for repair work. There are no threaded joints on the barrel. The valve chamber is placed beside and parallel to instead of in line with the cylinder, obviating all possibility of injury to the valve by the piston. This construction gives a very much shorter tool, adding to its usefulness, as it can be used in closer quarters.

"Little David" riveters are made with either outside or inside types of triggers, in five regular sizes, adapted to all kinds of riveting work. In addition there are two sizes of jam riveters which have an exceptionally short over-all length, making them peculiarly well adapted for riveting in very cramped quarters.

The Von Riegen Patent Firebridge Bar

The Von Riegen firebridge bar, illustrated, has been designed to improve the combustion of fuel in Scotch boilers and to do away with the troubles commonly experienced with the ordinary grate and bridge. The title "firebridge bar" has been given to this arrangement because when all the bars are placed in the grate they form the firebridge by means of their rear hook-shaped ends resting upon a thickened ledge or flange on a partition which closes the ash pit. The forward ends of the bars are freely suspended from cross-beams. Each firebar is provided on its rear upwardly bent end with lugs by means of which the bars mutually support each other. The lugs also form passages between the bars for the circulation of air. The partition which closes the ash pit toward the rear consists of two parts with pieces laid in—an arrangement which facilitates varying the height of the firebridge according to the nature of the fuel used. In the lower part of this partition a hole with a small door is provided for purposes of cleaning. As shown by the illustration, all brick work is dispensed with, so that the bars can easily be placed in position, allowing speedy repairs. Another advantage is that the fires can be cleaned at sea in a comparatively short time, thus reducing fluctuations of steam pressures to a minimum. It is also claimed that clinker does not adhere to this structure as it does to brick work, and that the firebridge bar will not become choked up with slag and ashes.



The patents for the Von Riegen firebridge bar are controlled by Paul Pajewski, Hamburg 30, Eidelstedterweg 8, Germany.

Electric Resistance Welding Machine for Safe-Ending Boiler Tubes

A unique feature of electric resistance welding is that the heat is generated in the metal itself at the joint, while by all other processes of welding, from the old-time forge and hammer down to the oxy-acetylene blow-torch, the heat is applied to the outside of the metal. It might be said as distinguishing the electric resistance method from all others that

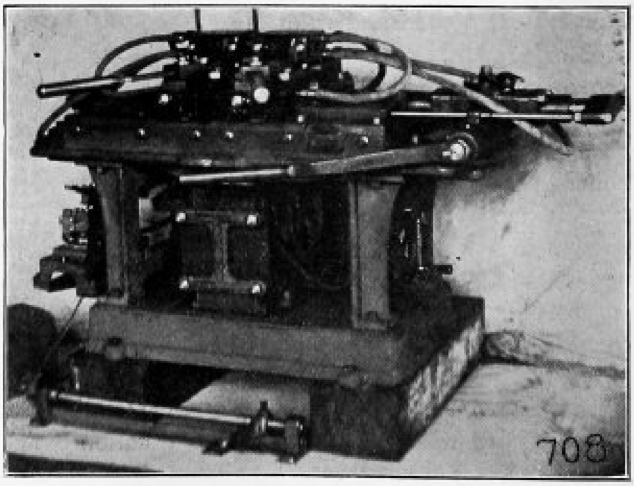


Fig. 1.—Thomson Electric Resistance Tube-Welding Machine

in the former the heat starts in the inside and works out, while in the latter the heat starts on the outside and works in. The electric resistance process is, therefore, the exact reverse of all the others. The heating effect of the electric resistance process is more local than any other and, consequently, more heat is used in ordinary work and not so much is conducted away and wasted. This is largely due to the fact that the weld is made much more quickly than by other methods, which in itself is a considerable advantage, as the saving of time means a saving of labor, rent, heat, light, taxes, insurance, interest and other overhead expenses.

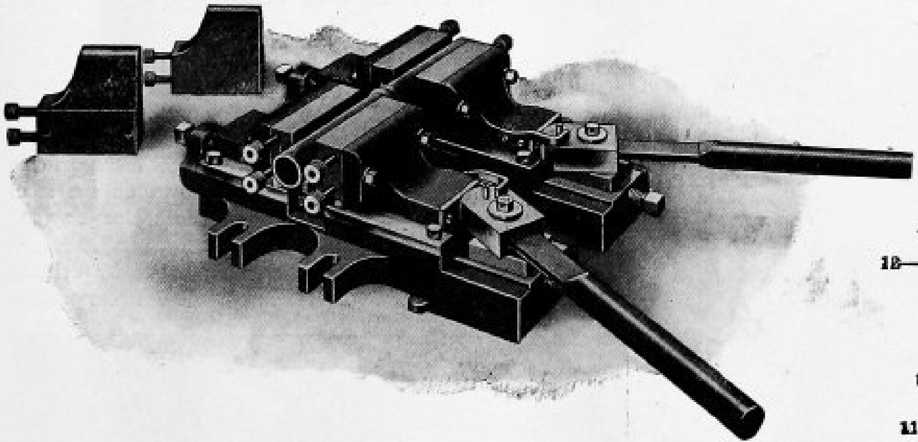


Fig. 2.—Clamps on Electric Tube Welding Machine

With an electric resistance welding machine it is possible to safe-end boiler tubes of common sizes, although the machine illustrated, which is manufactured by the Thomson Electric Welding Company, Lynn, Mass., has a capacity up to 3-inch tubes only. This machine can also be be used for welding extra-heavy pipe ½ to 1½ inches, double extra-heavy pipe from ⅜ inch to 1 inch, solid rounds up to 1¼ inch and thick flats and like sections within its capacity.

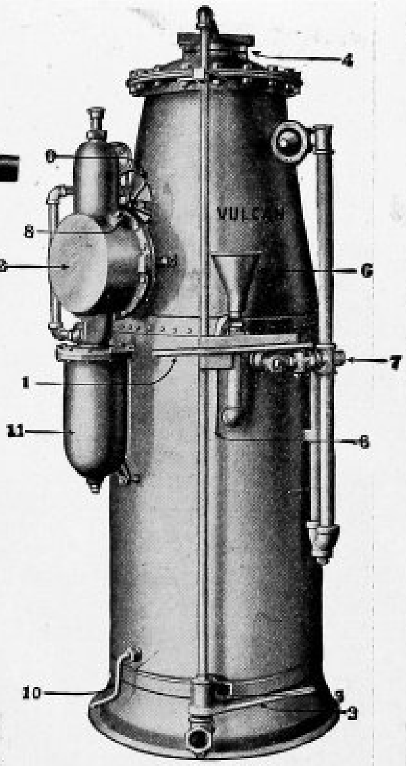
Briefly, the electric resistance welding machine consists of a transformer and a suitable clamping and pressure device. On the machine shown in Fig. 1 a breakswitch mounted on the left is operated by a treadle at the front. A switch, mounted on the right, taps the primary coil and regulates the current for large, medium and small sizes. A 5-ton double-acting oil jack on the right of the machine, operated by a lever at the front, gives the necessary pressure. Quick-acting water-cooled gun-metal clamps (Fig. 2), mounted on the terminals of the secondary coil, hold the work and are provided with water-cooled, renewable, accurately-fitting drawn copper dies, which grip the tubes on both sides of the joint.

To install the machine it is only necessary to put up a wall switch and two insulated wires running to the source of power. The machine requires an alternating current of 30 kilowatts (45 kva) single phase, or it can be wired from one phase of a two-phase or multi-phase current 40 to 60 cycle and it can be adapted to any voltage between 100 and 600.

The method of operation is to drop the tubing into the dies or push it through until the two ends meet midway between the dies. The two clamp levers (Fig. 2) are pulled together to tighten the grip on the tubing and then the treadle is pushed down with the foot. The tubing immediately begins to heat in full view of the operator and, when at a welding heat, the jack lever is pumped two or three times, the foot being removed from the treadle at the same time, and the weld is made. The tubing is then removed from the welding machine and the fins made by upsetting the ends of the tubes are rolled off. On tubes 2¼ and 2½ inches diameter the current is used from 15 to 20 seconds for each heat, no current being used between heats. It is claimed that from 60 to 65 completed welds can be made in an hour and that the cost of current at 1 cent per kilowatt hour is about 12 cents per 100 welds. A skilled operator is not required.

A Unique Acetylene Generator

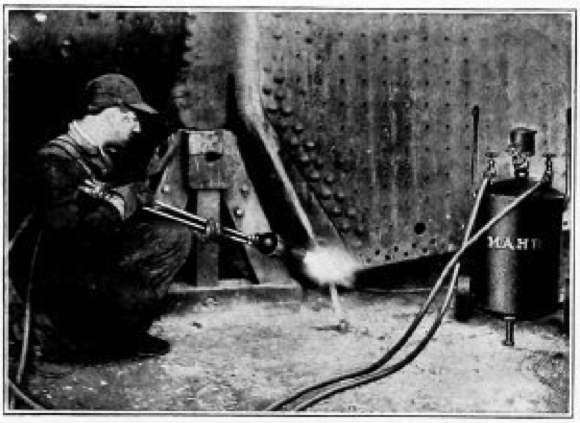
An acetylene generator that employs a new and ingenious principle to meet the very exacting demands of an autogenous welding outfit is being marketed by the Vulcan Process Company, of Minneapolis, Minn., and Cincinnati, O. In this machine the feed mechanism drops an automatically measured quantity of 1¼ by ⅜-inch carbide into the water, varying the quantity to suit the demands made on the gas supply, producing a clean, cool gas at unvarying pressure. The motor that drives this automatic feed utilizes the buoyancy of the gas passing from the generator to the torch; thus the feed is increased as the gas consumption increases, or lessened when the gas consumption lessens, or the feed is automatically stopped and started when the torch is turned off or on. If the pressure for any reason should tend to rise above normal, the gas is conducted through a by-pass, rendering the feed inoperative until sufficient gas is used to lower the pressure. Possible accidents due to puncture are eliminated, it is claimed, by locating the feed motor in the pipe between the generator and the torch, and using the passing gas as motive power, instead of following the usual method of utilizing the gas pressure in the machine.



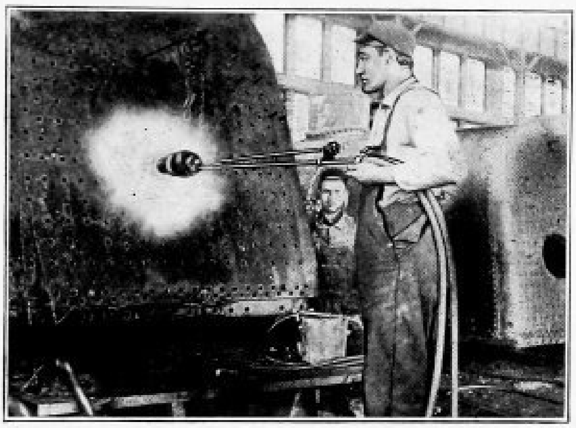
Being designed to use 1¼ by ⅜-inch carbide, it is claimed the machine will deliver 15 percent more acetylene than if the same quantity of screenings of carbide was used, and better gas results from the carbide falling deep into the water before complete decomposition ensues, securing cooler generation than is possible with screenings, which have a tendency to decompose near the surface, causing generation under high temperature and failure to give the gas the benefit of rising through a considerable volume of water, whereby it is washed and cooled. The carbide chamber and feed mechanism are removable, thus opening the machine for complete inspection. The entire generator is protected against careless manipulation by a locking device, which prevents removing the cap for refilling or opening any valves without following a definite safe routine.

A Portable Torch

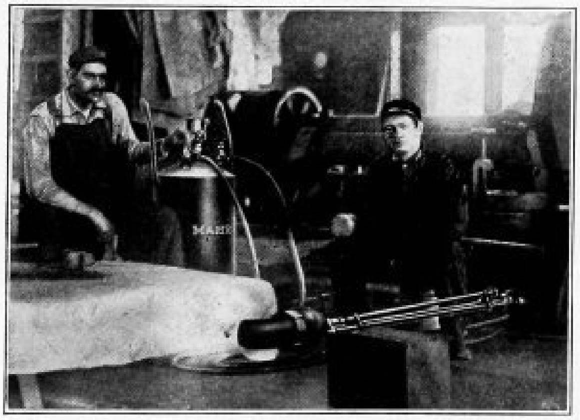
The Mahr portable torch for boiler shop use, which is manufactured by the Mahr Manufacturing Company, Minneapolis, Minn., burns either crude or kerosene oil. The torch itself consists of an atomizer and a double chamber. The vapor is discharged from the atomizer into the first chamber, where it ignites. This first chamber has an aperture in the form of a choke through which the burning vapor passes into the second chamber. In passing, the vapor draws free air into the second chamber through auxiliary air openings, causing, it is claimed, a perfect-burning mixture and a steady, compact flame. The operator has perfect control over the flame, and regulates it so as to cover only the necessary area to be heated. Interchangeable straight and elbow nozzles are provided, which make it handy for any kind of work, as shown by the illustrations. Any air pressure from 10 to 120 pounds is suitable, and it is claimed that in any case no unburned particles of oil or cold blast in the center of the flame will strike the surface to be heated. The torch is made in three sizes—large, medium and small, the medium being suitable for general boiler shop work.



Laying Up Mud Ring Corner



Laying Up Lap of Fire Door Hole



Shaping Back Head to Fit Shell

Efficiency of Welded Joints as Applied to the Manufacture of Warehouse Trucks

A striking example of the increased efficiency and generally decreased cost of manufacture, by welding sheet metal articles compared with drilling and riveting is shown on the steel trucks made by the Standard Motor Truck Company, of Chicago.

These warehouse trucks were formerly made by drilling and riveting all of the joints. Welding by the Oxweld process was proposed and a test truck made by this method. The results were so conclusively in favor of this construction that it was immediately adopted and the riveting process abandoned.

Welding not only produced a one-piece truck in which the welded joints proved far stronger than the riveted joints formerly used, but it has increased the output per man about 20 percent with a saving of over 30 percent of the previous cost of manufacture per truck.

Tests of both the welded and riveted joints used in the manufacture of these trucks were made by the Bureau of Inspection, Tests and Construction of Robert W. Hunt & Company, engineers, Chicago. Three specimens were tested; the first consisted of a stringer tube and a cross tube welded together by the Oxweld process. Under a maximum load of 25,460 pounds the cross tube broke from the stringer tube at the weld. The second specimen consisted of a cross tube riveted to a stringer tube by two ¼-inch rivets in double shear, one in the stringer and one in the cross tube through a plug and bushing inserted in the cross tube. Under a maximum load of 4,740 pounds the rivet in the stringer tube sheared off. The third specimen consisted of a cross tube joined to a stringer tube by a ¼-inch rivet in double shear in the cross tube and a ¼-inch riveted reduction of a plug inserted through the stringer tube, the head of the plug being in tension. Under a maximum load of 5,800 pounds the rivet in the cross tube sheared off and the riveted connection in the stringer tube pulled partially through the stringer tube.

Personal

G. E. BROOKSHAW, formerly foreman boiler maker of the Georgia Car & Locomotive Company, Albany, Ga., has been appointed foreman boiler maker of the Seaboard Air Line shops at Raleigh, N. C.

S. R. KENT, for the past two years foreman boiler maker at the Atlantic Coast Line shops, High Springs, Fla., has accepted a position with the Merrill-Stevens Company, Jacksonville, Fla. Mr. Kent is the inventor of the Kent safety boiler plug.

CHARLES HEGGIE has been elected president of the Scully Steel & Iron Company, Chicago, Ill., succeeding Mr. Alexander B. Scully, whose death was announced in our last issue. George Mason, Jr., has been elected vice-president of the company, in charge of sales, and G. H. Avery, vice-president, in charge of credits.

D. H. KANE has been appointed acting foreman boiler maker of the American Locomotive Company, Dunkirk, N. Y., to fill the vacancy caused by the death of Frederick G. Bird. August Swanson has been appointed acting assistant foreman of the boiler department and C. E. Lester boiler inspector, to fill the vacancies at this plant caused by the deaths of George A. Bird and Otto E. Walter.

Obituary

FREDERICK G. BIRD, general foreman of the boiler department of the American Locomotive Company, Dunkirk, N. Y., was killed recently in an automobile accident near Ripley, N. Y. Two other well-known boiler makers, George A. Bird, the son of Frederick G. Bird, and Otto E. Walter, boiler inspector of the American Locomotive Company at Dunkirk, were killed in the same accident.

Frederick G. Bird was born in Dunkirk, N. Y., fifty years ago, and for a long time was prominently connected with the American Locomotive Company's plants in Dunkirk and in Schenectady, N. Y. At the time of his death he was general foreman of the boiler shop at the Dunkirk plant. Mr. Bird was twice married, and is survived by his second wife, a daughter, four brothers and two sisters.

GEORGE A. BIRD, son of Frederick G. Bird, was 30 years old at the time of his death, and had spent most of his lifetime in Dunkirk, N. Y., working at the boiler maker's trade. For several years prior to his death he had charge of the laying-out department in the boiler shop of the American Locomotive Company at Dunkirk.

OTTO E. WALTER, the third victim of the automobile accident, was 48 years old, and for many years had been connected with the Brooks locomotive plant of the American Locomotive Company. At one time he was general foreman of the boiler shop, retiring because of ill health, and at the time of his death he held the position of boiler inspector at this plant.

JOHN DONALD MACKINNON, founder of what is now the MacKinnon Boiler & Machine Company, Bay City, Mich., died on June 4, 1914, aged 73 years.

Mr. MacKinnon was born in Cape Breton, Province of Nova Scotia, Canada, March 17, 1841, leaving there in September, 1860, for New York City. For eighteen months after that time he was engaged in sailing between New York and the West India Islands, and in the spring of 1863 he left New York for Chicago, and sailed on the Lakes during that summer.

In the fall of 1863, Mr. MacKinnon went to Cleveland, Ohio, entering the employ of the Cleveland, Columbus & Cincinnati Railroad Company, under an uncle, Neil MacKinnon, superintendent of the shops, to learn the trade of boiler making. From Cleveland he went to Columbus, Ohio, working at his trade, from there to Dubuque, Ia., and then returned to Cleveland, where, on July 8, 1864, he was married to Agnes Kirk.

Subsequently Mr. MacKinnon worked for the Cleveland & Pittsburg Railroad Company, and later for the Miller & Jameson Boiler Works in Cleveland. He was one of the organizers of the Variety Iron Works, of Cleveland, and the next year, 1867, sold out his Cleveland interests and moved to Bay City, Mich.

In Bay City Mr. MacKinnon erected a boiler shop and started in business under the firm name of MacKinnon & Bestor, although in 1868 Joseph T. Kirk bought out Mr. Bestor's interest and the firm name was changed to MacKinnon & Kirk. In the latter part of 1869 Joseph T. Kirk retired from the partnership, and the business was continued under the name of the Bay City Steam Boiler Works, John D. MacKinnon, proprietor. In 1883 a machine shop, foundry, pattern shop, blacksmith shop and drafting department were added to the business, and the name was changed to MacKinnon Manufacturing Company.

John Donald MacKinnon

Mr. MacKinnon was elected Alderman of the Fourth Ward of Bay City, and served two terms, from 1878 to 1882, and afterwards served four years as Bridge Commissioner on the Police Commission, and on the Water Works Commission for five years, from 1885 to 1890. He spent the winters of 1900 and 1901 in the Bermuda Islands and the winter of 1902 in Porto Rico.

In 1902 Mr. MacKinnon sold out his business interests to his sons, Hector D. and Arthur C. MacKinnon, when the title of the concern was changed to MacKinnon Boiler & Machine Company. In 1903 he took a Western trip, spending some several months on the Pacific Coast, and upon returning to Bay City decided to take up his residence in Ocean Park, Cal. He took an active part in the upbuilding of Ocean Park, serving several years as one of the trustees, and during his term of office he superintended the installation of the high-pressure salt-water fire mains established in the city.

During his business career, until his retirement in 1902, Mr. MacKinnon was extremely active, and met with well-merited success. He is survived by his widow, his two sons, Hector D. and Arthur C., and four grandchildren.

Letters from Practical Boiler Makers

A Reliable Plate Clamp

Occasionally it is asked if someone can furnish data for a reliable plate clamp capable of lifting plates vertically by utilizing the weight of the plate to secure the grip of the clamp to the plate. The accompanying sketch shows a clamp which has worked with perfect safety, the dimensions being for a clamp to carry plates from ¼-inch to ½-inch thick.

It is simple in design, cheap to make and far superior in every particular to the old screw clamp. The clamp shown is particularly adaptable for lifting plates which are stacked vertically in racks, as is the custom generally. In this way its use would save considerable time, since it is only necessary to drop one side of the clamp over the edge of the plate and push the roller into position as tight as possible. When the plate is being lifted the clamp will automatically create its own grip, the action being similar to a wedge. If, on releasing the plate, it must be let down flat on the floor, the top edge of the plate should have a block of wood, etc., placed under it, so that the clamp will be free. The clamp may then be released by tapping the turndown of the roller bar. To carry lighter plates than ¼ inch a larger roller should be substituted, which requires only about a minute to change. If plates are heavier than ½ inch, a larger clamp should be employed than the one shown in the sketch.

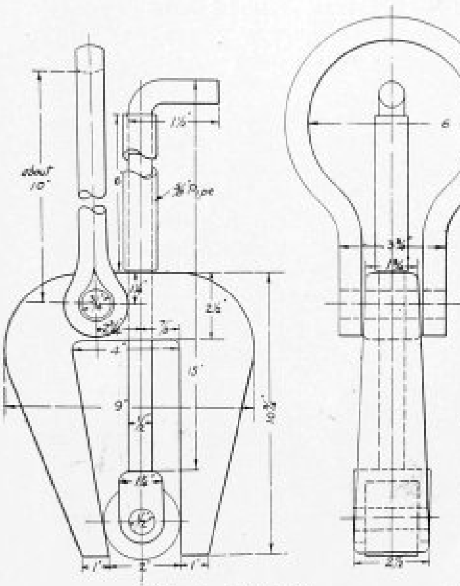


Fig. 1.—Plate Clamp

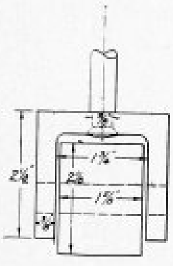


Fig. 2.—Detail of Roller Enlarged

Toronto, Canada. S. Harriman.

Boiler Shop Apprentices

After reading the article by Mr. Forbes in the June issue of The Boiler Maker, I have come to the conclusion that he has the right idea on the subject of apprentices. I have been engaged in boiler making for a good many years, but I do not remember seeing any bound apprentices in a boiler shop. In the first place, there is no law to compel a young man to be indentured to any trade in the United States. He can go to work for a concern and leave when he likes. Some will enter a shop as an apprentice and stay for a short time; when they get so they can handle a few of the tools they skip out to some other place and hire out as a boiler maker, or as an operator of a long-stroke hammer or some other tool which they may do in a way that will pass the foreman, who may know as little about the tool as the workman does himself. With such workmen in the shop it is no wonder that poor work is turned out and that all boiler makers get the blame for it.

No one can learn the boiler making trade in one or five years, although after that length of time a man may be able to do some parts of it. A lot has been said about education in the shops. How many young men that have a high school education will enter a boiler shop as an apprentice? As a matter of fact very few will do it. They would rather seek a position in an office, even if they receive only two or three dollars a week for their work. Generally it will be found that after a young man has been in the shop for a year or two he will try and get an education either at a night school or through a correspondence school; that is, if he takes interest in the business.

The main desire in a boiler shop, nowadays, seems to be not for apprentices but for handy men who can use a long-stroke riveter, or a calking hammer. Very little hand riveting is done nowadays and this reminds me of a job I saw in the riveting of a furnace in a Continental boiler. I could turn about half of the rivets in the hole with my thumb and finger after they had been driven. This was caused by heating the point of the rivet hotter than the head. The soft point of the rivet spread out under the blows of the hammers and did not allow the cooler neck and head to upset in the hole, so that when the rivet cooled off it was loose.

No rivet should be driven with the points hotter than the head and neck. If anything, the head should be hotter than the point, so that the neck will upset in the hole properly. This is a necessary requirement for both hydraulic and hand riveting. It stands to reason that if the head and neck of the rivet are the hottest parts of the rivet, the metal will flow to fill the hole under the blows of the hammer. If the point is the hottest the metal will spread and not upset in the hole, so that as soon as the rivet becomes cold and contraction ceases the rivet is loose. This is the reason why so many rivets have to be calked when testing the boiler. Neither iron nor steel rivets should be heated to a fusing heat, as that alters the nature of the metal. By heating the rivets in an oil furnace until they are brought to a straw color they will be safe and no damage will be done to the metal.

Springfield, Ill. John Cook.

The Foreman Boiler Maker

Archtube's complaint in the May issue of The Boiler Maker, of the way the foreman boiler maker is treated in most of our engine houses and repair shops, is the complaint of large numbers of foremen, and there is no reason why there should be cause for such a complaint; but it is a fact that either an engineer or a machinist is given the authority and the position from which they can dictate to the foreman boiler maker, regardless of the boiler maker's ability to handle his own department.

Many of our railway officials think that an engineer, being a capable man at the throttle, careful of the use of oil, tallow and coal, is a good man to be general foreman or master mechanic, and by appointing such men to those positions they think they are working for the best interests of the company; but they make a great mistake, for they are putting great power in the hands of men who cannot possibly be qualified for such positions.

There is no other trade in the country that is so overridden as that of boiler making, and many of our shop managers, master mechanics and general foremen seem to think that anyone is good enough for a boiler shop foreman. The very fact that a foreman is capable of handling from 75 to 300 men, doing new work and general repairs and turning out the work mentioned by Archtube, ought to be a sufficient guarantee that he thoroughly understands his business, and should be consulted in all cases regarding the work of his department. If our master mechanics and general foremen were graduate mechanical engineers, who had made a study of boiler construction, I am sure that they would at all times consult the foreman boiler maker in all matters pertaining to his department, and that his judgment would be taken as final as to what repairs should be made and whether an engine was fit for service or not, regardless of the condition of his machinery. It is about time that the bawling-out of a foreman (for the failure of a repair job, done directly counter to his good judgment) came to a stop. And here it may be said that if our foremen had a little stamina and backbone and told some of the master mechanics and general foremen to go to El Paso or some other warm climate, I think there would be less bawling-out done. If they asserted themselves once in a while, knowing that they are right, the master mechanics and general foremen would be loathe to incur the foreman boiler maker's displeasure.

I think that when a man is appointed foreman boiler maker he should be invested with full authority to discharge and hire his own men, just the same as the foreman pattern maker, carpenter and blacksmith are in any of our large railway shops or manufacturing works. If they are not allowed to say what shall or shall not be done in their shops what are they there for? If they are there only as figureheads then do away with the position, save their wages and let the general foreman run the whole affair and see how long he will hold his job or how long it would take to put the place in disorder. Some years ago the writer was appointed foreman, and the conditions upon which he accepted the position were that he was to be foreman in every sense of the word, to take orders directly from the superintendent, hire his men, set their rates, up to a certain point to advance a man's wages, and discharge when necessary. When handling a large force of men it is to the foreman's advantage that his men know that these powers are invested in him, for he can hold many an unruly man in check with the power at his command, as going to the general foreman would avail the man nothing. With conditions of this kind it is possible for a foreman to get together a good force of men, which he can place to the best of advantage and where the ability of the good mechanic will surely show itself.

Again, a foreman capable of keeping a large force of men properly employed must be a leader of men himself, capable of instructing his men and of imparting to them things that they are not familiar with, thereby getting the good will of his men and getting more work out of them than he would by driving them. The use of the straw boss or pusher is an abomination to the trade and many a good man given the job of assistant foreman finds that he is nothing but a driver or pusher; and if he has any sense of manliness in his make-up, he soon throws up his job and the company loses a good man. No doubt withholding the power to hire and discharge from some foremen works to the advantage of both the company and men alike, for there are men who, once given power over their fellows, forget themselves and for the slightest mistake give a man his time, although perhaps that man has spent years in the company's service and for the mere use of a profane word was cast adrift. Such cases have come under the writer's notice.

It is well to overlook small mistakes, for very few of us are free from them, and the man making a mistake once seldom or never makes the same one again. On one occasion the writer put a man to cut out the radial stays from the crown sheet of a boiler, instructing him not to cut out the sling stays. Being called to another part of the shop to attend to another job, and returning in about an hour, I was very much surprised to find that the man had given his whole attention to the eye bolt of the slings and they were past redemption. The entire lot had to be renewed. Now, I could have discharged that man for good and proper cause, but, instead, I gave him a good, quiet lecture on paying strict attention to orders in future and let it go at that. Now it is safe to say that that man would not make that mistake again, and it worked to his good and mine. The damage done was considerable, but it was not beyond repair. Again, withholding the power to hire and discharge from the foreman is withholding the respect that goes with the position of foreman, alike from officials and shop men, for where there is no respect shown to a foreman by his superior officers the men under him cannot be expected to be respectful. With poor shop organization the work is badly done, for it must be remembered that boiler makers are but human and are just as quick at finding loose screws in a shop system, and just as quick at taking advantage, as anyone else when they know that authority is lax.

Without authority to sustain him, the foreman is at the mercy of any unscrupulous man under him who may see fit to go over his head to the general foreman or master mechanic, and there is no redress for him—only the one we all have, that of quitting. There is a case very fresh in my memory of a master mechanic, in the presence of the foreman boiler maker, directing a boiler maker to do a certain job, telling the man to take no orders from any but him. Now here was a case where the boiler maker, a bright, intelligent man, was put in a very embarrassing position and where the master mechanic showed anything but dignity and good judgment, and the foreman not one particle of self-respect or manliness, or he would have quickly handed in his resignation. With a foreman of this kind in charge of a shop and a master mechanic who will deliberately insult him before his men, what kind of work do they expect to have turned out? A man in charge of such a shop is a sailor in charge of a ship without a rudder whose captain is drunk or crazy and the ships' company in a state of mutiny. The man is perfectly helpless.

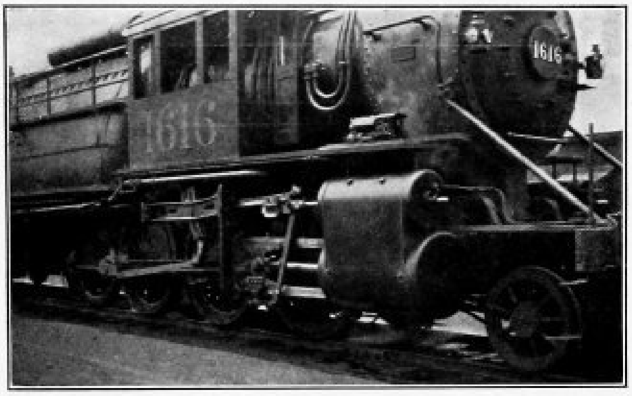
Again, as Archtube says, there is more work now since the Interstate Commerce Commission law has come into effect; and I say, since the boiler maker foreman is held responsible for all leaks about a boiler, that he should have "the say" in the case of all steamtight work connected with the boiler, and that nothing should be O.K.d without his or his inspector's consent, and that his word that a steam or any other pipe under direct boiler pressure was not in good working condition should be sufficient to have it attended to at once. In the case of engines in for washout or inspection, when the nature of repairs to be made, if any, are made known to the foreman boiler maker, he should have power to order the engine out of service, so that proper attention can be given to the putting of the boiler in proper working condition.

There are no trades in existence to-day where as much is expected of the men as there is at the hands of the boiler maker. There is no trade where promotion is slower, and there is no trade where after promotion the salary is so small, especially in railway shops. Further, there is no trade in all of the mechanical branches, except that of boiler making, where the foreman is not recognized as an authority in his trade. That, and the indifference in which the foreman is held by the motive power department, make the life of the foreman anything but an ideal one.

The remedy is to put in office as master mechanics, general foremen, etc., men with technical educations, liberal-minded men, who are not afraid or ashamed to ask for information and take the word of a good, honest boiler maker. Eliminate the bonehead who, because he is an engineer, machinist or fireman, thinks he is a superior being, far removed above the common herd of boiler makers who are not capable of thinking for themselves. Then and not till then will the foreman boiler maker come into his own and be on an equal footing with the foreman of our railway shops and be respected alike by masters and men. FLEX IBLE.

Model of Saddle-Tank Four-Wheel Locomotive

During the recent visit of the Master Boiler Makers' Association to the plant of the Lukens Iron & Steel Company, Coatesville, Pa., Theo. B. Conner had on exhibition a model of a Vulcan switching engine, as manufactured by the same company. Having received numerous inquiries as to the size of the model, Mr. Conner has submitted the illustration shown herewith and the following data:



23-Inch Model on Running Board of Large P. & R. Locomotive

Boiler—

- Diameter, 3½ inches.
- Thickness, No. 10 Lukens flange steel.
- Five tubes, 10 inches long, ½ inch diameter.
- Single riveting, 3/16-inch rivets, ¾-inch pitch.
- Firebox, 4 inches wide by 4 inches long by 3 inches deep.
- Tested to 135 pounds pressure.

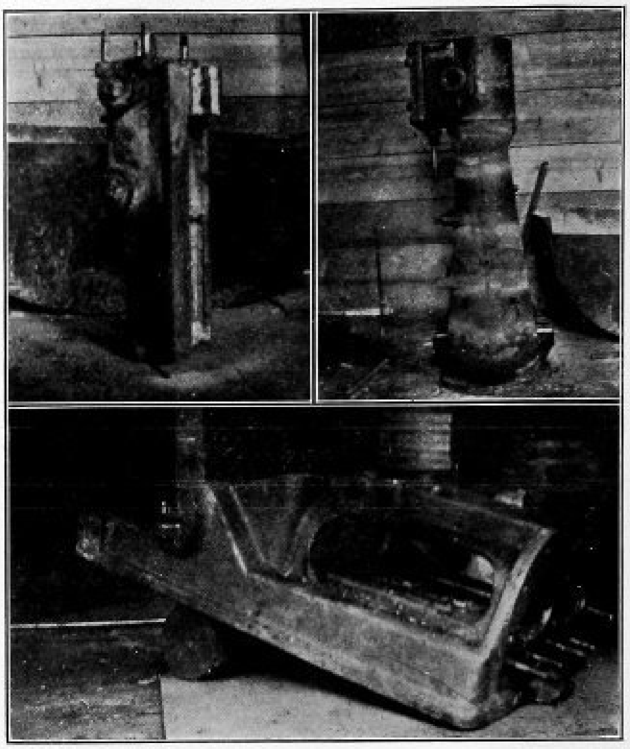
Engine—

- Cylinder diameter, 1⅛ inches by 1¾ inches stroke.
- Driving wheel, 3 inches diameter.
- Stevenson link motion.
- Steam ports, 1/16 inch wide by ½ inch long.
- Exhaust ports, ⅛ inch wide by ½ inch long.

The total length of the model is 23 inches and the total height 9 inches. It has been worked out to a scale of ⅛ inch to 1 foot, and is perfect in every detail, weighing 61 pounds.

Samples of Boiler Shop Welding

T. Hogan & Company, boiler makers in Halifax, Nova Scotia, recently welded several iron castings for the Cook Construcion Company, and the Wheaton Brothers, Limited, contractors for the new railroad extension in Halifax. One of the illustrations shows a vertical engine belonging to a "cyclone" drill which was broken in seven parts. This engine was welded up in the Hogan boiler shop without doing any damage to the babbitted bearings. Since the repairs were made, this drill, as well as another one which was broken in only two parts, has been running for about four months both night and day. The other photographs shown are castings, one of which belongs to a steam shovel and the other to a rock drill electrically driven. These photographs will illustrate the wide range of repair work which can be accomplished in a boiler shop by the use of welding methods.



Castings Welded at the Hogan Boiler Shop

The welding at the Hogan boiler shop was done by the oxy-acetylene process with apparatus supplied by Messer & Company, Philadelphia, Pa.

PNEUMATIC RIVETERS AND RIVETING CONDITIONS IN STRUCTURAL WORK.—The field connections in the lower seven stories of the Equitable building, New York City, are very largely made with 1⅛-inch rivets, of grip up to about 9 inches. It has been found that to drive these rivets successfully the largest obtainable pneumatic hammers are required, and air pressures up to 110 pounds must be used. Further, it is important that the point of the rivet be no hotter than the shank under the head, and in some cases the rivets are cooled at the point by dipping into water. In the early stages of the work, a rather heavy percentage of rivets was condemned by the inspector, in some cases because not enough stock had been left for the heading up. As these rivets are now being used a length of 2⅛ inches is allowed over the grip to form the head and to supply metal for the upset. This allowance is somewhat excessive, but it gives a safe margin to allow for any overrun in the size of the hole, etc. Practically all the field-connection holes are reamed out after assemblying, in spite of the fact that they are already drilled holes. The reaming insures a perfect match and guards against difficulty in entering the hot rivet. The hammers used are long-stroke Boyer and Ingersoll-Rand 1 13/64 by 8-inch hammers.—*Engineering News.*

Technical Publications

MARINE BOILER MANAGEMENT AND CONSTRUCTION. Fourth edition. By C. E. Stromeyer, M. Inst. C. E. Size, 6 by 9 inches. Pages, 405. Illustrations, 463. New York and London, 1914: Longmans, Green & Company. Price, $4 and 12/6 net.

This book, which contains one of the most complete collections of information regarding the manufacture and management of marine boilers, is typical of the author, whose broad viewpoint, covering exhaustive investigations of every subject under discussion, makes the book not only of special interest but of the utmost value. For the information of manufacturers, the troubles to be expected from the use of defective materials are discussed, as well as the dangers to which a boiler is exposed after it leaves the manufacturer's hands. For the benefit of steam users, descriptions are given as to the processes of boiler construction and also scientific inquiries regarding fuels, corrosion and similar subjects. On account of the increasing use of wrought iron and steel, instead of copper, for steam pipes, a new chapter has been added on this subject which reviews all available experiments on the losses of pressure due to friction and to radiation, explains the methods of manufacture and discusses steam pipe explosions, of which about 200 have been reported by the Board of Trade as being due either to water hammer, to inelastic arrangement, or to bad material. The question of elasticity of pipe bends has necessitated the addition of a few mathematical remarks on curved beams and a comparison with experiments on full-sized pipes. High-speed tool steel, oxy-acetylene and electric welding are other subjects brought out in the present edition. The last two chapters include Lloyd's Register and Board of Trade Boiler Rules.

THE WORKING OF STEAM BOILERS. Fifth edition. By Edward G. Hiller, B. Sc., M. I. C. E., M. I. Mech. E. Size, 5½ by 8½ inches. Pages, 147. Illustrations, 83. Manchester, Reddish and London, 1913: Taylor, Garnett, Evans & Company, Ltd. Price, 1/6; bound full cloth, 2/–.

This book contains a collection of notes on a great variety of questions pertaining to steam boilers. It is intended primarily for the use of those in charge of and responsible for the working of steam boilers insured with the National Boiler & General Insurance Company of Great Britain. The directions and instructions given refer to matters which this company's experience has shown to be essential to safety, and also to various precautions necessary for satisfactory working and for the prevention of undue deterioration of the steam-raising plant. While these notes apply directly to those types of boilers which are in use on land in the United Kingdom, the principles of care and management can readily be applied to other types of boilers.

MEXICAN FUEL OIL. Size, 6¼ by 8¾ inches. Pages, 150. Numerous illustrations. London, E. C., 1914: Anglo-Mexican Petroleum Products Company, Ltd. Price, 3/6 net.

While the book is intended primarily to give a comprehensive account of the production, refining, distribution and uses of Mexican oil as produced by the Mexican Eagle Oil Company, it includes a very general discussion on the advantages of oil for fuel and its many and varied uses. Starting with a review of the progress of petroleum, the general advantages of fuel oil and the types of burners and systems used, descriptions are given of special applications of fuel oil in the navy, the mercantile marine, on railroads and for stationary steam plants. All through this discussion prominence is given to the subject of coal versus oil fuel, the data given showing some very startling advantages for fuel oil in practically every one of its many applications.

Selected Boiler Patents

Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

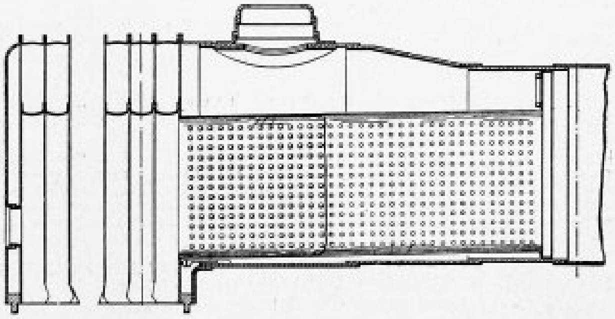
Readers wishing copies of patent papers, or any further information regarding any patent described. should correspond with Mr., Decker.

1,092,854. APPARATUS FOR FEEDING AIR TO FURNACES. JOHN H. PARSONS, OF RIDLEY PARK, PENNSYLVANIA, ASSIGNOR TO PARSONS ENGINEERING COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

Claim 1.—In a furnace fire box an air conductor comprising a base member having a chambered upper portion, a series of conductor members located on the base and provided with a series of integral heat radiating ribs projecting into the air space, a commingling chambered member at the upper end of the conductor and a nozzle on the said last-mentioned member. Two claims.

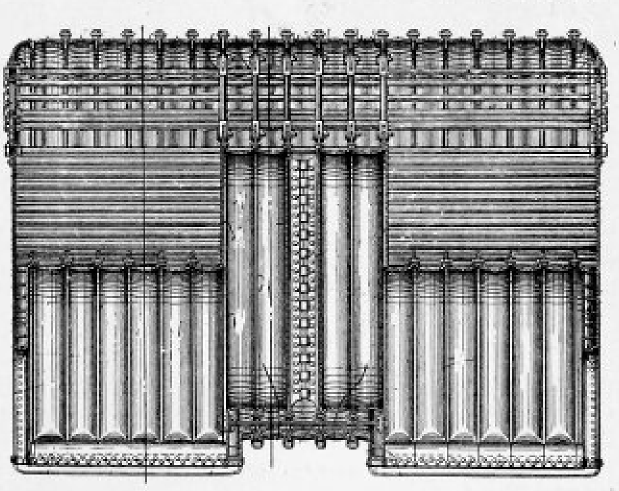
1,093,429. BOILER-FLUE. HENRY W. JACOBS, OF TOPEKA, KANSAS, AND FRANK W. SHUPERT, OF BRISTOL, INDIANA.

Claim 2.—A boiler flue composed of flat sheet metal provided with a series of indentations or impressions at prearranged intervals, the sheet metal being bent so as to produce an enlongated flue in cross section with the indentations or impressions on the portions of the sheet constituting the opposite side walls adapted to register with each other. Eight claims,



1,093,430. BOILER. HENRY W. JACOBS, OF TOPEKA, KANSAS.

Claim 2.—A boiler, composed of one or more fire-boxes and one or more combustion chambers arranged at opposite ends of the boiler with the combustion chambers arranged adjacent to the vertical center line of the boiler, the fire-boxes and combustion chambers being composed of sections substantially U-shape in cross section, having their flange portions presented outwardly, with the flange portions of the adjacent fire-box sections and combustion chamber sections elongated upwardly and downwardly, respectively, so as to provide integral flue sheets and fire-box inner end sheets adapted to be secured to the adjacent flanges on the water side of the boiler. Ten claims.

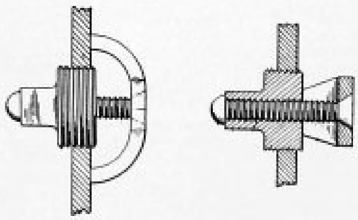


1,093,054. SPARK-ARRESTER. ROBERT E. JACKSON, OF VICTORIA, AND FRANK E. BELL, OF NORFOLK, VIRGINIA.

Claim.—The combination in a locomotive, of a fire box, a smoke box, flues extending between and connecting the fire box and the smoke box, a diaphragm dividing the smoke box into a rear chamber in communication with the flues, and a forward chamber; said diaphragm including in its forward portion a foraminous plate, a smoke discharge leading from the upper portion of the forward chamber, a steam discharge pipe adapted to be connected with a source of steam supply and alined with said smoke discharge and communicating with the forward chamber, a conduit leading from the forward portion of the rear chamber, at a point in front of the foraminous plate of the diaphragm, and back to and communicating with the fire box, and a conduit connected with a source of steam supply and arranged to discharge steam into the said conduit that leads back to the fire box. One claim.

1,093,434. STEAM-BOILER PLUG. SAMUEL R. KENT, OF HIGH SPRINGS, FLORIDA.

Claim 1.—A tubular plug adapted to be inserted into a hole in a boiler, the plug having a head at its outer end and a threaded bore; combined with a yoke adapted to span such hole and having a perforation, a bolt having a threaded body engaging said bore and its inner end swivelly mounted in said perforation, and means for turning the bolt from its outer end. Eight claims.



1,093,386. GRATE-SHAKER. JAMES A. DEMPSEY, OF NEW YORK, N. Y.

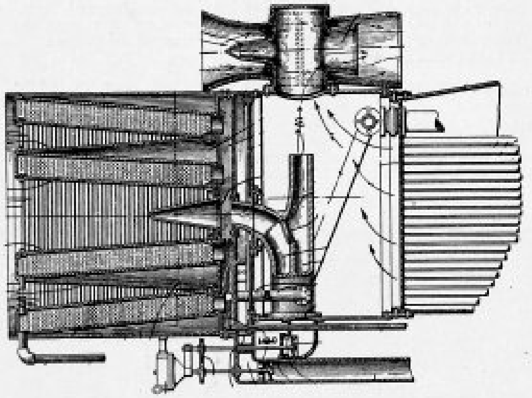
Claim 1.—The combination with a furnace, of a motor for operating the furnace grates and means for automatically controlling said motor, said means being adapted to be actuated by the opening of the furnace door. Seven claims.

1,093,161. DAMPER-REGULATOR. JAMES WILKINSON, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—In combination, a boiler, a source of heat, a flue for the exhaust gases, a regulator for the draft due to said flue, a main for conveying vapor from the boiler, a means sensitive to changes of pressure of the vapor in the boiler for adjusting the regulator, and a means sensitive to changes in the rate of flow of vapor through the main from the boiler, which also adjust the regulator.. Nine claims.

1,093,942. CONDENSER FOR LOCOMOTIVES. JAMES M. McCLELLON, OF EVERETT, MASSACHUSETTS.

Claim 3.—The combination with a locomotive boiler, of a condenser comprising an open-ended casing extending forwardly from said boiler, concentrically-arranged condensing pipes within said casing, means to admit the exhaust steam to said pipes, and deflectors to deflect air currents across said pipes. Ten claims.



1,093,519. SUPERHEATER. EDWIN J. AKINS, OF MOUNDSVILLE, WEST VIRGINIA.

Claim 1.—In a superheater device for traction engines, the combination with the boiler of a traction engine, of a steam dome connected to the upper part of said boiler and in free communication with the upper part of the interior of the boiler, means for directing steam from said steam dome to a point of discharge, and exhaust reheating coil surrounding said dome, and means for automatically connecting said dome and said coil for maintaining a predetermined pressure in said coil. Eight claims.

1,093,446. FIRE-DOOR DRAFT-CHECK. ROBERT G. LONG, OF LAWRENCE, KANSAS.

Claim 1.—In combination with a furnace having a plurality of fire doors and a damper, a draft check comprising a shaft journaled upon the furnace, a handle lever fixed to the shaft, a member pivoted to the handle lever and arranged to move so that the point of pivotal connection between the said member and the handle lever may be carried from one side to the other of a vertical line passing through the center of the shaft, a flexible member connected with the said pivoted member and the damper, blocks fixed to the shaft and corresponding in number to the number of fire doors, each block having a recess, a pawl pivoted in each recess and projecting into the path of movement of one of the fire doors. One claim.

1,093,790. STEAM-BOILER FURNACE. CHARLES E. LLOYD, OF PHILADELPHIA, PENNSYLVANIA.

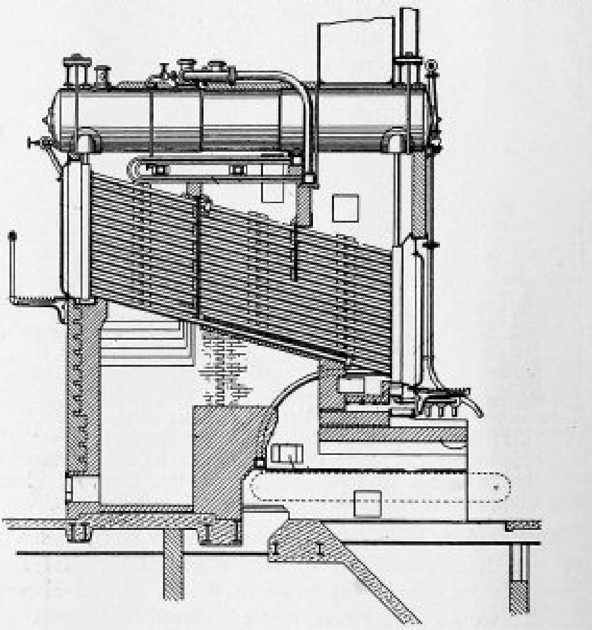
Claim 1.—The combination with a furnace wall having an internal supporting shoulder, a drum supported on said shoulder, a seconod drum above the first-mentioned drum, water tubes connecting said drums, tubular flues extending through the last-mentioned water tubes and communicating with the spaces above and below said drums, a magazine projecting through the central openings in both of said drums, the lower portion of the furnace below the lower drum constituting a firebox, vertical water tubes in said firebox communicating with the lower drum, and a base ring communicating with all of said last-mentioned water tubes. Four claims.

1,093,911. BOILER-FURNACE. JOHN M. CAMERON, OF JOHNSON CITY, TENNESSEE, ASSIGNOR, BY MESNE ASSIGNMENTS, TO CAMERON SMOKELESS BOILER COMPANY, OF JOHNSON CITY, TENNESSEE, A CORPORATION OF TENNESSEE.

Claim 1.—The combination with a boiler, of a grate extending longitudinally beneath the boiler and a coal hopper extending longitudinally with relation to the boiler and extending down around the side of the boiler and opening upon the grate, of a reciprocable feed plate extending longitudinally parallel to and disposed within the hopper, said plate having a corrugated face, the corrugations of which extend transversely to the direction of movement of the plate and parallel to the direction of feed of the fuel, and means for longitudinally reciprocating said plate. Five claims.

1,094,754. WATER-TUBE BOILER. MINOTT W. SEWALL, OF ROSELLE, AND DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, 9..O GEORGE E. PALMER, OF CHICAGO, ILLINOIS, ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim 1.—In a watertube boiler, in combination, a furnace having side walls, an arched roof spanning the furnace above the grate, a cross wall above the arch, a roof extending from said cross wall and forming with the cross wall a chamber into which soot may fall, a floor for said chamber above the arch and forming with the arch a space excluded from the furnace, buck stays forming abutments for the opposite ends of the arch, and tie rods connecting the buck stays through said space. Two claims.



1,094,702. FURNACE-FRONT. FRANCIS MORTON CLARK, OF GARDEN CITY, NEW YORK, ASSIGNOR, TO MULTIPLE-GRATE-BAR ENDLESS CHAIN STOKER COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—In a furnace, side walls, a metallic beam resting on said side walls, a slotted fuel-distributing plate secured to the front of said furnace, fire-brick blocks mounted below said beam in position to protect it from the heat of the fire, an L-shaped supporting means within each fire-brick block, the vertical portions of said supporting means bein attached to said beam, and the horizontal portions passing through slots in the distributing plate and being secured to said plate. Seven claims.

1,095,907. SMOKE-CONSUMING FURNACE. PATRICK HENRY McGIEHAN, OF BROOKLYN, NEW YORK.

Claim 1.—In a smoke-consuming furnace, a bridge wall provided at the rear side of the firebox and provided with air emission ports in its rear face, stacks arranged rearwardly of said bridge wall and provided with air emission ports presented rearwardly of said stacks, a checker wall spaced rearwardly of said stacks and provided with a plurality of openings, said checker wall dividing the furnace into two combustion chambers, and air ducts connecting the rearmost wall of the furnace with said checker wall and having their orifices in the front side of said checker wall. Two claims.

1,095,991. BLOWER FOR BOILERS. JAMES C. BENNETT, OF DETROIT, MICHIGAN, ASSIGNOR OF ONE-HALF TO GORDON C. BENNETT, OF DETROIT, MICHIGAN.

Claim 23.—In a steam blower, the combination with a boiler setting and flue sheet, of a steam-supplying pipe movably supported by said boiler setting, a frame carried by said pipe in parallelism with said flue sheet, a movable body in communication with said steam-supplying pipe and movable in a plane parallel with said frame, a steam-ejecting arm movable in said body and in communication therewith, a carrier connected to said arm and guided by said frame, and manually operated means in proximity to said steam-supplying pipe for imparting movement to said carrier whereby said arm is' shifted in front of said flue sheet. Twenty-four claims.

THE BOILER MAKER

AUGUST, 1914

Pennsylvania Mikado and Pacific Locomotives

Belpaire Type Boilers Adopted—Throat Sheet Flanged Integral with Lower Half of Rear Barrel Sheet—Superheaters and Fire Brick Arches Fitted

During the last few years the Pennsylvania Railroad Company has felt the need of a larger freight locomotive for use on the main line between Altoona and Pittsburg, in order to reduce double-heading to a minimum and to avoid breaking up trains arriving at Altoona and Pittsburg before sending them forward over the Pittsburg division. It was also thought desirable to experiment with a very heavy Pacific type locomotive for passenger service on the same division. With this object in view a Mikado locomotive, which will bear the Pennsylvania Railroad classification "L-1-s," and a Pacific type locomotive, which will bear the Pennsylvania Railroad classification "K-4-s," have been developed. The first "L-1-s" locomotive was placed in service in May of this year, while the first "K-4-s" locomotive was placed in service in June.

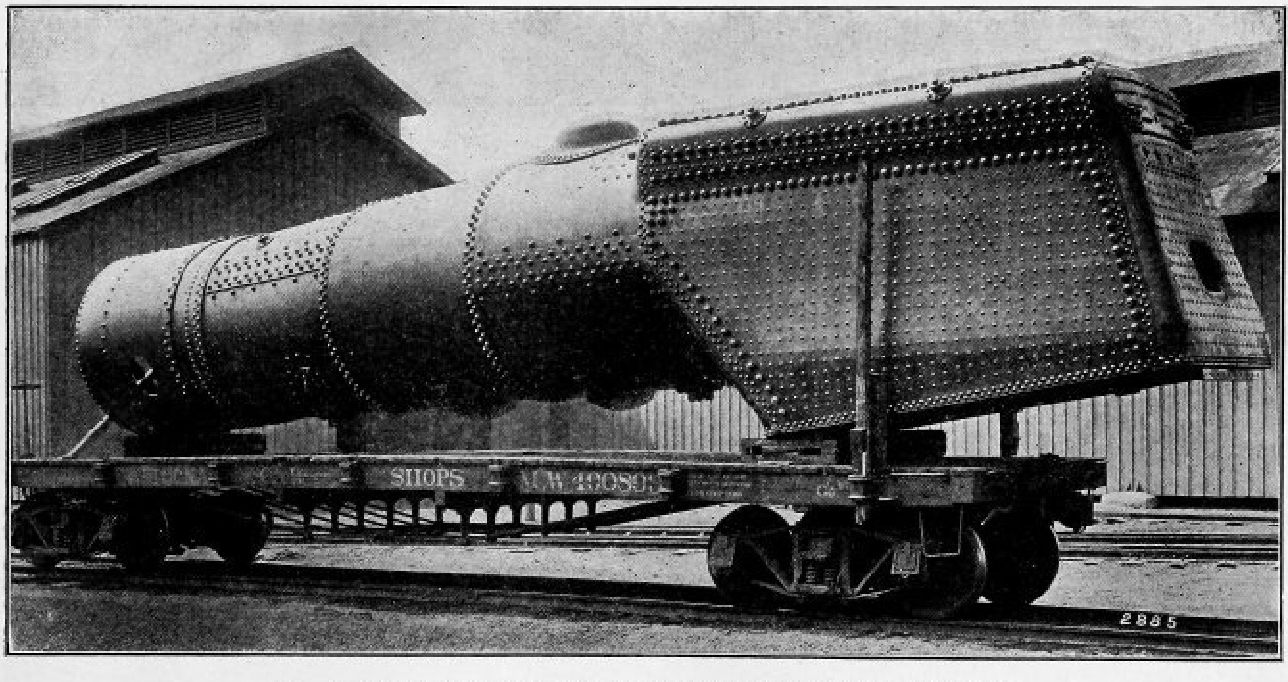


Fig. 1.—Completed Belpaire Type Boiler for New Pennsylvania Locomotives

Inasmuch as the road clearance is somewhat limited, also the weight per pair of driving wheels is limited to 65,000 pounds, with a 5 percent margin for scale variations, and the dynamic augment of the unbalanced reciprocating parts at 70 miles per hour is limited to 30 percent of the weight on the drivers, it was necessary to keep the locomotives within restricted limits and make the revolving and reciprocating parts as light as possible and at the same time maintain the necessary strength. Further, it was found desirable to maintain as many parts as possible interchangeable in these two types of locomotives and to use as many parts as possible which are embodied in the design of the E6s locomotives.

The design of boiler is particularly interesting in the type of flanging used. It will be noted that the throat is flanged integral with the lower half of the rear barrel sheet. The advantages of this scheme are that it was possible to lower the locomotive about 1⅞ inches and at the same time give sufficient clearance for the rear driving wheels, the clearance being close at this point, particularly with the Pacific type locomotive. The practice of flanging the neck sheet and the barrel sheet in one piece has been followed on quite a number of the modern Pennsylvania locomotives, also that of flanging the dome in one piece has been used to quite an extent. The boilers of the "L-1-s" and the "K-4-s" locomotives are interchangeable.

The locomotives are equipped with all-steel cabs, which are considerably smaller than the standard type of cab used on the Pennsylvania Railroad. On account of the fact that the locomotives are equipped with screw reverse gear a cab of great length is not necessary, and it is believed that the

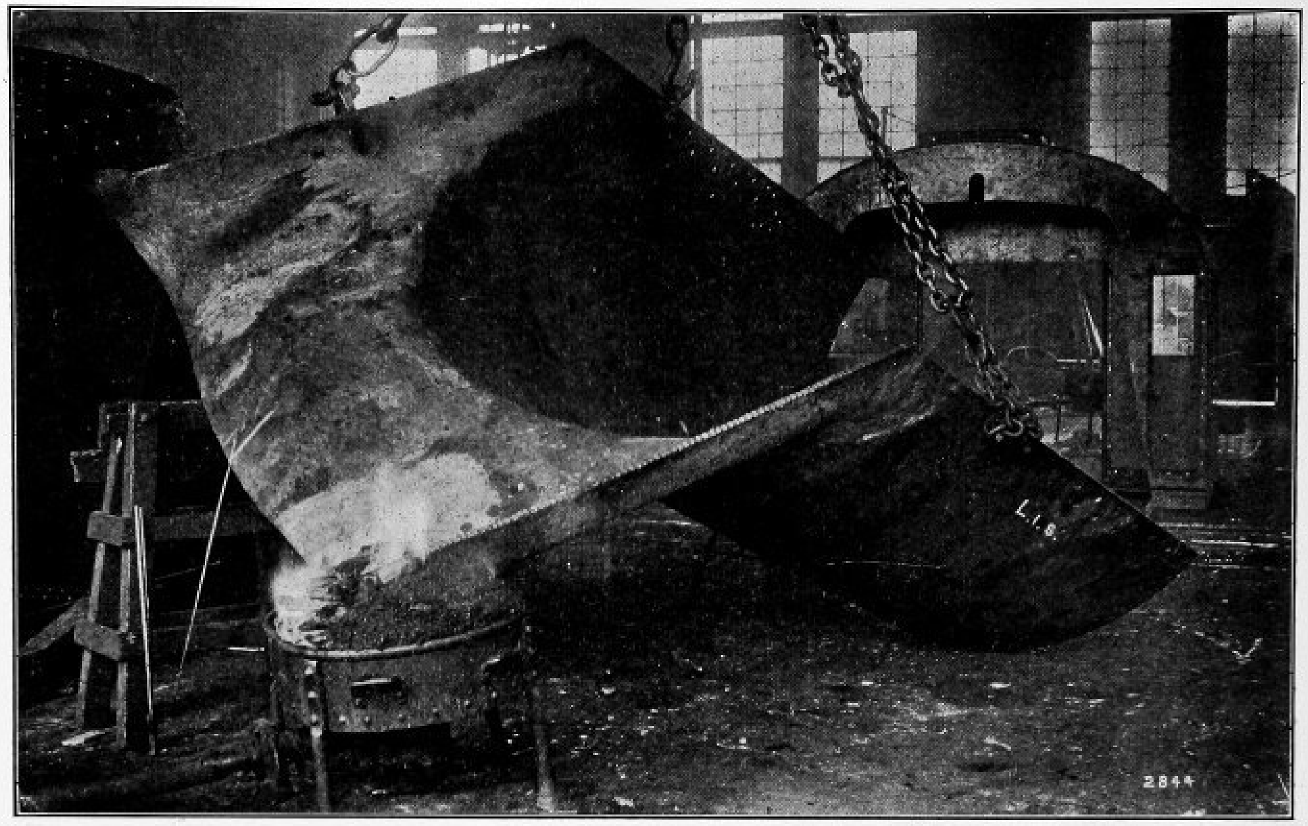


Fig. 2.—Lower Half of Dome Course Flanged Integral with Throat Sheet

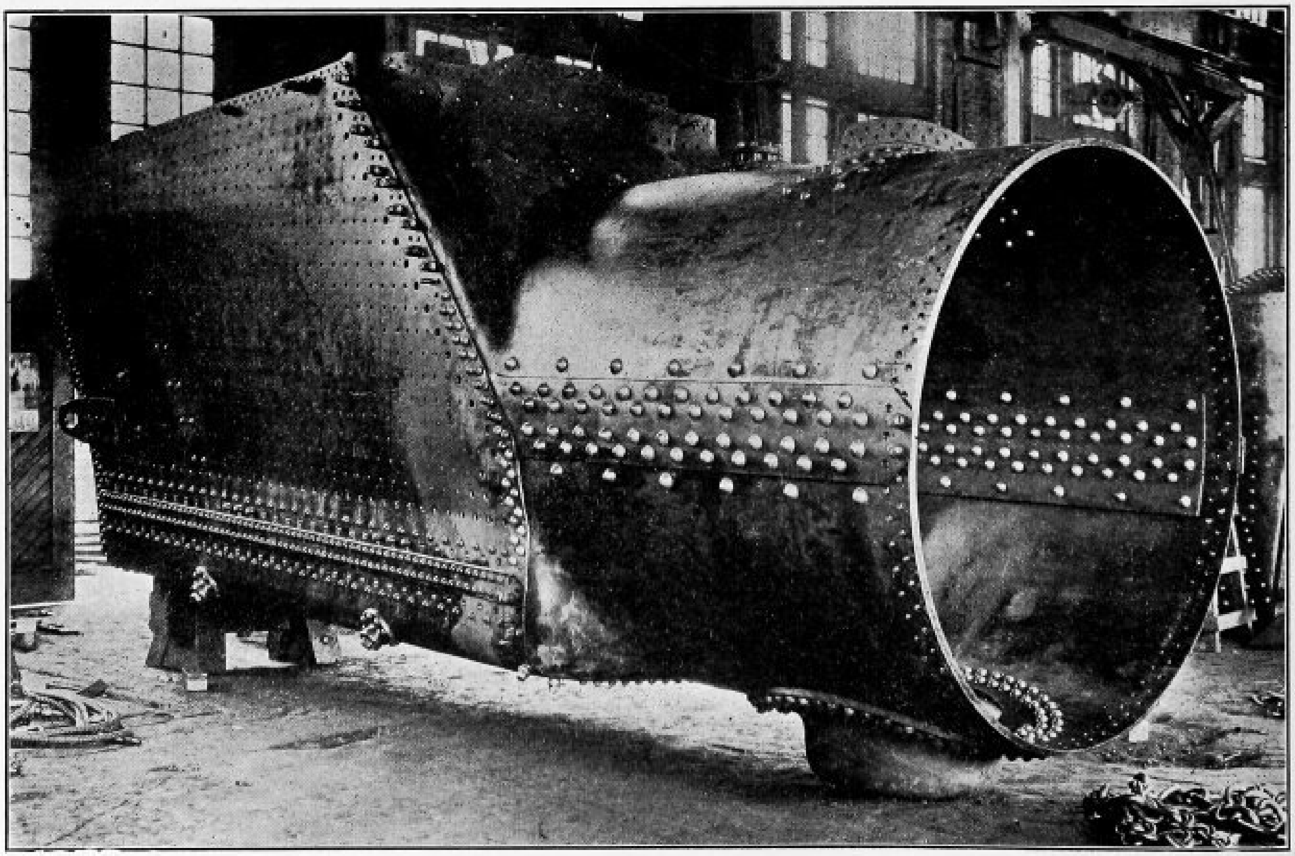


Fig. 3.—Outer Shell of Firebox and Dome Course Assembled

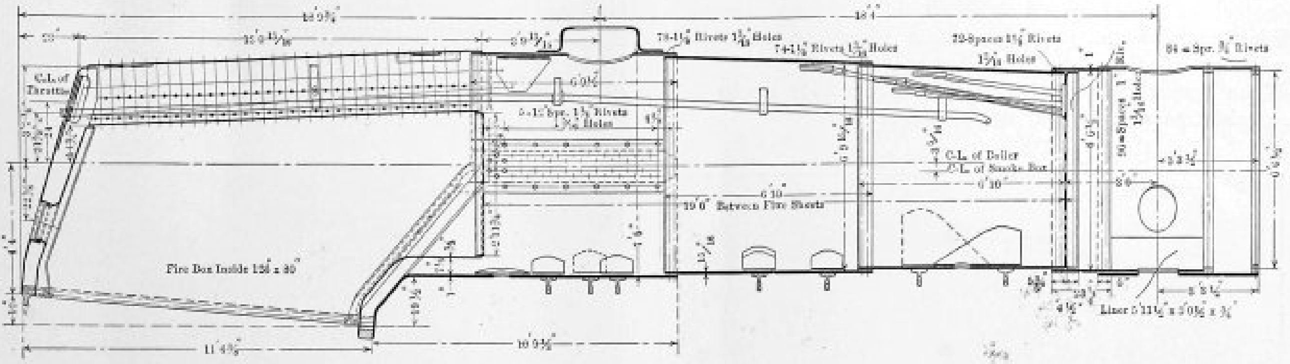


Fig. 4.—Longitudinal Section of Boiler

shorter cab will give the engine crews better opportunity to observe signals.

The running gear has been lightened as much as possible by the use of heat-treated material for driving axles, crankpins, piston rods and side and main rods. The axles, crankpins, wrist pins and piston rods are provided with holes through them with a view of reducing the weight and at the same time providing a better chance for the heat treatment to take effect.

The driver brake arrangement is particularly interesting on

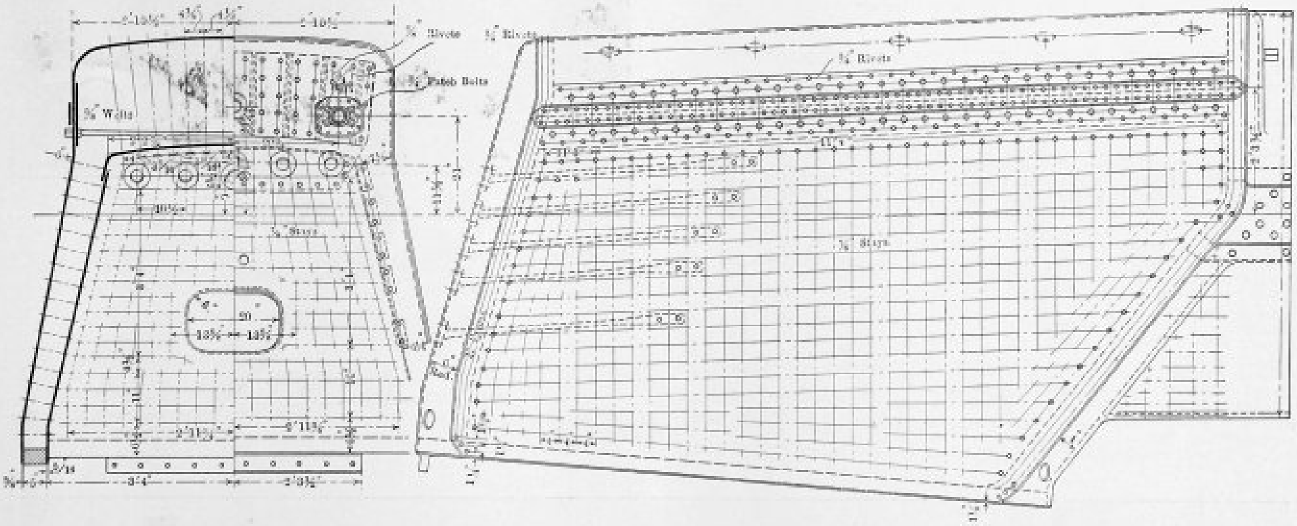


Fig. 5.—Details of Outer Shell of Firebox

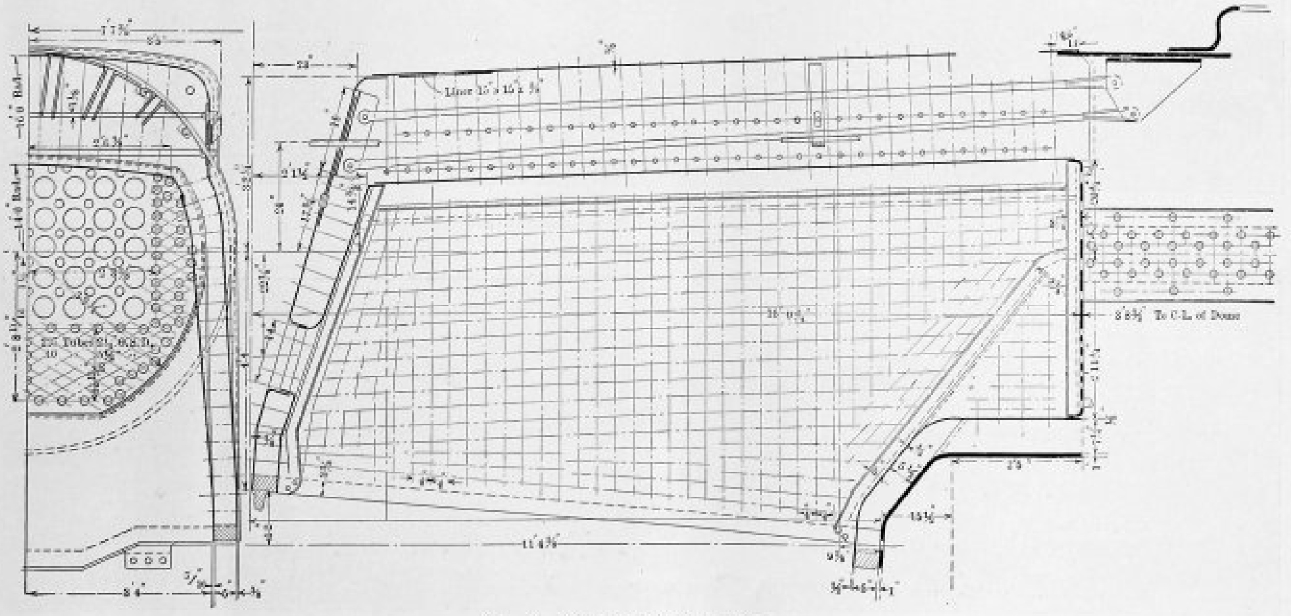


Fig. 6.—Sections Through Firebox

account of the arrangement of cylinders, this arrangement being necessary to provide sufficient space for two 16-inch cylinders, which are necessary for proper control.

The locomotives are equipped with Schmidt smoke tube superheaters and Security firebrick arch.

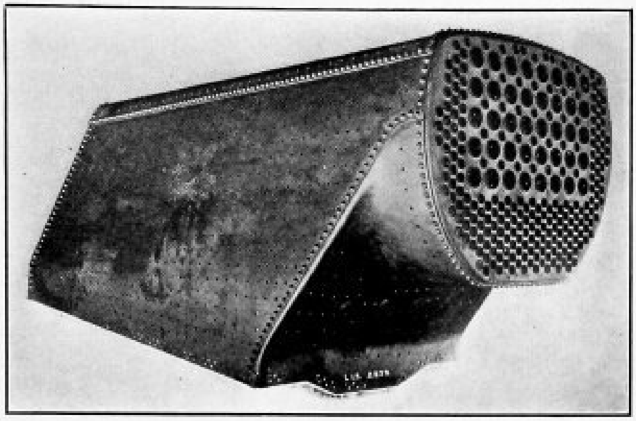


Fig. 7.—Complete Firebox

COMPARISON OF CLASS L-1-S AND H-9-S LOCOMOTIVES

Type	Consolidation	Mikado
P. R. R. Classification	H-9-s	L-1-s
Gage	4′ 9″	4′ 9″
Service	Freight	Freight
Fuel	Bit. Coal	Bit. Coal
Tractive Power—M. E. P.=4/5 Boiler Pressure	46,290	57,850
Estimated Total Weight in Working Order	250,000	330,000
Estimated Total Weight on Drivers	220,000	262,000
Wheel Base—Engine and Tender	62′ 5¼″	72′ 3″
Total Heating Surface* ÷ Grate Area	76.21	82.38
Firebox Heating Surface ÷ Total Heating Surface*, perct.	4.45	5.05
Volume both Cylinders, cubic feet	15.91	19.88
Total Heating Surface* ÷ Volume both Cylinders	264.1	290.0
Grate Area ÷ Volume both Cylinders	3.46	3.52
Kind of Cylinders	Simple	Simple
Diameter and Stroke of Cylinders	25″x28″	27″x30″
Driving Wheels, Diameter over Tires	62″	62″
Type of Boiler	Belpaire	Belpaire
Working Pressure	205 Lbs.	205 Lbs.
Outside Diameter of First Course in Barrel	78¾″	78¾″
Firebox, Width and Length	72″x110¼″	80″x126″
Firebox Plates, Thickness	⅜″& 5/16″	⅜″& 5/16″
Firebox Water Space	5″	5″
Tubes, Number and Outside Diameter	265 – 2″	237–2¼″
Superheater Flues, Number and Outside Diameter	36–5½″	40–5½″
Tubes, Thickness	.125″	.125″
Superheater Flues, Thickness	.148″	.148″
Tubes, Length	180″	228″
Heating Surface Tubes, Saturated	2841.2	3746.8
Heating Surface Firebox, Saturated	187.0	288.6
Heating Surface, Total, Saturated	3028.2	4035.4 } 5189.3
Superheater Heating Surface	782.2	1153.9
Grate Area, Square Feet	55.13	70.0
Dome, Height Above Rail	180″	180″
Center of Boiler Above Rail	9′–9″	9′–9″

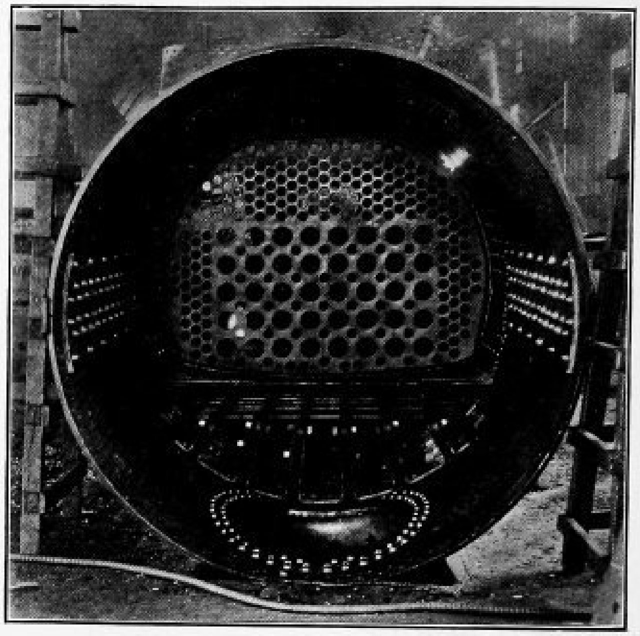


Fig. 10.—Interior of Dome Course

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* Equivalent Heating Surface { 4201.5 Square Feet – H-9-s
5756.3 " " – L-1-s

TENDERS.

P. R. R. Classification.	H9s	L1s
Tank	Wat. Bottom	Wat. Bottom
Water Capacity	7,000 Gals.	7,000 Gals.
Coal Capacity	25,000 Lbs.	25,000 Lbs.

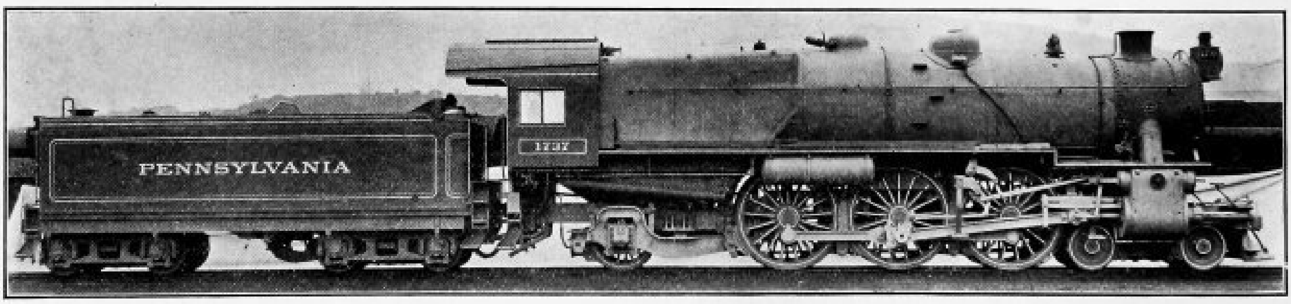

Fig. 8.—Pacific Type Locomotive

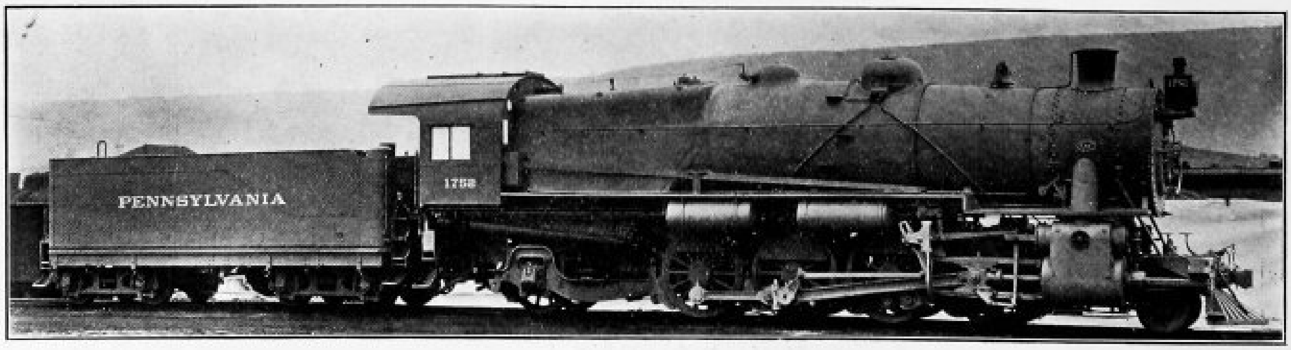

Fig. 9.—Mikado Type Locomotive

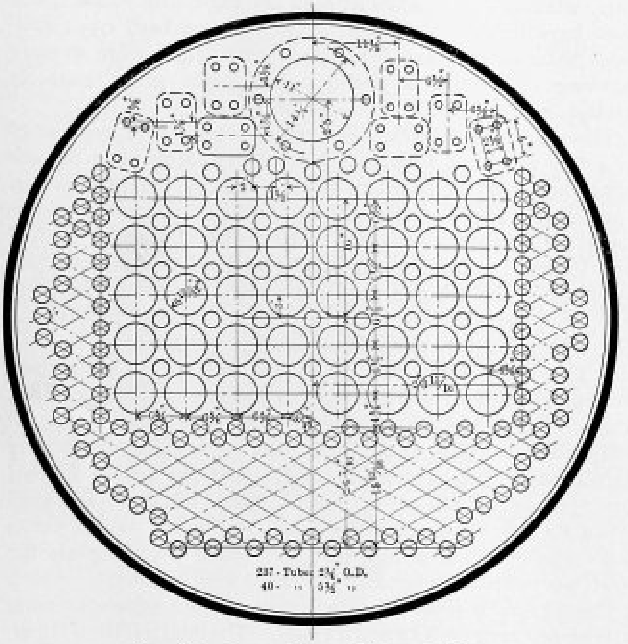

Fig. 11.—Cross Section Through Boiler

COMPARISON OF CLASS E-6-S AND K-4-S LOCOMOTIVES

Type	Atlantic.	Pacific
P. R. R. Classification	E-6-s	K-4-s
Gage	4' 9"	4' 9"
Service	Passenger	Passenger
Fuel	Bit. Coal	Bit. Coal
Tractive Power M.E.P.=4/5 Boiler Pressure, Pounds	29,427	41,845
Estimated Total Weight in Working Order, Pounds	240,000	305,000
Estimated Total Weight on Drivers, Pounds	133,100	200,000
Wheel Base—Engine and Tender	63' – 10½"	71' – 10"
Total Heating Surface* ÷ Grate Area	71.30	82.38
Firebox Heating Surface ÷ Total Heating Surface*, perct	4.93	5.05
Volume both Cylinders, cubic feet	13.10	18.55
Total Heating Surface* ÷ Volume both Cylinders	300.00	310.80
Grate Area ÷ Volume both Cylinders	4.21	3.77
Kind of Cylinders	Simple	Simple
Diameter and Stroke of Cylinders	23½"x26"	27"x28"
Driving Wheels, Diameter over Tires	80"	80"
Type of Boiler	Belpaire	Belpaire
Working Pressure, Pounds	205	205
Outside Diameter of First Course in Barrel	78½"	78½"
Firebox, Width and Length	72"x110¼"	80"x126"
Firebox Plates, Thickness	⅜"&5/16"	⅜" & 5/16"
Firebox Water Space	5"	5"
Tubes, Number and Outside Diameter	242–2"	237–2¼"
Superheater Flues, Number and Outside Diameter	36–5⅜"	40–5⅜"
Tubes, Thickness	.125"	.125'
Superheater Flues, Thickness	.148"	.148"
Tubes, Length	180"	228"
Heating Surface Tubes, Saturated, Square Feet	2,660.5	3,746.8
Heating Surface Firebox, Saturated, Square Feet	195.7	288.6
Heating Surface, Total, Square Feet	2,856.2	4,035.4
Superheater Heating Surface, Square Feet	721.0	1,153.9
Grate Area, Square Feet	55.13	70.0
Dome, Height above Rail	180"	180"
Center of Boiler above Rail	9'–10"	10'–1"

*Equivalent Heating Surface, Square Feet. 3,937.7 5,766.3

Electric Welding While You Wait

An incident is related in a recent issue of the *Electrical World* where a workman in a railway shop approached his foreman with a request for a new machinist's hammer, showing his former tool split into longitudinal halves as the result of a heavy blow. Being busy, the foreman, in a half-joking manner, said, "Take it to the electric welder; we're out of hammers." Without question the workman obeyed. Later the foreman noticed the man lustily chipping a nut, and asked him where he got the new hammer. The inquiry elicited the fact that the two pieces of the broken hammer, small and irregular as they were, had been welded electrically with a neatness almost defying detection. Whether this was an economical process or not has yet to be determined, but as evidence of the electric welder's skill and general usefulness the incident is well worth chronicling. No doubt many other similar repairs to hand tools have been accomplished in boiler shops, and it would be well worth while to have them brought to light. The time saved in such emergencies may often offset the increased cost of such repairs or the replacement of damaged tools.

Safe Boiler Support

The importance of safe boiler support is not generally recognized, and the boiler laws that have been enacted in the various states and municipalities do not seem to have taken into account its influence as affecting the safe operation of boilers. Anyone familiar with boiler explosions will be sure to feel that if a boiler should fall down while under steam, an explosion would be almost certain to follow; yet it is rare to hear this cause advanced as the explanation of boiler explosions where other causes are not in evidence. It seems more than probable that a good number of mysterious boiler explosions, occurring with sound boilers and where there has been conclusive evidence that no overpressure existed, may have been due to the falling down of the boilers or their changing position to such an extent as to result in the breaking of the pipe connections, thus producing the explosion of the boiler.

Investigation into the conditions surrounding the explosion of two sound boilers recently seemed to indicate that the falling down of one of the boilers was the only reasonable explanation for the accident. These two boilers exploded simultaneously, the explosion of one having undoubtedly been the cause of the explosion of its mate. The tears through the shells of both boilers were similar, occurring through the top manhole reinforcement, which was of the outside pattern and weak. The girth rivets at each end of the course that contains the manhole opening were sheared. All parts of the shell that were fractured were without evidences of defects, the tears being through the solid plate. Calculation showed that the structure should have stood about five times the load due to the steam pressure that was on the boilers at the time of the accident, and that there was not an excess pressure at this time was clearly indicated by the condition of the pop safety valves that were attached to the boilers. One boiler showed distinct marks on the manhole course of having been dented by a blow delivered to it by the manhole frame of the adjoining boiler when it exploded. From the nature of the breaks on these boilers, it is probable that the main steam connection on one boiler was broken by the falling down or settling of the boiler. The sudden opening and the resulting outrush of steam, caused a wave action of the water in the boiler which resulted in its rupture girthwise and the manhole course lengthwise through the manhole reinforcement. This explosion probably would have been prevented if the boilers had been properly hung instead of depending on the settings for support.

The Massachusetts and Ohio rules prescribe that boilers above 78 inches diameter be hung, and that the support be independent of the setting walls. This provision was evidently made for fear that such large boilers could not be safely supported on the setting walls, which is doubtless correct. It would also seem to be a reasonable precaution to have all sizes of horizontal tubular boilers hung. The smaller size boilers are usually installed in the smaller plants, where the condition of the settings is not as apt to be so closely watched as in the larger plants, and small boilers for this reason are probably more likely to be exposed to the danger of explosion from improper support than larger boilers.

The American Boiler Manufacturers' Association, at its twenty-fifth convention, proposed that the Massachusetts Rules be modified in regard to the requirements for hanging boilers, and that the boiler manufacturers be allowed to follow the present practice, which had been proved safe. Such a move would seem to be a step backward, and if any change is made it should be to require that the smaller sizes of boilers also be hung. It requires more than the mere statement of the boiler manufacturers to show that lug-supported boilers are safe, for there have been many instances to show that this means of support has often been the initial cause of boiler explosions.—*Power.*

Front End Design and Air Openings of Grate and Ash Pans*

BY M. C. M. HATCH†

The locomotive front end, reduced to its simplest terms, is an apparatus for providing draft at the fire. It is a vacuum pump drawing air and gases through the ash pan, grate, fuel bed, firebox and tubes, discharging through the stack, and with the exhaust steam jet from the engine cylinders as its source of power. This pump must be capable of creating and maintaining high vacuums. An engine, recently under test at Altoona, showed a maximum smokebox vacuum of 19.6 inches of water, equivalent to 11.32 ounces. This high locomotive draft was measured in front of the diaphragm; behind it the draft had fallen to 10.2 inches, a drop of 48 percent; and in the fire to 3.7 inches, a reduction of 81 percent. This indicates that but 19 percent of the total draft furnished by the front end vacuum pump was actually active at the fire. Excessively long tubes will obviously cause greater differences in the draft head between the tube sheets than will shorter tubes of the same or even less diameter. On an Atlantic type locomotive with 2-inch tubes, 13 feet 8⅝ inches long, 6 inches of draft back of the diaphragm sustained a fuel rate of 100 pounds of coal per square foot of grate per hour, while on a Pacific type with 21-foot tubes, 2¼ inches diameter, the same draft burned but 88 pounds of coal. These figures indicate what is to be expected when tubes are made very long. From a careful consideration of all the data at hand I am led to believe that the ratio of tube diameter to length should be not less than 1 to 110, and that better results will be obtained from large boilers by the introduction of combustion chambers in place of the use of tubes much over 18 feet in length.

Front ends must have consideration as spark arresters, or more properly, spark killers, as they should be self-cleaning. This means that they must be provided with an ample area of netting or perforated plate, the openings in which will control the maximum size of sparks emitted. They must be designed to give an equalization of draft through the boiler tubes and over the entire surface of the fire.

The shape of the exhaust nozzle seems to play some part in the efficiency of the front end as a draft producer. Nozzles have been made square, oval, rectangular, star-shaped, annular, etc., with varying results, but the general practice still clings to the familiar circular shape, either double or single, with the preference for the latter. One tendency of the average engine house force in regard to nozzles should be discouraged, and that is their immediate desire to reduce the size when an engineer reports "engine not steaming." Closing up the nozzle should be a last resort, not to be permitted until all else has been tried and found ineffectual. If the opening must ultimately be reduced, bridges or splits should not be used; bush or change the tip, but leave a free opening for the exhaust jet.

All else being equal, the spark discharge is a function of the rate of combustion which is, again, dependent upon draft intensity. If we must burn 120 pounds of average bituminous coal per square foot of grate per hour, we will have a draft at the fire of not far from 3 inches of water. A negative pressure of this degree will, no matter how created, cause small particles of fuel to be carried off from the fuel bed, and in the restricted space of the locomotive firebox, these will not be consumed, but will enter the tubes, be discharged into the front end, and thence from the stack. The amount of solid matter discharged from the stack is large, and the quantity and fuel value of this loss, as ascertained by some recent investigations, has been found to vary from 2 percent and 1 percent, respectively, at a rate of 2,000 pounds of dry coal fired per hour, to 14 and 12 percent, respectively, at a rate of 7,000 pounds.

There are mechanical considerations which will limit the air openings in the grates, and these, rather than those of proper combustion, will govern. In the absence of absolute figures covering this matter, it is believed that the principles of efficient combustion will be best served if the percentage of air openings be made as large as possible without causing losses of fuel through the grate. As to the form of the grate bars, whether finger or table, both are used with success, and both have their adherents. Experience with both types indicates that, for average bituminous coals and under average working conditions, a well-designed finger grate, properly applied, will give the best general service.

The proper theory of ash-pan air opening can be enunciated in a few words, as follows: Air ingress openings in the ash pans should be of sufficient area to ensure the presence of atmospheric pressure under the fire when the grate is working at its maximum fuel rate. The standard practice card of one locomotive builder reads: "The total unobstructed air openings in the ash pan need not exceed the total tube area, nor must they be less than 75 percent of total tube area." One of the largest railroads, which has gone into matters of this sort deeper than any other, has established a standard ash-pan opening of not less than 14 percent of the grate area. Prof. W. F. M. Goss concludes, from data gathered at the locomotive test plant at St. Louis, that "It is evident that after a relation of 0.14 square feet of air inlet per square foot of grate was reached, no further decrease of draft occurred when the air inlets were increased, and when the air inlets were less than 0.11 square feet per square foot of grate the draft necessary to supply air increased very rapidly."

Consider an engine with a grate area of 65.8 square feet and a tube fire area of 8.73 square feet. The maximum of Prof. Goss, shown to give best results, exceeds the minimum allowance of the builder by 29 per cent. In other words, modern engines working with an ash-pan air ingress opening equal to 75 percent of the tube area have but 0.7 as much as they should have, according to what are at present our most reliable data.

An engine with 65.8 square feet of grate area had 9.2 square feet of ash-pan air inlet, equivalent to 14 percent of the grate area, and under heavy test conditions, when consuming 130 pounds of coal per square foot of grate per hour with a firebox draft of 3.2 inches, had but 0.3 inch draft in ash pan. A second engine tested at St. Louis had a total tube fire area of 6.51 square feet, a grate area of 49.9 square feet, and ash-pan air inlets of 4.95 square feet, equivalent to 74.5 percent of tube area and 9.72 percent of the grate area. This engine, under about the same test conditions as the first, showed, while at a fuel rate of 116.25 pounds of coal, a vacuum in the ash pan of 0.64 inch with 2.22 inches in the firebox.

To recapitulate, what general conclusions can be drawn from the foregoing? Briefly, let us design the front end so that it shall be as efficient a vacuum pump as possible: let us get the boiler tube ratios right: let us admit plenty of air, well distributed, through the grates, and let us open up the ash pans so that the front end pump does not have to work against added restrictions there. If we follow these practices we shall make progress. Fuel economy, from the standpoint of design, means the use of a boiler and furnace which will take out the greatest possible amount of heat (perfect combustion) from the coal, at the expenditure of the least possible amount of energy.

All my investigations show that the amount of definite and authoritative information on the subjects under consideration is amazingly small. We *should* and *must know* more about these matters, and this association should undertake

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* From a paper presented at the sixth annual convention of the International Railway Fuel Association, Chicago, Ill., May 18 to 21.

† Superintendent Fuel Service, Delaware, Lackawanna & Western.

the work of investigation, and at once. I, therefore, suggest that we, as an association, bespeak the aid of the Pennsylvania Railroad, Purdue University and the University of Illinois, requesting them to collaborate with a committee, to be appointed by this association, with a view to determining and finally enunciating what, for modern practice, should most efficiently govern the design of the details we have just considered.

Cutting and Welding Devices in Railroad Work*

BY A. W. WHITEFORD

All modern cutting and welding devices, irrespective of type, design, the source of their energy, or the principle involved, are built with but one object in view—a more flexible distribution of power.

They are not intended to perform any labor nor to accomplish any result that has not already been accomplished by some standard means, but they do it in a different manner. The result of their efforts is usually seen in one of three different ways; a decrease in time required—an increase in efficiency—or a reduction in cost.

They have, perhaps from lack of a better or more comprehensive term, gradually come to be known under the head of autogenous welding devices.

This really is a misnomer, as *autogenous* welding in its literal sense means *self*-welding or welding by means of heat alone. Some authorities have made an effort to divide the work into two classes, one to be called autogenous welding and the other to be called heterogeneous welding; autogenous welding to include all welding where no outside metal was introduced, and heterogeneous welding to include all welding where an alloy or foreign substance of any kind was used.

This hardly seems to be correct either, as in each class there would then be a division of principle. A more recent effort has been made to divide them according to their sources of power. This would class them under two heads—electricity and gas. As all electric machines receive their power from an electric current, and as all gas machines receive their power primarily from the gas of combustion, which is oxygen, it would seem that the terms electric welders and oxywelders would not be far out of the way.

Whatever might be their names, however, and irrespective of how they might really be classed, the history of their various developments presents some interesting features.

The electric group has two main divisions—resistance or sectional welding and arc of surface welding. Aside from the fact that they both receive their power from an electric current they are in no manner similar.

Resistance welding was developed by Prof. Elihu Thompson at Franklin Institute in Philadelphia, in 1877. He was conducting some experiments with a Leyden jar and he noticed that under certain conditions the two coils of wire with which he was working would become fused together at certain spots. The result of his investigations is what we know to-day as the "Thompson process." Briefly, it consists in passing an electric current through two pieces of metal brought into close contact, the resistance at the point of contact generating enough heat to cause the ends to fuse when sufficient pressure has been applied mechanically.

The arc or surface system of welding has three divisions, each division being named after the man who first developed it.

The earliest effort at producing anything of this kind of which we have any record was made in 1874, by a German, named Werdner. He attempted to take an electric arc and deflect it by means of an air jet and thus secure what would have practically been an electric blow pipe, but his efforts do not seem to have been successful.

In 1881, a Frenchman, by name of De Meriten, succeeded in welding lead plates together for use in battery jars by means of an electric arc, but nothing seems to have come from it.

Two Russians were next, Benardos and Olszweski, who developed an arrangement whereby they passed an electric current from a carbon electrode, which was one terminal, to the metal to be welded, which became the other terminal, the result being the formation of an arc between the two which generated sufficient heat to flow the metal within a given radius and thus produce a surface weld. This is known as the "Benardos process," and is the first arc welding machine that was successfully developed. This was about 1884, and the United States patent was issued in 1887.

Benardos was followed closely by Slavianoff, a fellow-countryman, who got out a very similar device except that where Benardos used a carbon electrode he used a metal electrode of substantially the same composition as the metal to be welded. This idea has been known ever since as the "Slavianoff process." From these two original ideas all subsequent arc welding devices have been developed, with the exception of an idea worked out by Zerener, a German, which came out somewhat later. He really tried an improvement on the original Werdner idea of deflecting the arc, only instead of using an air jet he used a magnet. This idea, like Werdner's, has never been extensively developed.

The Benardos and the Slavianoff processes, however, have been developed to quite a considerable extent, not only in Europe but also on this side of the water.

The Siemund Wenzel Company, of New York, were the pioneers in this work in this country, followed closely by the C. & C. or Garwood Company, of Garwood, New Jersey, and to these two concerns belongs the credit for introducing the idea into the American railroad service. The machines and outfits are made in various types and sizes—both portable and stationary—and you are all more or less familiar, no doubt, with the equipment and the work that is done by it.

Standing somewhat by itself, although really allied to the gas branch, is what is known as the alumino-thermite process, or "Thermit, welding." This is a German development, brought out about 1900, and consists of an arrangement whereby the uniting of metallic oxides and aluminum is brought about in such a way as to produce a flowing mass of metal at about 5,400 Fahrenheit. This is made possible by the increasing affinity that the aluminum has for oxygen over the balance of the mixture. When ignition takes place, the oxygen in the other metals makes a rush for the aluminum, the aluminum oxide rising to the top in the form of a slag; the free body of clean metal, still at a flowing heat, then running down into the mold and joining the parts together.

The gas branch of these cutting and welding devices also has several sub-divisions. Unlike the electric group, however, these are not divisions of principle, but only divisions of degree.

These sub-divisions usually take their name from the secondary gas which is combined with oxygen to secure the necessary heat. They come under various heads, such as coal gas, Pintsch gas, water gas, Blau gas, hydrogen and acetylene.

The principle involved is the same in all cases, being the proper combination of the secondary gas with the main gas or the gas of combustion, which is oxygen; and the various degrees of efficiency possible in each case are directly proportionate to the amount of oxygen required to produce the proper temperature.

With coal gas you are all, no doubt, familiar. The same is also true of Pintsch gas.

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* A paper read before the New England Railroad Club.

Water gas and its by-product, producer gas, is formed by passing jets of steam through furnaces filled with coke which has been brought to a glowing heat.

Blau gas is a form of liquefied illuminating gas produced by the distillation of mineral oils in red hot retorts. This is in a manner very similar to Pintsch gas. Chemically, it consists of the same elements as coal gas, but in essentially different proportions.

A combination of oxygen and practically any heat-carrying gas can be utilized for cutting metals, but as far as we know, in the present state of the art, no torch has yet been developed whereby welding can be successfully or economically done with any of the above combinations. From the standpoint of general service, therefore, all these other gases may be disregarded, as either the operation is slower, the oxygen consumption is much larger, the cost is greater, or the work is more inefficiently done than with either hydrogen or acetylene.

Historically, hydrogen should be mentioned first. It was discovered in 1766 by an English chemist—Cavendish. It is a primary gas, and is the very lightest substance known. It was named hydrogen, or water-former, by Lavoisier, a French chemist, from the fact that it was found so plentifully in water, and in fact, water is still the greatest source of its supply—the term H_2O, no doubt, being familiar to you all.

Acetylene was also discovered by an Englishman, Sir Humphry Davy, who detected it by the odor while making some experiments with potassium, in 1836. Some years later, Berthelot, a Frenchman, succeeded in making some of it by passing a jet of hydrogen through an electric arc. In 1862, Woehler, a German chemist, succeeded in producing it from a combination of lime, zinc and carbon, which he brought to a white heat. This was the forerunner of calcium carbide. It was first liquefied by Cailletet, in 1877, and Claude and Hesse succeeded in working out the process by which it is possible to dissolve it, along about 1895. Acetylene gas, as we know it, is formed by combining calcium carbide and water. Calcium carbide is the metal found in lime rock fused with a low-ash coke. The credit for the commercial development goes to an American, J. M. Moorehead, who, in conjunction with Wilson, successfully worked out the problem of producing it from lime rock, which they did down in North Carolina in 1892.

To Moorehead, also, goes the credit for the development of the process whereby acetylene can be compressed into cylinders, along the line of the idea first laid down by Claude and Hesse. These cylinders are packed with porous asbestos and filled with acetone, into which the gas is dissolved. Acetone is a form of denatured alcohol, which possesses the peculiar property of being able to take to itself twenty-five times its own volume of acetylene gas for every atmosphere of pressure under which it works.

Oxygen, however, is the real factor in the successful application of either hydrogen or acetylene. It is one of the primary elements and also one of the most abundant. It comprises about eight-ninths of all the water, and about 50 percent of all the rock in earth. It is also very prevalent in flesh and human tissue, 66 percent of the human body being oxygen. In volume it is 21 percent, and in weight 88 percent of the air.

It was discovered in 1774 by Priestley, an English chemist, and very nearly so by Sheele, a Swede, in 1772; but he had not been quite able to prove his case, so the honors divide.

In 1789, Lavoisier proved conclusively that it was the gas of combustion and that without it no combustion was possible. Guy Lassac worked out the law of combining gases by volume in 1808. By 1851 they had gotten so far as to try and manufacture it. In 1877, Pictet, a Swiss, and Cailletet, a Frenchman, proved that it could be liquefied. By 1880, the electrical angle had been introduced, and finally came the atmospheric development.

As a final result of about one hundred years of experiment and research, oxygen can now be produced successfully in three ways—chemically, by electrolysis and from the atmosphere.

The chemical method consists of putting chemicals of various sorts, generally potassium chlorate and dioxide of manganes, into a retort, sealing them up and bringing them up to about 400 degrees of heat. Oxygen is set free at this point, properly washed and cleaned, and stored for service.

The electrolytic process consists in passing an electric current through a given volume of water and setting free the hydrogen and oxygen of which water is composed. This is done by putting sulphuric acid in the water, which forms what is known as an electrolyte, and the action of the current then sets the gases free, the hydrogen following the negative pole and the oxygen the positive pole.

The atmospheric process consists in taking it out of the air and separating it from the nitrogen by what a layman would call the "freezing" process. This is done by reducing the temperature of the atmosphere in given volumes under pressure to a point at which the oxygen liquefies. This is in the neighborhood of 320 degrees below zero. The oxygen is then drawn off, expanded and compressed into cylinders ready for service.

There are various methods whereby these separate ideas for making oxygen are carried out. Bassingault developed the first of the chemical processes in 1851, but Brin's process, which was developed later, seems to give more satisfactory service. Any of the chemical processes are much more expensive and the product less satisfactory for service than either of the others.

The method worked out by Garuti, an Italian, seems to lead in the electrolytic line, the largest American plants, such as the American Oxy-hydric Company, of Milwaukee, and about 80 per cent of all the European plants using this process.

There are various other developments of this electrolytic idea, chief among which are those of Shuckert, Schmidt, Flamand and Renard, but Garuti's system has the advantage for two reasons:

First—Lower amount of electric motive force required.

Second—More perfect separation of the gases.

There are also several types of the atmospheric process, including those of Knudsen and Claude.

It remained for a German, however, Dr. Carl Linde, to really perfect the atmospheric process, which he did in 1895. His idea, or what is known as the Linde process, is generally conceded to be the simplest, cheapest, most efficient, and to produce the purest oxygen of any of the atmospheric systems.

Practically all the commercial oxygen used in this country and also a very large part of that used in Europe, where hydrogen production is not a factor, is the product of equipment working on the Linde principle.

The development of the torch also played its part in the working out of these various devices. Like many of the gas developments, an oxy-hydric blow pipe was known to chemists for years before it branched out into other fields. The first man who seems to have made an effort to apply the idea practically was an Englishman, by the name of Fletcher. He experimented with coal gas and oxygen in 1886, but either owing to the fact that he had nothing but coal gas to work on, or because his oxygen was poor, he never made a success of it.

The first man who really developed the idea was a Belgian, by the name of Jottrand, who used it successfully to cut metal in 1888. He used a combination of hydrogen and oxygen.

The next man to follow the idea and the first to use acetylene with oxygen was a Frenchman, Le Chatelier. This was about 1895. Next came Fouché and Picard in 1901 and 1903; then Rodrigue-Ely and Gauthier, and then again Fouché's later developments in 1908. Up to the present time these include all the main ideas of the different types of torches in use.

As to a comparison of the work done by the two separate combinations of hydrogen and acetylene with oxygen, it is safe to say that each has a field in which it is supreme; cutting and welding can be done with both; hydrogen is most effective for very light welding, say under a sixteenth of an inch in thickness, and for very heavy cutting of, say, over 10 inches in thickness. In the entire intermediate field, that is, all welding one-sixteenth and over, and all cutting up to 10 inches, which range covers practically all of the work done on railroad shops, acetylene is most efficient. In either case, however, successful welding depends on the following:

1—Purity of the gases.

2—Use of metal filler as near as possible to the same composition as the metal to be joined.

3—Thorough fusion of the inside surfaces before adding additional metal.

4—Cleanliness of the parts.

5—Control of the mixture and size of the flame.

There are also various features of torch design and construction that might be entered into in comparison with the various classes of work to be done, but from a general standpoint of service demanded, any torch to be satisfactory should include:

1—Perfect interchangeability of parts.

2—Ease of adjustment.

3—Convenience of handling.

4—Constant gas consumption.

5—Constant pressure.

6—Largest possible opening at nozzle tip for each thickness of weld.

The application of these devices to railroad service also presents various problems. These problems are usually solved in accordance with the conditions under which the equipment has to work.

Either of the three gases can be obtained for use in one of two ways. They can be generated on the ground for immediate use, or they can be generated at central plants and distributed in portable containers. In the general run of railroad work, the most widely adopted plan for the handling of either oxygen or hydrogen is to secure it in commercial cylinders from the nearest source of generation. The same thing can also be done with acetylene; for all work where the demand will not warrant the installation of a generator the dissolved or commercial cylinder process is used, but in the larger plants it is usually piped from a generator installed on the ground.

These generators as built to-day are of two types:

1. Water-to-carbide; in which water is brought in contact with the carbide, the volume of carbide being in excess of the volume of water during the first part of the operation.

2 Carbide-to-water; in which the carbide is thrown into the water, the volume of water always being in excess of the carbide.

Irrespective of types, however, it is generally conceded that successful generators embody the following points:

1—Low temperature of generation.

2—Complete decomposition of the carbide.

3—Maximum evolution of the gas.

4—Removal of all air from the generator before gas generation starts.

5—Low pressure in all parts of the generator.

6—Continuous supply of gas, simplicity of mechanism and ease of recharging.

As to the general use to which these various systems are now being put, it is safe to say that either one system or the other is rapidly making its way into every known branch of the metal working art. This is particularly true of oxy-acetylene. From a standpoint of volume, America leads the world, with Germany second, France third and England a rather poor fourth.

In scientific research and special development, Germany leads all other countries. This is partly due to the fact that the German government has taken a hand in the work and established schools at various points, where the art is taught as one of the applied sciences.

In all of their leading industrial centers, such as shipyards, steel mills, gun works, etc., oxy-acetylene has become part of their regular equipment. In the manufacturing lines especially this system is greatly used.

As one feature of the work over there. I might mention that piping of all classes and sizes is now being made by rolling from flat plate, and welding by means of the oxy-acetylene torch. Piping is also being laid without the use of threads or flange joints. In this way they are enabled to use pipe of about half the thickness of our standard pipe, thereby saving greatly in material costs. To show what the German government thinks of this, it is only necessary to mention that at Cologne, in the new Palace of Justice building only recently completed, there is nearly seven miles of piping in which there is not a single threaded joint, all being welded by the oxy-acetylene method.

Wonderful progress has also been made here in America. To Massachusetts belongs the credit of having installed the first plant in this country. This was at Quincy in 1905, by the Fore River Ship Building Company. This was only eight years ago, and to show how rapid has been the growth in the United States, I will cite the fact that in one of the latest battleships turned out at one of the navy yards about $70,000 worth of the work was done with oxy-acetylene equipment. The work of raising the battleship *Maine* at Havana was also greatly facilitated by the same means.

How to Heat Rivets Satisfactorily

BY EMIL EATON

How often have I heard the boiler maker call to the heaters to get his rivets hot! The only thing the boy bears in mind is to get the rivet hot. That is all he knows about the rivet. He doesn't care what part of the rivet is hot so long as it is hot. The boiler maker observes the appearance of the stock that projects for forming the head. If that part is at a white heat the boiler maker is convinced that the rivet is all right. The reason that the boiler maker pays so much attention to the point of the rivet being hot is that it becomes so much easier to drive. Otherwise no attention would be given it at all.

In heating the rivet the boy sticks the point down into the fire first. That is the custom of all rivet heaters. If the boy were to stick the head of the rivet down first the boiler maker would exclaim to the boy: "Where did you learn how to heat rivets?"

As an experiment I tried the following on several mud-ring rivets, each six inches long; I cut these rivets out at the head-end after they had been riveted up. The rivets that were heated from the head-end were harder to back-out and the fillet extended further than those that were heated at the driving point. Particular care must be exercised in heating the rivet, so that every part of the rivet, from the shank or head to the grip of the several sheets, has a very bright and glowing white heat (not burned) with the balance of the stock brought only to a cherry red. In driving the rivet it is then upset at its hottest part first, and is less likely to bend over at its end, which is often the case, being the first element to a poor and worthless rivet.

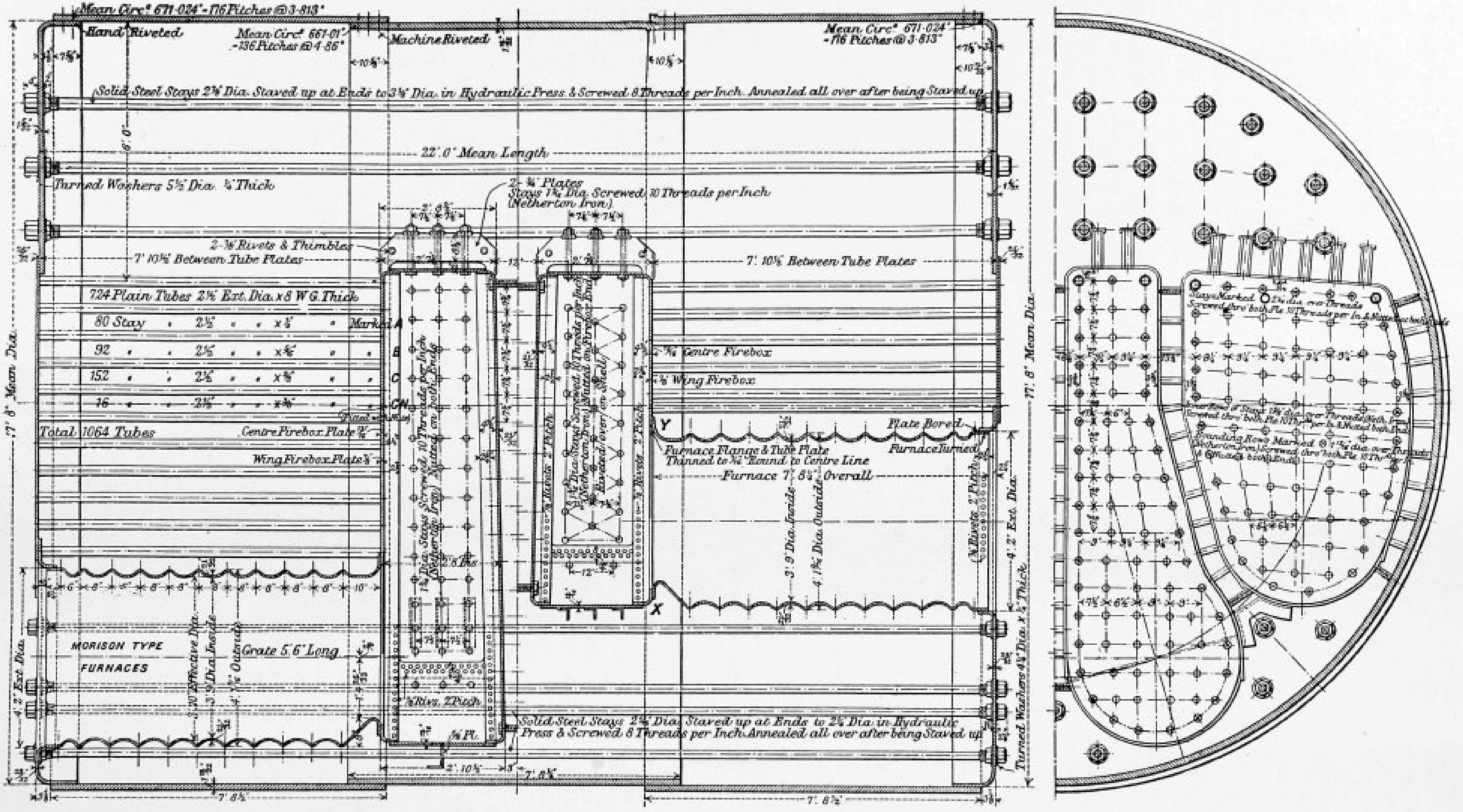


Fig. 1.—Longitudinal Section of Double-Ended, Eight-Furnace Scotch Boiler for the Mammoth Cunard Steamship *Aquitania* and Half-Cross Section Through Combustion Chambers

Another thing that often happens when driving rivets of this length with a "gun" is that the rivet breaks somewhere in its length. Then, naturally enough, the riveter will say, "What a poorly manufactured rivet!" If, however, he examines the rivet, he will find that the rivet is not at fault, but that it was overheated.

Boilers of the New Cunard Liner Aquitania

The new Cunard steamship *Aquitania*, of 49,430 tons displacement and 23 knots speed, built by John Brown & Company, Ltd., Clydebank, Scotland, is equipped with 21 double-ended, eight-furnace Scotch boilers, designed to carry a steam pressure of 195 pounds per square inch. The boilers are all of the same size, with a mean diameter of 17 feet 8 inches and a mean length of 22 feet. Each boiler has a total heating surface of 6,599.8 square feet, distributed as follows: Tube heating surface, 5,479.6 square feet; furnace heating surface, 405.6 square feet, and firebox heating surface, 714.6 square feet. The grate area of each boiler is 168.66 square feet, making a ratio of heating surface to grate area of 39.1 to 1. The area through the tubes in each boiler is 25.12 square feet and the steam space is 1,231.7 cubic feet. The ratio of the grate area to the area through the tubes is 6.71 to 1; the ratio of the steam space to the grate area is 7.3 to 1, and the area of the tube heating surface to the grate area, 32.48 to 1.

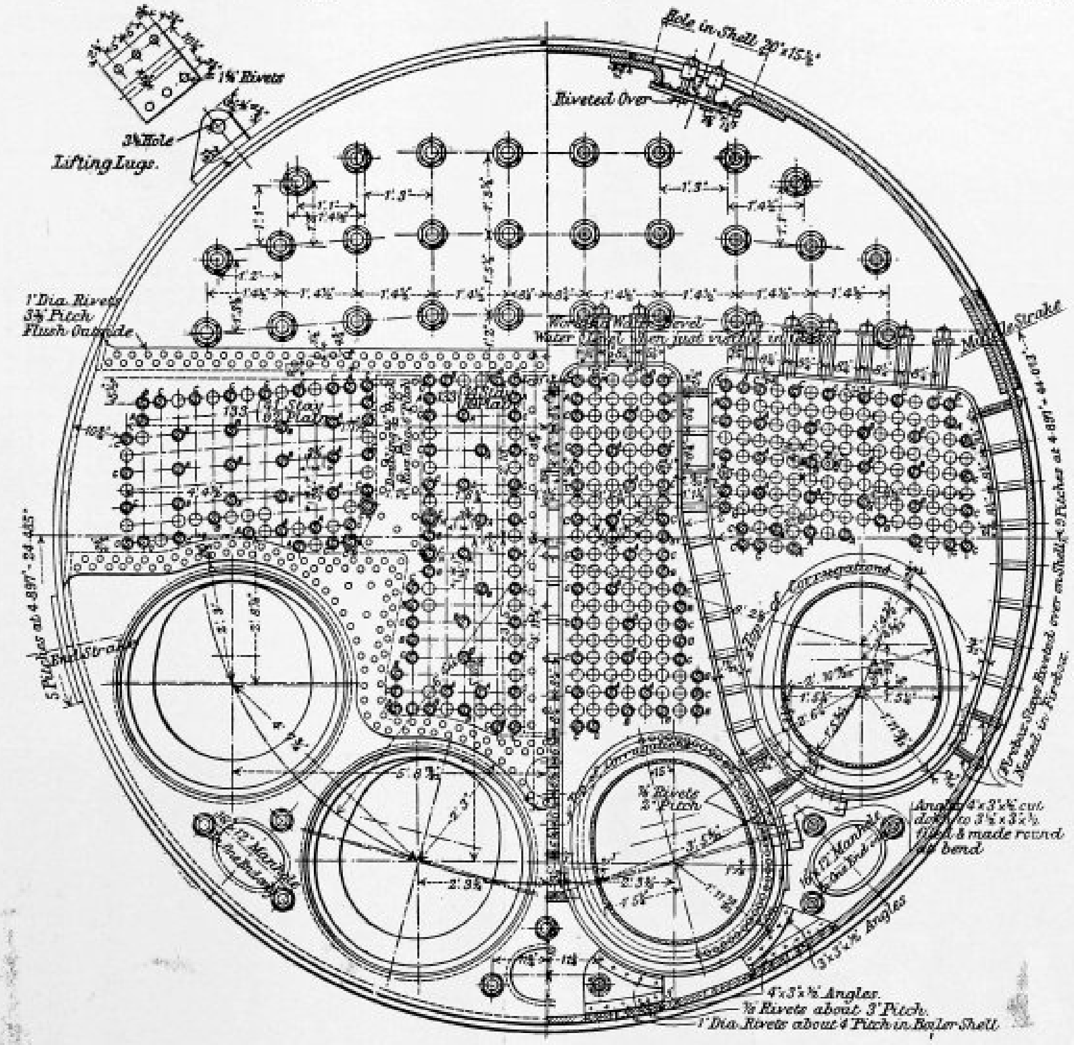


Fig. 2.—End View and Section of Boiler for the *Aquitania*

The shell of each boiler is built in three courses with two plates in each course. The shell plates are 1 19/32 inches thick. The longitudinal seams have triple-riveted butt strap joints with rivet holes 1⅝ inches in diameter, while the two middle circumferential seams are triple-riveted lap joints with rivet holes 1 23/32 inches diameter. The end circumferential seams, joining the shell to the heads, are double-riveted lap joints with rivet holes 1⅝ inches diameter.

The upper part of the end plates, or heads of the boilers, are 1 5/32 inches thick. The front tube plates are 25/32-inch thick and the lower part of the end plates, or heads around the furnaces, are 29/32 inch thick. The tube plates of the center combustion chambers are 13/16-inch thick, and of the wing or outer combustion chambers, ⅞-inch thick. The backs of the combustion chambers are 21/32-inch thick, and the wrapper sheets, 13/16-inch thick.

The distance between the tube plates is 7 feet 10½ inches. All of the plain tubes, of which there are 724 in each boiler, are 2½ inches outside diameter of No. 8 wire gage. The stay tubes are 2½ inches outside diameter, but vary in thickness, 80 stay tubes being ¼-inch thick; 92, 5/16-inch thick, and 168, ⅜-inch thick. The total number of tubes in each boiler is, therefore, 1,064.

The upper heads of the boilers are braced by 28 solid steel stays, 2⅞ inches diameter upset at the ends to 3⅛ inches diameter, and threaded 8 threads per inch. These stays are spaced from 1 foot 3⅛ inches to 1 foot 5½ inches, vertically, and from 1 foot 1 inch to 1 foot 4½ inches, horizontally. The lower parts of the boiler heads around the furnaces are braced by 9 solid steel stays, 2 1/16 inches diameter upset at the ends and threaded 8 threads per inch. Staying of the wrapper sheets of the combustion chambers is by 1 9/16-inch diameter stays, threaded 10 threads per inch. The back sheets of the combustion chambers are stayed with 1⅝-inch stays, threaded 10 threads per inch, except around the outer edges, which are supported by 1 13/16-inch stays; while at the upper corners 2 1/16-inch stays are used. The combustion chamber stays are spaced 9¼ inches horizontally and 7¾ inches vertically. The girders staying the tops of the combustion chambers consist of 2¾-inch plates with three 1 9/16-inch stays in each girder.

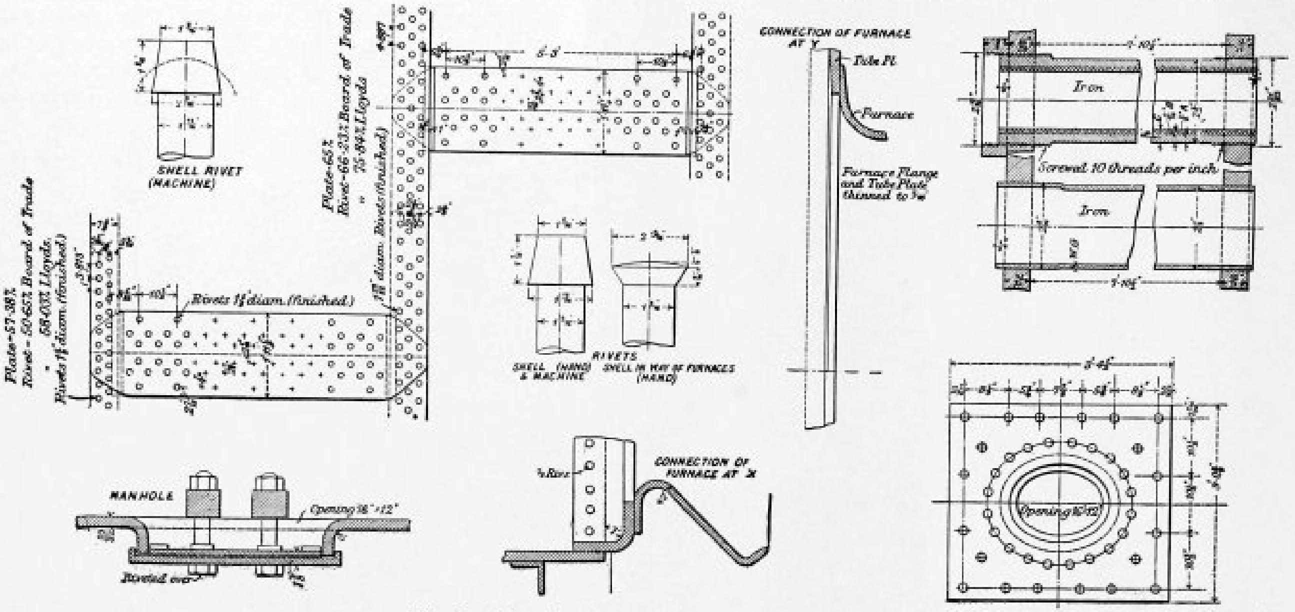


Fig. 3.—Details of Riveted Joints and Connections

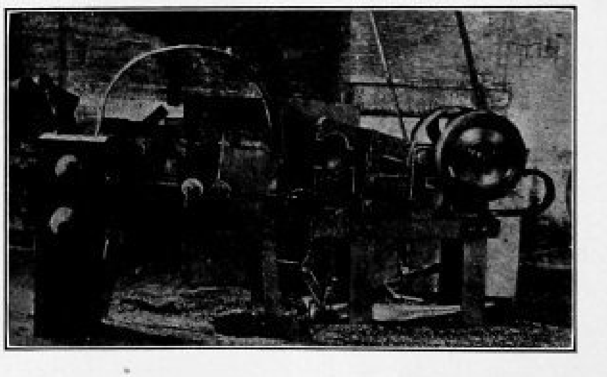
In the ship, the boilers are arranged in four separate boiler rooms, six boilers being located in each of the three forward boiler rooms, while the after boiler room contains only three boilers. The coal bunkers are placed fore-and-aft at each side of the boiler rooms with cross bunkers between the first and second and second and third boiler rooms. As the main engines of the *Aquitania* are of approximately 56,000 horsepower and the auxiliary machinery of several thousand additional horsepower, it is evident this immense boiler plant with its 168 furnaces, which supplies steam for this machinery, requires a large force of firemen, coal passers and water tenders. For this purpose there are in the ship's crew 168 firemen, 100 trimmers and 16 leading firemen.

Flue Welding Machine, C. & O. Ry.

Superheater Flue Welding Machine

The illustrations show a machine for welding 4½-inch and 5½-inch superheater flues, which was designed by James W. Mulcahy, foreman blacksmith shop of the Chesapeake & Ohio shops at Covington, Ky., and which was built at the shops. One of the illustrations shows the machine alone, while another shows it in conjunction with the oil furnace. The machine produces a weld that is the most perfect in every respect that I have had the opportunity of seeing. The welding arm or hammer is actuated by a belt-driven shaft. By pressing on the foot lever the motion is transmitted through a system of levers until the upright arm which holds the striking hammer is drawn back, thus allowing the hammer to get into action.

The machine was built out of old scrap car axles at a total cost of $122, and its capacity is 20 superheater flues per hour, or 180 flues in nine hours. It is operated by three men, whose rates are 24.5 cents, 22.4 cents and 15 cents per hour. The cost per flue for welding is a fraction over 3 cents.—*By W. P. Hobson, M. M., Chesapeake & Ohio Railway, in the Railway Master Mechanic.*



Oil Furnace and Flue Welding Machine

Meeting of the Executive Board of the Master Boiler Makers' Association.—The executive board of the Master Boiler Makers' Association will hold a meeting at the Hotel Sherman, Chicago, Ill., at 2 P. M., Friday, September 18.

John and the Steel Tape

A Rough Method for Measuring the Distortion in a Boiler Shell Under Pressure

BY JAMES F. HOBART, M. E.

"Come, John; get the steel tape and come over here, I want to show you how to do a little stunt which may come handy some time. Come on!"

"In just a minute, Mr. Hobart. Some daffy geezer has had this tape and got a kink in it which I can't get out. Blame a steel tape, anyway; they are always getting full of kinks, and you can't look at one twice without breaking it!"

"Go easy there! There isn't a better tool in the shop than the steel tape. Just don't abuse it, that's all. What good would the old cotton tape be in a boiler shop? The cotton tape which never measures twice alike in the same place. Go to it, John! You've got a steel scale, haven't you?"

"Yes, I have, and a good one, too; 24 inches long, and graduated accurately to a dot!"

"Ever have any trouble about getting a kink or two in that scale, John?"

"You bet I haven't, Mr. Hobart. I keep that scale in my little locker and it doesn't get out of my hands while I'm using it, you bet. I just take care of that scale, all right, all right!"

"Well, then, wouldn't it be a mighty good plan to take as good care of a steel tape as of a steel rule? Neither is a tool for laborers to walk over or to be left lying around loose. How would it do to take care of the tape half as well as you take care of the scale?"

"Say, that's one on me all right, and you won't have to 'call me' again for that piece of nonsense. I'll do with the tools as my room-mate makes me do with clothes and things in the room."

"How is that, John?"

"Why, that chum of mine has got a habit—and he is breaking me into it, too—of never throwing a thing down on the bed or on the floor. 'Hang it up,' he says, 'while you have it in your hand.' Everything that chap uses—clothes and everything else—he just puts right where they belong when he lays 'em down; and say, that chap never has one thing out of place around the room! Everything is always ship-shape and tidied up."

"That's a mighty good scheme. I advise you to follow it and then do the same trick here in the shop. Furthermore, just commence with the steel tape and with everything else you get your hands on."

"Say, Mr. Hobart, I'm just goin' to try that out for fair. But what is that stunt with the steel tape?"

"It's out in the yard, John, where they are getting ready to test that 66-inch shell. I want you to see what happens when pressure is put to a shell, so you will have a better understanding of what happens to rivets when the pressure comes on. Here we are. Just pass the tape right around the shell and over the top a second time. The sketch, Fig. 1, shows how to do it. Pass the ring end *A* over the top of the shell; bring it under the bottom and over the top again as shown at *A*, and tie on a brick or a bit of iron as shown.

"Then tie on another weight at *B*, and the tape is held fast to the shell and stretched pretty tight. And be sure to put the tape in place before the pressure is put on. It is well, if you can, to rig the tape in place before the boiler is filled with water."

"What is that for, and what is the whole trick going to show, anyway?"

"It will show, John, the change of shape which takes place in a boiler shell when pressure is applied or released. In other words, it will show you just how much the shell stretches under pressure."

"You don't mean to tell me, do you, that a boiler shell will stretch when pressure is applied?"

"Certainly. You cannot apply pressure or stresses of any kind to a piece of metal without changing its form in some way or amount—slightly, perhaps, but still a measurable and a noticeable change of shape. In the steam boiler the change of diameter under pressure which the tape will reveal to you is only the first step toward tearing the boiler to pieces by internal pressure."

"But, say, don't that change of shape mean danger and damage to the boiler?"

"No, John, not as long as the stretch is well within the elastic limit of the metal of which the shell is made—that is, as long as the shell comes back after stretching to the dimensions it had before pressure was applied, just so long the change of shape will do no harm. But just as sure as the shell doesn't spring back to its original size then look out. There is something wrong, and it is up to you to find it 'pronto.'"

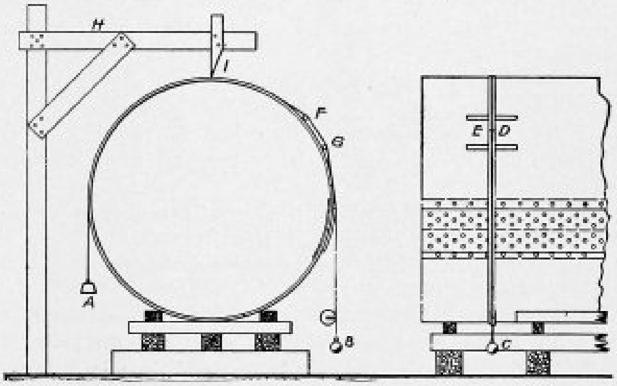


Fig. 1.—Sketch of a Boiler Shell, With Steel Tape in Place

"Pronto! What's that?"

"Oh, just a Spanish word for 'in a hurry,' 'quick,' meaning 'right off.'"

"I didn't know the Spanish had any hurry-up words. But now what will I do with that tape?"

"Just bring the folds of the tape close together as shown at A, then put two little rolls under the tape as shown at *F* and *G*. This will keep that portion of the tape which is to be watched away from the shell of the boiler. Two bits of broomstick will do very well at *F* and *G*. Next, twist around each fold of tape a very fine wire. String will do, but No. 32 to No. 35 wire is better—copper wire is best of all. Bring these wires opposite each other, as shown at *D* and *E*, and should there be any movement of the boiler shell these wires will no longer be exactly opposite each other."

"Oh, I see! The wires make a sort of indicator so you can read the circumference of the shell right on the tape?"

"Yes, that's the idea. Just take the exact reading on each fold of the tape where the wires are opposite each other. Subtract one reading from the other, and the difference is the circumference of the boiler. But now we will not bother to take readings. Just see that the wires *D* and *E* are exactly opposite each other, then let water into the shell."

"The water's runnin' in."

"All right, John, just stop it for a minute. I forgot the top indicator. Here, let's nail up some pieces of board and rig a little pointer to just touch the middle of the shell at *I*. There, now we can see if the shell settles down under test."

"Reckon it won't settle any, Mr. Hobart. That blocking is solid and rests right on the concrete."

"Watch the indicators, John, and let the water come. Half full, you say? Good. And just look at pointer *I*, will you?"

"Gee! But that pointer is more than an eighth of an inch away from the shell already. What's happening?"

"The shell is becoming of an oval shape. As it fills with water, the static pressure of that fluid, being carried by the lower portion of the shell, tends to flatten the circular shell to somewhat of an oval shape——"

"Look, Mr. Hobart, the wires *D* and *E* are separated. There's an eighth of an inch between them. The shell is stretching under just the weight of water in it, and and it is not full yet! Say, I don't think much of this boiler shell. Why, it won't carry 50 pounds of steam!"

"Just hold on a bit, John. Don't ever talk until you know what you are talking about, and you don't know now—not this time, my boy."

"Why, what do you mean? Can't I see that the tape is ⅛ inch longer where it reaches around the shell. Can't get back of that, can you?"

"Yes, John, the boiler has fooled you, that's all. Just wait a while and then see. What's that? The shell is full of water? All right. Just note pointer *I*, then pump up the pressure."

"Pointer *I* is more than a quarter of an inch from the shell, Mr. Hobart, and there's 3/16 inch more tape around the shell. Thunder, what a bum shell this one is!"

"Watch the pressure gage, John, and tell me when it shows 50 pounds?"

"All right, Mr. Hobart; here it is, nearly 55 pounds. Shall I shut off on the pressure pump?"

"Yes, shut it off, and look at the indicators and pointer *I*. What do you find?"

"Well, I declare, Mr. Hobart, pointer *I* has come back until it is only about 1/16 inch above the shell; and I'll be hammered if the tape hasn't come back, too, and the wires *D* and *T* are exactly opposite each other, same as when we put them on the tape! What does it all mean, anyway?"

"It means that the weight of water in the shell flattened it a bit, making it take an oval shape, as indicated by pointer *I*. And when a shell takes that form it shows slightly in the circumference. I can't see any reason for its doing so, but as the boy said, 'there it is!' And when we put in a slight pressure the shell rounded up again under the strain, which, even at 50 pounds per inch, is much greater than the slight static pressure of the water in the shell, which cannot be more than half a pound per square inch for each foot of depth. So, you see, John, the pump pressure overcomes the vertical static pressure of the water, rounds up the oval shell, and the pointer and the tape wires come back to their original readings again. But sometimes they go even further than this. The shell may be a little out of shape to begin with, and may rise up above pointer *I* under pressure, and the wires *D* and *E* may show a less distance around the boiler under a low internal pressure than when the shell was empty."

"I see it, Mr. Hobart. The shell is under just enough pressure now to round it up into a perfect circle."

"That's the idea, and now we will go ahead with the pump pressure and see what happens to the shell, tape and indicator *I*."

"One hundred pounds, Mr. Hobart, and nothin' doin', only wires *D* and *E* show 1/16 inch greater shell circumference."

"That's to be expected, John. Put the pressure up to 200 pounds. Here it is. Now hold it there while we look things over. Shell pretty tight, eh? Only three or four rivets weeping and a couple of tubes leaking a bit? All right; here is Bill, marking the leaks. He will attend to them as soon as the pressure is off. And, John, how are the marks?"

"Mr. Hobart, pointer *I* is just the same, 1/16 inch above the shell, while there is about 3/16 inch between wires *D* and *E*."

"That's good and proper, John. There must be some stretch to the shell—yield of rivets and plates, you know. But just run the pressure up to the limit, and see what happens."

"All right, up she goes, 250, 275——"

"Hold on, John; what pressure are you going to stop at?"

"I don't know, Mr. Hobart; we figured the other day that the bursting pressure of this shell was somewhere around 750 pounds per square inch, didn't we?"

"Yes, but that doesn't mean that we should pump up any such pressure. The bursting strength of a boiler is four or five times its working pressure; but take it from me, never put any more pressure inside a boiler than is necessary—cold water pressure in particular."

"Why is cold water pressure worse than hot water or steam pressure?"

"I don't know that it is, John, but people seem to think it is. But I do know that a boiler leaks worse under cold water pressure than under steam of the same pressure. I suppose it is because the sheets, tubes and rivets are tested under different conditions of expansion, and are tight when hot. But the less pressure in any boiler the better, and I only advocate enough pressure at test to determine if the shell is tight."

"Say! Don't the test requirements usually call for a cold water test of one-half more than the working pressure of the boiler?"

"Yes, that's the usual manner of applying an hydrostatic test, but in practice I never go much above the working pressure. Let me see that the shell does not leak at 10 to 20 pounds above the usual working pressure, and I am satisfied with the cold-water test. So you are running the pressure up far too high. This shell is to work under 225 pounds gage pressure, and as you have already pumped up 275 pounds, better not go any higher. According to the usual system, you could run the pressure up to 337 pounds; but I don't believe it is good practice, as I said before, to put more pressure than necessary in or on any steam vessel, therefore 'avast pumping,' as the sailor would say."

"Look at the wire indicators, Mr. Hobart; they are a full quarter of an inch apart. Is it possible that the shell has stretched that much in circumference?"

"It's not only possible but an actual fact. There is always a slight yielding in the rivets of a shell; most of the quarter inch comes from a full and complete rounding of the shell into a perfect circle, and some of the stretch comes from actual stretch of the steel sheets under the stated pressure. Should the pressure be increased much beyond the present amount of 275 pounds, John, you would find that the tap would show a considerable increase of actual shell stretch."

"Say! How far can a shell be stretched and then 'come back' when the pressure is let off?"

"That depends entirely upon the metal in the shell. Some steel will stretch and 'come back' more than other kinds, and the testing machine, working on a piece of steel actually cut from the same sheet, is the only way of telling what any steel will actually stand up under. This we can't do, as we have no test piece from the shell, and no testing machine, either, so we must take the words of the books for the 'elastic limit' of the steel in this boiler shell."

"Mr. Hobart, tell me, does that name, 'elastic limit,' mean the stress any piece of steel will stand up under and be able to 'come back' after the pressure is released?"

"That's just exactly what it means, John. Therefore, if we put a test piece of this steel into the testing machine, and find out that its 'elastic limit' is 12,000 pounds or 15,000 pounds, or only 10,000 pounds per square inch, then we know that we must never put on such pressures as will load the steel beyond that elastic limit. We will be safe if we keep within it, but in danger if we exceed the load beyond the elastic limit of the steel in use."

"But how do we use the 'factor of safety' when we work within the elastic limit of the steel? It seems to me that we are cutting down the pressure too far when we work with a factor of safety of 4 or 5 and keep within the elastic limit of the steel."

"To be sure we would, John. When we work to the elastic limit of the steel we don't need any 'factor of safety.' That is an ancient term which was made and used before engineers found out about the 'safe fiber stress,' which is the elastic limit of steel. And the 'factor of safety' is still a convenient way of allowing a margin of safety when we don't know the elastic limit of the steel. The term is also mighty convenient when, as the boiler gets old, the inspector wants to cut down working pressure a bit, so he increases the 'factor of safety' a small fraction, say from 5 to 5¼, and down goes the 'safe working pressure' of your boiler from 140 pounds to 114½ pounds. And then you get bids on a new boiler."

"I see. The term 'factor of safety' is another way of keeping within the 'elastic limit' of the steel? I see that all right; but tell me, in rigging the steel tape on the boiler why did you have me put the two broomstick rollers under the tape at *F G*. I don't see that they have done any good. Why did you put 'em in?"

"For this very good reason, John. Had I left out the rollers the wire indicators *D* and *E* would have to drag over the shell, and there would be danger of their sliding along the tape instead of moving with it. Therefore I had the rollers put under the tape to keep the wire rings away from the shell. A couple of lead pencils would be just as good as the broomstick rollers. See?"

"That's plain enough, Mr. Hobart, and I'm a chump for not thinking out the reason for the rolls. But, say! The pressure is off and the boiler is nearly empty, and I'll be hanged if the indicators *D* and *E* haven't got back to the position opposite each other that they occupied before the shell was filled with water. And when the pressure was all off, the tape showed the same 'oval stretch' that it did when the shell was first filled. By Jiminy, I didn't realize before how many interesting things there are to be seen when a man knows how to look for them, even with a steel tape!"

Canada's Largest Tank

The largest elevated steel water tower in the Dominion of Canada has been completed recently at St. Thomas, Ontario, for the improved city water supply. The capacity of the tank is 600,000 U. S. gallons; height to top of tank, 131 feet 2¾ inches; diameter, 46 feet, and height of shell, 37 feet 3¾ inches.

The tank itself is made of ½-inch plate in the lower part of the cylinder and diminished to ¼-inch plate at the top. The bottom of the tank is made with double lap-riveted joints, the metal being ⅜ inch thick at the connection to the cylinder and 7/16-inch thick at the extreme bottom.

The bottom of this tank is made to a special curvature, which is used exclusively by the firm manufacturing this structure. The bottom in section is a three-centered curve which connects to the vertical cylinder on a tangent to this curve. In this design there is no other stress transmitted to the cylinder than in the commonly used hemispherical design. The advantage claimed for this bottom is that it is more shallow than a full hemisphere, the total depth being 18 feet 2 inches, while the hemisphere would be nearly 5 feet deeper. This particular curve is selected because it gives the greatest capacity for the amount of steel used and reduces the stresses in the bottom to a minimum. Furthermore, it gives sufficient slope to the bottom, so that no sediment will remain in the tank.

The complete water tower exclusive of foundations was built for about $27,000. The engineer for this improvement was M. Ferguson, city engineer of St. Thomas. The design was submitted by the Pittsburgh-Des Moines Steel Company, of Pittsburgh, Pa., which manufactured and erected the structure with its own forces.—*Engineering Record.*

Training Apprentices on the Erie Railroad*

BY WILLIAM S. COZAD†

The problem of fully supplying the ever increasing demand for thoroughly skilled and trained mechanics is probably further from solution at this time than ever before. For many years past it has caused a great deal of anxiety to the heads of large industrial corporations, and on every hand may be heard the remark that the ranks of the old-fashioned mechanics are becoming rapidly depleted.

The average boy, who, by circumstances over which he has no control, is forced out of school at an early age and compelled to take up his life work, has little to look forward to in the matter of education. If he has the will and the physical endurance he may study after hours, attending night school when possible and after a few years of unrelenting toil he may finally attain some general knowledge of a few primary subjects, all of which will probably be more or less imperfect.

To offset these bad results, various systems of industrial education have recently been developed, prominent among which is the method of training young men in the different trades by a regular course of apprenticeship which combines technical as well as practical training.

In keeping with this advanced movement, the Erie Railroad, a little more than five years ago, created an organization for the purpose of giving thorough technical and practical instruction to all young men who enter its service as apprentices, in the trades which they seek to learn.

In order to meet the heavy demands made on its shops on account of the large increase in business, requiring much more and heavier power, this company has within the past few years practically renewed all shop machinery on the entire system. additions to shops and roundhouses, new power houses, new roundhouses and roundhouse machine shops have been built in order to provide for keeping in good condition the motive power and car equipment. This was necessary because every dollar of revenue from freight which goes into the treasury must be earned by the locomotive.

Having, therefore, provided a full complement of tools and equipment, to obtain the greatest possible benefit from this investment it becomes necessary also to provide a competent corps of intelligent, skilled and careful workmen. With this object in view, it was decided in June, 1908, to establish a thorough apprenticeship system to train young men; not only to become competent and skillful in the mechanical arts, but to instill in them a proper interest in the business, loyalty to the railroad and familiarity with Erie standards and Erie methods.

The first school was established in the Meadville shop and the first class called for technical instruction at 9 A. M. on the 7th day of July, 1908. The schools were afterward extended to Hornell, Susquehanna, Dunmore and Port Jervis. These schools are free to apprentices in all department and attendance is compulsory.

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* From the Railway Master Mechanic.
† Superintendent of Apprentices and Piecework.

The company furnishes, free of charge, the class room, heat and light, drawing tables, drawing instruments, blackboards, stools, filing cabinets and all necessary material for conducting the school.

These schools are in charge of competent instructors and are open from Sept. 1 to June 30, inclusive. Each apprentice is required to attend the classes four hours per week, two hours on each of two different days, for which time he is paid at his regular hourly shop rate.

Instruction in these classes covers the fundamental rules of arithmetic, common and decimal fractions, proportion, simple problems in interest, weights and measures, the elementary principles of geometry, mechanical drawing, practical and theoretical sheet metal development, tin, pipe and copper work, and special instruction in Erie standard practices pertaining to the construction and maintenance of cars and locomotives, as well as lessons in the successful and economic operation of same:

The original organization consisted of:

1st. A supervisor of apprentices who was also the superintendent of the piecework system.

2d. An assistant supervisor of apprentices who was a mechanical engineer and thoroughly familiar with the standards of the mechanical department.

3d. A technical instructor for shops having fifty or more apprentices.

4th. A man possessing the combined practical and technical ability necessary to instruct in shops having less than fifty apprentices.

The above organization was effective approximately three years and proved efficient in systematizing and extending the work, but since the text book containing all necessary technical instruction has been developed, and a well grounded set of rules and regulations laid down for the organization of the schools, it has been found advisable to reduce this organization, making it much less expensive, without in any way impairing the service.

Fifty percent of all the operations in the shops of this company (car and locomotive work combined) are performed on a time basis, and as the instruction of apprentices and a systematic study of shop economy are very closely related, it was thought advisable to combine the two organizations. The supervising force as at present constituted consists, therefore, of:

1st. A superintendent of apprentices and piecework.

2d. Two inspectors of apprentices and piecework.

3d. Local instructors of apprentices who combine the necessary technical and practical training to successfully handle both class and shop instruction.

Before detailing the duties of the respective members of this organization, it is well to state that in addition to a general mechanical superintendent, there are three mechanical superintendents, one having direct charge of locomotive work, lines west from Salamanca to Chicago, one in charge of same work, lines east from Salamanca to New York, and one in charge of car work over the entire system. What now follows will be readily understood.

The superintendent of apprentices and piecework reports directly to the general mechanical superintendent, but he is required to work in harmony with the mechanical superintendents and they must agree on all rules and regulations in connection with the operation of the schools. Changes in standards or methods of conducting the work must be submitted jointly to the general mechanical superintendent for his approval before being made effective.

The superintendent of apprentices and piecework has charge of the practical and technical educational features of the system and deals directly with all problems affecting apprenticeship work. His duties are to outline the different courses of instruction both in the school and shop, organize all schools, see that the standing of each apprentice is kept according to prescribed rules, that apprentices are moved from one class of work to another according to the standard shop schedule and that apprentices in the different departments of the shop are given equal opportunity to advance in the trade. He must require that all school rooms are kept in a clean and sanitary condition, that apprentices take the proper care of all drawing instruments and other material furnished them by the company and insist on a strict adherence to all rules and regulations which must necessarily be followed in order to make the system a success. All business pertaining to the schools is transacted through the master mechanic or shop superintendent of the plant and he is held responsible for the technical and practical training of the apprentices under his jurisdiction.

The local instructors of apprentices are selected with special reference to their fitness to give necessary practical and technical instruction in the work of repairs and renewals to locomotive and car equipment. Some are graduates of a recognized technical college who have subsequently served time in the shop. Others are self-made men who are not only thoroughly practical mechanics, but have by personal effort familiarized themselves with mathematics and mechanical drawing to the extent that they can successfully teach the lessons contained in the apprentice text gook. The instructors devote one-half day to technical instruction in the class room and the remaining half to practical instruction in the shop. They distribute all lesson sheets, require apprentices to do certain work at home, keep record of all examinations, make all monthly reports and account to the master mechanic for the daily performances of the apprentices.

The inspectors of apprentices and piecework report directly to the superintendent of apprentices and piecework. They make frequent visits to the different shops and their duties in relation to the apprentice system are to become personally acquainted, as far as possible, with the apprentices in all departments and engage them in conversation as to progress made, examine conditions, study their work, see that changes are made from one class of work to another as per shop schedule, consult the master mechanic, general foreman, and local instructor as to work accomplished both in class and shop, and report their findings from time to time to the superintendent of apprentices. All matters requiring attention are then taken up with the local officer for proper adjustment.

The local instructor of apprentices makes out a detailed report at the end of each month which shows work performed by each apprentice both in class and shop. This report is forwarded through the master mechanic to the office of superintendent of apprentices and piecework, where the information is transferred to a card record and from this record it may be determined at any time whether the apprentice is receiving necessary advancement from one class of work to another as per shop schedule.

Apprentices are required to serve a term of three years of 300 days each, unless they can qualify in a shorter period; the number of hours worked by the shop to constitute a day. Although the specified course is based on a period of three years, apprentices who diligently apply themselves to the work in school and shop are invited to request a change from one class of work to another at any time they feel confident of the work in hand and at the end of the second year or any time thereafter they may make application in writing to their instructor for promotion from apprentice to mechanic. If, in the opinion of the instructor, the apprentice is worthy of promotion, he is recommended to the master mechanic, who, if satisfied as to the ability of the applicant, makes up the necessary form, which is subject to the approval of the mechanical superintendent and superintendent of apprentices. Apprentices who complete the course as indicated by the award of a certificate of apprenticeship and continue in the

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The house is fortunate in entering the field, with the taking over of the plant, merchandise, equipment, and good-will of the W. G. Hagar Iron Company. It will express its faith in this market by immediate additions to provide complete modern warehouses, handling and cutting devices for beams, channels, structural shapes, plates and reinforcing bars, and other heavy lines not carried at the Hagar plant.

The W. G. Hagar Iron Company have been favorably known to this immediate market for twenty years—Joseph T. Ryerson & Son have been known to steel users throughout the country for a seventy year record for quality, service and fair dealing.

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employment of the company are given the journeyman's rate in the shop in which they are employed, the rate being based on ability and merit.

Apprentices are subject to the same regulations in regard to advancement as any other employee of the company and must show some aptitude for the work in which they are engaged. Their conduct, punctuality and attendance, both in school and shop, must be satisfactory; failing in this, they are not retained in the service.

Boys making application for the position of apprentice in any trade are sent directly to the instructor of apprentices, who examines them as to their general efficiency. If he finds that they are qualified for the position sought, they are given a certificate to the proper officer and the applicant may enter the service pending ratification by the employment bureau.

In some shops where no schools are in progress, the ranking officer personally examines applicants for apprenticeship and report of same is made to the superintendent of apprentices in the regular blank form provided for that purpose.

Employment is on approbation and if at the end of three months the apprentice does not develop a capacity to learn the class of work to which he has been assigned, he will not be continued in the service as an apprentice. At the expiration of three months, which is the trial period, if the applicant gives promise of becoming a good workman and has the ability to successfully handle the school work, he is thenceforward regarded as a regular apprentice and entitled to all the advantages of apprentices in his class.

Boys must not be less than 16 nor more than 21 years of age to enter the service as apprentices and preference is always given the sons of employees.

Apprentices are not assigned to night work except in cases of emergency and then not for a longer period than four consecutive nights. No allowance is made to apprentices for overtime worked and no reduction made for reduced working hours.

The efficiency of apprentices in the shop is based entirely on the quality and quantity of work where 100 percent equals the amount of work which could be accomplished by the average mechanic in a certain fixed time.

The class work is marked in accordance with the progress made and extends by intermediate steps from perfect to failure. In problem work 10 percent is allowed for neatness and the grading is based on the percentage of problems solved correctly in each lesson.

A shop schedule for the various trades has been carefully prepared and forms a very important part of apprentice training. When apprentices have served the required time on one particular branch of the work, it may not be advisable, for good and sufficient reason, to immediately change them to new duties. It also occurs that on account of the very valuable service rendered by an industrious apprentice on work with which he is familiar, the foreman is not always either anxious or willing to make a change which will not only result in temporarily decreasing his output, but also that of the apprentice who follows him.

The shop record, however, is carefully maintained and in the exceptional cases such as outlined above the change is made at the first available opportunity.

The shop schedule is based on a course of three years, but until recently it was found necessary to carry many of the boys into and occasionally to the end of the fourth year, because of improper advancement prior to the organization of the schools, and in all cases of this kind the fourth year has been spent in familiarizing the apprentice along new lines of work.

Our experience in this work, however, has proven conclusively that a reasonable adherence to the three-year shop schedule, along with a careful, practical training by the instructor and foremen, is sufficient to give the average apprentice a general knowledge of the trade which he seeks to learn. Having been properly trained along theoretical and practical lines, the award of a certificate of apprenticeship means to its recipient added responsibilities and if he is interested in the work he will usually continue his studies along the lines of his chosen profession.

The shop schedules for boiler maker apprentices are as follows:

Heating rivets and helping at light work on punch and shear, scaling boilers, etc.	4 months
Ash pan and netting work, also as much miscellaneous sheet iron work as possible	6 months
New firebox work, reaming and tapping staybolt holes, running in, setting and cutting off staybolts, etc.	4 months
Helping to scarf, roll, fit, shear, apply rivets and calk new firebox or new sheets	6 months
Setting flues	3 months
Helping on flange fire	3 months
Working with boiler maker on general work, such as flanging, riveting, applying new sheets, bracing and staybolt work	10 months
Total	3 years

The following statement will show briefly the results which have been obtained by a careful and systematic study of details in their relation to apprentice training and the resultant effect of maintaining an efficient corps of mechanics in the service:

Number of apprentices, all classes, on pay roll January 1, 1908	298
Number of apprentices, all classes, on pay roll January 1, 1914	447
Number of apprentices granted certificates July 1, 1908, to January 1, 1914	362
Number of apprentices granted certificates at end of 2d year	6
Number of apprentices granted certificates while in 3d year	70
Number of apprentices granted certificates at end of 3d year	87
Number of apprentices granted certificates while in 4th year	151
Number of apprentices granted certificates at end of 4th year	48
Percent of apprentices granted certificates who are still in the service	60
Number of special apprentices (graduates of recognized technical colleges) in service January 1, 1914	24

A certificate of apprenticeship is granted apprentices in every department who satisfactorily complete the course of instruction. This certificate bears the personal signature of the general foreman, master mechanic, mechanical superintendent, general mechanical superintendent and is approved by the superintendent of apprentices. It carries with it a bound copy of the apprentice text book, together with a complimentary letter setting forth in detail the progress made by the bearer while engaged in learning the trade.

From six to eight apprentices are kept in the drafting department at all times, where they are taught blue print work, detail drawing, standards of design and construction, etc. They are drawn from the different shops over the system and are required to spend six months in this department. This at once provides each shop with young men capable of making such miscellaneous sketches and drawings as may be required by the master mechanic or shop superintendent.

Methods of instruction both in the shop and classroom are simplified as much as possible. In the school each apprentice, no matter in what department employed, is required to make a freehand pencil sketch of such miscellaneous parts as a crosshead, cylinder head, angle cock, gage cock, boiler check, eccentric strap, eccentric, and others of similar nature. When this sketch has been completed and necessary dimensions supplied, the object is taken away and the apprentice is required to make a complete detail drawing from the sketch, showing each part assembled in its proper place. Drawings thus completed are submitted to the master mechanic for his personal inspection and occasionally they are forwarded to the superintendent of apprentices.

Our school rooms are all equipped with a sectional model of air motor, air hammer, injector, pop, whistle, triple valve, pump governor, engineer's valve, lubricator and similar parts used in the operation of the locomotive. All classes of apprentices are taught the uses and abuses of these parts both from the models and also in practice in the shop. Other apparatus for instruction consists of lantern slides, files, chisels, hammers, taps, drills, square, calipers, boiler punches, reamers, samples of the various sizes of square and hexagon nuts, models of block and fall, brake leverage, outside valve gear, link motion, compound cylinders, gas engine charts, dynamo charts, steam turbine charts, valve setting charts, superheater charts, etc. These models or samples are used in imparting instruction with reference to the proper use and care of same. This is especially true of small tools, where particular instruction is given with reference to using same so that maximum amount of work may be obtained without destroying the tool.

The primary aim of the school is to each by actual example as far as possible, or by the use of a model or chart. As an illustration: The lever is found at work in almost every machine used. It is of first importance, therefore, that the boy obtain a lasting impression of the lever at work, so that he will recognize it again when it appears in another form. In other words, he must be able to understand the principle of the lever, the pulley block, the incline plane, the screw, the wedge, etc. If he does not have mechanically constructed models to illustrate these principles the study becomes dull and uninteresting.

In the shop, boys as a rule work with skilled mechanics; this is particularly true in erecting and vise work, boiler making and blacksmithing. This course is followed out until the boy can show that he is able to do the work alone. Then, if the mechanic should take a day off, the boy is placed on the work along with another apprentice. This immediately places him on his merits and he at once becomes an instructor to the apprentice assisting him.

The instructor of apprentices follows the practical work of each apprentice in detail to see that he thoroughly understands how to perform the operations correctly and in proper time and by this means the average boy becomes thoroughly familiar with the various classes of work covered by his trade.

It will be found that apprentices receiving practical training along these lines will perform the larger part of the operations on a locomotive in about the same time as required by the average mechanic, and that the quality of the work will pass required inspection.

Boiler Explosion in Hawaii.—In Hawaii, where there is no boiler inspection law and no license law for engineers and firemen, a locomotive type boiler engaged in operating a coal hoist and conveyor exploded recently on account of low water, killing the fireman and injuring other persons nearby. The crown sheet and tube sheet of the boiler were pulled off from the staybolts and tubes, and severed portions showed evidences of having been overheated.

Flanged and Pressed Work in Boiler Shops*

BY F. A. GARRETT

Useful Formulae

It now remains to give some useful rules for finding the size of plate required to make a given size of flanged plate.

Rule 1. Flanged diameter plate, as at *A*, Fig. 13. Let D = diameter of plate when flat. Other references as given in illustration. Then $D = d + 2f + 1.5708\,(2r + t)$.

This will give an allowance for machining the flange so as to make a good calking edge, since the metal will gather round the flange, making it slightly deeper than it otherwise would be.

Rule 2. In Fig. 13 *B* represents a section through a plate which has been flanged outwards, thus forming a circular opening.

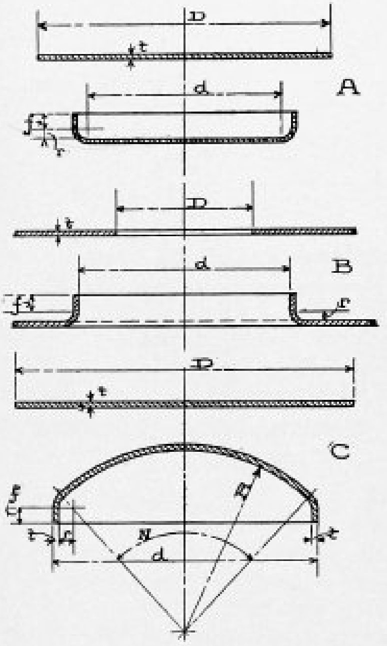

Fig. 13.—Rules for Finding Allowance of Plate Required for Flange

Let D = diameter of hole to be cut in plate. Other references as given in illustration. Then $D = (d + 2t + 2r) - [1.5708\,(2r + t) + 2f + \tfrac{1}{2}\text{ inch}]$.

This formula also allows sufficient material for machining. It is often necessary to make the plate thicker than would otherwise be the case, the reason for this being that the plate has to stretch considerably in the flanging operation, thus making it much thinner at the edge than it was originally. As it is often required to find the final thickness at the edge, the following formula is given:

$$\text{Final thickness } T = \frac{\sqrt{(4Dt + d^2)} - d}{2}.$$

Rule 3. Dished crown plate, Fig. 13, *C*. References are as shown in the figure.

The projected radius of cambered part equals:

$$\frac{\frac{d}{2} - (t + r)}{R - r} = \text{sine}\,\frac{N}{2}.$$

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* Concluded from the July issue.

Upon reference being made to a table of sines, we can find the angle to which this figure corresponds. This result has to be multiplied by 2, thus giving us the number of degrees N in the cambered portion, and therefore diameter of plate when flat:

$$D = \frac{(2R + t) \times N}{114.5} + 2f + \pi r.$$

This formula also allows sufficient material for machining.

Dies for Cold Punching

The writer now proposes to give some data for the design of dies for punching steel plates without heating. The following particulars apply only to punches of, say, 6 inches in diameter and upwards.

There seems to be a general impression among engineers and boiler makers that punching plates cold is injurious to the material. This does, no doubt, apply to small, flat punches and large dies having excessive clearance between them, but when these are designed correctly and kept in proper working condition, very little injury is done to the plate; and given these conditions it is my opinion that cold punching constitutes good boiler practice, except in the case of exceptional jobs.

The above conclusion has been arrived at after examining very carefully the effects produced when using dies having a very small clearance, and this should, indeed, always be kept down to the very lowest limit, and the punch should be made so that it will only just pass through the die. The most economical design of punching dies consists of cast iron holding blocks, made so that hardened steel faces may be fitted into them, thus forming a hardened face where the actual shearing of the material occurs. Fig. 14 gives an example of this.

It is now generally conceded that when a plate is being sheared, the material is not completely severed until the punch has reached a point one-third of the way through the plate. From many observations and experiments which the writer has made, it would appear that when the edge of the punch reaches the surface of the material, the pressure required increases rapidly from nothing to a maximum when the edge of the punch reaches the fracture line, the exact location of which I believe must vary considerably with the different angles which the punch face makes to the horizontal, and I hope to give a more detailed theory of this at some future time. It must suffice at present to say that the edge of the punch, having reached a point one-third of the way through the plate, the material is completely severed, and only sufficient pressure is required to remove the piece which is punched out from the remaining material.

The graphical chart shown in Fig. 15 will enable the lead required for various diameters of punch to be found without it being necessary to make any calculations. It is plotted from the formula:

$$L = \frac{.02083\,T}{1 - \cos.\left(\dfrac{.9P}{.0502\,D\,T}\right)}$$

Where T = thickness of plate in sixteenths of an inch.
P = pressure exerted by hydraulic press in tons.
D = diameter of punch in inches.
L = lead of punch face in inches.

When making calculations, assume that the pressure required is equal to the resistance of the plate area which is in contact with the edge of the punch from the point where it cuts the fracture line to where it breaks contact with the upper surface of the plate, adding about 10 percent to the result.

The profiles of holes most commonly punched are circular, elliptical or oval. The formula by which the required lead may be found is similar to that given above for circular punches, and the required lead for the two last mentioned profiles may be found by the following formula:

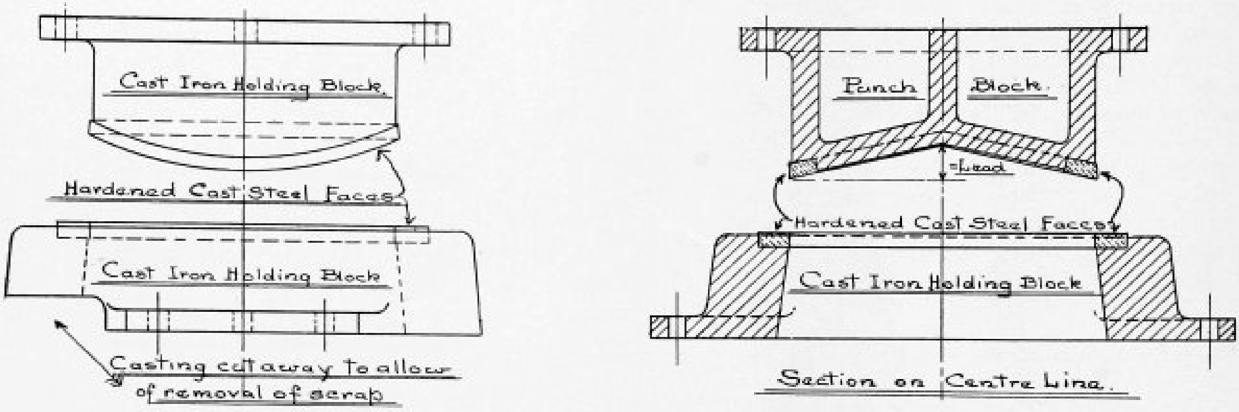

Fig. 14.—Punch and Die for Punching Steel Plates Without Heating

$$L_1 = \frac{L \times d}{D}$$

Where L_1 = lead for elliptical or oval-shaped punch.
L = lead for circular punch as found by previous formula.
d = major axis of elliptical or oval punch.
D = twice radius at ends of elliptical or oval punch.

An important point when designing punching dies is to keep the lead as small as will allow it to pass through the plate, because with an excessive lead the hardened steel face is very liable to fracture at the edge, with the consequent expense of frequent renewal.

The material which should be used for the cutting edges of dies is known as "double shear steel," and it should be carefully hardened. The amount of hardness should be such as will allow the edge of punch to turn up sooner than chip off, which it most assuredly will do if the steel is not properly hardened. Upon this depends the life of a set of steel parts, and consequently the cost of upkeep of a given set of dies.

To give an instance of the importance of this I know of a set of dies which had punched 1,400 holes measuring 14 inches by 10 inches in 7/16-inch steel plates, and the steel parts were then in quite good condition. Needless to say, the hardening process was very carefully carried out. On the other hand, with improper hardening I have known the steel face to give out before half a dozen plates had been passed through the dies.

There is no doubt that a certain amount of "flowing" of the metal takes place under the pressure of the punch, this being more pronounced with the smaller sizes of holes, being quite noticeable with a hole, say, ⅝ or ¾-inch diameter. The result will be more easily seen if we try an experiment with a piece of thick sheet lead. With this material a very large percentage of the material under the punch flows into the adjacent surroundings, the "burr" itself being very much less in thickness than the sheet was originally.

This may possibly have something to do with the plate not fracturing sooner than is actually the case. To prove that the material of the plate *does* flow to a certain extent, it is interesting to get a piece of plate too thick for a punch with a given lead to pass through. Having placed this between the dies the pressure is applied. Upon examining the plate it will be found that there is a slight indentation in the plate at the upper surface, and upon removing the plate from the dies a corresponding detentation will be found on the lower surface. If the plate is now sawn across it will be found to show no sign of fracture. It would appear to be a case of plastic flow of the material. It is needless to say that the depth of indentation must be small as compared with the thickness of the plate if the above result is to be observed.

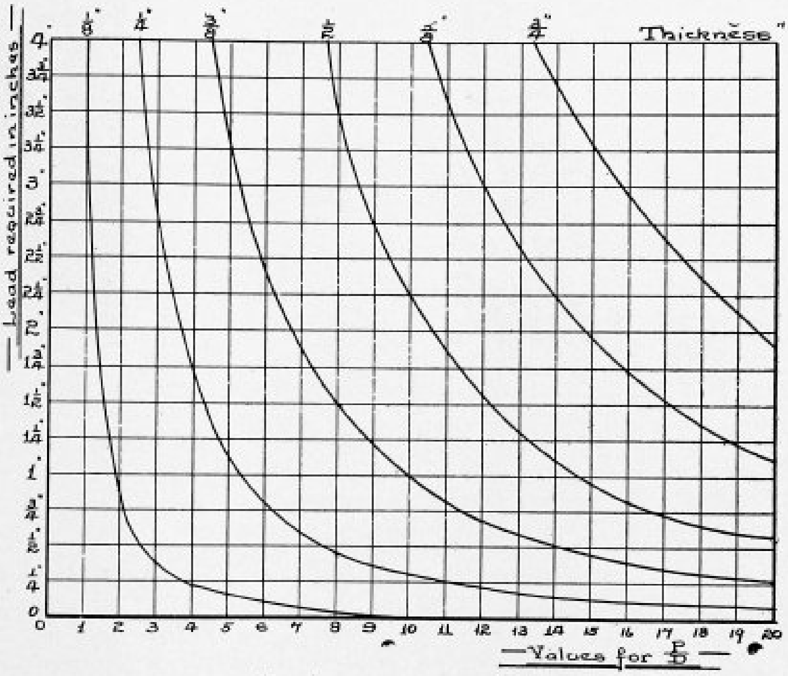

Fig. 15.—Chart for Solving Lead of "Cold" Punch

It would be interesting to have the experience of any reader who has made observations with reference to cold punching, because there is a large field for this class of work in boiler shops. With properly designed dies a very large variety of satisfactory work may be done by this process, the cost amounting to practically only one-half that of hot punching. The dies used for hot work may be similar in design to those already shown, the only difference being that little lead is given to the punch. This method complicates the problem of keeping the steel in a hardened condition, because the heat treatment to which the steel parts are, of necessity, continuously subjected, makes the working life comparatively short. Therefore the adoption of this method is not advisable when any other course is open, as the sum total cost of a given job will be very high when compared with the same job done cold.

Conclusion

The notes and data given above have been collected by the writer during his experience in designing hydraulic press tools, and as they are taken from practical experience the data may be relied upon to give satisfactory results. Although it has been impossible to treat the matter to its full extent, it is hoped that the particulars given will be of use to a large number of readers. I would repeat that in a good many cases sufficient attention is not given to the design and maintenance of press tools, and I would impress upon readers the necessity of close attention being paid to this subject, for therein lies the fundamental basis of high-class work at a reduced cost.

Revelations of Some Damaged Boilers*

Altogether eighteen cases of accidents were taken up, five of which were fully investigated, as follows:

A. A lower shell plate of a double-flue boiler, built in 1892, for seven atmospheres (above atmospheric) pressure, with a heating surface of 979 square feet, after being started up for three hours on blast-furnace gas and under three atmospheres pressure, was ruptured in the fourth girth seam. The crack extended over eight rivet holes and ran into the solid plate, so that the boiler was emptied.

The investigation showed that the material cannot be pronounced inadequate, but that the rivet holes were punched. It is to be assumed that fine cracks were thus produced and gradually increased during service, finally leading to a complete break. Such fine cracks were noticed extending from the parts distorted by punching.

B. The second case was that of a front head of an eccentric corrugated flue boiler of 862 square feet heating surface, built in 1902, for twelve atmospheres pressure. After renewing the first flue section, which had been bent somewhat by use of oil and grease and much bent by the hydraulic test which followed, a crack in the round corner at the edge of the flue was observed at the time of cleaning. This crack was almost through and extended over half of the head.

The neighboring parts were covered with numerous fine parallel cracks. It can well be assumed that the main crack

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* Report presented by Chief Engineer Bütow, for the committee on testing damaged boiler materials, to the Munich convention of the International Association of Steam Boiler Inspection Societies, June, 1912. Translated from *Glueckauf*, March 1, 1913, and published in *Power*, August 26, 1913.

was produced by extension and running together of such originally small ones. Nothing could be learned as to their cause. Perhaps very fine, unnoticed cracks were caused by the flanging of the head. Perhaps, also, a heavy stress on the head was produced by the bending of the bagged flue. The material tests all gave satisfactory results.

C. The third case concerned a shell plate from the last belt of a double-flue boiler of 915 square feet heating surface, built in 1908, for eight atmospheres pressure. During cleaning it was noticed that water leaked from a crack. The test piece submitted was a part of the shell plate.

The belt in question lay on a baffle of the setting, and showed cracks extending through the part supported near the girth seam, and also strong corrosion on the outside. By the various etching tests and photomicrographs it was perceived that the crack followed the edges of the ferrite grains, whence it is judged that the cracking was caused by strong alternate stresses upon the plate. This assumption is strengthened by the fact that the feed pipe ended just over the damaged place. The cracks are, therefore, very probably due to the circumstance that, in cleaning, cold water was let upon the not sufficiently cool plates. The composition of the material was shown by the tests to be normal.

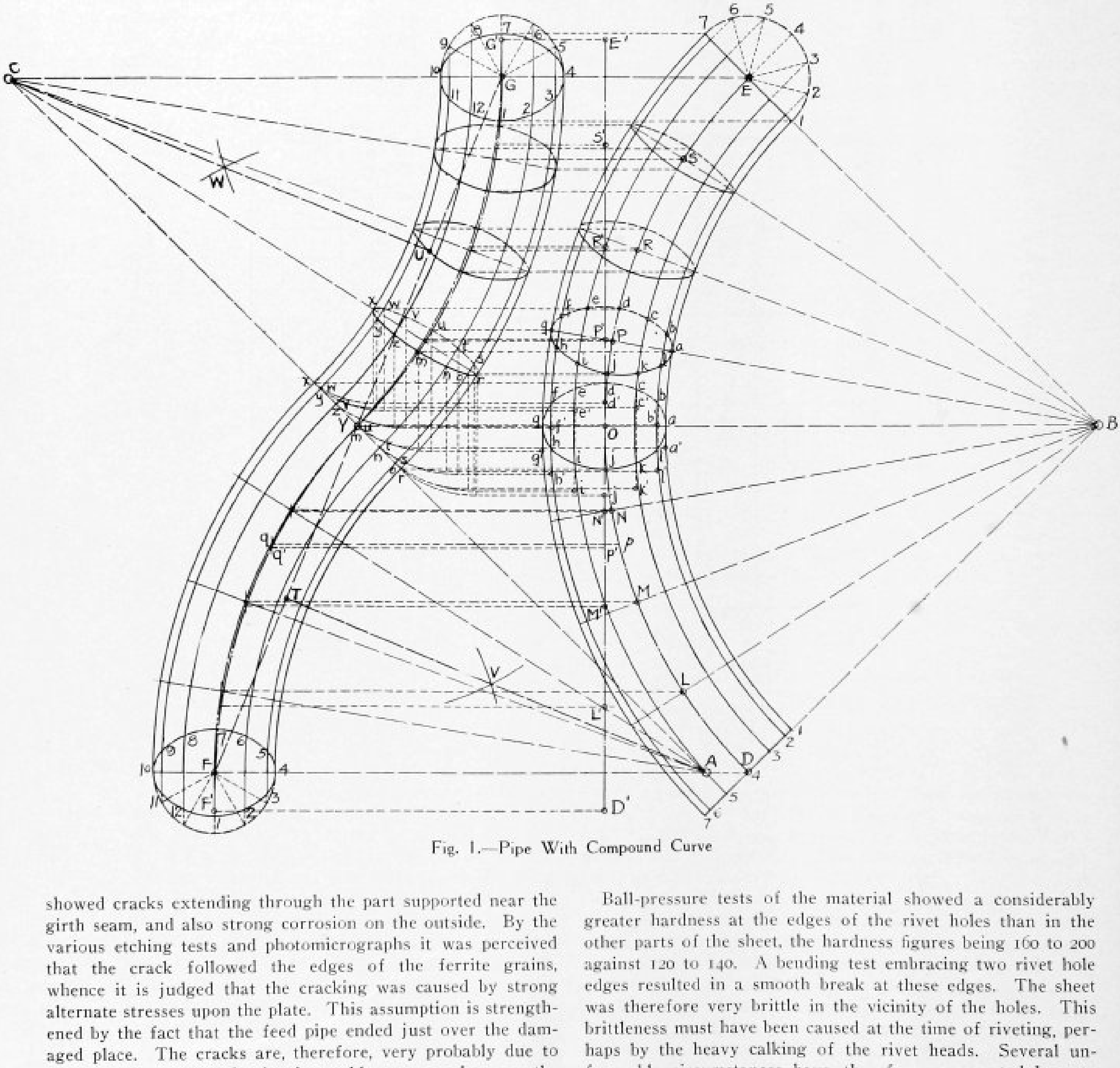


Fig. 1.—Pipe With Compound Curve

D. The fourth case had to do with three shell plates of a double-flue boiler having 646 square feet of heating surface, which was built in 1894, for six atmospheres pressure. At the time of a regular hydraulic test, leaks were found in the girth seams. On calking these places a piece about 4 inches long broke out of the edge. The rivets there were then removed and the piece chiseled out. Various cracks were now seen running from hole to hole of the seam and several cracks in the edges of the holes. After repairs, and during the hydraulic test, there occurred, at another girth-seam rivet hole, hair cracks which hardly were moistened. After this piece also had been cut out several cracks appeared not only in it but also in the underlying plate.

Investigation shows that the rivet holes had been punched. It was determined also that the sheet was so bent that the punching burr lay outward. Thereby were produced, from the start, fine hair cracks extending from the rivet holes.

Ball-pressure tests of the material showed a considerably greater hardness at the edges of the rivet holes than in the other parts of the sheet, the hardness figures being 160 to 200 against 120 to 140. A bending test embracing two rivet hole edges resulted in a smooth break at these edges. The sheet was therefore very brittle in the vicinity of the holes. This brittleness must have been caused at the time of riveting, perhaps by the heavy calking of the rivet heads. Several unfavorable circumstances have therefore co-operated here to form the cracks. In addition came a not altogether proper method of blowing off the boiler in shutting down, for the too sudden cooling produced strains. The percentage of oxygen, sulphur and calcium was found to be somewhat higher than is good practice to-day for boiler plates. Notwithstanding, the material, according to the other tests, could not be pronounced unsuitable.

E. The last case was that of three tubes in a watertube boiler of 3,229 square feet heating surface, built in 1911 for thirteen atmospheres pressure. It had been in service for forty-five and one-half shifts when a watertube of the lowest row ruptured for 10 inches. The ruptured bulge was on the bottom and the tube was bent upward by the reaction. Several other tubes were badly bagged.

Right after the accident it was determined that the metal of the ruptured tube at the place of the crack was not drawn so thin as elsewhere. In the back part of the tube was found thin scale; in the rear header of the tubes was a layer of scale pieces 2 inches deep.

By microscopic investigation it was found that at the bagged places a strong decarbonization and coarsening of the structure had taken place; the size of grain was six times as great as in the immediately neighboring parts of the tube, therefore a sharp local overheating had occurred, and this had caused the tube to burst.

The eighteen cases of accident submitted from September, 1907, to the beginning of 1912 occurred in sixteen instances with stationary steam boilers, in one with a locomobile boiler and in another with a steam drum or tank. In the seventeen boiler accidents the material was mild steel, while the drum was made of wrought iron.

If the cases be classified according to the causes of the accidents, as they appeared upon the tests, in only two cases must the blame be charged to the material alone, while in a third case other conditions were superadded. In three more cases the cause of the disasters was faulty workmanship; a watertube called seamless proved to be badly welded, and twice old welded cracks broke open again. In six cases the punching of the rivet holes is accepted as the cause, in another case faulty design—an inadequately stayed head. Too quick shutting down and introducing cold water into the insufficiently cooled boiler led to two disasters. In three more instances watertubes were burst by scale and overload.

Layout of a Pipe with a Compound Curve

The problem of laying out a pipe with a compound curve presents many difficulties which can be eliminated by a little forethought on the part of the designer. Take, for example, the design of a pipe to connect two circular openings, one in a horizontal plane and the other in a vertical plane, having centerlines that do not meet, *i. e.*, with openings off center. Fig. 1 shows two views of such a pipe connection, the axis or centerline being *F-Y-G* and *D-O-E* in each view, respectively. To simplify the layout, the curve *D-O-E* is made the arc of a circle with center at *B*, the line of intersection of the planes of the openings. Also in the other view the curve is made of two equal arcs, *F-Y* and *Y-G*, with centers at *A* and *C*, respectively. These centers are found by joining *F* and *G* with a straight line, and dividing it into four equal parts by points *T*, *Y* and *U*, then with *F* and *Y* as centers describe arcs to locate *V*, and draw *T-V* until it intersects *F-D* at *A*, which is the center for arc *F-Y*. This is also done for curve *Y-G* by locating the center *C* as described for *A*. The pipe is then drawn as shown, and the circumference divided into an even number of parts, twelve in this case, by points 1, 2, 3, etc., on the semi-circle about *E*, and these are projected down to the line *E-B*, and arcs drawn the full length of the pipe about the same centers as used for the axis. These lines, 1-1, 2-2, 3-3, 4-4, etc., are called elements.

As previously stated, the pipe as shown is designed to simplify the laying out. By a close analysis of the figure it is seen that if the pipe were divided into an equal number of parts, such that the axis or centerlines of all parts were equal, the same elbow layout would do for each part or section, only that each succeeding one would be twisted around a little more than the one preceding. Following this more closely, in order to use this method of equal subdivision, it becomes necessary to divide the true axis of the pipe into an even number of parts. The axis of the pipe is neither shown in its true form nor length in either view, but it can be found in its true length (the true form cannot be shown on a flat surface) by bending the pipe in the right-hand view, so that its axis *D-O-E* becomes the straight line *D'-O-E'*. In the left view this will still be a curved line, as it has only been straightened in one direction.

To find this curved line, which is shown in the figure as *F'-Y-G'*, take various points, such as *p* on *D-O-E*, which would fall at *p'* on the straight line *D'-O-E'*. Project *p* and *p'* across, and where the projection of *p* crosses the axis *F-Y-G*, as at *q*, drop a perpendicular *q-q'*, then *q'* is a point on the curve in question. After a sufficient number of such points are located the curve can be drawn as the arcs of circles, with centers somewhere near *A* and *C*. When this curve is drawn it is divided into an equal number of parts, and the dividing points are projected over to the straight line *D'-O-E'*, giving points *D'*, *L'*, *M'*, *N'*, etc.

Now imagine the pipe bent back to position *D-O-E*, then the points *D'*, *L'*, *M'*, etc., will fall at *D*, *L*, *M*, etc., which will determine the sections of the pipe for cutting in order to get equal elbows. Now project these points *L*, *M*, *N*, etc., over to the original axis in the left view and draw radial lines through all these points in both views.

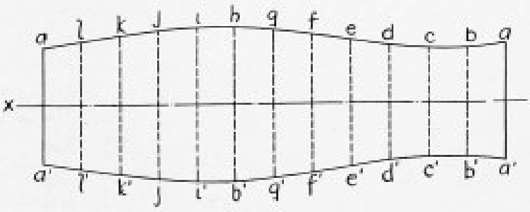


Fig. 2.—Pattern

Only one section was laid out, that from *P* to *O*. This was done by first drawing the ellipses at *P* and *O*. That at *O* was simple, because in the other view it is a straight line and corresponding points on the elements were projected over, giving points *a*, *b*, *c*, *d*, etc. The ellipse at *P* is constructed in any convenient manner, the four points *a*, *d*, *g* and *j* being known. The points *a*, *b*, *c*, *d*, etc., are then projected to the other view, giving *u*, *v*, *w*, *x*, etc. Now with *m-m* as a radius draw an arc until it intersects a perpendicular dropped from the upper *m* as shown, and project this intersection over until it intersects a perpendicular dropped from the point *a*, which corresponds to *m*. This gives point *a'*, and similarly points *b'*, *c'*, *d'*, etc., are found. The straight line distance from *a*, on the ellipse at *P* to *a'*, is the true length of that part of the element *a-a*.

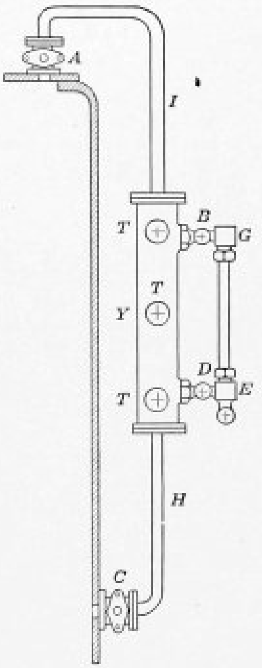
If, then, in Fig. 2, on a line, *X-X*, we lay out perpendiculars 1, 2, 3, etc., equidistant and of such a distance apart that 1-1 is equal to the circumference of the circular section of the pipe, and transfer the lengths *a-a'*, *b-b'*, etc., as shown, so that they are symmetrical with respect to *X-X*, we will have points on the outline of the elbow. These points are then connected by curved line *a-a* and *a'-a'*, Fig. 2. This is the pattern for the elbow, and it will be found by checking, *i. e.*, going through a similar operation for any other section to satisfy all sections throughout the pipe.

But these elbows must be joined together in the proper manner to produce the given pipe. In order to see this clearly, several adjacent sections should be developed and by careful delineation the method of joining ascertained. This is also advisable as a means of checking so that no errors might creep into the work. The figures show the pipe in question divided into eight equal parts or sections, but actually more subdivision is necessary to make an accurate layout.

Serious Accident Due to Shortness of Water

To all marine engineers the boilers are the most important section of their department, and it cannot be too deeply impressed on the minds of those in charge the serious results that may be incurred by the neglect of the water gage glass, and that a large proportion of boiler troubles are caused by shortness of water. The writer's experience showed that in one case, anyhow, a serious accident would have been averted had proper precautions been taken in the first instance.

We were about to leave Cardiff on a voyage down the Mediterranean and Black Sea ports, when our fourth engineer (who, by the way, was continually growling about the misery of a marine engineer's life) failed to show up on the morning of sailing, so we either had to go to sea short-handed or else seek a substitute. The latter course was favored by the chief engineer for obvious reasons, so our own donkeyman, who was a trustworthy man, but did not hold any certificate or license, was engaged.



Arrangement of Water Column

After a couple of four-hour watches, in which the chief helped the donkeyman out, he was left to go below alone, in sole charge of the engines and boilers. I myself had to relieve him at midnight and all was well.

One night several days out, however, about 11 P. M., I was aroused from my meagre slumbers by a terrific noise as of escaping steam somewhere in vicinity of the fire room, which caused me to dress hastily and rush from my berth. At the top of the fiddley grating I was met by an oiler who acquainted me with a hurried explanation of the explosion. He said the starboard boiler's high furnace had burst.

Proceeding down the ladder to the stokehold, I saw the chief, second, and some firemen attempting to close the starboard boiler stop valve and auxiliaries. The heat was intense on the tops of the boilers, and I remember the top button of my boiler suit burned my chin when it came in contact with it, raising a blister. It was useless to attempt putting water into the boiler, as the combustion chamber top had collapsed and was down about 4 inches, the nuts stripped off eight of the staybolts supporting it, and six of them were drawn through the plate, leaving six 1½-inch diameter holes through which the steam escaped with great violence, the pressure carried being 180 pounds per square inch.

There was no doubt that the boiler became short of water, the combustion chamber crown plate was overheated and was drawn over the ends of some of the supporting stays. Our erstwhile fourth engineer swore there was plenty of water in the starboard boiler, and upon examination this proved to be incorrect, although the glass was full. The trouble lay in the top double shut-off cock or valve becoming choked with deposit, allowing the gage glass to fill up.

The test cocks on marine boilers in the writer's experience have usually been for ornamentation, as they are packed tight to prevent leakage, and difficult to open, so consequently never touched. Now, to help junior engineers who are not fully conversant with the methods of testing water gages, I propose to give a short, reliable way to ascertain if all pipes, cocks, valves, etc., on gage columns, etc., are clear.

To blow glass through shut *B* and *D* alternately and keep *E* open, but to blow through the water gage it is necessary, after blowing through the glass, to shut *A* and *C* alternately, at the same time keeping *B*, *D* and *E* open long enough to completely discharge the contents of the gage and its connections. Suppose *A* is choked, assuming *B*, *D* and *C* are clear. The steam in the column and in the pipe *I* becomes condensed, and the water flowing through *C* to take its place rises in column *Y* and in the glass to a level higher than the water in the boiler. This means a false level. If we now open *E* and water is blown out, then on *E* being closed again the water will rise higher again than before misleading the engineer further.

When *B*, *D* and *A* are clear and *C* choked, then any water that may be in the glass is trapped and no longer rises and falls with the water in the boiler, or with the motion of the ship. It will, however, rise in the glass, owing to the condensation of the steam in the upper part of the gage until *E* is opened, when all the water in the glass is blown out. On closing *E* the glass shows no water, although the water in the boiler may be at the working level.

When the test cocks *T*, *T*, and *T* are attached to column *Y*, they cease to be reliable when either double shut-offs *A* or *C*, or the pipe in connection, is choked or partially so.

Woodbridge, N. J. F. W. Christiansen.

Recent Development of Express Locomotives in France.—In a paper presented at the Paris meeting of the British Institution of Mechanical Engineers, Prof. Edouard Sauvage gave an interesting account of the most recent improvements in locomotive construction in France, chiefly in connection with the boilers. He pointed out that superheated steam is largely used, the Schmidt standard superheaters being almost universally adopted. Owing to the large size of tubes necessary to receive the superheater pipes it frequently happens that the heating surface is greatly curtailed, and in some cases the total heating and superheating surface is less than the surface which might have been obtained without superheating. No difficulty is reported to arise from the use of superheaters. Summarizing, the author states that the large increase in the power of the express locomotives is characteristic of recent construction, nevertheless a further increase will be required in the near future. Larger boilers have been designed and fitted with superheaters. The conditions in France seem to be similar to those in Great Britain, in both of which countries special experiments as well as ordinary practice have proved that superheat confers an important increase of power without causing trouble or undue expense. Another point on which experts agree is that superheat alone is equal or even better than compounding with saturated steam. As regards express engines French practice is in favor of superposing superheating and compounding.

Shop Promotions

The Things That Put a Man Ahead in the Shop

BY JAMES FRANCIS

Every man and boy in the shop is looking ahead to promotion to one of the positions immediately in advance of him. This is right, and as it should be, but how many of us go about the "promotion study" in the right manner, or carry it along to the best possible advantage?

Nine out of ten of us are keeping an eye upon the position immediately in advance, but that eye is usually more of a jealous one than it is one devoted to fitting one's self for the particular position in view. Now, boys, if we want to get and hold that position, let's understudy it for all it is worth. We will not spend one minute in figuring what the other fellow may do toward getting it for himself. Let's do everything possible to cinch the job for our own selves.

There are several things to be done before we can lay claims to the position, and not the least of these things is to be able to do the work which that position calls for, and to do it satisfactorily and perhaps a little better than it is being done now. When we can do that, and a few other things, then we can lay some claims to a possibility of getting the jobs we want.

Don't be satisfied with a general knowledge of the work the position calls for. Study the details. It is the knowledge of detail which counts in any position, be it that of manager, foreman or down to rivet boy. If you know exactly how to do each and every operation, and to do it well, or in a better way than the present man is doing it, then you are in line for promotion to that position with some chance of getting it.

But if you are working for the chance, and say to yourself and to others, "I can pick up the work quick enough when I get there," then you might as well quit bothering yourself about promotions, for advances don't come to those who are not prepared or are not preparing for them. The position is jumped right over your head and somebody else gets it, while you take out your disappointment in berating the management for their lack of appreciation of your service with them, and with accusations of favoritism and "pull" on the part of the successful man, when, in fact, his only "pull" was an acquired knowledge of the work required by the position—a knowledge acquired while you and the other fellows were having a good time and talking about your chances of getting there.

I remember very well the manner in which two boys went through the shop. They were Sam and Len, and both came into the shop during the same week. Sam could raise more deviltry and kick up more fun in a day than all the other cubs could dig up in a week. He was quick as a flash, and could "do anything and not half try," as the foreman sized Sam up.

Len, on the other hand, was another proposition altogether. It took him four times as long to comprehend anything new as it did Sam to get the same into his head, but while Sam might forget the matter as quickly as he acquired it, Len never forgot, and always had at his finger-ends any bit of "know-how" which he had acquired.

Start the two boys at two similar jobs at the same time, and Sam would be finished and pitching punchings before Len was done. But Sam had only hit the high places in his job, while there was not a crook, a turn or a motion to be made in Len's work but what Len knew the reason for it, and why it was necessary to be made. And Len carried the matter even further than that. When he had a little time, instead of deviling the other boys, or pitching pennies or punchings, Len would be working with somebody near him, and finding out all about what was being done, why it was done that way, and why it was not done some other way. Just as surely as Len found something he didn't understand, then he would go to working the matter back to a point where he could understand. Then, commencing there, Len would come at the problem hammer and tongs until he had finished it. In this manner Len worked through algebra and well into geometry before he knew what he was about, and before Sam had thought about anything besides playing tricks and having "fun."

Before many months had passed Len was promoted and was working at a better job, while Sam was still skylarking. And this sort of thing kept on happening, Len going over Sam's head and over the heads of some others, much older than he was, and who had been in the shop three times as long.

It was not long before Len was a "straw boss," and pretty soon he had a little gang of men, each one of whom was older than he was, and who had been in the shop longer. Everybody, except the superintendent and manager, wondered why Len got ahead so fast, and why Sam, who seemed much the brighter of the two, was "left back" with the other cubs. But the officers knew why it was. They knew that Len got next to everything he saw, and that not a detail of what he had to do ever was slighted or passed over without being fully understood and worked out. They knew, also, that when they sent Len to do a job it would be done right, that Len would let them know what was wrong, provided he couldn't get out of trouble on his own account. But they found that when Sam was sent out on a job, although the work would be done well and quicker than Len might do it, they were never quite sure that Sam hadn't rushed through so quickly that something had been slighted or left partly finished where it might give trouble later. They felt within themselves that Sam might squeeze in a drift and drive a crooked rivet in his rush without realizing the fact, while they were certain and sure that if Len ever found two holes which were not fair he would ream the defective holes and drive a larger rivet to fill them.

The above and other similar reasons are why Len was pushed ahead so fast, and soon got far beyond Sam and the other boys, and it is the reason why they are whispering around the shop that Len will be superintendent just as soon as the present "super" is promoted to general manager. Now, boys, this is the way in which shop promotions are worked out. It all lies with you whether you become superintendent with Len and his kind, or whether you stay on the other side of the carpet with Sam and his cronies. You are just as smart as Len was. The difference is only this: are you willing to work hard and work overtime for the sake of a shop promotion? If you are, then throw the clock out of doors. Don't ever look to see how near 5 o'clock it is, but just watch out to see when you can get the work done which you want to finish before going home for the night. That's the way to get in line for promotion—that and the way Len did in working out the why and wherefore of each and every little detail of the business.

There was no trick or kink in the whole shop so small that Len didn't find out how it was done, why it was done, and what it was good for. And then he would practice doing it until he had the "know-how" down so pat that he could do the trick as well or a little better than anybody else in the shop. That's the way Len went into things and dug to the bottom of them and more, too.

It used to be a standing joke around the shop that Sam could drop his work, put on his coat and beat the second stroke of the bell to the door by 10 feet. But nobody ever saw Len bothering to beat the second stroke or the last stroke of 5 o'clock. Instead of that the watchman says that many times he had to let Len out after he had finished some job he was studying out!

Sam and the last stroke of the morning bell always slipped through the shop door together, but Len never heard that bell once while he was in the shop, for he was always on hand some time before beginning time, and was busy digging away at something which he wanted to investigate about the work he was doing.

One day Sam and Len were put to work together, bending and riveting some 3-inch by 4-inch angles which were to support and stiffen some tanks. The angles were punched before they were bent, and some of the holes usually came wrong, because the angles didn't take up as much as the draftsman had figured on their doing. Sam quickly disposed of this trouble by filling the rivet holes and making new ones, but Len was not so easily satisfied. He went to the library that night and read up on neutral axis and all that sort of thing, and found where the books located the neutral axis in 3-inch by 4-inch angles. Then he bent some pieces of that size of steel, and after bending some short and others long, he found that the neutral axis didn't always stay where the book people had located it. He found that after he had bent an angle that the "neutral axis" moved inward at the point of bending, and as he bent the angle more the axis moved still further inward, and that the piece, after bending, was longer than it should have been according to calculations. This means that the stretch in the outside of a bent angle is greater as the shortness of the bend increases, and instead of the neutral axis being fixed it moves sidewise, so to speak, with the shortness of the bend made in the angle.

Before Len could fully understand the matter, and even before he could even comprehend what the "neutral axis" was, he found it necessary to do a whole lot of studying and to brush up his book knowledge in a dozen directions. But Len kept at it, until he fully understood the whole matter of moment of inertia, radius of gyration, section modulus, extreme fiber stress, and all the rest of the stress calculating family of mathematics. Why, Len was all of one long winter working these things out—used to do it while Sam and the other cubs were skating, playing basketball and singing or playing cards.

Len used to play basketball regularly, but he would not spend all night about it—just the game, then he was off to his studying and the other fellows could go home with the girls. Len used to dance, too. Would go regularly to a good dance once each two weeks. Said it "kept his feet under him" and "helped his company manners." But Len was always on deck at 5 o'clock next morning, for a half hour with his books or with some problem he was working in cube root, logarithms, or some other thing he chanced to be studying. Sam was never troubled that way in the least. He always had a fight with the last call to get up, and nearly took the count to breakfast every morning. And, as stated, he always slid through the shop door with the last stroke of the bell.

The above are some of the things which affect shop promotions, as viewed from the angle of the boys. From the standpoint of the foreman, superintendent and other officials, the same things are found to affect promotions, although they may come in slightly different shape. The foreman who simply drives his men as though they were so many pounds of beef and brawn, that man will not reach promotion as soon as the brainy foreman who looks out far in advance, for the progress of the work, who details each man to the work he is best fitted for, and who takes advantage of all the tricks, kinks and short-cuts known to the trade.

The man who usually gets promoted first is the foreman who has everything planned far ahead, so that tools, material and supplies come along as needed without a wait or a hitch. This man seldom has to wait for something which has been forgotten, overlooked or misplaced. There is not a tool on the job, or a man, but is known to the good foreman, and the exact condition of man or tool and their precise location are also well known, so they may be reached at any instant in the shortest possible length of time.

And the man who gets promoted is the one who is not afraid he will earn a little more than his pay comes to. A man is never promoted until he is worth more pay than he is getting, so don't ever run away with the idea that a man don't have to earn more for the company until after he is promoted, for men who have such ideas are never promoted and never will be.

The company is entirely selfish in this matter as it is in several others. They only promote men in order that the men promoted may make more money for the company. Therefore, if a man shows that he is only working for the man and 5 o'clock, and not for the company, you may be sure that the promotion never visits that man. It is the "live wire," the man who is all the time, in hours and out, looking after the interests of the company, both in his own position and in that of those about him, that is the man who gets the promotion, more pay and an increased field of usefulness.

The management knows that such a man will do more than is expected of him, and they know that the bigger the field the more the man will do, the more useful he will become, and the more money he will make for the company, and that is why they promote him and give him a larger field of usefulness.

Now, Mr. Foreman, put the matter right up to yourself. Are you doing all it is possible for you to do to win promotion to the superintendent's position? Are you taking care of all the work which belongs to the "super's" office when you find a chance to do so? Are you going out of your way or putting in some extra time to take care of things which do not belong to your position, but which will benefit the company by your taking care of them?

Are you leaving work for some one else which you know you can do to better advantage than any other man available, even when that work does not belong to your own department? If you are, then you belong in Sam's class, and the promotion man will pass you by. But if you keep an eye out for every bit of work you can find—"for the interests of the company"—be that work in yours or in some other department, then you will become so valuable to the department that they will push you ahead to positions where the opportunities are still greater—to where your opportunities for benefiting the company will be greatly increased.

I have heard men say, "Oh, that is none of my business. That job belongs to the timekeeper. Let him do it. I am not going to put myself to any trouble to help the timekeeper out, he never did anything for me." That spirit doesn't win shop promotions, or office promotions, either. When you see a chance to do something as described above, don't do it or leave it with the view of "helping the timekeeper." Just do it because it will help your company. That is the concern you are working for, not for any of the individual employees, although it pays to help each one of them when you can, no matter whether such help is appreciated by them or not. It helps the company, and that is what you are there for, and that is your duty, first, last and all the time, and that is the way to be in the lead when shop promotions are being given out.

"What can I do to earn promotion?" Help the company. Do any work I can find needing to be done, do it in hours or out, whenever I find it needs doing. Do the work to the best of your ability and judgment, and if possible do it better than anybody else can do it. Learn the duties and the business of the men above you, and do their work for them when you get a chance. It is a mighty help to promotion to the position of general manager, to be able to step right into that gentleman's desk and do his work just as he would do it himself.

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NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

All boiler, tank and stack manufacturers, steel plate makers and representatives of boiler supply houses are urged to attend the twenty-sixth annual convention of the American Boiler Manufacturers' Association at the Waldorf-Astoria Hotel, New York City, September 1 to 4. A number of interesting papers on subjects of importance to boiler and plate manufacturers will be read at the convention, while special attention will be given to a thorough discussion of uniform boiler laws and specifications. The American Society of Mechanical Engineers has already taken this matter up in a comprehensive manner and its committee on Uniform Boiler Laws has prepared a tentative report which will be discussed at a hearing in the society's rooms at 29 West Thirty-ninth street, New York, on September 15. In order to obtain united action on this report the mechanical engineers' society has asked the boiler manufacturers' association to co-operate with them by appointing a representative committee to attend the hearing to present the best views of the boiler manufacturers on this important question. It is therefore of the utmost importance for all boiler and plate manufacturers to attend the forthcoming convention so that concerted action can be taken to secure the most desirable standard for boiler laws and specifications.

In Canada the movement for uniform boiler laws has culminated in a conference of the chief boiler inspectors of the different provinces in which boiler laws are now in force to prepare standard boiler regulations which will be adopted for the entire Dominion. At present Nova Scotia, New Brunswick and Manitoba have no regulations, although the necessary legislation has been passed. The regulations in the other provinces are so diverse that the boiler trade is badly hampered. The work of the conference, therefore, consists of revising the various regulations and making such amendments as are necessary, so that the laws and regulations of the different provinces will be brought into uniformity and inspection in any one province will be accepted in any other. This desirable step is directly in line with the work which has been undertaken by the leading engineering societies in the United States, although the necessary legislation in the various States is still to be enacted. As soon, however, as a standard boiler law is promulgated, it will probably have considerable weight in influencing the enactment of uniform legislation throughout the United States.

Occasionally complaints reach us from railway foreman boiler makers to the effect that they are hampered in the performance of their duties by authorities higher up, who, although invested with the authority to overrule the decision of the foreman boiler maker, are, nevertheless, incompetent to pass judgment on boiler work. Dictation from an official who is in no position to judge boiler work and who does not have a practical knowledge of boiler making can very easily cost the railway company large sums of money each year. Furthermore, such conditions will tend to decrease the efficiency of the boiler shop in many ways. In the boiler department, the foreman boiler maker should have complete charge of the work and of the men under him. The railway company should rely upon his ability and judgment to tell what work should be done; how it should be done and the time which should be allowed to do the work properly. Conditions which deprive the foreman boiler maker of authority which should be in his hands tend not only to discredit his work, but also discourage the man himself in his efforts to turn out the work as it should be done. While the organization of many of our railroads has been perfected so that there is no cause for such complaints, nevertheless there are others where such complaints are fully justified and where a change of policy is very much needed. A man who is a master of his trade should have sufficient authority to exercise his judgment without being hampered by officials higher up who are in no sense masters of the various trades which come under their jurisdiction. The day for department figureheads has long since passed, and the necessity for making a business of boiler making is gradually making itself felt in the railway boiler shop.

Engineering Specialties for Boiler Makers

"Quickwork" Power Hammer

H. Collier Smith, of 807 Scotten avenue, Detroit, Mich., has placed on the market a new power hammer especially adapted for hammering and bumping operations on any kind of sheet steel, copper or brass. As the hammer makes about 700 strokes a minute it is particularly suitable for forging within its capacity. The hammer can also be furnished in a slightly modified form for flanging steel up to ½ inch thick, for scarfing the edges of plates of the same or greater thickness, and for all kinds of light forgings.

Especial attention is called to the fact that while the "Quickwork" power hammer resembles the old-fashioned hammers, in so far as the machine in general is composed of two separate brackets bolted to a post with the hammer in front swung by a half buggy spring and flexible strap, all the other features of the machine are new. The pintle which jigs the hammer up and down is governed entirely by the foot pedal. When the pedal is depressed this pintle moves away from the center of the shaft and the stroke begins. The distance that the pintle moves away from the center of the pulley drum shaft is governed entirely by the amount the pedal is depressed. It is claimed that the pressure on the pedal necessary to move the pintle in and out of center, or, in other words, to get a long or short stroke as may be desired, is trifling, and that the hammer responds instantly to the movement of the foot without decreasing or affecting in any way the speed or number of blows per minute. Because of this direct and positive control it is claimed that not only can an inexperienced man learn to operate the "Quickwork" hammer in a much shorter time than he could learn to operate the old-fashioned friction clutch hammer, but also that an experienced man can accomplish a given amount of work in much less time on this machine.

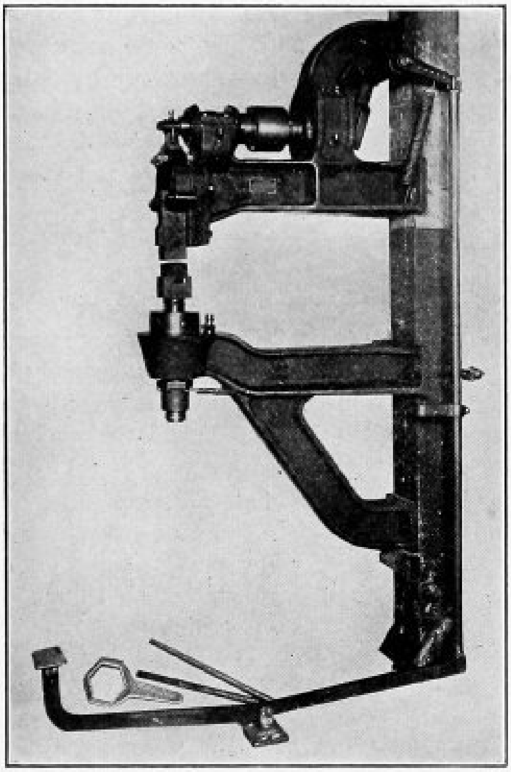


Fig. 1

An automatic stop is provided which can be set to limit the maximum stroke or force of blow so that in finishing operations there will be no danger of depressing the pedal too far and striking unnecessarily hard blows in any one spot. The lower anvil is vertically adjustable. For roughing or doing heavy hammering in shaping operations the anvil is lowered to allow a considerable swing of the hammer head in order to get a very hard blow, and in finishing operations where only a slight blow is required, calling for a short stroke, the lower anvil is raised accordingly. The main bearings are 6 inches long, and the swivel in back are ring oiled, and means are provided for taking up any wear.

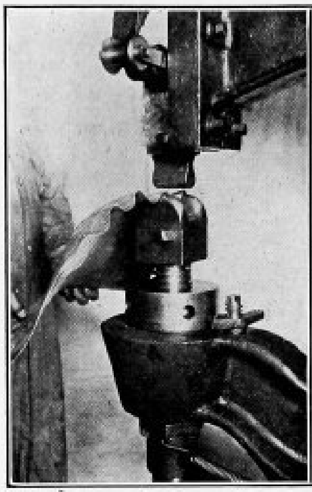


Fig. 2

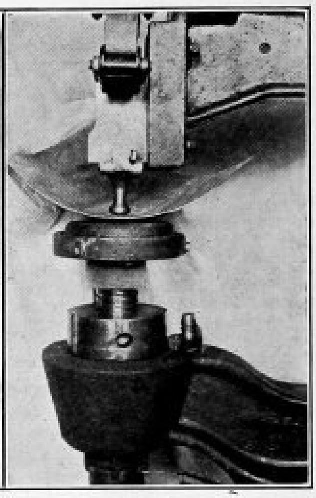


Fig. 3

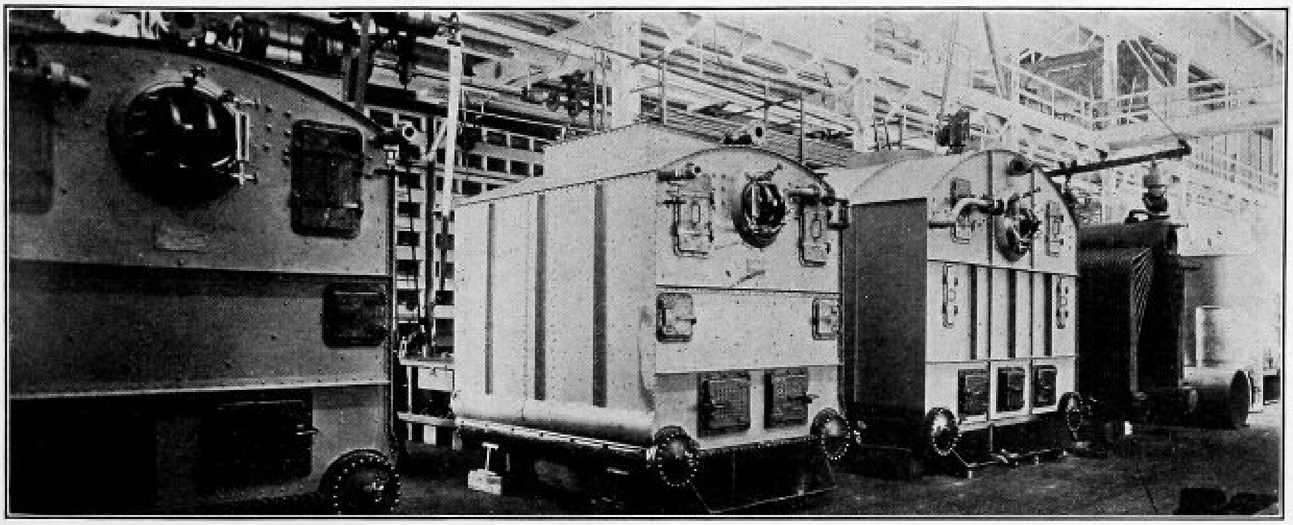
A large variety of shaping, bumping and planishing dies can be used interchangeable with the regular standard dies furnished with the machine, thus making a malletting hammer, a rough bumper, planisher or universal shaping and hammering machine by the simple exchange of dies, which can be done very quickly.

New Seabury Boilers

In the construction of the Seabury marine watertube boiler, manufactured by the Gas Engine & Power Company and Chas. L. Seabury & Co., Con., Morris Heights, New York City, four of which are shown in the course of construction in the accompanying illustration, the steam drum consists of a tested steel plate of 60,000 pounds tensile strength, rolled up and double riveted with bumped heads of tested material riveted in. The two mud-drums are usually constructed of lap-welded steel tubing, having flanges riveted to each end, to which cast steel covers are secured by means of studs. The steam and mud-drums are then accurately drilled with jigs for tube holes. The tubing, of which the greater portion of the heating surface consists, is of seamless drawn steel, expanded into the holes in the steam and mud-drums, there being no screw joints subjected to the intense heat in the combustion chamber. The tubes are so bent and arranged as to leave ample passage for the gases, as well as to provide necessary baffling and allow for expansion and contraction.

Over the nests of tubes on both sides of the steam drum is located a feed-water heater, through which the water passes before entering the drum. The heater is constructed of steel piping and malleable iron return bends, and between the heater and drum is interposed a check valve. The boiler is cased in a substantial sheet steel jacket, stiffened with angles and lined on the inside with magnesia and asbestos, except the ends of the combustion chambers, which are lined with firebrick. The casing is fitted with all necessary fire and cleaning doors.

The shaking grates with which all Seabury (anthracite) coal-burning boilers are equipped are an important feature in their design. They consist of square steel bars running lengthwise of the boiler, carried on two iron bearers; these bars extend through the boiler front, where they can be conveniently shaken. Cast iron grate bars in sections are fitted when it is desired to burn soft coal.



Owing to its large combustion chamber, however, the Seabury boiler is well adapted for the burning of fuel oil, and any of the many successful systems now on the market can be readily applied.

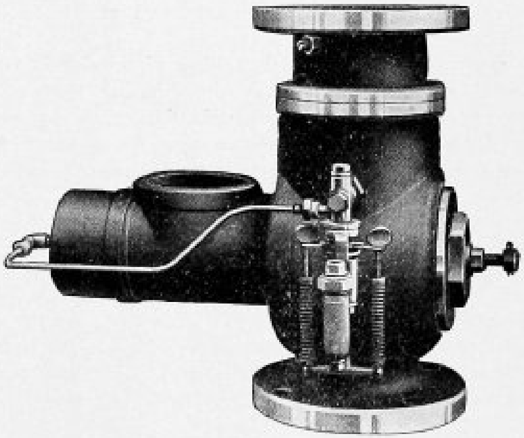
A New Starting Unloader for Motor Driven-Compressors

To maintain a uniform pressure in the receiver and pipe lines, and to prevent the engine or motor driving the air compressor from stalling through overload, it is essential that the compressor, whether steam, gas or motor driven, be provided with some device that will unload it when the desired receiver pressure is attained and start the air into the receiver again when the pressure has fallen but a small amount below maximum, or any predetermined point.

An unloader for motor-driven compressors, in which the motor current is cut out or in to stop or start the compressor when a maximum or minimum load is reached has recently been added to the field of air-controlling devices by Mr. George M. Richards, formerly of Erie, Pa. The unloading action is obtained by the velocity of the air pressure passing through the chamber and the variation of the receiver pressure. It is claimed that the compressor is completely unloaded when the speed is reduced about 25 percent, and by this action any recoil on the last revolution experienced when stopping against a load is obviated.

When the motor starts, the air is by-passed to the atmosphere until the desired speed is obtained, at which point the by-pass valve closes and the air passes to the receiver until the predetermined pressure at which current is cut out is reached. Then the by-pass is opened by the receiver pressure, via the trigger, against the unloading piston. The intake air has then, with the compressor unloaded, a practically free passage through the cylinder, with resultant cooling effect until the machine stops.

The different loading and unloading operations are dependent upon the speed of the machine, and therefore entirely automatic. When the current is cut out and the compressor slows down, the by-pass valve opens automatically and unloads before the compressor stops. When the current is cut in, compression does not occur until the motor has obtained the desired speed. It is claimed that a compressor equipped with this new unloader will require very much less power to start it, and that such a compressor can therefore be driven by a motor of much less power than ordinarily used. The unloader in no way controls the starting and stopping of the motor, it merely unloads the compressor and keeps it unloaded until it is again started and up to the required speed.



The control of the motor current is accomplished by some one of the standard controlling switches and circuit breakers.

Mr. Richards has recently formed a connection with the Yarnall-Waring Company, Chestnut Hill, Philadelphia, Pa., who in the future will manufacture and sell all of the Richards air-controlling devices.

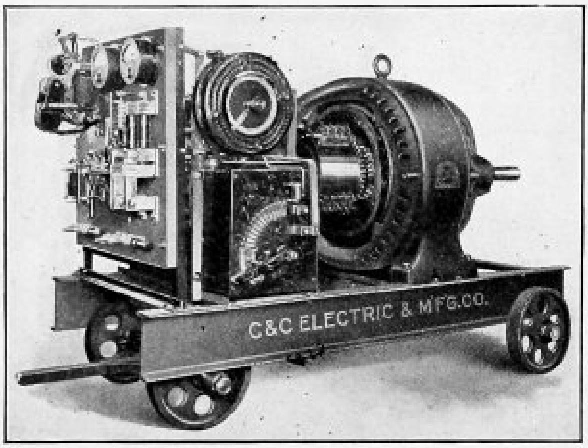
Portable Arc Welder

A new portable arc welder, having all the features of the larger stationary equipments, has been designed by the C & C Electric & Manufacturing Company, of Garwood, N. J. The equipment is extremely flexible for welding and repair work in shipyards, machine shops, locomotive shops and foundries.

The motor circuit can be connected to any available part of the shop or yard circuit.

The apparatus, consisting of dynamotor, control apparatus and switchboard, are supported on a base of I-beams and mounted on a heavy iron truck on wheels. The welding current is generated by a 110-volt dynamotor, the generator end having a capacity of 200 amperes at 70 volts. The motor shaft is extended for receiving a pulley for belt drive by gas, oil or steam engine when in use on barges, in shop yards or where electric current is not available.

As illustrated, the starting box and field control rheostat are mounted on the frame structure supporting the switchboard. The switchboard carries a main line switch and circuit breaker for the motor and automatic control relays for two individual welding circuits. A set of 400 amperes will provide for one graphite electrode or two metallic electrodes for welding. The graphite electrode gives a temperature of about 4,000 degrees C., and is used for cutting, preheating and welding with auxiliary bar. The metallic electrode for welding furnishes the welding metal directly and can be used on vertical or overhead work.



The automatic relays in each welding circuit insert and cut out small steadying resistances on drawing the arc, and thereby prevent burning of the metal. Automatic devices also prevent interference between operators. An ammeter in the welding circuits permits the accurate adjustment of the current to the work.

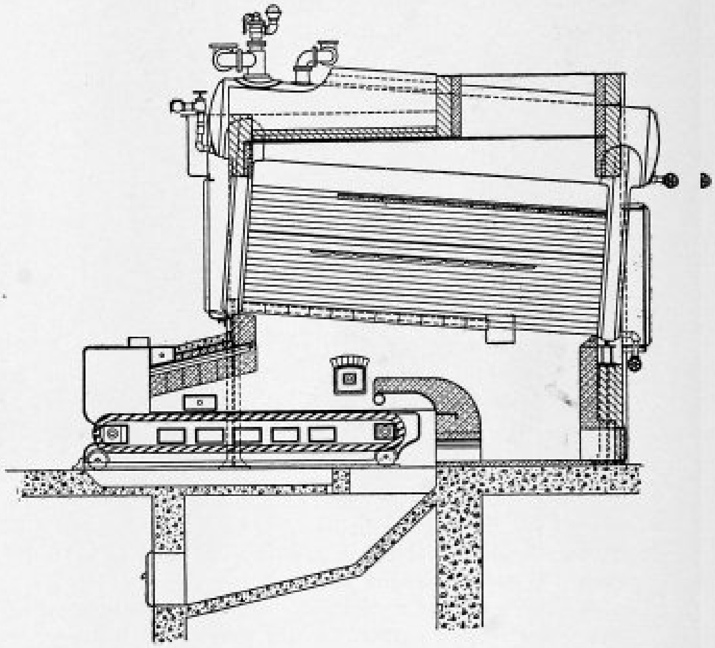
Heine Boilers at the Lytton Building

This plant contains three Heine watertube boilers of 540 horsepower each, set over McKenzie chain grate stokers, with a divided pass method of baffling shown by the sectional drawing. The boilers are of the high-pressure type, being built in accordance with the strict Chicago requirements for 200 pounds working pressure. Each boiler has two large shells built of three sheets, ½ inch in thickness, with the longitudinal seams of the triple-riveted double strap-butt joint type, and the roundabout seams with lapped joints, single riveted. The water legs are of the well-known Heine pattern, built of two sheets, machine flanged and joined by a butt strap along the bottom and sides. The water legs are double stayed; that is, are built with twice the customary number of hollow staybolts. Each boiler has 349 3½-inch by 16-foot hot finished seamless tubes of No. 9 gage.

The illustration shows the setting of one boiler, also the baffling. Each boiler is supported on a steel chair at the rear, and cast steel brackets riveted to the sides of the front water-legs rest upon column supports. Rollers at the rear permit of free expansion and contraction.

The lowest row of tubes is encircled by "L" tiles to within about 5 feet of the rear water-leg. This row of tiling serves as a roof for the furnace and combustion chamber, and permits of a very simple and standard arrangement of the stoker, with plenty of room to give the flames time to burn out without an excessively high setting. The flame travels horizontally, and the gases burn out in the combustion chamber before reaching the tubes.

The middle baffle rests upon the ninth row of tubes with an opening both front and rear. The top baffle extends from the rear water-leg to within several feet of the front water-leg, leaving an opening for the discharge of the gases from the boiler tubes. The gases entering the boiler divide into two streams, one flowing beneath and the other above the middle baffle. Before passing to the smoke outlet the gases flow under the boiler drums.



McCabe Pneumatic Flanging Machine

A pneumatic flanging machine has been designed by the McCabe Manufacturing Company, Lawrence, Mass., for flanging plate such as is used in boiler shops and other sheet metal working plants.

The machine is self-contained, and therefore requires no foundation or attachment to the floor. As it is operated by compressed air, the machine can be placed anywhere within range of the ordinary ¾-inch air hose containing 80 to 100 pounds air pressure. Each machine is furnished with six sets of forms for flanging different classes of work. The claims made for the capacity of the machine include flanging rectangular plates while cold of any length or width and up to ½ inch in thickness on one or all four sides; also circular plates 48 inches in diameter and larger, and up to ½ inch in thickness; dished heads, half heads, cone heads and segments of circular heads up to ½ inch in thickness without heating the plates. For rectangular tank work round and square corners are flanged in one heat with one stroke of the bender.

Welding in Half-Side Sheets.—In welding in firebox half-side sheets good results are sometimes obtained by applying the staybolts and rivets after the welding is done.

Letters from Practical Boiler Makers

Heavy Plate Developments

In the June issue of The Boiler Maker, under the title "Heavy Plate Developments," there is given a method of laying out a pipe connection. I would like to criticise one point in this work. The writer of the article, Mr. Linstrom, uses the outside diameter of the pipe *C* and the mean diameter of the connection *A-B*. In my opinion the inside diameter of *A-B* should be used, because the inside of *A-B* strikes the outside of *C*. To illustrate, take Fig. 1. This is part of the figure for an ordinary T-connection. We will consider only the outside of the connection, as it shows the greater difference. Using ½-inch plate the difference is 1 13/16 inches.

Suppose the pipe were in the field so the cut-out cannot be made until the connection is ready to be made. If the connection were put on the pipe to mark the cut-out and flange holes, it would bind on the sides while the top of the connection is 1 13/16 inches away from the pipe. Of course, it could be forced down, but that ought not to be necessary.

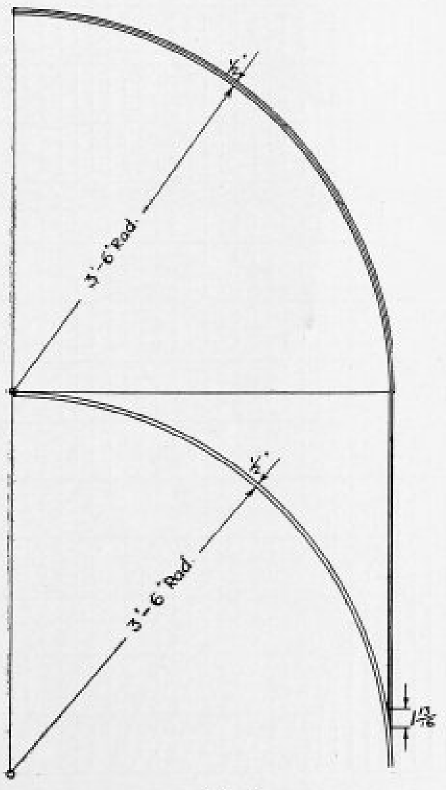
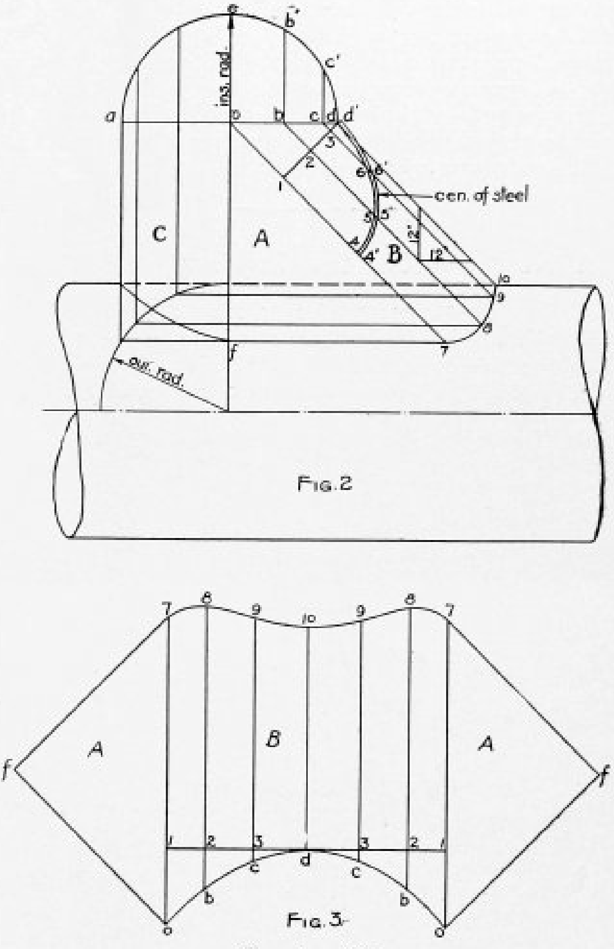


Fig. 1

Again, if the outside diameter of the pipe and the inside diameter of the connection were the same, a line drawn from the neutral diameter of the connection would pass ¼ inch to the side of the pipe. Would it not be better to put the flange line where the steel comes together?

I would also like to offer a suggestion on the design of a connection similar to the one illustrated by Mr. Linstrom. I believe the one shown and developed in Figs. 2 and 3 answers the same purpose and is easier and cheaper to make. As shown, the flaring part *B* slopes 45 degrees and *O-7* is parallel to *d-10*. This makes section *B* uniform in shape throughout its length and it is easier to roll. It can also be rolled to fit a circular template, since a section through *O-d*, or any plane parallel to it, is a semi-circle. No template need be used to roll it. It also does away with triangulation, which is quite an item on large work, considering the time taken to lay it out. Section *A* is a flat triangle and needs no rolling. Section *C* is half of a T-connection.

I believe the development needs very little explanation, as it is not complicated. In Fig. 2, line 1-4 equals *o-e* and 2-5 equals *b-b'*, etc. The quarter ellipse 4-5-6-*d* is half the length and shape of section *B* on a plane perpendicular to *d*-10. The line 4'-5'-*d'* is the length of the same on the center of the steel. In Fig. 3 make line 1-*d*-1 twice the length of 4'-5'*d'*, Fig. 2, and divide it, not into equal spaces but proportionally to 4-5-*d*. Other lines in Fig. 3 are equal in length to the corresponding lines in Fig. 2.



Figs. 2 and 3

C. G. Reem.

Ensley, Ala.

The Layout of a Round Top Tank

In the November issue of The Boiler Maker a reader asked for a layout of a round top. Since then three men have sent in their layouts for publication. Now, before I start my remarks I want to say that I have never had the experience of laying out such a piece of work, but I am very much interested in the same, and this is the reason why I write. It is not to criticise these men or their way of laying it out. There are lots of readers, however, that cannot layout such work, and of course they would be thankful to know the proper method.

On going over these three layouts, and noting how much difference there is in them, a person would not know which layout to take as correct. While it is a fact that no three men can differ on the same subject and all be correct, yet it is possible that they may all be wrong. So I think it will be a good thing to hear a little more on this round top.

In the December issue the contributor takes for the large radius one and one-half times the diameter. The diameter is 180 inches, so the radius would be 22 feet 6 inches. In the February issue Craglug says, take the diameter plus one-tenth of the diameter, or 16 feet 6 inches; for a radius, a difference of 6 feet. In the May issue Mr. Mellon uses for his radius 37 feet 6 inches, making the difference in the three cases 15 feet 6 inches and 21 feet, in spite of the fact that all are layouts of the same top. There is also a difference in the top radius and in the cap plates.

Now, I hope these men will look at this article in the same light as I have written it: that is, not as a man who wants to criticise and find fault with other men's methods when I have no method at all, but as a man who is after a correct method and wants to be sure. C. T.

A New System for Laying Out the Surface of a Cone

A problem which frequently occurs in boiler shops is that of laying out the surface of a cone. If it is not possible to lay it out graphically, all measurements must be found by mathematical calculations, which are long and tedious, and which not only make the work longer than it would be by using the graphic method but introduce greater chances of error.

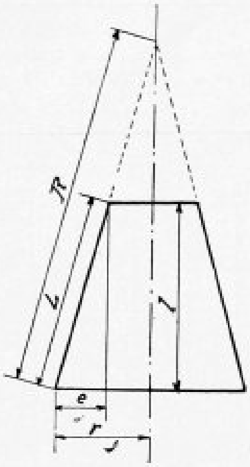


Fig. 1

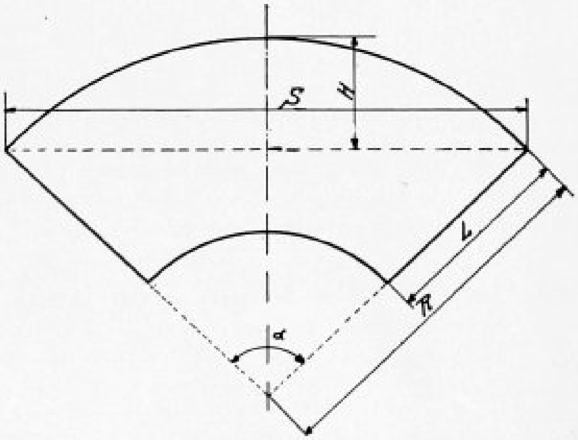


Fig. 2

For the purpose of simplifying the work, the writer has calculated and drawn the accompanying chart, Fig. 3, for use in the following method of solving the problem. The cone to be laid out is shown in Fig. 1 and its development in Fig. 2:

$$L = \sqrt{l^2 + e^2},\ R = r \times \frac{360}{\alpha}.$$

To find α take the value of e on the vertical scale at the left of the lower chart in Fig. 3, and run over horizontally to the curve having a value of l, the height of the cone. Where this horizontal line and curve cross, run up vertically to the scale for the value of α. For instance, if e equals 8 and l equals 14, the point of intersection is marked on the chart by the small circle, running up a vertical we get for α 180 degrees. Now, to find H and S in Fig. 2, we find the intersection of the same vertical with the lines h and s in the upper part of the chart, Fig. 3. In the case previously taken we would get for h 2 and for s 4, reading our values on the scale to the left of the chart. Then use the formulas $H = h \times r$ and $S = s \times r$, which give values for H and S.

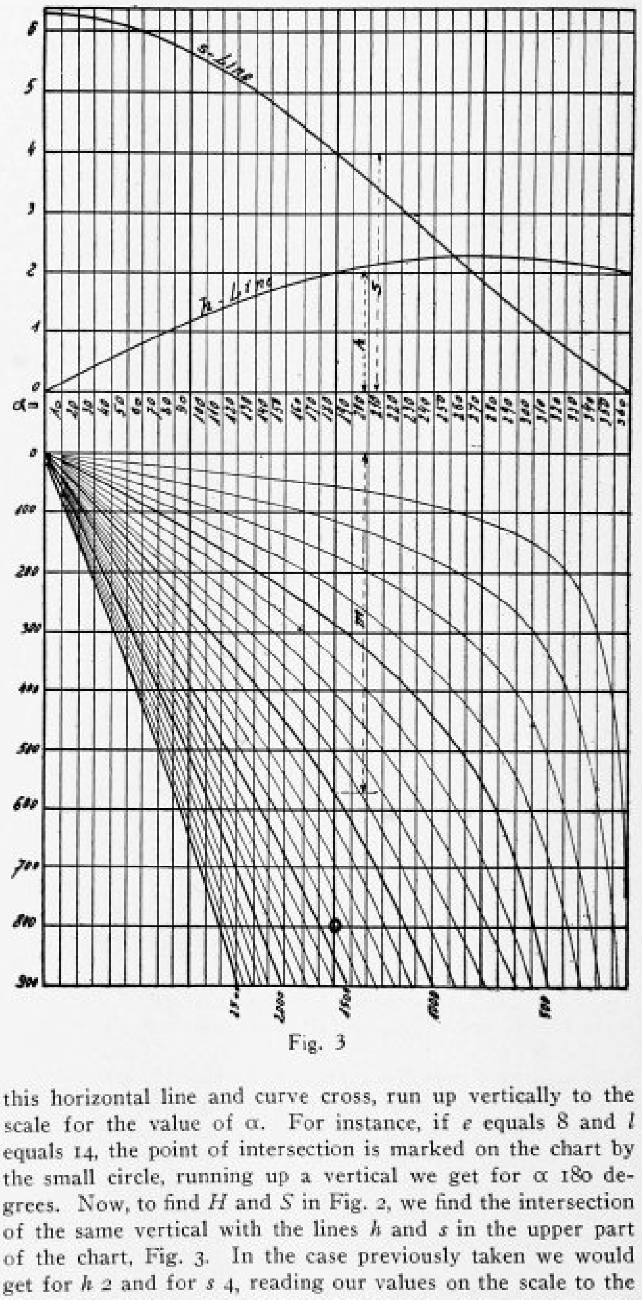


Fig. 3

To construct Fig. 2, we first find a value of α, and from the formula, $R = \frac{360}{\alpha} \times r$, we can find R, and as shown above we find H and S. From these values it is a simple matter to lay out the development as shown in Fig. 2.

To construct the diagrams in Fig. 3 make a table as shown for the values of m, s and h from formulas:

$$m = \frac{\alpha}{\sqrt{360^2 - \alpha^2}};\ s = \frac{720}{\alpha} \sin. \frac{\alpha}{2};\ h = \frac{360}{\alpha}\left(1 - \cos. \frac{\alpha}{2}\right)$$

TABLE

α	m	s	h
0	0	6.283	0
10	27.79	6.275	0.1372
20	55.64	6.25	0.27
30	83.62	6.21	0.41
40	111.85	6.16	0.54
50	140.25	6.09	0.67
60	169.05	6.00	0.80
70	198.20	5.90	0.93
80	227.90	5.78	1.05
90	258.19	5.66	1.17
100	298.15	5.51	1.29
110	320.90	5.36	1.40
120	353.55	5.20	1.50
130	387.24	5.02	1.60
140	422.12	4.83	1.69
150	458.34	4.64	1.78
160	496.13	4.43	1.86
170	535.72	4.22	1.93
180	577.30	4.00	2.00
190	621.40	3.78	2.06
200	668.10	3.54	2.11
210	718.20	3.31	2.16
220	772.00	3.07	2.20
230	829.40	2.84	2.23
240	894.40	2.60	2.25
250	965.10	2.359	2.27
260	1036.50	2.12	2.27
270	1133.10	1.89	2.28
280	1237.50	1.65	2.27
290	1359.50	1.42	2.25
300	1507.50	1.20	2.24
310	1693.30	0.98	2.21
320	1940.00	0.77	2.18
330	2293.60	0.56	2.14
340	2873.60	0.35	2.10
350	4163.00	0.16	2.05
360	∞	0	2.00

As shown in Fig. 3, these values of *m*, *s* and *h* are plotted on ordinates representing angles α. In the lower chart only one curve will be obtained in this manner. To obtain the other curves for different values of *l* than unity, we divide the distance *m*, as shown on each ordinate, into ten equal parts. Continuing our subdivision below the curve for unity we get curves for values of *l* greater than unity. These curves are all tangent to the ordinate of 360 degrees at infinity; *i. e.*, the ordinate is an asymptate to all the curves. The upper diagram—that is, curves *h* and *s*—are easily laid out for various values of α.

This method of laying out the surface of a cone or part of a cone can only be applied in cases where the surface is all in one plate. John Jashky.

Graz, Austria.

Portable Support for an Oil Burner

Figs. 1 and 2 show a device which the writer has designed for the operation of oil burners when laying up flanges or firebox corners. This device is now in use in the West Albany shops of the New York Central Railroad, and has demonstrated its advantages over the old makeshift methods of supporting oil burners. The construction of the device and the method of operation are obvious from the illustrations. The burner can be operated at any angle or at any height, and obviates the danger of accidents commonly met with in the operation of portable torches. For this reason it may be classed as a "safety first" device

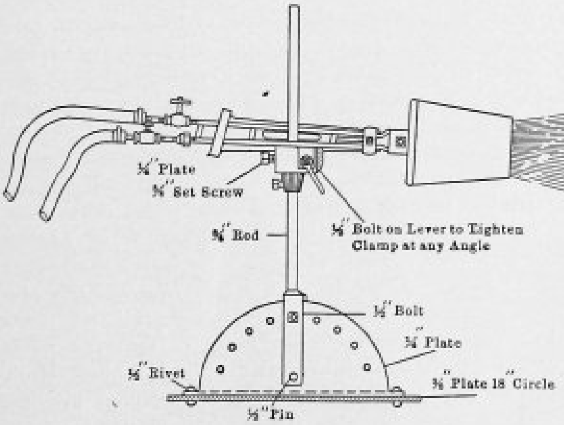


Fig. 1

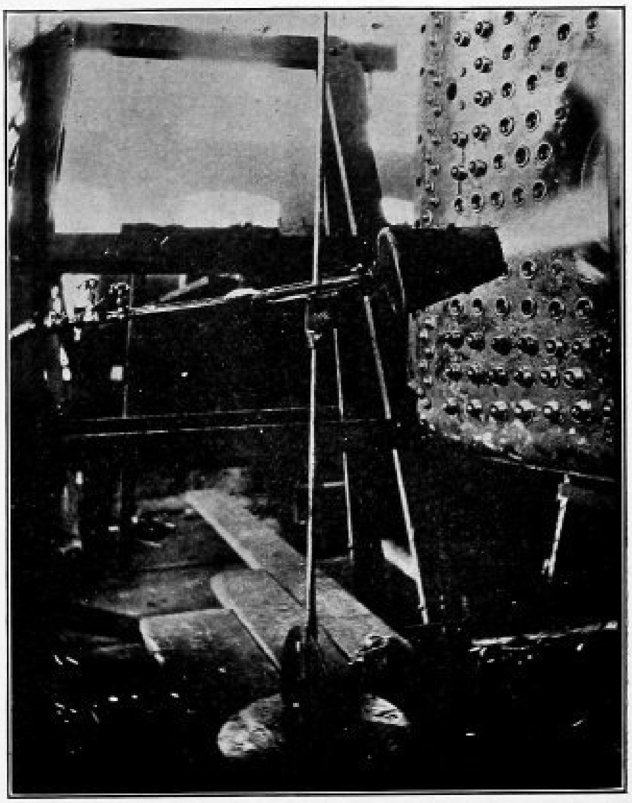


Fig. 2

Schenectady, N. Y. H. A. Lacerda

Boiler Braces

To calculate the number and size of braces for the surface of a boiler head, multiply the area in square inches by the steam pressure, which will give the total stress upon the unstayed surface of the head. Call this product 1. Multiply the cross sectional area of the brace in square inches by 6,000, if of iron. This will give the stress in pounds to be allowed on each brace. Call this product 2. Divide product 1 by product 2 and the quotient will be the number of braces of that size which will support the surface. This is for a direct, straight-away pull; for diagonal braces the area will have to be increased in proportion to the angle which it may form with the stayed surface. For example: Assume the area to be 750 square inches and the steam pressure to be 100 pounds; then, as per the rule, 750 × 100 = 75,000 pounds, which will be the total pressure to be sustained by the braces. If, for instance, it is decided to use 1¼-inch braces, the cross sectional area is 1¼ × 1¼ × .7854 = 1.227 square inches. 1.227 × 6,000 equals 7,362 pounds to be carried by one stay. Dividing 75,000 by 7,362 gives 10 with a little over; thus, to be safe, we would use eleven 1¼ braces for direct staying.

The usual method of laying out flat or parallel surfaces, such as fireboxes of locomotive or vertical boilers, to be supported by staybolts, is to consider each bolt as sustaining a certain part of the plate to which it is secured. If the bolts are spaced equal distances apart the area of plate stayed by each bolt is found by multiplying the distance in inches between the centers of the bolts by itself, which gives the area or number of square inches of surface exposed to the pressure, less, of course, the area of the staybolt itself supporting this surface, which is so small that it is seldom considered. Multiplying this area in square inches by the steam pressure and dividing by 5,000 will give the required area of stay, as expressed by the formula: Area of stay = square of distance × pressure ÷ 5,000.

Where stays or braces are to be placed in the water space their entire surface is exposed to the effect of corrosion; and in order to be sure that, after being wasted by corrosion to a considerable extent, enough metal will remain to safely support the surface, a large factor of safety is employed, about one-eight or one-tenth of the breaking stress of the material being used.

Albany, N. Y. CHARLES MILLER.

How to Heat Rivets Satisfactorily

The proper heating of rivets has always appealed to the good riveter at all times, and many are the methods employed by him to get the best results and, at the same time, turn out work enough to give satisfaction to his employer and keep up his reputation as a good workman. This has led to the introduction of many different kinds of forges and furnaces, all of which no doubt have given satisfaction to their inventors and filled the want for which they were built. But we cannot very well enter into the subject of rivet heating without at the same time considering some of the many uses to which the rivet is being put, especially that of boiler work.

In one of our Eastern shops, where the writer formerly worked, and where marine boilers of the Scotch return tubular type were built, a furnace of the bee-hive pattern was used. This furnace was built of brick and was centrally located in the shop. The fuel was coke and the draft was natural and was controlled by a damper in the furnace stack. The furnace was in charge of an elderly man, whose duty it was to keep the furnace properly heated and charge the rivets for the various jobs. There being several holes for charging and withdrawing rivets each riveting gang had a boy who kept them supplied with rivets. In this shop 100 rivets was a day's work, and when riveting up the fire box—that is, the corrugated furnaces, combustion chamber, and the bottom section of the front ends—hammers weighing about seven pounds were used to plug the rivets in the holes, and finishing hammers with the sharp edge ground off were used to finish the rivet, leaving the rivet with a thick edge. The back head and shell were riveted by the hydraulic riveter, but the rivets were all heated in the one furnace, and when withdrawn were of a bright yellow color and very hard, but free from scale, and when driven as above described made a tight job and gave entire satisfaction both to the firm and to the inspector watching the work.

For some years the writer worked in a locomotive works doing a very large business. Here a gas furnace was used for rivet-heating. The fuel was natural gas, and compressed air was used for combustion and draft. This furnace was about 36 inches long, 18 inches wide, 14 inches high, of ¼-inch plate, lined with firebrick, with a rising door in front for charging and withdrawing rivets. The gas and air entered the furnace at the end, close to the floor of the furnace, and when the furnace was in working order the combustion was almost perfect. Almost any desired heat could be obtained by the proper control of the flow of gas.

Rivets ranging in size from ⅝ inch to 1¼ inches were driven under pressures varying from 30 tons to 150 tons. It was the practice here to heat all rivets for the hydraulic machine to a bright red heat, for at that heat it was found that the rivet flowed before the ram and filled the dies without bending, forming a good head equally around the hole. Some of the rivets, 1¼ inches in diameter, were driven in tanks for compressed air locomotives, the shell being of 13/16-inch material with inside and outside covering plates, and the dished heads 1¼ inches thick. These tanks were built for a working pressure of 850 pounds per square inch and were tested to 1,150 pounds hydraulic pressure. By following closely the above practice it was possible to avoid that fatal blue color so frequently seen on work where no regard has been paid to the proper heating of rivets, and where quantity rather than quality was required.

Before the introduction of the pneumatic hammer, for general purposes, especially blast furnace and hot blast stove work, it was considered good work to drive 450 ¾-inch rivets, calk the work and lower the platform in nine hours. The rivets for this work were heated in a forge of the old-time bellows type. The bellows, a little round affair, was fastened between the legs of the forges, directly below the forge bowl. The fuel used was good soft coal. The rivets for heating were placed in a piece of old boiler plate suitably punched with ten or twelve holes, and it was possible for a good boy, with good *iron* rivets, to get a melting heat without wasting the iron and keep his men on the jump. This form of heating was for many years considered most satisfactory. Some time ago the writer was called upon to make a small portable furnace for rivet heating. Being in a hurry, one of the old shop forges was taken and the sides and ends raised so that they measured as follows:

Length, 18 inches; width, 14 inches; height, 14 inches, and thickness of material, ¼ inch. To the top on both sides were rivet pieces of angle iron, 1¼ inches by ¼ inch by ¾ inch, so that a plate top could be bolted on after the furnace was lined with firebrick. In front there was an opening 3 inches by 7 inches for charging and withdrawing. The fuel was natural gas and compressed air.

The gas and air connections were under the furnace and branched off through Ts to the side, where they met in Ys and were conveyed to the furnace through 1-inch pipe, the nozzles of which were directly opposite each other, causing the flame to be deflected to the bottom of the furnace. On a recent test, after the furnace had been working about an hour, rivets were charged and were withdrawn in just one minute.

Again, without any attempt at record making, with a boy in his third year, with a long stroke air-hammer, 658 ½-inch by 1½-inch rivets were driven on a locomotive tank bottom in nine hours. These rivets were heated to a bright yellow, good alignment was kept and a good, tight job made, giving satisfaction to the master mechanic.

Another kind of work that requires good, careful heating and good riveting is the tubes for the double-tube boilers used on our river steamboats, and at one time so much used in the rolling mills. On account of the size of the tubes, being so small, leaks are hard to get at, and the greatest care was exercised to ensure a good, dry job, yet 335 ⅝-inch rivets were driven in nine hours. The rivets were heated in the old-time coal fire in a stationary forge, with fan blast, and here the best satisfaction was given.

In summing up the whole subject it is the writer's experience that, although rivets can be heated satisfactorily in gas or oil furnaces, they have their drawbacks; that is to say, where compressed air is used to cause draft the air coming in contact with rivets causes them to scale badly unless they are removed quickly on coming to a proper heat and this prevents large charges being made. On the other hand, rivets heated in a coal or coke fire with blower or fan blast, or in a coal or coke furnace with natural draft, are comparatively free from scale. Hence it is the writer's opinion that the coal or coke fires or furnaces are the best means for heating, a bright red the best heat for hydraulic riveting, and a bright yellow heat the best for driving with the pneumatic hammer, especially when steel rivets are used.

Pittsburg, Pa. G. H. HARRISON.

Why There Are Specialists

My mother used to bake the best bread that was ever eaten by man. Everybody admitted it. But my aunt had her beaten at baking cake. My mother herself admitted that. Each was aware that the other was a specialist in *one* product of the kitchen at least, and they often exchanged their labors. My mother would make bread for two families and my aunt would make cake for two families.

This, in a homely way, explains why a manufacturer had better stick to his own product—his specialty. If you make steam boilers, for instance, make them better than anybody else can make them. Study them from the time they were ore until they are ready for the scrap heap after years of good, hard service. Don't get off the track and try to make your own small tools—taps, dies, drills, expanders, etc., for you can't do it any more than my aunt could make the best bread. Remember that there are some mighty good specialists in the small tool line. They make nothing else. With their multitude of special machines, trained workmen in their special line and years of study, it is but natural for them to turn out a superior product at a good, reasonable price.

Where you have a special machine to make, for instance, that does not require great skill, and if you are equipped to make it, all right. Go ahead and make it if you have the time. But if it *does* require skill, and if there is a specialist nearby who makes similar machines, the specialist is the man who should get the job if, of course, his price is within reason.

No doubt every large manufacturer agrees with this sentiment; for the steel maker, for instance, would dislike very much to see a small boiler manufacturer make his own steel when it could be purchased much more cheaply from the steel manufacturer. And the boiler maker does not like to compete with a steel manufacturer from whom he purchases his steel in the making of boilers.

According to present adjustment, specialization is the thing. Farmers farm, railroaders railroad, merchants buy and sell, and it is as it should be. If the farmers of the world would combine and manufacture all the flour, bread, cakes, etc., and set their own price, it would be pretty tough on some of us, methinks.

However, there is not much danger of such combination, because, after all, the specialist will rule his own field.

New York. N. G. NEAR.

A Question for Readers to Answer

I would like to hear from some of the readers of THE BOILER MAKER about the following: I tested a boiler of the O. G. firebox type and found some crown bolts, which were 22 inches long, broken clean off at the wrapper sheet and badly fractured about 2 inches from the crown sheet. I broke the bolts down from the outside, leaving a stump of 2 inches in the crown sheet. Now I would like to know why a 1⅛-inch bolt, 22 inches long, breaks in this manner at the top and bottom. A SUBSCRIBER.

PULVERIZED COAL BURNER.—At the West Albany shops of the New York Central Railroad, successful experiments have been made with a pulverized coal burner on a switching locomotive. Four screw conveyors under an oval-shaped fuel tank carry the powdered coal dust to the firebox, where it is forced into the firebox through two 14-inch pipes by motor-driven fans supplied with current from a turbine-driven dynamo at the front of the engine.

Technical Publications

INSTRUCTIONS ON OXY-ACETYLENE WELDING AND CUTTING: THE VULCAN PROCESS. Size, 6ffl by 8¾ inches. Pages, 86. Illustrations, 55. Minneapolis, Minn., and Cincinnati, Ohio., 1914: The Vulcan Process Company. Price, $1.00.

As the title shows, this book is devoted to an explanation of the methods and uses of the oxyacetylene process for cutting and welding metals. The illustrations alone give a good idea of the remarkable work done by the oxy-acetylene welding and cutting process. The information is given in a very clear manner and covers the subject comprehensively touching upon every important detail of this process in all of its many uses.

HOW TO BUILD UP FURNACE EFFICIENCY. Seventh edition. By Jos. W. Hayes. Size, 5 by 7¼ inches. Pages, 126. Illustrations, 30. Rogers Park, Chicago, 1914: Jos. W. Hayes, Publisher. Price, $1.00.

The aim in this book has been to show the manager, superintendent, engineers and firemen of the power plant how they may proceed at once to actually make a real reduction in the coal bills. No theories are expounded, but the subject is treated from a very practical viewpoint and will prove of interest and value to any one having to do with fuel economy. The book is divided into five chapters. The first two tell why and how fuel is wasted; these are followed by chapters showing the methods of "spotting" and stopping fuel wastes and a final chapter on the subject of "How to Keep Fuel Wastes Stopped."

ARITHMETIC OF THE STEAM BOILER. By Charles J. Mason. Size, 5 by 7 inches. Pages, 225. Illustrations, 21. New York, 1914: McGraw-Hill Book Company, Inc. Price, $1 net. London, E. C., 1914: Price, 4/2 net.

This book is a compilation of arithmetical rules and formulas applicable to steam boilers of various types. The author claims no originality in the preparation of the material, excepting only the arrangement and manner of presentation. It is intended as a book of reference for those who may require rules and formulas directly related to steam boilers, and its aim is concentration and logical order in the arrangement and treatment of the various features introduced. It is not intended to teach the elements and principles of arithmetic in this book, as might be inferred from its title, but only the application of arithmetic to steam boiler calculations. It is presumed that those who may use it already understand arithmetic but desire to have a compact set of rules and formulas conveniently ready for use, without having to look through several books for a certain formula when required. Those who are preparing for examination for engineer's certificates and licenses will find the work of great assistance to them.

HANDBOOK FOR MACHINE DESIGNERS AND DRAFTSMEN. By Frederick A. Halsey, B. M. E. Size, 8½ by 11 inches. Pages, 494. Numerous illustrations. New York and London, 1913: McGraw-Hill Book Company. Price, $5.00 net.

After over thirty years of active association with machine design and construction, fifteen of which were spent in designing machinery for one of the leading manufacturers of the United States and eighteen as editor of the *American Machinist,* Mr. Halsey has brought together in convenient form for desk use the essential data and basic facts which designers, draftsmen, superintendents, engineers and machinists need constantly in the work of designing all kinds of machinery and machine parts. The book is in no sense a treatise on machine design or applied mechanics. It is a collection of material carefully digested, classified and indexed, presented in such form as to give as clearly as possible all of the facts which designers, draftsmen and others need in all classes of machine design.

The contents of the book may be classified, roughly, in three parts: First, the data in common use, available by itself but essential to work of this character; second, the best of the contributions to the technical press and proceedings of technical societies which are not easily accessible, and, third, the contributions of specialists who have given freely of their data to make this work as broadly useful as possible. A better idea, however, of the broad scope and remarkable completeness of the book can be gained from the list of subjects discussed. The first half of the book includes chapters on mechanical principles of design, plain or sliding bearings, ball and roller bearings, shafts and keys, belts and pulleys, flywheels, cone pulleys and back gears, spur gears, bevel gears, friction gears, worm gears, helical gears, planetary gears, ropes, chains, brakes, friction clutches, cams, springs, bolts, nuts and screws, wire and metal gages, hydraulics and hydraulic machinery, pipe and pipe joints, minor machine parts, press and running fits and balancing machine parts. Following this are notes on miscellaneous mechanisms and the performance and power requirements of tools, and then several chapters are devoted to the materials commonly used in machine construction, taking up in turn cast iron, steel and the various alloys. A separate chapter is devoted to the construction and proportions of steam boilers, while there are similar chapters on the steam engine, the gas engine and compressed air. Finally there are chapters on mechanics and the strength of machine parts and over fifty pages of useful tables.

To present such an enormous mass of useful data in suitable form for immediate reference within the limits of a book of this size, and still treat each subject adequately, is a task of no small magnitude, and the author has shown excellent judgment in the form of presentation as well as in the skilfull use of illustrations, charts, diagrams and tables. The size of page, style of type and form of charts and tabulated matter all aid in making a well balanced, useful reference book for machine designers.

Selected Boiler Patents

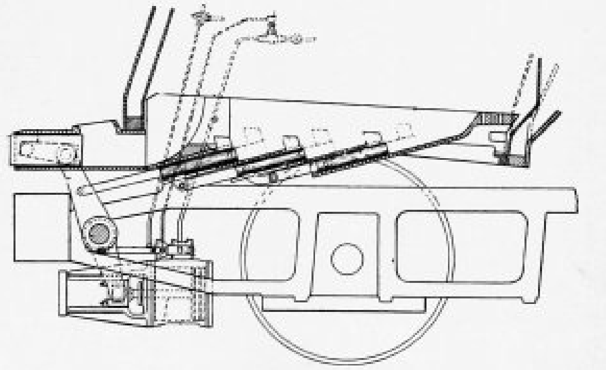
Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,
Millerton, N. Y.

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

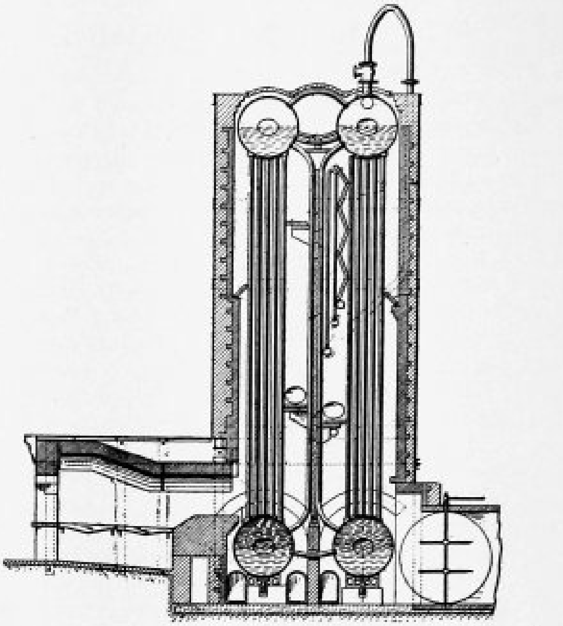
1,096,106. AUTOMATIC STOKER. WILLIAM C. A. HENRY, OF COLUMBUS, OHIO.

Claim 1.—The combination with an underfeed stoker having a feed trough and an auxiliary feed member working in the trough and during its forward movement approaching the surface of the fuel in the trough and during its rearward movement receding therefrom, of a steam engine having a piston connected for operating the feed means, a positively operated main valve, a steam actuated secondary valve controlling the movement of the piston and itself controlled from the main valve, and manually controlled means for stopping the secondary valve in such position that the piston will be stopped with the feed member in its rear position. Four claims.



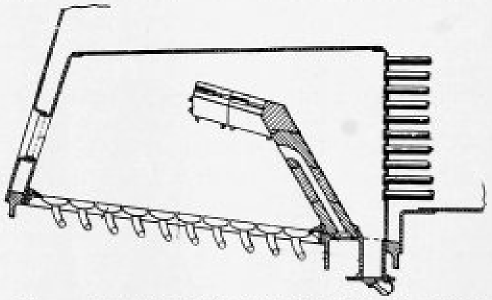
1,096,090. STEAM-BOILER. JOHN E. BELL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim 1.—A superheater boiler having two banks of tubes, a baffle between the banks whereby the gases are directed upwardly through the first bank and downwardly through the second bank, a superheater in the downtake pass and a baffle between said superheater and the tubes of the second bank to divide the flow of the gases into two portions, one of which passes over the boiler tubes and the other over and among the superheater tubes. Three claims



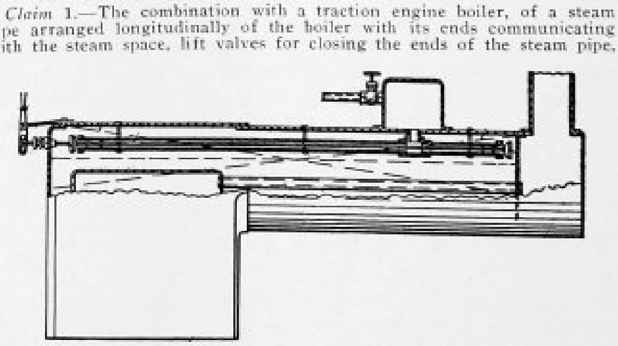
1,097,125. LOCOMOTIVE-FURNACE. FREDERICK F. GAINES, OF SAVANNAH, GEORGIA, ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 8.—In a locomotive boiler firebox a transverse refractory wall arranged in the forward end of the box adjacent to the flue sheet and rising from substantially the level of the grate in rearwardly inclined position, a transverse refractory arch arranged adjacent to the upper end of the wall supported by the side sheets of the firebox and serving to hold the wall in its inclined position, and vertically arranged air admission passages in said wall adapted to admit air to the firebox beneath said arch. Eight claims.



1,097,523. BOILER FOR TRACTION-ENGINES. THOMAS J. BROWN, OF CRAWFORDSVILLE, IOWA.

Claim 1.—The combination with a traction engine boiler, of a steam-pipe arranged longitudinally of the boiler with its ends communicating with the steam space, lift valves for closing the ends of the steam pipe, a coupling-rod extending through the steam pipe and having the said valves secured to it, said coupling-rod having an extension which projects from the steam space of the boiler and affords a means for operating the valves, and a steam outlet pipe connected to the said steam pipe between its valves. Two claims.



THE BOILER MAKER

SEPTEMBER, 1914

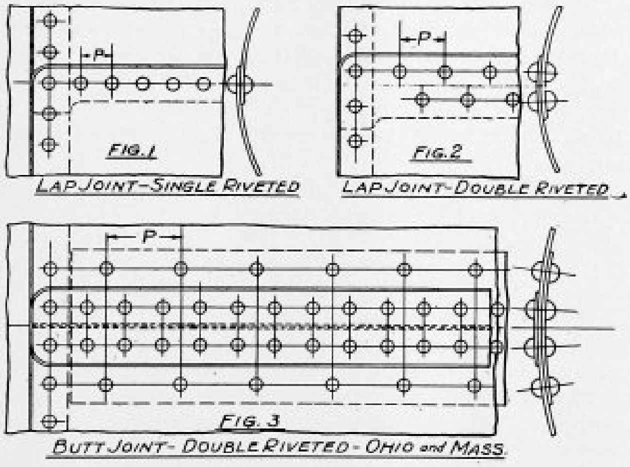
Uniformity in Boiler Laws and Rules

Comparison of Boiler Laws, with Suggestions for a Uniform Code of Rules

BY G. G. DANA, M. E.

The need of uniformity in boiler laws is one of the subjects which is receiving much attention from the manufacturing interests in this line of business. At the present time there are in force in the United States and Canada three groups of laws which will form the basis of this article, besides others of less importance which will not be mentioned except in a passing way.

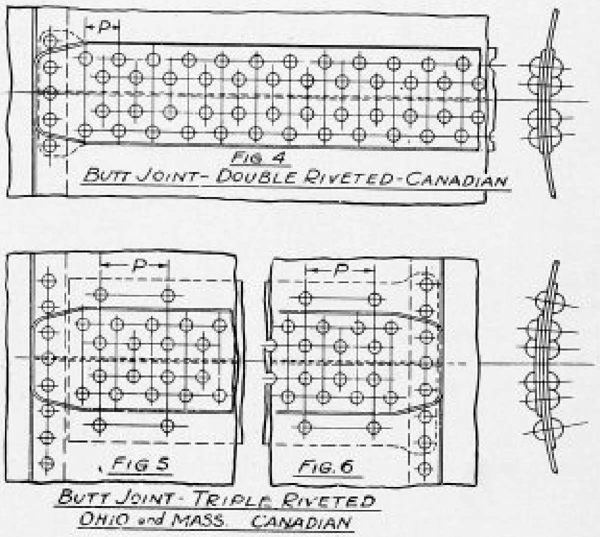
In the first group are the rules of the States of Ohio and Massachusetts, the cities of Detroit, Michigan and Manila, P. I. In the second are the Canadian provinces of Alberta, Ontario and Saskatchewan, the third being the rules of British Columbia. In the first group the application of the rules to manufacturing are practically alike and will be mentioned in what follows as the Massachusetts rules, as the others of the group were all patterned after this set of rules. The second group, which will be referred to as the Alberta rules, differs widely in many respects to those of the first group. The third or British Columbia rules have many points in common with the Alberta rules, yet differ considerably in other respects. Where individual differences occur in the groups of rules they will be pointed out under the proper subject.



Lap and Butt Joints

The British Columbia rules were the first of the laws under consideration to go into effect, which was in January, 1902. The latest revision of these rules went into effect July, 1913. The Alberta and Saskatchewan rules were effective in 1906. The latest revisions of which the author has knowledge were made under the dates of Jan. 1, 1911, and Jan. 1, 1913, respectively. Massachusetts was the first State to enact a set of boiler laws, which went into effect May 1, 1908, the latest edition of these rules having been published in 1913. The Ohio law went into effect Jan. 1, 1912, with revisions under the date of Sept. 1, 1913, by the authority of the State Industrial Commission. The Ontario rules are the latest, having gone into effect July 1, 1913.

In Wisconsin the State Industrial Commission has formulated a set of rules for the installation, operation and inspection of boilers. The parts of these rules referring to boilers already installed go into effect Sept. 1, 1914, and those relating to new construction are effective Sept. 1, 1915. The Wisconsin law was patterned in a general way after the Ohio law, with several modifications and improvements.



Double and Triple Riveted Butt Joints

The American Society of Mechanical Engineers has issued a preliminary standard specification for the construction of steam boilers and other pressure vessels, which was discussed at their spring meeting, held in St. Paul and Minneapolis in June, 1914. Their committee on boiler rules is to hold another meeting in New York Sept. 15, 1914, at which time all parties interested are to be given a hearing. It is believed that the work of this society is the greatest step toward uniformity that has thus far been made, and that when its committee has completed its work the society will have a set of rules worthy of adoption by any State or nation. Several States are now waiting for the A. S. M. E. rules to use as a foundation of a similar law in their commonwealth.

One of the first questions which naturally will come to the mind of the reader in regard to a uniform law is, why should we not have a national law covering the design, construction and inspection of boilers? The question has been brought to the attention of congressmen, senators and the President of the United States, and it has been found that it would not be practical, as it interferes too much with States' rights. We now have national laws which control boilers used on railroads and on steamboats, but as these come under the Interstate Commerce laws, it is not necessary that the national law should govern them.

The aim of this article will be to make comparisons of and point out some of the differences in the various rules as regards their general application to all boilers, but giving more particular attention to their application to the locomotive type of boilers of the medium and smaller sizes. A few suggestions will be made in the hope of promoting uniformity in boiler legislation.

In Massachusetts and Ohio there is a Board of Boiler Rules composed of five members, the chief boiler inspector being chairman, with a member representing each of the following interests: boiler users, boiler manufacturers, boiler insurance and operating engineers. Under the authority of this board come the framing and interpretation of the laws, supervision of inspection, and to it are referred the various questions which arise regarding the design and construction and installation of boilers and appliances used in connection therewith. This board also keeps all records, data reports, etc., of boilers built under its jurisdiction.

In the Alberta group the boiler inspection comes under the Department of Public Works, with offices at the seat of government of the province. In British Columbia this work comes under Chief Inspector of Machinery.

Approval of Designs

The method of obtaining permission to build boilers under the rules of Massachusetts is substantially as follows:

Application must be made to the Board of Boiler Rules stating your intention to build boilers to conform to the rules of that State. A facsimile of the stamping which is to be placed on the completed boiler must be submitted, and also a list of your shop equipment, that the Board may get an idea of your facilities for turning out first-class work. After receiving permission you may proceed with construction under authorized inspection, providing your design has no special features which are not covered by the rules. If special features are embodied in the design they must be submitted to the Board for their approval. If not satisfactory they will inform you of the changes necessary, but will not commit themselves by stamping approval on any blue prints.

The rules of all of the Canadian provinces require that three blue prints of the working drawings with specification report in duplicate be submitted to the Department of Boiler Inspection for approval of design, together with the fee as specified in the rules, before starting construction of boilers under their rules. The blanks for the specification report are obtained from the Boiler Inspection Department gratis. Approval must also be obtained for boiler fittings, such as safety valves, pressure gages, water gages, gage cocks, stop valves, blow off valves, etc. This approval is usually obtained by the manufacturers of these fittings, however if these parts have not been approved and registered it will be necessary to obtain approval or exchange them for such as have been approved before shipping the boiler.

If the design is approved, one set of the working drawings and specifications will be returned to the manufacturers with the approval stamp thereon showing the registration number and the allowable working pressure. From this set of drawings and specifications any number of boilers may be built.

If your design is not approved you will be advised as to the changes required. After making these changes you will submit a new set of prints and specifications which will, if satisfactory, be stamped and returned as explained above.

While some delay may be caused by the awaiting of approval, the plan adopted by the Canadian provinces in having the boiler designs and specifications approved before any boilers are built has the advantage that the builder has a definite knowledge of what will be required in advance of any work being done on the boiler. The designer thus has a chance to modify the design, if for any reason the working pressure allowed by the inspector does not meet his requirements. The Massachusetts plan leaves the interpretation of their rules entirely to the designer, but the inspector has the authority to determine the pressure of any boiler, and therefore the designer has no means of knowing what pressure will be allowed until the boiler is under construction, in case he has misinterpreted the rules.

By the Massachusetts rules a data report must be submitted to the Boiler Inspection Department for *each boiler built* to that standard *before the boiler leaves the boiler shop*, regardless of whether the boiler will be shipped into the State or not.

By the Canadian plan only such boilers as are *actually shipped into the province* shall have an affidavit of manufacture submitted. This affidavit shows the approval number and other data, which must check up with the specification under this approval number. It must be signed by the boiler shop foreman and attested by a notary public.

For the Alberta group it must be sent to the purchaser, while for British Columbia it must be forwarded to the chief inspector.

Stamping and Identification

Boilers built according to the rules of the Massachusetts group must be stamped with the name of the State or city, in abbreviated form, then the serial number of the boiler built by this standard, this series having started with one, then the name of the manufacturer in abbreviated form.

The stamping for the Alberta group is more elaborate, giving the following information: Firm name and the firm's serial number, the provincial letter and registration number, lowest tensile strength of plates used in the shell of the boiler, with S for steel, I for iron, plate maker's name and the date of construction.

The British Columbia stamping is the same as the above except that, in the place of the plate maker's name, the initials of the inspector who supervised the construction and testing of the boiler, together with his serial number, are used.

The following are samples of the required stamping for boilers built by the J. I. Case Threshing Machine Company:

FOR OHIO	FOR ALBERTA	FOR BRITISH COLUMBIA
OHIO STD 215 CASE	CASE 26437 A. 665 55000. S. LUKENS 26.4.14	CASE 26442 BC—1880 55000. S. J. D. 472 15.5.14

The size of the letters for stamping the Ohio boilers must be at least 5/16 inch, while all of the other rules require them to be not less than ¼ inch. The location of the stamps is specified in each set of rules for all the common types of boilers.

The Canadian rules have an advantage in that any number of boilers may be built to an approved design, and only boilers actually shipped into the province are required to be stamped or have an affidavit of manufacture submitted. The Massachusetts rules, however, require that the boiler be stamped and the data report submitted to the Board of Boiler Rules on the completion of the boiler, regardless of whether the boiler is to be installed in that State or not. If many States were to pass similar rules it would be necessary for the builder to know the destination of each boiler before its completion, or otherwise stamp each boiler for the several States and submit a corresponding number of data reports. This would be a very cumbersome procedure for a manufacturer building stock boilers in large quantities. The Massachusetts requirement may be all right for those manufacturers who build boilers to order, but to the builder of approved standard stock boilers which form a part of the finished machine, as does the boiler for a steam traction engine, road roller, steam shovel or hoisting engine, the fulfiling of this requirement means that the destination of each machine must be known before its boiler leaves the boiler shop, or that each boiler built shall be stamped and data reports filled out for each State into which there is a probability of the machine being shipped.

If the Massachusetts rules were modified to require that the manufacturer of stock boilers shall keep an accurate record of all the materials used in each boiler when being built under authorized inspection, etc., then from this record the data report could be filled out, the boiler stamped with the kind of standard and the serial number, etc., after the destination is known, much of the cumbersome procedure mentioned above would be eliminated.

MATERIALS

All of the rules require that the steel used in the construction of boilers shall be made by the open hearth process. The other requirements can best be compared by referring to Table I.

It will be noticed that the Ohio and Massachusetts rules are the only ones in which the brand of steel is specified. The Canadian rules lay more stress on the physical and chemical properties being up to standard.

Shells, etc., by the Massachusetts rules must be of firebox steel, while for Alberta the tensile strength, etc., bring them into the class which is known to the trade as flange steel.

Stayed surfaces may be of any grade of open hearth boiler steel for Massachusetts, while Alberta requires them to be the same as shells unless they are exposed to the fire, in which case they must be what is commonly known as firebox steel. Fireboxes and combustion chambers for Massachusetts may be of any of the three brands of steel.

The percent of elongation in 8 inches is allowed to vary by the Saskatchewan rules being determined by dividing 1,450,000 by the tensile strength, so that as the tensile strength increases the ductility decreases, which is a natural result with most kinds of steel. This sliding scale method of specifying the elongation requirement, as used by the American Society for Testing Materials, which is considered the best authority on this subject, is now recognized as the proper one, being equitable to purchaser and manufacturer.

The minimum amount of phosphorus is allowed to be higher when the steel is made by the acid process than when the basic process is used. It is claimed that the acid process makes a better quality of steel, but it is difficult to keep the phosphorus content down as low as may be done with the basic process.

The Association of American Steel Manufacturers publishes a set of standard specifications for boiler steel which agrees quite closely with the Saskatchewan rules. The table below shows the chemical and physical properties as recommended by this association:

CHEMICAL COMPOSITION

Elements Considered.	Flange Steel.	Firebox Steel.	Boiler Rivet Steel.
Manganese, percent..........	0.30 to 0.60	0.30 to 0.50	0.30 to 0.50
Phosphorus, max. per cent.:			
Basic....................	0.04	0.035	0.04
Acid....................	0.05	0.04	0.04
Sulphur, max., percent......	0.05	0.05	0.045

TABLE 1.—Giving comparisons of the kind of materials required for the parts of a boiler by the various rules

Part of Boiler.	Properties Considered.	Ohio and Massachusetts	Alberta and Ontario.	Saskatchewan.	British Columbia.
Shells, domes, drums and butt straps..................	Brand..............................	Firebox steel...........	....	....	....
	Tensile strength, pounds per square inch	52,000 to 62,000	55,000 to 65,000	55,000 to 65,000	55,000 to 72,000
	Elongation in 8 inches not less than.....	26%	22%	‡26% to 22%	20%
	Phosphorus shall not exceed	.03%	.04%	Basic, .04%; acid, .05%	.04%
	Sulphur shall not exceed..............	.04%	.04%	.05%	.04%
	Manganese..........................	.30% to .60%			
Heads or any plates requiring staying or flanging........	Brand..............................	Flange, firebox or ex. soft...	May be the same as for shell....	May be the same as for shell..................	....
	Tensile strength, pounds per square inch	45,000 to 65,000			55,000 to 67,000
	Elongation in 8 inches not less than.....	25%, 26% or 28%			23%
	Phosphorus shall not exceed............	.04%, .03% or .04%			....
	Sulphur shall not exceed..............	.05%, .04% or .04%			....
	Manganese..........................	.30% to .60%; .30% to .50%			....
Firebox or combustion chamber....................	Tensile strength, pounds per square inch	May be the same as for heads...................	52,000 to 62,000	52,000 to 62,000	55,000 to 65,000
	Elongation in 8 inches not less than....		26%	‡28% to 23.4%	25%
	Phosphorus shall not exceed...........		.035%	Basic, .035%; acid, .04%	....
	Sulphur shall not exceed..............		.035%	.04%	....
Rivets......................	Brand..............................	Extra soft	....	....	....
	Tensile strength, pounds per square inch	45,000 to 55,000	45,000 to 55,000	45,000 to 55,000	55,000 to 65,000
	Elongation in 8 inches not less than....	28%	28%	28%	25%
	Phosphorus and sulphur not to exceed..	.04%	.04%	.045%	....
Staybolts, through stays and braces—weldless steel.....	Tensile strength, pounds per square inch	62,000 maximum (certified)	52,000 to 62,000	52,000 to 62,000	55,000 minimum
	Elastic limit, pounds per square inch...	†Not less than ½ T. S.....	33,000 maximum	33,000 maximum	33,000 maximum
	Elongation in 8 inches not less than.....	28%	25%	25%	22% to 25%
Staybolts, through stays and braces—weldless iron.....	Tensile strength, pounds per square inch	....	46,000 minimum	46,000 minimum	46,000 minimum
	Elastic limit, pounds per square inch....	†.........................	26,000 minimum	26,000 minimum	26,000 minimum
	Elongation in 8 inches not less than....	....	22%	22%	20% to 22%

‡By the Saskatchewan rules the elongation percent in 8 inches may vary inversely as the strength of the material, being determined by dividing 1,450,000 by the tensile strength and the phosphorus contained in the steel may have a higher percentage when made by the acid process than when the basic process is used.

†Ohio and Massachusetts rules do not give any requirements for staybolt material, either iron or steel.

When a certified report of the material accompanies the data report the qualities shall be given as in this table.

PHYSICAL PROPERTIES

Properties Considered.	Flange Steel.	Firebox Steel.	Boiler Rivet Steel.
Tensile strength, pounds, per square inch.......	55,000-65,000	52,000-60,000	45,000-55,000
Yield point, minimum pounds, per sq. inch...	0.5 tens. str.	0.5 tens. str.	0.5 tens. str.
Elongation in 8 inches, minimum, percent....	$\frac{1,450,000^*}{\text{tens. str.}}$	$\frac{1,450,000^*}{\text{tens. str.}}$	$\frac{1,450,000}{\text{tens. str.}}$

*For plates over 3/4 inch in thickness, a deduction of 0.5 from the specified percentage of elongation will be allowed for each increase of 1/8 inch in thickness above 3/4 inch, to a minimum of 20 percent.

For plates under 5-16 inch in thickness, a deduction of 2.5 from the percentage of elongation specified in the table shall be made for each decrease of 1-16 inch in thickness below 5-16 inch.

This association has also published a very commendable criticism of the specifications for boiler steel proposed by the committee of the American Society of Mechanical Engineers.

The Saskatchewan specifications of material seem to be the best adapted to the various parts of a locomotive type of boiler. The shell sheets are allowed to be of higher tensile strength and of lower percentage elongation than those which are exposed to the products of combustion; thus the plates which are of the best chemical as well as the best physical properties are required where they are subjected to the most severe conditions. The same is true of the plates which form the flat surfaces and flanged portions of the boiler, those parts which are exposed to the fire being of firebox steel, which is the best material to withstand the heat and the resulting expansion and contraction under varying conditions, while those plates forming the exterior parts of the boiler may be of the quality known as flange steel.

The variation in the rules regarding the specifications for boiler materials makes it necessary for the manufacturer of stock boilers to lend his efforts toward having the laws modified so that he does not have to carry a stock of material as well as a stock of finished boilers to meet the requirements of the various laws.

RIVETED JOINTS

The Canadian rules cover the subject of riveted joints in a somewhat different manner than do the rules in the States. In the first place, the Canadian rules limit the maximum pitch for all joints by the formula,

$$P_m = (C \times T) - 1\tfrac{5}{8} \text{ inches.}$$

in which

P_m = maximum pitch of rivets immediately inside of the calking edge.
T = thickness of plate in inches.
C = a constant which is given in Table 2.

TABLE 2

Number of Rivets in one Pitch, Inside of the Calking Edge.	Constant for Lap Joint.	Constant for Double Butt Strap Joints.
1	1.31	1.75
2	2.62	3.50
3	3.47	4.63
4	4.14	5.52
5	....	6.00

Using the above formula and constants the results for several thicknesses of plate are as given in Table 3.

This rule reduces the pitch a considerable amount below that which would be obtained at the maximum efficiency of the joint. The rule does not consider the diameter of the rivet, so that the pitch would be the same whether a small or large rivet was being used in a joint of a given thickness of plate.

As regards the kind of joint which may be used, the Massachusetts rules require the butt joint, Fig. 3 or 5, on all boilers over 36 inches in diameter and on any boiler, regardless of size, which is to carry over 100 pounds pressure per square inch. Boilers under 36 inches which carry a pressure not exceeding 100 pounds per square inch may be constructed with the lap joint as shown in Figs. 1 and 2.

TABLE 3

Maximum pitch of rivets allowed by the Canadian rules:

Thickness of Plate.	Pitch of Rivets in Inches.		
	Single Riveted Lap Joint.	Double Riveted Lap Joint.	Double Butt Strap Joint Shown in Figs. 4 or 6.
1/4	1.952	2.280	2.500
9-32	1.993	2.362	2.609
5-16	2.034	2.445	2.719
11-32	2.075	2.520	2.828
3/8	2.116	2.608	3.0375
13-32	2.157	2.690	3.047
7-16	2.198	2.772	3.156
1/2	2.280	2.935	3.375
9-16	2.360	3.098	3.590
5/8	2.432	3.262	3.813

The Canadian rules do not prohibit the use of lap joints, but restrict their use for all pressures and on all sizes of boilers by penalizing them through the increase of the factor of safety.

The butt joints which are allowed by the Canadian rules are those shown in Figs. 4 and 6. Their rules do not allow the double riveted butt joint as shown in Fig. 3, but require that a double riveted butt joint shall have the inside and outside butt-straps of equal width. The joint shown in Fig. 3 is a good kind of joint and well adapted for use on small sizes of boilers, while that shown in Fig. 4 is considerably more expensive to make and is less efficient owing to the close spacing of the rivets in the outer row, and the consequent weakening of the shell sheet at this line. The joints shown in Figs. 5 and 6 are essentially the same except that the Canadian style, Fig. 6, has the inner butt-strap scarfed to take the rivets in the circumferential seam. Massachusetts does not require this, nor do they object to it.

RIVET HOLES

The Massachusetts rules provide that rivet holes, except for attaching stays or angle bars to heads, shall be drilled full size with plates, butt-straps and heads bolted up in position, or they may be punched not to exceed one-fourth (1/4) inch less than full size for plates over five-sixteenths (5/16) inch in thickness, and one-eighth (1/8) inch less than full size for plates not exceeding five-sixteenths (5/16) inch in thickness, and then drilled or reamed to full size with plates, butt-straps and heads bolted up in position.

The Alberta rules prefer rivet holes drilled from solid plate, but require that holes thirteen-sixteenths (13/16) inch in diameter and under be punched one-eighth (1/8) inch less than full size and rivet holes over thirteen-sixteenths (13/16) inch in diameter be punched out three-sixteenths (3/16) inch less and drilled or reamed to full size after assembling.

For British Columbia all rivet holes must be made perfectly true and fair by clean cutting punches or drills; the sharp edges and burrs are to be removed by slight countersinking and burr-reaming.

In the manufacture of stock boilers, where several hundred of one size are often built at a time, the drilling of the rivet holes from the solid plate is considered to be much more expensive than punching them through templates. The reaming of holes an amount which will take out the metal that may have been crystallized by punching is no doubt a step in the direction of safety, but the amount of reaming required by some of the rules should be modified to come into more practical limits. The amount required to be reamed out of the punched holes by the Massachusetts rules makes it not practical to punch some thicknesses of plate at all.

The Alberta rules are more practical in this respect, and when actually applied to riveted joints of standard construction work out so that the rivet holes in plates ⅜-inch thick and less will require ⅛-inch reamed out and for plates over ⅜-inch in thickness 3/16-inch is to be taken out of punched holes. (This is assuming that ¾-inch rivets will be used with ⅜-inch plates, which is in accord with standard practice.)

It is therefore suggested that the rules now in force in Ohio and Massachusetts be modified to read that rivet holes, when punched, shall be one-fourth (¼) inch less than full size in plates over five-eighths (⅝) inch in thickness; three sixteenths (3/16) less than full size in plates over three-eighths (⅜) inch and not exceeding five-eighths (⅝) inch in thickness; and one-eighth (⅛) inch less than full size for plates three-eighths (⅜) inch in thickness and less. If this modification of these rules were allowed it would bring the practical application of the Canadian and States rules to uniformity.

It has been found that the punch breakage is excessive when punching for 23/32-inch holes in 7/16-inch stock with a punch 15/32 inch in diameter, as required by the Massachusetts rules. By the rule suggested a 17/32-inch punch could be used, which would reduce the punch breakage very materially. The stock in a 7/16-inch plate is left in as good condition after a punched hole has been drilled out 3/16 inch as it is in a plate 5/16 inch thick after having a punched hole drilled out ⅛ inch.

In a case where two sheets of unequal thickness are riveted together in a lap joint, it is recommended that the amount the holes are required to be reamed out shall be determined by the thinner plate. The thicker sheet under the same conditions always is stronger than the thinner, and therefore does not require any more to be reamed out. When the holes which come together are the same size it makes fitting up much easier and does not in any way impair the strength of the joint.

Factors of Safety

The Massachusetts rules require that the least factor of safety to be used in calculating the allowable pressure on cylindrical shells shall be five (5) for all boilers constructed under their law. The Alberta rules allow 4.50 to be used when all of the requirements of the rules are fulfilled, but if all of them are not complied with, additions are made to this factor as prescribed in the rules. For example, if a double riveted lap joint is used instead of a double butt-strap joint, .70 is added to the 4.50, making 5.20 as the factor to use; or if a triple riveted lap joint is used, .50 is added, making the factor 5.00, the same as required by Massachusetts. If not built under inspection, .50 more is added; other additions taking into account the manner in which holes are made, material used, etc., making nineteen items in all, one or more of which may be used in determining the factor of safety to be used in calculating the working pressure.

The British Columbia rule regarding factors of safety is similar to that of Alberta except the base factor is four (4). These are rather cumbersome methods of arriving at the factor of safety, but they do take care of various kinds of construction in a logical way.

Stayed Surfaces

By the Alberta rules the maximum stress allowable on flat surfaces shall be determined by the following formula: (All stayed surfaces formed to be a curve, the radius of which is over 21 inches, are to be considered as flat surfaces):

$$\text{Working pressure} = \frac{C \times t^2}{S^2}$$

where

t = Thickness of plate in sixteenths of an inch. (Where doubling plates are used, for t take 75 percent of the combined thickness of both plates.)
S = Pitch of stays in inches when equally spaced in both directions.
C = Constant varying from 112 to 200, depending on conditions, which take into account the style of staying used—that is, screw stays with nuts; through stays with nuts inside and outside of plates; through stays using nuts or doubling plates, and the latter having a thickness at least equal to that of the plate; through stays for plates stiffened with angle or tee bars.

For screw stays, the Massachusetts rules use the following formula:

$$\text{Working pressure} = \frac{C\,(t+1)^2}{S^2 - 6}$$

where

C = a constant = 66.
t = thickness of plates in sixteenths of an inch.
S = pitch of stays in inches.

British Columbia gives the rule for stays on flat surfaces as follows:

$$\text{Working pressure} = \frac{C\,(t+1)^2}{S^2}$$

the letters representing the same as for Massachusetts rules, except C, which is 125 for screwed stays; 165 for screwed stays with nuts on the outside; 200 when nuts are used inside and out; 290 when doubling plates the same thickness as the heads are used.

Table 4 shows the comparison of pressures allowed by the various rules when screwed stays with riveted ends are used:

TABLE 4

Showing Comparison of Working Pressures Allowed on Flat Surfaces when Screwed Staybolts with Riveted Ends are Used.

Thickness of Plate Inches.	Pitch of Staybolts, Inches.	Area of Surface Sq. In.	Allowable Working Pressure Pounds per Square Inch.		
			Ohio & Mass.	Alberta, Ont. & Sask.	British Columbia.
5-16	4½ x 4½	20¼	170	138	222
⅜	5 x 5	25	170	161	245
7-16	5⅝ x 5⅝	31.64	170	173	253
1½	6⅛ x 6⅛	37.51	170	205	270
9-16	6¾ x 6¾	45.56	170	213	274
⅝	7¼ x 7¼	52.56	170	228	287
11-16	7⅞ x 7⅞	62.02	170	234	290

In this table 170 pounds per square inch is taken as a working pressure for Massachusetts and the pitches of staybolts for the several thicknesses of plates is as given by the table published in the rules. The allowable pressures for these pitches for Alberta and British Columbia are computed from the formulas given in their rules. It will be noticed that Alberta allows the lowest pressure on the thin plates and is more liberal than Massachusetts on the thick plates; while British Columbia allows a higher pressure on all flat surfaces than the others. On the 7/16-inch plate, where the pressures allowed by Massachusetts and Alberta are nearly equal, the rules of British Columbia will allow about 80 pounds per square inch higher pressure.

The Canadian rules make provision for uneven spacing of stays by allowing the substitution of

$$\frac{S_h^2 + S_v^2}{2} \text{ to be made in place of } S^2,$$

where

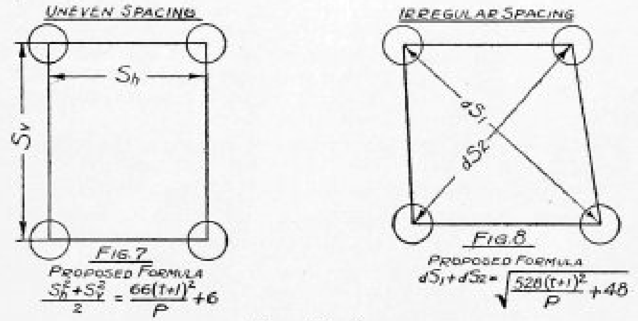
S_h = horizontal spacing of staybolts.
S_v = vertical spacing of staybolts.

If this substitution were allowed in the Massachusetts rules, the formula would be as shown in Fig. 7.

Irregular spacing is also provided for in the Canadian rules by allowing the substitution of

$$\frac{(dS_1 + dS_2)^2}{8} \text{ to be made in place of } S^2$$

where dS_1 and dS_2 are the diagonals of the irregular spacing, as in Fig. 8. If this substitution were allowed in the Massachusetts rules, the formula would be as shown in Fig. 8. These substitutions in place of S^2 for uneven and irregular spacing are recommended as being necessary in determining the working pressure in cases where it is impractical to use regular spacings.



Stayed Surfaces

DOMES

The Massachusetts rules do not provide for steam domes except to require that, when they are to be used, a working drawing shall be submitted to the Board of Boiler Rules for approval.

The Alberta rules cover this point in a very practical manner by requiring the opening under the dome, which is over 2½ inches, to be reinforced by a plate riveted to the shell. This plate shall be at least equal in strength to the plate which has been cut away, and the area of the rivets holding the reinforcement to the shell shall be at least 120 percent of the area of this plate.

The demand for boilers which will be allowed to operate in the various States as well as in Canada is continually increasing among contractors whose work takes them into these various commonwealths, and the need for uniform legislation becomes more apparent as the greater variety of laws are put into force.

There are many details that have not been mentioned, and no doubt there are differences of opinion regarding some of the points that have been covered, but it has been the aim of the writer to bring out some of the suggestions which have come to him in his attempts to design standard boilers which will be allowed to operate under any of the laws, in the hope of promoting uniformity in boiler laws.

AUTOGENOUS WELDING.—In a report presented at the recent General Foreman's Convention, it was stated that both the electric and oxy-acetylene methods of welding have their advantages, the electric for welding flues to the back flue sheet and the oxy-acetylene for cutting. There is a difference of opinion as to which is best on the general run of boiler work. Economy and efficiency are the two main points to consider. Autogenous welding has enabled the railroads to reduce the cost of repairs, increase mileage of flues, prolong the life of firebox, reclaim the worn parts of locomotives, repair broken parts of machinery and numbers of other savings.

Welding Malleable Castings

While the process of autogenous welding is being used so successfully in all the metal trades, many unsuccessful attempts have been made to weld malleable cast iron, and to those who have experienced disappointment the following explanation from *The Iron Age* of why their efforts failed, with an outline of a method by which these castings can be mended, should be of benefit:

Malleable castings are first made in the condition of hard, brittle, white cast iron and subsequently made malleable by heat treatment. The heating process which converts cast iron to malleable iron is called annealing, and effects a chemical change in the structure by decarbonization. This decarbonization is nearly complete at the surface and penetrates in a lessening degree toward the center, giving the outside portion the texture of mild steel while the inner portion may retain, in a more or less degree, the qualities of cast iron. When this metal is remelted the carbon is dispersed and the entire mass reverts to cast iron.

The operator who is used to welding mild steel and cast iron will recall that they are handled differently—that the method used in welding steel to steel would be useless in welding cast iron, or the methods employed with cast iron would be equally unsuccessful with steel. That is practically what he is trying to do when he undertakes to weld a malleable casting. The material is not homogeneous. The bottom portion of the welding being in cast iron, and the top portion in steel, with no definite dividing line between, it is useless to follow the method prescribed for either, and to his trouble is added the difficulty occasioned by the diffusion of the elements in the material melted from the sides of the fracture.

It follows that to successfully mend a malleable casting the process employed must not necessitate the sides of the fracture, that the welding material should fuse at a lower temperature than the casting, and that its adherence, bonding qualities, physical strength and ductility should closely resemble the original casting. After much study and experiment the Vulcan Process Company and their allied interests in Minneapolis are having considerable success in mending broken malleable castings, and a description of their methods will undoubtedly be useful to others who are employed in the metal trades.

In preparing the work for mending, the fracture is chipped away in the form of a V groove with the pointed bottom just coming to the surface on the opposite side, or, if the casting is thick and the opposite side accessible, two grooves are cut with their pointed bottoms meeting in the center. The part surrounding the fracture is then heated with an oxy-acetylene torch to a bright red, and sprinkled with Vulcan flux, followed by a few drops of Tobin bronze melted from the welding rod. If the bronze remains in a little globule the work is not hot enough, but if it spreads and adheres to the surface, the temperature is right, and the groove should be quickly filled. It is not advisable to keep the work hot any longer than is necessary, but to make the mend as quickly and at as low a temperature as possible. The behavior of the bronze affords a guide in regulating the temperature. This process cannot be called autogenous welding, but a malleable casting mended in this way is practically as good as one piece. It has about the same tensile strength and ductility as the original and the process has the advantage of being very quickly performed.

Boiler Manufacturers' Annual Convention

Twenty-Sixth Annual Convention of the American Boiler Manufacturers' Association, Held at the Waldorf-Astoria Hotel, New York, September 1—4

The twenty-sixth annual convention of the American Boiler Manufacturers' Association was held at the Waldorf-Astoria, New York City, on Sept. 1, 2, and 3, 1914, and transacted considerable business of value not only to the Association, but to boiler manufacturers generally, although the attendance of active workers present was less than had been reasonably expected and hoped for. For some reason or other boiler manufacturers seem to be more indifferent to the advantages of contact with their fellows and the benefits to be gained from mutual exchange of business experience, ideas and methods, than many other classes of business men.

There was a good representation of supply and material men present, and these, with their ladies and guests, added to the number present and gave to the meeting the social tinge that is always agreeable and beneficial. The comparatively small attendance of manufacturers has thoroughly awakened the Old Guard who always attend to the importance of more vigorous effort to induce the "stay-at-homes" to come out in future more numerously.

A pronounced feature of the meeting was the opportunity afforded to still further advertise the coming hearing to be held in New York City on Sept. 15, pursuant to the call sent out by the American Society of Mechanical Engineers to discuss their proposed new uniform specifications for boiler design, construction and materials.

A regrettable fact was the absence on account of illness of Colonel E. D. Meier, whose presence and influence has always contributed so much of interest and activity to the meetings of this Association.

The sessions were presided over by Vice-President Thomas M. Rees, of Pittsburgh, under whose guidance matters proceeded smoothly. Practically nothing was done on the first day beyond the usual interchange of courtesies, awaiting arrivals expected on the second day.

Address of Welcome

The convention was opened by an address of welcome by Mr. Henry Bruere, City Chamberlain, whose remarks were not only well turned, but above the ordinary welcome address in pithy force. Mr. Bruere referred to the changed attitude of municipal government toward the community with respect to efficient service for the public welfare. He referred to the fact that New York City had achieved a rather unenviable reputation in former years on account of its police graft scandals, etc, but he maintained that it had fully retrieved itself in that through its business men it has since furnished an example to the entire country of what can be accomplished for a city through the active participation of its best citizens, in bringing about the best possible administration of its affairs.

Mr. W. H. S. Bateman, of Philadelphia, was called upon to respond to the address of welcome, which he did in a pleasing and appropriate manner, taking occasion at the same time to defend Philadelphia's reputation against the soft impeachment that the Quaker City is a little "slow." Mr. Bateman congratulated the local committee upon the preparation of a program of entertainment which would insure all visitors a very pleasant and profitable time.

TUESDAY AFTERNOON SESSION

At the afternoon session on Tuesday no business was transacted other than the appointment of the Auditing Committee, Messrs. J. Don Smith and George N. Riley.

Fuisible Plugs

A recent circular letter of the Steamboat Inspection Service, Department of Commerce, under date of June 30, 1914, referring to fusible plugs, was discussed by Messrs. Schaaf, Rees and others, Mr. Rees contending that those who were interested in western river practice believe that there is no necessity of having more than one plug in the flue and one in the shell, and that the plugs should not be placed where they might necessitate the engineer lowering steam in order to get at them, as through such lowering of steam there might be occasioned serious interference with the safe navigation of a boat just at a time when it might be at a critical point in the river. Captain Rees said that he did not believe there had ever been a case where a fusible plug properly made and properly placed had failed to give timely warning that the water in the boiler had fallen below the proper level, and when that warning has been once given the engineer can then act with due regard for the safety of the vessel; but if the plug be placed in an inaccessible position, such that it is necessary to lower steam and go ashore, this might prove very dangerous to the navigation of the boat. He thought the provision that the plugs must be renewed after four months' service was an unnecessary hardship, and in one case had occasioned an extra expenditure of about $1,500.

Mr. H. J. Hartley, of William Cramps Sons, Philadelphia, stated that the Lloyds requirements under which they work did not specify any plug at all, but on the first indication of a leak or blowout a plug is merely screwed in and the matter remedied in that way. He had heard nothing about the circular mentioned.

Mr. A. J. Schaaf, of the Monongahela River Consolidated Coal & Coke Company, Pittsburgh, Pa., stated that in the case of locomotive boilers the requirements in the circular would make necessary the placing of three plugs in the crown sheet, one 12 inches from each end and one in the center, so that they would be practically nine-inch centers apart. In a two-flue boiler, before this provision went into effect, one plug was placed 4 feet from the forward end in the shell just under the fire line, and one in the after end in the flue. Under the new law they will be required to put in an extra plug in the top of the flue in the center of the boiler. One inspector had told him to put a plug in one inch through the crown sheet of the submerged boiler, which would put the plug one inch into the fire. He believed it was a mistake to have an extra plug in a two-flue marine boiler in the middle of the flue, on account of its being the coldest part of the boiler. If safety is the object, it ought to be in the shell 8 or 10 feet from the forward end, where it would get the heat of the furnace, and he had so written General Uhler.

WEDNESDAY MORNING SESSION

The proceedings of the second day, when more of the active members had put in an appearance, were opened by Secretary Farasey reading a communication from Colonel Meier, which was considered as the president's address.

President's Address

On May 21 I issued a circular letter giving you a short historical review of the movement for uniform laws and specifications for the construction of boilers. While the A. B. M. A. can justly claim to have inaugurated the movement twenty-five years ago, the best fruits of its persistent work are found in the gradual growth of a sentiment in favor of uniformity and the many earnest suggestions as to how to reach it. A national law for steamboat boilers has been in active and beneficent operation for many years; a few years ago one for locomotive boilers has been passed. Both of these are based on the Interstate Commerce provision of the Constitution of the United States. Several committees have consulted the national government in the hope of finding some way to bring stationary boilers under this provision, but learned that an amendment to the Constitution would be necessary. Meanwhile excellent State laws have been enacted by Massachusetts, Ohio and Michigan; all similar, but not entirely uniform. The National Tubular Boiler Makers' Association has also formulated an excellent set of specifications, and is duly pushing them in several States of the Middle West.

There is then danger that the purpose of the movement may be perverted by the very zeal its friends have created. There is another important point to consider. Like all the mechanical trades, boiler making is being rapidly improved in its material and its methods. This is wisely allowed for by the steamboat inspection law by giving the Board of Supervising Inspectors power to make changes at a special meeting in January of each year, to which boiler manufacturers and steamboat men are invited in conference, bringing new facts and figures to the discussion. Changes then made by the board, when sanctioned by the Secretary of Commerce, have the power of law. It is only necessary to have a permanent committee of experts representing in its membership the makers and the users of boilers as well as State and insurance inspectors, capable of hearing and acting on complaints and suggestions, their experience being the basis of the authority, which their appointment by the State simply confirms.

We have abundant precedent for this. In 1876 the Centennial Commission at Philadelphia appointed a committee to formulate a code for power tests of boilers and engines. This was drawn mainly from the membership of the American Society of Mechanical Engineers, together with some prominent foreign engineers. Its work was so satisfactory that the A. S. M. E. afterwards made it one of its standing committees. It was never fortified by any legal enactment, but this code has long been recognized in all civilized countries. In 1911 I had the honor to be president of the A. S. M. E., and as such appointed a "Committee to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and for Care of Same in Service." I appointed on this committee as chairman Mr. John A. Stevens, M. E., who had been for seven years the mechanical engineer of the Massachusetts Board of Boiler Laws, two members of the A. B. M. A. to represent the boiler making interests, the officer in charge of the boiler department of one of our largest boiler insurance companies, two professors of engineering specially noted for the number and accuracy of their practical tests of boilers and engines, and one of the best steel manufacturers of this country, well known for his careful, practical tests of boiler plate. They have done very thorough and exhaustive work and early this spring submitted their preliminary report "subject to revision and correction." This was discussed at a joint meeting of the committee with committees from the National Tubular Boiler Makers' Association and the American Association of Steel Manufacturers in Chicago on June 15, and at the convention of the A. S. M. E. at Minneapolis on June 16, 1914. It created such phenomenal interest that a further discussion was fixed for Sept. 15, 1914, at 10 A. M., at the Engineering Building, 29 West Thirty-ninth street, New York. A copy of this preliminary discussion was furnished to each member of our Committee on Uniform Specifications. The preparation of this report has cost over $3,000, and the eminent gentlemen composing the committee have received the thanks of the A. S. M. E. for the excellent work they have done.

I shall appoint a special sub-committee from the Committee on Uniform Specifications to attend this meeting, but any and all members of the A. B. M. A. will be welcome. The final report of this committee will be submitted by letter ballot to the 6,000 members of the A. S. M. E., and if adopted will be published as the conclusion and recommendation of this great society. You will recognize that a very large number of the members are consulting engineers for important manufacturing concerns, and it is but reasonable to expect that the specifications for new plants or for the improvement of old ones will contain the provision, "Boilers to be built according to the Standard Specifications of the A. S. M. E."

I therefore strongly recommend that you take this matter up with members of our own committee on specifications and through them make such suggestions and criticisms as you think advisable at the meeting of the A. S. M. E. committee on Sept 15. We must always remember that any standard suggested or adopted will not meet all the wishes of all men in the trade, but a carefully worked out standard, though it may contain minor defects, is better for the trade than no standard at all. Similar arrangements have been made by the A. S. M. E. with the manufacturers of flanges, of pipe threads, etc., which, while now national, are in a fair way of becoming international in a few years. I shall make it my duty to work up with the A. S. M. E. an arrangement to make this a standing committee and to have annual meetings with the A. B. M. A. and other boiler and cognate interests, for further continued improvements of these rules. in the same manner as has worked so well in the Steamboat Inspection Service.

You will find them even more complete than the State Rules, which they follow very closely. It is only necessary for a State legislature to create its Board of Inspectors, instruct them to inspect according to these standard specifications, and to attend these meetings for revision by sub-committees; such revisions to be given the force of law in each State by the signature of the governor or some designated officer.

Where for some reason such action is not had, there is no doubt but the general acceptance by the trade and by purchasers will place their authority on an even firmer footing than can be done by a mere legal form or an official signature. As explained above, this is shown by the general acceptance of the Code of Tests, the standard for flanges and those for pipe threads, etc.

Upon motion of W. C. Connelly, Connelly Boiler Company, Cleveland, a committee of three was appointed to report on the president's address, consisting of W. C. Connelly, Cleveland, A. J. Schaaf, Pittsburgh, and Bartholomew Scannell, Lowell, Mass.

Secretary Farasey next read a personal letter received from Colonel Meier, advising that Mr. Stevens and other representatives of the A. S. M. E. were to be given a hearing Wednesday morning, and suggesting that a special committee consisting of Messrs. Rees, Koopman and Durbin be appointed, with Messrs. Schaaf and Brunner as alternates, to represent the Association at the A. S. M. E. hearing on the 15th instant. Colonel Meier also advised that he had been appointed on the A. S. M. E.

committee which is to make the final revision of the proposed A. S. M. E. specifications, which place he had accepted vice Mr. Meinholtz, deceased. Colonel Meier further stated that the A. B. M. A. expects to get the endorsement of the A. S. M. E. for the steel specifications as they were originally formulated in Pittsburgh in 1889. This would enlist the powerful influence of the 6,000 members of the A. S. M. E. in favor of the adoption of these specifications. Colonel Meier sent hearty greetings to the membership present, with the assurance that only illness prevented his attendance. He also stated that it would be impossible for him to accept the presidency for another year.

Colonel Meier called attention to his circular letter to the membership, dated May 21, 1914, further copies of which he offered to supply on request. This letter referred to pioneer work in uniform specinfications and laws by the A. B. M. A.

On motion of Mr. Hammond, this communication from Colonel Meier was received and filed. Action on Colonel Meier's retirement was taken lated on.

Mr. Stevens' Address

Mr. John A. Stevens, from the committee of the A. S. M. E., addressed the convention, explaining the methods adopted by the A. S. M. E. in formulating their proposed standard specifications for the construction of steam boilers and other pressure vessels and for care of same in service. Mr. Stevens urged that all interested attend the hearing to be held in New York City by the A. S. M. E. on the 15th instant. He felt that regard for safety of life and property should far outweigh any consideration of cost, and the object of the new specifications was to insure the best possible design, construction and materials. He invited suggestions from all quarters, and stated that the opinions and criticisms of some 1,600 engineers who were recognized authorities on boiler design and construction had been requested by letter, and the replies collated and considered; that the hearing on the 15th instant was for the purpose of still further bringing out and discussing suggestions looking to the formulation of the very best specifications possible. He understood that the Wisconsin law recently enacted was being held up before being put into effect, awaiting the result of this conference. He thought that the Wisconsin law was a retrograde step from the proposed standard in the fact that it called for reducing the factor of safety from 5 to 4½, and allowed the use of flange steel in place of firebox in boiler shells. He urged that the very best boilers that can be made for money be insisted upon.

Mr. George A. Luck, chairman of the Massachusetts Board of Boiler Rules, was next invited to address the convention, and read in full a schedule of certain proposed changes which his board are considering putting into effect after the usual legal preliminaries shall have been complied with, a proper hearing had, etc., but which the board is at present holding up for hearing until after the proposed A. S. M. E. conference on the 15th instant. Mr. Luck's remarks were of great interest, and his appearance at the convention as an especially accredited representative of Governor Walsh, of Massachusetts, was highly appreciated. Prefacing his presentation of the proposed changes, Mr. Luck remarked as follows:

Mr. Luck's Address

You heard quite a little from Mr. Stevens in regard to the Rules and Regulations formulated by the Board of Boiler Rules, so that it is not necessary for me to go into that matter. During the past year there have been 2,259 boilers constructed according to the Massachusetts Rules and Regulations, making a total, since the Rules and Regulations have been in effect—some six years—of 12,251 boilers that have been built according to the Massachusetts standard. One hundred and sixteen boiler manufacturers are to-day building according to this standard. Last year we had an act passed in regard to air tanks used for the storage of compressed air for the use of pneumatic machinery. Now that law exempted any tank of 18 inches diameter and below from inspection; but we have now included in our proposed changes all tanks and other receptacles exceeding 50 pounds pressure, regardless of the diameter. Accordingly the board had to rewrite the Rules and Regulations for tanks of 18 inches diameter and below, and these are in the hands of the printer at the present time, and in the very near future they will be ready for distribution. They will even take in pipe lines. If you merely have a pipe line in your compressed air system that will come under inspection.

The Board of Boiler Rules of Massachusetts has had in contemplation a number of changes in their rules, but they held off calling a hearing upon them, awaiting the action of the A. S. M. E. at St. Paul, Minn., and nothing definite having eventuated there, we are still continuing to hold up the making of these proposed changes until after the 15th of this month; but I am instructed to acquaint you gentlemen here with the proposed changes now in contemplation. (The full text of these proposed changes is printed on page 281.)

In reply to a question by Mr. C. S. Barnum, of the Bigelow Company, New Haven, Conn., Mr. Luck stated that the board, with reference to welded joints, called for the forging process, not considering acetylene or electric welding advisable. Mr. Barnum asked that the word "forging" be defined in this connection, and Mr. Luck replied that he supposed everyone understood what was meant by that from the fact that a circular letter had been sent out.

Mr. C. S. Blake, H. S. Boiler Insurance Company, Hartford, Conn., thought that circumstances might arise making it desirable to define the meaning of the term, to which Mr. Luck replied that if the language was not sufficiently explicit, acetylene or electric welding might be expressly prohibited before the rules were finally adopted.

Vice-President Rees returned the thanks of the convention to Mr. Luck for his presentation of the proposed changes in the Massachusetts rules.

In reply to a question by Mr. John L. Gill, of the D. M. Dillon Steam Boiler Works, Fitchburg, Mass., Mr. Luck stated that lugs or brackets were permitted to be attached to portable boilers with reinforcing pad, the wording of the rule being "*may be*." He explained that in Canada it is customary to put on lugs on portable boilers with reinforcing pads and that the board had been requested to make the proposed change in order that boilers so built will be accepted in Canada, as being in accordance with the practice there.

Mr. Gill inquired if a line of rivets went through the shell in a longitudinal position whether this would not make a single riveted boiler out of it so far as an allowance of pressure was concerned. Mr. Luck replied that it was not necessary to put the rivets so close together as to bring the boiler within less limits of pressure; that you do not have to reduce the efficiency in the joint, and, besides, you can place the reinforcing pad on the inside of the boiler if you so wish.

Mr. L. E. Connelly, chairman of the Committee on Uniform Boiler Laws, presented their report, as follows:

Report of Committee on Uniform Boiler Laws

Since the meeting of this body last September, there has been practically no boiler legislation of any consequence enacted in any of the States.

At the meeting of this Association a year ago, the Massachusetts requirements, somewhat modified, were adopted by this body as a standard. Since that time a committee appointed by the American Society of Mechanical Engineers (two of this committee being members of this Association) have compiled a set of requirements as a standard. They also have used the Massachusetts and Ohio laws as a model, and the Society has issued a very complete book on this subject.

Other organizations (notably the National Association of Tubular Boiler Manufacturers) have done a great deal of missionary work to further this cause. The committee from the National Tubular Boiler Manufacturers' Association held a meeting at Pittsburgh on October 30 and 31 of last year, and two members of the committee from the A. B. M. A. were invited to be present, and did attend.

At this meeting representatives from the Boiler Boards of Massachusetts, Ohio, Detroit, Chicago, Philadelphia and Seattle were also present. A committee from the American Association of Steel Manufacturers was also present a part of the time. The report of the proceedings of this meeting has been put in pamphlet form, and no doubt you have all read the same.

While a great deal of work has been done in the past, there still remains the problem of getting the different States to adopt a law, and of getting them to adopt the same standard, making things uniform.

The steel plate manufacturers are already issuing new specifications regarding the quality of steel they propose to furnish. They have been making this boiler steel to meet the present requirements for some few years; they make steel for the United States Government, and when it is not up to specifications they make it over again. Now as long as the plate makers get paid for making this quality of steel, and they have demonstrated that they can make it, this committee at this time is of the opinion that we should make a stand for keeping up the quality. We have no voice in making the price, but believe the boiler manufacturers are not assuming too much to make a determined stand for quality.

We have heard that there is a movement on the part of the provinces of Canada toward unification of their boiler laws; also, that there will be a meeting in New York on September 15 of the committee of the American Society of Mechanical Engineers on "Standard Boiler Laws," at which time they expect to go further into the subject.

L. E. CONNELLY, *Chairman*.
M. H. BRODERICK.
ROBERT JOY.

On motion the foregoing report was adopted as read.

Mr. W. C. Connelly called attention to the fact that in a recent communication received by him from several of the steel makers, he had been notified that on and after Oct. 1 they would refuse to accept orders for firebox steel with a range of less than 8,000 pounds tensile strength.

Mr. A. B. Carhart, Superintendent, Crosby Steam Gage & Valve Company, Boston, Mass., speaking by invitation of the chair, urged upon the members the advantages of using two small pop safety valves on each boiler rather than one large valve, and emphasized the waste of coal and steam and the lack of economy through the frequent blowing of safety valves too large or unsuitable and the longer life of boilers secured by the use of accurate steam gages and well-designed valves.

Mr. Charles F. Koopman, Jr., New England Iron Works Company, Boston, Mass., referring to the matter previously mentioned by Mr. Connelly of leeway in tensile strength, thought that this would come up sooner or later in the Massachusetts law. He had just learned that under the Massachusetts law another 1,000 pounds was to be given, from 52,000 to 63,000, instead of from 52,000 to 62,000. The mills were asking for a leeway of 8,000 pounds, bringing the tensile strength down to 54,000 pounds. In figuring on a 72-inch boiler, ½ inch thick, 150 pounds working pressure, this would mean a change in the construction of boilers in Massachusetts. This had been brought up in Boston, and the speaker had suggested to the mill that they do not make an arbitrary rule of that sort without first learning what effect it would have upon the boiler manufacturing industry. The mill did not listen to what he told them, but had asked to have the limit reduced to 8,000, which would change the entire figuring of the manufacturer. In Massachusetts, if you are a point shy it will not go, and the thing has to be watched from start to finish. He suggested that the Association confer with the mill men in order to see whether some happier medium than 8,000 pounds cannot be arrived at. They stamp their plates 54,000 minimum tensile strength. They do not stamp them what they are, and this is going to affect the product later on in the manufacture of boilers.

Mr. T. M. Rees, Pittsburgh, said that he had been all his life a high tensile strength man, and he did not want to be confined to a low tensile strength which would limit the thickness of the material. He always succeeded in getting the steel that he wanted by paying enough for it, and had just received word that after six years' constant service night and day with 185 to 190 pounds pressure, only one little fire crack had shown up on a certain piece of work. When the price was $1.80 for the ordinary steel furnished, he had paid $3.25 in order to get what he wanted, and always used from 60,000 to 65,000 tensile strength in his shop.

The convention now adjourned for lunch, after which further discussion of the tensile strength leeway was resumed, and Mr. J. O. Leech, of the Inspection Department of the Carnegie Steel Company, Pittsburgh, Pa., was called upon to present the views of the steel plate makers.

WEDNESDAY AFTERNOON SESSION

MR. LEECH'S ADDRESS

I would like to read one or two extracts from a "Criticism of the Specifications for Boiler Steel Proposed by the Committee of the American Society of Mechanical Engineers," that will be presented by the Association of American Steel Manufacturers on the 15th instant:

"Statements are made from time to time of the losses of life and property resulting from boiler explosions, but how many of these are chargeable to the steel in the boiler and how many can be traced to careless workmanship or handling? Standard specifications for boiler material, agreed to by both steel makers and boiler manufacturers and users, have been worked under for many years, and therefore before putting out new specifications more stringent in some respects and less so in others than these, it seems pertinent to inquire what has been the service record of the steel made under the older specifications. Some experience of which we are not aware may point out clearly the necessity of keeping intact provisions of the proposed specifications in which we have recommended changes. If this is the case we shall be glad to reconsider our recommendations in the light of any details which may be brought to our attention, but otherwise we feel that our recommendations should carry.

"Slight differences in chemical composition or in physical properties do not alone govern quality as now designated by the terms "flange" and "firebox." A comparison of existing specifications will show that some have as high sulphur limits for firebox quality as others allow for flange quality, and that there is considerable difference in the chemical requirements of each quality individually. The ranges in tensile strength for boiler quality vary from 52,000-62,000 pounds to 62,700-71,680 pounds (occasionally plates for marine boilers are ordered with a minimum tensile strength of 65,000 pounds); and the tensile ranges for firebox quality vary from 48,000-58,000 pounds to 55,000-65,000 pounds. Lloyd's and the British Standards Committee specifications specify a tensile range of 58,240 pounds to 67,200 pounds for combustion chamber plates.

"The Pennsylvania Railroad specification for boiler and firebox steel is one of the earliest, if not the earliest, for this class of material. In a letter dated May 5, 1914, addressed to Mr. A. A. Stevenson, past president of the Association of American Steel Manufacturers, Mr. C. D. Young, Engineer of Tests of the P. R. R., states, 'So far as our records are concerned we are not aware of any barrel sheets or firebox sheets which have failed or resulted in loss of life or injury to persons due to the character of the material entering into the construction of the boiler.' From 1886 to 1913, inclusive, the P. R. R. purchased over 115,000 tons of boiler and firebox steel, and, except for the years 1905-1907, when no record of tests was kept, they made 166,000 tests of this material."

There seems to be considerable misapprehension about the position taken by the steel manufacturers in regard to tensile strength. All that the steel manufacturers are asking for is a reasonable working range—less than 8,000 pounds range is considerable of a hardship. We do not care where that range lies, we can make the steel any range within reason. We believe that you can obtain the very best quality of steel for boiler purposes with a tensile strength up to 68,000, or perhaps higher. Marine boilers are regularly built with a minimum of 60,000 pounds. All we are asking is a reasonable working range, and we do not believe it is necessary to specify a maximum of 62,000 to 63,000 pounds to obtain the best quality of steel.

Phosphorus and sulphur limits within reason have nothing to do with the tensile strength. That is governed principally by the carbon and manganese, and as to the ductility, you will get the same relative ductility. You cannot expect a piece of 68,000 pounds tensile strength steel to show as much elongation or as much reduction of area as a piece of 60,000 pounds tensile strength, because as the tensile strength goes up, the ductility drops.

CHAS. F. KOOPMANN, Jr., Boston, Mass.: On October 1 we in Massachusetts will be compelled to order our plates with 54,000 tensile strength unless we are relieved before that time. That is the condition that confronts us there, and it means a change in the thickness of the plates of almost every boiler that we build.

WILLIAM H. BOEHM, M. E., New York: I do not know whether the advantage of having a narrow range is well understood. Of course that is the whole point of the discussion, as to what is the advantage of asking the steel manufacturers to work to a narrow range—that is, a range of 8,000 pounds or less. I have been led to believe that you cannot secure high tensile strength and great ductility from the same material. If you specify high tensile strength, you necessarily must have the material that is more or less brittle—a material that can be easily fractured. You do not want a brittle material in boilers. That is the real reason why we want the manufacturers to work to a narrow range if they can do it.

ROBERT JOY, Oswego, N. Y.: I do not want anybody to get the impression that I am a high tensile strength advocate, for I am not. I know that in certain types of boilers we need 58,000 pounds tensile strength in order to keep the plate within certain limits. If you cannot get 58,000 pounds tensile strength, all your steel externally fired boilers will have to have very thick plates, and I do not think you will be adding very materially to the safety of the boiler by reducing your tensile strength and thickening up the plate.

T. M. REES, Pittsburgh, Pa.: I have been all my life a high tensile strength man. I have never found a good piece of high tensile strength plate that failed, provided I paid for the quality. Most of the steel in the '80's that went 80,000 to 85,000 pounds was crucible steel.

Mr. Paul M. Klein, M. E., of the John Simmons Company, New York City, by invitation of the chair briefly addressed the convention, calling attention to his new invention for circulating water in boilers, especially so-called Scotch marine boilers.

Mr. Ernest T. Child, President, Child & Scott Company, New York City, addressed the convention, stating that the proposed new A. S. M. E. specifications would limit cast iron boilers to 15 pounds pressure, and as representing the National Association of Steam and Hot Water Fitters, and in their behalf, he asked the assistance of the A. B. M. A. to obtain a modification of that recommendation with particular reference to cast iron sectional boilers for hot water heating. The installation of cast iron sectional boilers for heating water is prohibited in office buildings over 35 feet high.

Mr. William H. Boehm, M. E., Superintendent, Department Steam Boiler & Fly Wheel Insurance, Fidelity & Casualty Company, New York City, as a member of the A. S. M. E. committee, inquired of Mr. Child whether the reason he made this request to increase the allowable working pressure on such boilers was not because some of these cast iron boilers operate engine-driven fans, and whether in such cases he did not want a permissible pressure as high as 20 pounds per square inch, and, if so, whether he thought such pressure perfectly safe under steam and hot water pressure. Mr. Child replied that he knew that a cast iron sectional boiler was perfectly safe working on 65 pounds static pressure, as he had one in use at the present time.

Mr. Boehm insisted upon a direct answer to his question, in reply to which Mr. Child said that he did not recommend the use of cast iron sectional boilers for high pressure steam, such as 40 pounds.

THURSDAY MORNING SESSION

At the morning session Thursday, Sept. 3, 1914, the following telegram was read from Mr. Robert Joy, Oswego, N. Y., who had in the meanwhile returned home after attending the previous day's session:

"OSWEGO, N. Y., Sept. 3, 1914.

"Jas. D. Farasey, Secretary A. B. M. A.,
Waldorf-Astoria,
New York City.

"Referring to yesterday's discussion on tensile strength, the specification of twenty years ago, made by the late R. K. McMurray and others, almost invariably specified flange steel from 55,000 to 62,000 tensile strength. We never heard a protest made against this range. It makes little difference to us in our line how the thing goes, but if Massachusetts and Ohio persists in fixing the maximum and the mill insists on a range of 10,000 there is going to be trouble all along the line on certain types of boilers for high pressure. Robert Joy."

The report of the Committee on President's Address, endorsing the course of action which he outlined, was read and accepted.

Resolutions consequent upon the retirement of Colonel Meier from the presidency were also adopted.

The report of the Auditing Committee to the effect that the books and accounts were correct was received and filed.

The delegation from the Supplymen's Association were now given the floor, their spokesmen being Messrs. Bateman and Champion. The matter under consideration was the proposed withdrawal of the Supplymen's Association from further active control of the entertainment features of the conventions. In response Secretary Farasey thanked the Supplymen for their very valable assistance to the Association, and hoped, whether or not they contributed their assistance to the entertainment features of future conventions, they would nevertheless continue their pleasant individual relations with the Association, as in the past.

Secretary Farasey remarked further that the subject would be considered by the A. B. M. A. active members at the Thursday afternoon executive session, and the Supplymen duly advised of the action taken.

Mr. D. J. Champion, of the Champion Rivet Company, Cleveland, Ohio, assured the convention that the Supplymen would always be most willing to co-operate with the Association in any way that they were requested, and would be pleased at all times to attend the conventions without wishing to dictate as to any arrangements.

The Supplymen then retired for the purpose of holding their own session.

On motion of Mr. W. C. Connelly a special committee was appointed to confer further with the Supplymen's Association, consisting of Messrs. Connelly, Farasey and J. Don Smith.

The report of the Committee on Uniform Boiler Specifications was read, as follows:

Report of Committee on Uniform Specifications

In regard to the joint conference to be held September 15 in New York, at the instance of the American Society of Mechanical Engineers, we beg to report the following for your consideration and ask your endorsement of same as instructions to this committee, viz.:

We recommend that Section 8, Part II, Page 30, of the proposed recommendations by the A. S. M. E. be changed to read as follows:

Section 8.—Safety valves having either the seat or disk of cast iron shall be allowed when riveted direct to the shell of boiler.

Also, on same page, Part II, Section 9, that there be inserted in the third line after the word "type," the words "or lever safety valve," otherwise the said section to remain unchanged.

Also that on same page, Part II, Section 11 be struck out and the following substituted in lieu thereof, viz.:

Section 11.—Fusible plugs, except as otherwise provided for, shall have an external diameter of not less than three-fourths of an inch pipe tap, and the banca tin shall be at least one-half of an inch in diameter at the smaller end and shall have a larger diameter at the opposite end of the plug; provided, however, that all plugs used in boilers carrying a steam pressure exceeding 150 pounds to the square inch may be reduced at the smaller end of the banca tin to five-sixteenths of an inch in diameter.

Fusible plugs, when used in the tubes of upright boilers, shall have an external diameter of not less than three-eighths of an inch pipe tap, and the banca tin shall be at least one-fourth of an inch in diameter at the smaller end and shall have a greater diameter at the opposite end of the plug.

We further recommend that, on Page 31, of said A. S. M. E. proposal, Part II, Paragraph (*f*), of Section 12, read as follows:

(*f*) In vertical submerged tube boilers—in the upper tube sheet or side of cone.

We further recommend, Page 33 of said Part II, under Section 16, Paragraph (*b*) be changed to read as follows:

(*b*) Each boiler shall have three gage cocks, located as follows: the first gage cock to be located 2½ inches above flue, the second gage cock to be located 4½ inches above flue, and the third gage cock to be located 6½ inches above flue.

We further recommend that in Part II, beginning at Section 1, all of said Section 1, and all of the immediately following Section 2, down through the middle of Page 186, be struck out and that there be substituted therefor the present A. B. M. A. Specifications covering I. Materials, II. Workmanship and Dimensions, III. Factor of Safety, IV. Hydrostatic Pressure and V. Hanging or Supporting the Boiler.

We further recommened that on Page 208, Section 62, of Part III, of said proposal, said section shall read as follows:

62. Manhole plates shall be of wrought or cast steel or cast iron.

Thomas M. Rees, *Chairman.*
A. J. Schaaf.
Barth. Scannell.
H. J. Hartley.
Chas. F. Koopman, Jr.
Wm. A. Brunner.

Mr. George A. Luck, Chairman Massachusetts Board of Boiler Rules, suggested that he thought it would be well to make a maximum for the filling of fusible plugs, as only a minimum had been provided for, whereas the proposed Massachusetts rules provided for a maximum as well as a minimum.

Mr. Schaaf explained that what his committee recommended as to fusible plugs is in accordance with the United States Government rules.

On motion of Mr C. D. Stevens, Muskegon Boiler Works, the report of the Committee on Uniform Boiler Specifications was adopted.

Secretary Farasey called attention to the very great importance of the subject of cost accounting, and gave it as his conclusion that every boiler manufacturer in the United States could materially profit by attending these conventions and exchanging views on this as well as other important matters.

Mr. W. C. Connelly, chairman of the committee, read the report as follows:

Report of Committee on Uniform System of Cost Keeping

We would recommend that each boiler manufacturer classify his operating expenses in at least as many accounts as were named in the paper on "Shop Costs," as presented at the 1913 convention. Your committee has felt that the paper read at the last convention covered the subject of overhead charges so well as not to require a great deal of further attention, and we have therefore spent most of our efforts in the matter of obtaining correct cost of productive labor. Your committee is of the opinion that a cost record of the labor on any particular job should not only show the lump sum cost, but should also show the exact cost of each operation, and also the exact number of hours for each operation.

In order to arrive properly at these figures, we recommend the use of daily time cards, on which should be shown the various items of work as performed in a boiler shop. By this we mean such operations as laying out, punching, clipping, shearing, rolling, reaming tube holes, drilling tube holes, reaming rivet holes, fitting up, calking staybolting, setting tubes, flanging, blacksmithing, machine work, testing, painting, loading and unloading. In addition, these daily time cards should show the shop or contract number of the job, date, name of workman and his key number. If these time cards are made out by the workmen, they should be O. K.'d by his foreman promptly after being turned in to the office.

There is another method of recording the elapsed time for each operation; this being done with a special time clock known as a Calculagraph. It is the opinion of the committee that the Calculagraph system is to be preferred, as there cannot be any changes made from the records produced by same. Each day following the receipt of the time cards from the shop these costs and the total number of hours of each operation should be charged onto a separate labor cost sheet kept in the office for this purpose for each contract under way. In this manner, when the job is completed, you have the exact cost of each operation, as well as the total number of hours and the entire cost of labor performed. By having the exact cost of each operation, it is a simple matter if at any time you build a duplicate job, and there is any great variance in the labor cost, to tell in which operation the excess cost was made.

Your committee is of the opinion that it would greatly facilitate the solution of a uniform cost system if at our next convention we have a large bulletin board in the convention hall, and have each manufacturer send to the local committee (or a committee on uniform costs, if such a committee is retained) the various forms used by each manufacturer for his cost system. These forms could then be exhibited on the bulletin board in the meetings, labeled with the name of the firm sending them, and we are of the opinion that this exchange of ideas would result in much mutual benefit to the members of the Association.

W. A. Connelly, *Chairman.*
Cliff M. Tudor.
J. Don Smith.

A discussion followed which did not enter into details, but dealt generally with the importance of proper cost accounting. Willingness was expressed on all hands to frankly discuss this matter at future meetings along the lines suggested by Mr. Connelly. It is believed that this will become a valuable educational feature.

On motion of Mr. Brunner, the report was accepted and the committee continued.

Mr. J. Don Smith, Charleston, S. C., as chairman of the Committee on Topical Questions, reported that no questions had been forwarded to him during the year for discussion.

The morning session now adjourned.

Election of Officers

At the executive session in the afternoon the election of officers resulted in the re-election of former officers with the exception of Colonel E. D. Meier, Mr. W. C. Connelly being elected president, and in his response pledged himself to renewed efforts for increased membership and furtherance of the objects of the Association.

Social Features

Among the social features of the convention were, on Tuesday evening a reception with dancing and buffet refreshments, the grand promenade being led by Mr. and Mrs. George N. Riley; a sight-seeing tour for the ladies on a New York yacht Wednesday morning; shopping and sight-seeing tour to principal hotels and department stores Thursday morning; banquet in the Astor Gallery tendered by the Supplymen's Association Thursday evening, and also a trip to Coney Island, with dinner at the Hotel Shelburne, Friday.

Mr. George N. Riley was toastmaster at the banquet Thursday evening, and kept the company in the best of humor. Among those who responded to toasts were the following:

Charles R. Lamb, representing the Merchants' Association of the City of New York; W. C. Connelly, President-elect A. B. M. A., Cleveland; D. J. Champion, treasurer Supplymen's Association, Cleveland; Joseph Broderick, Muncie, Ind.; W. S. Bateman, Philadelphia, Pa.; Secretary Jas. D. Farasey, Cleveland; Hon. Joseph Hartigan, Commissioner of Weights and Measures, New York City; Hon. G. A. Luck, Chairman Massachusetts Board of Boiler Rules; John T. Corbett, President Supplymen's Association, Chicago; Miss A. B. Chute, Enterprise Boiler Company.

Mr. Bateman performed the pleasant duty of presenting to Mr. Champion, with the good wishes of his many friends in the Association, a solid silver water pitcher, which occasioned Mr. Champion many blushes and brought forth from him a selection from his favorite poet, Tom Moore.

To Mr. Corbett fell the pleasure of presenting a solid silver service to Mr. F. B. Slocum, of the Continental Iron Works, and secretary of the Supplymen's Association, in appreciation of his efficient services. This gift had a special significance in view of Mr. Slocum's approaching nuptials.

The banquet was concluded at a reasonably early hour and was followed by dancing.

The Supplymen, at their regular meeting, re-elected their former officers.

Decision as to place of next annual meeting of the A. B. M. A. is at present in abeyance, awaiting the action of the Executive Committee. It is understood that the matter of holding meetings possibly more frequently than once a year has been under consideration, and plans are on foot to secure in the future a larger attendance, as well as increased membership.

Wisconsin Boiler Code

The industrial commission law of Wisconsin provides that orders of the commission shall become effective thirty days after publication, but that persons affected by such orders may petition for and receive from the commission a public hearing on such orders as may be objectonable. It has been the past practice of the commission to print all proposed orders in pamphlet form, distribute by mail to all parties interested, and hold a public hearing at some convenient place to receive all objections to proposed orders, so that they may be modified if necessary or advisable, previous to being published in the official State paper. In keeping with this practice, a printed code of proposed orders dealing with boiler installation, operation and inspection was distributed on August 1, on which a public hearing was held in Milwaukee on August 21.

At this hearing the boiler manufacturers, owners and operators were given an opportunity to present evidence to show why any one or more of the orders should not become effective throughout the State at some future date. The orders are divided into three parts. The first part contains extracts from the industrial commission law, and general orders of safety which in themselves explain the proposed method of operating the department. The second part contains orders which apply to boilers installed previous to September, 1915. The third part deals with boilers installed after September, 1915, and define the method of construction and installation. In general the orders differ but little from the rules in the Ohio boiler code. However, it was to just these differences that the manufacturers had serious objection.

The orders proposed: To prohibit the future use of cast iron, to allow either flange or firebox steel for the construction of all parts of a boiler, and to require that tube holes be punched no larger than one inch and cut to fill size with a rotation cutter. On each of these proposals there was serious objection. Numerous other objections were registered to small details, along with some helpful criticism. At this time it is safe to say that final action will not be taken until after the September meeting of the A. S. M. E., when the orders will be revised to eliminate every objection as far as is possible and consistent with safety.

H. E. Pressinger, in charge of State Boiler Inspection.

Registered Attendance at the Boiler Manufacturers' Convention

Thomas Aldcorn, Chicago Pneumatic Tool Co., New York.
G. S. Barnum, Bigelow Co., New Haven, Conn.
W. H. S. Bateman, Parkesburg Iron Co., Champion Rivet Co., Philadelphia, Pa.
H. A. Beale, Jr., Parkesburg Iron Co., Parkesburg, Pa.
C. S. Blake, Hartford Steam Boiler Inspection Co., Hartford, Conn.
Chas. Booth, New York.
Joseph Broderick, Broderick Co., Muncie, Ind.
M. H. Broderick, Broderick Co., Muncie, Ind.
Douglas A. Brown, Official Reporter, Cincinnati, O.
H. H. Brown, Editor The Boiler Maker, New York, N. Y.
Henry Bruere, City Chamberlain of City of New York, New York, N. Y.
W. A. Brunner, Tippet & Wood, Phillipsburg, N. J.
J. T. Bulkeley, Jenkins Bros. Co., New York, N. Y.
W. H. Burquest, Domestic Engineering, New York, N. Y.
J. B. Campbell, McNeil Boiler Co., Akron, O.
Mr. Canfield, Scannell Boiler Works, Lowell, Mass.
A. B. Carhart, Crosby Steam Gauge & Valve Co., Boston, Mass.
Capt. C. A. Carr, U. S. N., U. S. Navy Dept., Brooklyn, N. Y.
D. J. Champion, Champion Rivet Co., Cleveland, O.
William Champion, Champion Rivet Co., Cleveland, O.
E. T. Child, The National Assn. of Steam Hot Water Fitters, New York, N.Y.
Miss A. B. Chute, The Enterprise Boiler Co.
H. R. Cobleigh, Hill Publishing Co., New York, N. Y.
James V. V. Colwell, M. E., New York, N. Y.
W. C. Connelly, Connelly Boiler Co., Cleveland, O.
G. A. Conner, McNeil Boiler Co., Philadelphia, Pa.
J. T. Corbett, Joseph T. Ryerson, Chicago, Ill.
Alfred Cunningham, C. Cunningham Co., Brooklyn, N. Y.
Chris. Cunningham, Chris. Cunningham Co., Brooklyn, N. Y.
O. W. Cutler, Ex-Mayor, Niagara Falls, N. Y.
Chas. N. Davis, Consulting Engineer, New York, N. Y.
George W. Denyven, Arthur C. Harvey Co., Boston, Mass.
W. H. Edgerly, Lukens Iron & Steel Co., New York.
F. J. Eisler, Manager Waldorf-Astoria Hotel, New York, N. Y.
J. D. Farasey, H. E. Teachout Co., Cleveland, O.
P. H. Ferguson, Pittsburg Steel Product Co., New York, N. Y.
M. Fogarty, M. Fogarty, Inc., New York, N. Y.
Hon. James A. Folley.
D. W. Glanzer, Otis Steel Co., Cleveland, O.
J. T. Goodwin, National Tube Co., New York.
H. A. Gray, Jos. T. Ryerson & Sons, New York, N. Y.
G. Gregory, Cleveland Pneumatic Tool Co., New York, N. Y.
J. Louis Haas, Walsh & Weidner Boiler Co., Chattanooga, Tenn.
Richard Hammond, Lake Erie Iron Works, Buffalo, N. Y.
Isaac Harter, Jr., Babcock & Wilcox Co., Bayonne, N. J.
H. J. Hartley, Wm. Cramp Sons, Philadelphia, Pa.
Philip Hiperhouser
D. S. Jacobus, Advisory Eng'r Babcock & Wilcox Co., Jersey City, N. J.
S. F. Jeter, Hartford Steam Boiler Inspection Co., Hartford, Conn.
W. D. Johnson, Milwaukee Boiler Co., Milwaukee, Wis.
J. C. Jones, Cleveland Steel Co., Cleveland, O.
Robert Joy, Kingsford Foundry & Machine Works, Oswego, N. Y.
William Kehoe, Kehoe Iron Works, Savannah, Ga.
A. R. King, Manning, Maxwell & Moore, New York, N. Y.
J. A. Kinkead, Parkesburg Iron Co., New York.
Paul M. Klein, John Simmons Co., New York, N. Y.
Chas. F. Koopman, Jr., New England Iron Works Co., Boston, Mass.
E. C. Kreutzberg, Iron Trade Review, New York, N. Y.
W. H. Kulass, Joseph T. Ryerson & Son, Chicago, Ill., New York, N. Y.
J. O. Leech, Assn. of American Steel Manufacturers, Pittsburg, Pa.
J. M. Lloyd, Iron Age, New York, N. Y.
Harry Loeb, Lukens Iron & Steel Co., Philadelphia, Pa.
F. B. Low, editor Power, New York.
J. E. Lynch, Hodge Boiler Works, Boston, Mass.
Eugene F. McCabe, McCabe Boiler Works, Newark, N. J.
W. F. Macon, Iron Age, New York, N. Y.
J. I. Mangle, Merriam Machine Foundry & Supply Co., Passaic, N. J.
W. W. Manning, Hartford Steam Boiler & Inspection Co., New York, N. Y.
A. S. Mitchell, Champion Rivet Co., New York, N. Y.
George E. Mollison, Tyler Tube & Pipe Co., New York, N. Y.
G. L. Morton, N. S. Safety Clamp Co., New York, N. Y.
J. J. F. Mulcahy, Worth Brothers Company, New York, N. Y.
Andrew Murray, Cooney & Co., New York, N. Y.
Mr. Neal, Scannell Boiler Works, Lowell, Mass.
F. S. North, Pemberthy Injector Co., Brooklyn, N. Y.
Frank M. Norton, Baltimore Trade Journal, Baltimore, Md.
T. T. Parker, Fidelity & Casualty Co., New York, N. Y.
B. B. Preer; Oil City Boiler Works, New York, N. Y.
W. P. Pressinger, New York, N. Y.
Thomas M. Rees, Jas. Rees & Sons Co., Pittsburg Pa.
J. A. Ridgway, McNeill Boiler Co., New York, N. Y.
G. N. Riley, National Tube Co., Pittsburg, Pa.
Emil W. Ritter, Burke Furnace Co., Chicago, Ill.
C. C. Rosser, Detroit Seamless Tube Co., Detroit, Mich.
Thomas F. Rowland, Continental Iron Works, Brooklyn, N. Y.
Chas. N. Rowland, Continental Iron Works, Brooklyn, N. Y.
Joseph T. Ryerson, Jos. T. Ryerson & Son, New York, N. Y.
Bartholomew Scannell, Scannell Boiler Works, Lowell, Mass.
A. J. Schaaf, Chf. Engr. Marine Dept., The Monongahela River Cons. Coal & Coke Co., Pittsburg, Pa.
Chas. J. Schluter, Logan Iron Works, Brooklyn, N. Y.
G. T. Schnatz, Lukens Iron & Steel Co., Philadelphia, Pa.
A. S. Sherwood, Epping-Carpenter Pump Co., New York, N. Y.
A. D. F. Simmons, Scully Steel & Iron Co., New York.
George Slate, The Boiler Maker, New York.
F. B. Slocum, Continental Iron Works, Brooklyn, N. Y.
P. F. Slocum, Supply Men's Assn. A. B. M. A., New York.
Chas. R. Smith
George A. Smith, Boston Representative of Mass. Inspection Dept.
George T. Smith, Walsh & Weidner Boiler Co., Chattanooga, Tenn.
J. Don Smith, Volk & Murdock Iron Works, Charleston, S. C.
S. C. Smith, New York-McClave-Brooks Company, Scranton, Pa.
C. D. Stevens, Muskegon Boiler Works, Muskegon, Mich.
John A. Stevens, Lowell, Mass.
George Thomas III., Parkesburg Iron Co., Parkesburg, Pa.
G. A. Tibbels, Continental Iron Works, Brooklyn, N. Y.
S. C. Tibbels, Continental Iron Works, Brooklyn, N. Y.
J. M. Towles, Chicago Pneumatic Tool Co., Boston, Mass.
Cliff M. Tudor, Tudor Boiler Mfg. Co., Cincinnati, O.
W. H. Van Vleck, Alan Wood, Iron & Steel Co., New York, N. Y.
J. A. Voelker, Pittsburg Steel Product Co., Pittsburg, Pa.

LADIES

Mrs. Thomas Aldcorn, New York.
Miss F. A. Aldcorn, New York, N. Y.
Mrs. Jas. Ashley, New York, N. Y.
Mrs. W. H. S. Bateman, Philadelphia, Pa.
Mrs. Chas. Booth, New York, N. Y.
Mrs. Broderick, Muncie, Ind.
Miss Broderick, Muncie, Ind.
Mrs. J. B. Campbell, Akron, O.
Mrs. Canfield B. Scannell.
Miss Maude Carson, Brooklyn, N. Y.
Mrs. D. J. Champion, Cleveland, O.
Mrs. Eleanor Champion, Cleveland, O.
Miss Ethel Champion, Cleveland, O.
Mrs. J. V. V. Colwell.
Miss Sue Crawford, Philadelphia, Pa.
Mrs. Chris. Cunningham, Brooklyn, N. Y.
Mrs. W. H. Edgerly, New York, N. Y.
Mrs. W. H. Kulass, New York, N. Y.
Miss Marie Farasey, Cleveland, O.
Mrs. P. H. Ferguson, New York, N. Y.
Mrs. D. W. Glanzer, Cleveland, O.
Mrs. J. T. Goodwin, New York, N. Y.
Mrs. G. Gregory, New York, N. Y.
Mrs. W. D. Johnson, Milwaukee, Wis.
Mrs. G. C. Jones.
Mrs. J. A. Kinkead, New York, N. Y.
Mrs. A. H. King, New York, N. Y.
Mrs. P. M. Klein, New York, N. Y.
Mrs. J. M. Lloyd, New York, N. Y.
Mrs. George E. Molleson, New York, N. Y.
Mrs. J. J. F. Mulcahy, New York, N. Y.
Mrs. F. N. North.
Mrs. K. O'Connell, New York, N. Y.
Mrs. T. M. Rees, Pittsburg, Pa.
Mrs. G. M. Riley.
Mrs. E. W. Ritter, Chicago, Ill.
Mrs. C. B. Rowland, Brooklyn, N. Y.
Mrs. T. F. Rowland, Brooklyn, N. Y.
Mrs. John Scannell, Brooklyn, N. Y.
Miss Mary Scannell, Lowell, Mass.
Miss Lillie Scannell, Lowell, Mass.
Mrs. A. J. Schaaf, Pittsburg, Pa.
Mrs. Josephine Schimpf, Philadelphia, Pa.
Mrs. C. J. Schluter, Brooklyn, N. Y.
Miss Ione Smith, New York, N. Y.
Mrs. S. C. Smith, New York, N. Y.
Mrs. C. D. Stevens, Muskegon, Mich.
Mrs. Stevenson
Mrs. J. M. Towles, Boston, Mass.

Changes Proposed in Massachusetts Boiler Rules *

In compliance with Section 26, Chapter 465 of the Acts of 1907, Commonwealth of Massachusetts (as amended by Section 2 of Chapter 393 of the Acts of 1909), a public meeting will be held by the Board of Boiler Rules to consider the following changes in the present Massachusetts steam boiler rules.

PART II

Section I

Page 5, Paragraph 1.—The pressure allowed on a boiler constructed wholly of cast iron, and boilers known as cast iron sectional boilers, shall not exceed fifteen (15) pounds per square inch.

Page 5, Paragraph 2.—The pressure allowed on a boiler the tubes of which are secured to cast iron headers, also on cast iron mud drums and malleable iron headers or mud drums, shall not exceed fifteen (15) pounds per square inch.

Page 5, Paragraph 6.—(Additional.) The shearing strength of the rivets and the crushing strength of the plate in front of the rivets, shall be ample to take care of the pressure on the head.

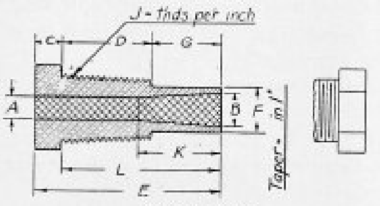
Page 6, Paragraph 7.—The lowest factors of safety used for boilers, the longitudinal joints of which are of lap-riveted construction, shall be as follows:

(e) Boilers over twenty-five (25) years old, of lap-seam construction, shall not carry a pressure in excess of fifteen (15) pounds per square inch.

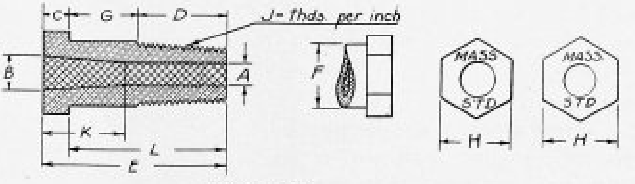
Section 2

Page 8, Paragraph 9.—Interpolate, after the word degrees in fourth line, the words, or about ninety (90) degrees.

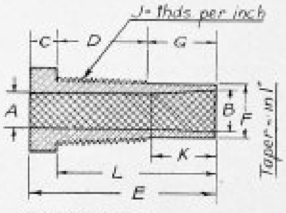
Page 8, Paragraph 10.—Fusible plugs, as required by Section 20, Chapter 465, Acts of 1907, shall conform to the following specifications:



Outside Long



Inside Long



Outside Long

OUTSIDE LONG PATTERN

Size	A	B	C	D	E	F	G	H	J	K	L
1/2	3/8	15/32	1/8	3/4	2 1/8	9/16	1	15/16	14	1 1/2	1 3/4
3/4	3/8	15/32	1/8	7/8	2 1/4	5/8	1	1 3/16	14	1 1/2	1 7/8
1	3/8	15/32	1/8	15/16	2 5/16	21/32	1	1 3/8	11 1/2	1 1/2	1 15/16
1 1/4	3/8	15/32	1/8	1 3/16	2 9/16	11/16	1	1 13/16	11 1/2	1 1/2	2 3/16
1 1/2	3/8	15/32	7/16	1 5/16	2 3/4	3/4	1	2 1/8	11 1/2	1 1/2	2 5/16

For pressures 150 pounds and above.

Size	A	B	C	D	E	F	G	H	J	K	L
1/2	1/2	19/32	1/8	3/4	2 1/8	11/16	1	15/16	14	1 1/2	1 3/4
3/4	1/2	19/32	1/8	7/8	2 1/4	3/4	1	1 3/16	14	1 1/2	1 7/8
1	1/2	19/32	1/8	15/16	2 5/16	25/32	1	1 3/8	11 1/2	1 1/2	1 15/16
1 1/4	1/2	19/32	1/8	1 3/16	2 9/16	13/16	1	1 13/16	11 1/2	1 1/2	2 3/16
1 1/2	1/2	19/32	7/16	1 5/16	2 3/4	7/8	1	2 1/8	11 1/2	1 1/2	2 5/16

For pressures less than 150 pounds.

INSIDE LONG PATTERN

Size	A	B	C	D	E	F	G	H	J	K	L
1/2	3/8	15/32	3/8	3/4	2 1/8	27/32	1	15/16	14	1 1/2	1 3/4
3/4	3/8	15/32	3/8	7/8	2 1/4	1 1/16	1	1 3/16	14	1 1/2	1 7/8
1	3/8	15/32	3/8	15/16	2 5/16	1 5/16	1	1 3/8	11 1/2	1 1/2	1 15/16
1 1/4	3/8	15/32	1/8	1 3/16	2 9/16	1 21/32	1	1 13/16	11 1/2	1 1/2	2 3/16
1 1/2	3/8	15/32	7/16	1 5/16	2 3/4	1 29/32	1	2 1/8	11 1/2	1 1/2	2 5/16

For pressures 150 pounds and above.

Size	A	B	C	D	E	F	G	H	J	K	L
1/2	1/2	19/32	1/8	3/4	2 1/8	27/32	1	15/16	14	1 1/2	1 3/4
3/4	1/2	19/32	3/8	7/8	2 1/4	1 1/16	1	1 3/16	14	1 1/2	1 7/8
1	1/2	19/32	1/8	15/16	2 5/16	1 5/16	1	1 3/8	11 1/2	1 1/2	1 15/16
1 1/4	1/2	19/32	1/8	1 3/16	2 9/16	1 21/32	1	1 13/16	11 1/2	1 1/2	2 3/16
1 1/2	1/2	19/32	7/16	1 5/16	2 3/4	1 29/32	1	2 1/8	11 1/2	1 1/2	2 5/16

For pressures less than 150 pounds.

Short Inside

FOR ALL PRESSURES.

Size	A	B	C	D	E	F	G	H
3/8	......	......	......	......	......	......	......	......
1/2	3/8	7/16	3/4	3/4	1 1/2	27/32	15/16	14

Specifications for Massachusetts Standard Fusible Plugs

All fusible plugs shall consist of a bronze casing, holes in which shall be reamed and tinned before being filled, and shall be filled with Banca tin.

All fusible plugs shall be stamped by the manufacturers with their names across the face of the plugs with letters not less than one-eighth of an inch (1/8") in height, and the letters MASS. STD.

The outside diameter of the plug is to be of the standard pipe threads.

No fusible plug shall be used for a longer period than one (1) year.

Page 9, Paragraph 12.—Add to parentheses (l), (m), (q), (r) and (t) the words, and extending not less than one inch (1") inside of boiler.

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*A report read at the Twenty-sixth annual meeting of the American Boiler Manufacturers' Association, New York, September 1914, by Mr. George A. Luck, chairman of the Massachusetts Board of Boiler Rules.

Page 10, *Paragraph* 13.—Interpolate the word brass before the word syphon on second line.

Page 10, *Paragraph* 17.—Each boiler shall have two (2) or more gage cocks, the center of which shall be located vertically within the range of the visible length of water glass, when the maximum pressure allowed does not exceed fifteen (15) pounds per square inch, except when such boiler has two (2) water glasses located not less than three (3) feet apart on the same horizontal line.

Page 10, *Paragraph* 18.—Each boiler shall have three (3) or more gage cocks, the center of which shall be located vertically within the range of the visible length of water glass when the maximum pressure allowed exceeds fifteen (15) pounds per square inch, except when such boiler has two (2) water glasses, located not less than three (3) feet apart, on the same horizontal line.

Page 11, *Paragraph* 25.—When there are two (2) connected boilers (gravity return system), one check valve and a stop valve shall be installed in the branch pipe to each boiler. (Omit Fig. 1, as shown.)

Section 3

Page 11, *Paragraph* 2.—A boiler having two (2) square feet of grate surface shall be rated at three (3) horsepower when the safety valve is set to blow at fifteen (15) pounds per square inch or less.

Section 6

Page 12, *Paragraph* 1.—When a boiler is tested by hydrostatic pressure the pressure applied shall not be less than one and one-quarter (1¼), nor more than one and one-half (1½) times the maximum allowable working pressure; except that twice the maximum allowable working pressure may be applied on boilers permitted to carry not over fifteen (15) pounds pressure per square inch.

Page 13, *Paragraph* 2.—When making annual inspections on boilers constructed wholly of cast iron, or boilers known as cast iron sectional boilers, a hydrostatic pressure test of not less than fifteen (15) pounds, and not more than twice the maximum allowable working pressure, shall be applied.

PART III

Section —

Page 21.—(Heading.) These rules, in addition to the rules contained in Part II, apply to boilers installed after May 1, 1908, and to any repairs or changes made hereafter.

Section 1

Page 21, *Paragraph* 3.—There shall be two (2) classes of open hearth boiler plate and rivet steel; namely, firebox steel and extra soft steel, which shall conform to the following limits in chemical composition:

	Firebox Steel (Percent)	Extra Soft Steel (Percent)
Phosphorus shall not exceed.......	Acid 0.04 Basic 0.03	Acid 0.04 Basic 0.04
Sulphur shall not exceed...........	0.04	0.04
Manganese	0.30 to 0.50	0.30 to 0.50

Page 21, *Paragraph* 5.—The two (2) classes of open hearth boiler plate and rivet steel—namely, firebox steel and extra soft steel—shall conform to the following physical qualities:

	Firebox Steel	Extra Soft Steel
Tensile strength, pounds per square inch	52,000 to 63,000	45,000 to 55,000
Yield point, in pounds per square inch, shall not be less than	½ T. S.	½ T. S.
Elongation percent in 8 inches shall not be less than.......	26	28

Page 22, *Paragraph* 7.—The two (2) classes, etc.

Page 22, *Paragraph* 7(*d*).—Omit the words flange or boiler steel.

Section 2

Page 25, *Paragraph* 1.—Shells, drums, butt straps, heads, combustion chambers, furnaces, or any plates that require staying or flanging, shall be of open hearth firebox or extra soft steel, as specified in paragraphs Nos. 3 and 5, Section 1, Part III of these rules.

Omit paragraph 2.

Section 3

Page 26, *Paragraph* 6.—Cross pipes connecting the steam and water drums of watertube boilers, and cross boxes, shall be of wrought or cast steel when the working pressure exceeds fifteen (15) pounds per square inch.

Page 26, *Paragraph* 7.—Mud drums of watertube boilers shall be of wrought or cast steel when the working pressure exceeds fifteen (15) pounds per square inch.

Page 26, *Paragraph* 8.—Pressure parts of superheaters, attached to the boilers or separately fired, shall be of wrought or cast steel. Cast iron for superheat is prohibited.

Page 26, *Paragraph* 10.—Waterleg and door frame rings of vertical firetube and locomotive type boilers shall be of wrought or cast steel, or wrought iron.

Page 26.—(After present paragraph 11.) DOMES or DRUMS.

Domes or drums shall only be allowed on a locomotive type boiler, and shall be located on the barrel of the boiler, but not on the wagon top.

Domes or drums shall be made of the same thickness and quality of material as the boiler shell.

When the pressure desired does not exceed one hundred (100) pounds per square inch the longitudinal joints of such domes or drums shall be of double riveted lap construction, and the flange shall be double riveted to the boiler shell.

When a pressure greater than one hundred (100) pounds per square inch is desired, the longitudinal joints of such domes or drums shall be of butt and double strap construction, and the flange shall be double riveted to the shell.

Heads of domes or drums shall be convex.

When a hole larger than four inches (4") in diameter is required in a boiler which is constructed with a dome it shall be reinforced to compensate for the metal removed.

At least two (2) drain holes three-quarters of an inch (¾") in diameter shall be located in the shell under a dome, at the lowest point where water can collect, for the purpose of draining.

Page 26, *Paragraph* 2.—A manufacturer who desires to construct Massachusetts Standard boilers shall send a written application to the Board of Boiler Rules, and receive written authority from said Board before taking any steps toward the construction of a Massachusetts Standard boiler. A detailed list of shop equipment must accompany the manufacturer's application for such authority; also advice of the name of the State inspector or of the authorized inspector holding a certificate of competency as an inspector of steam boilers for this Commonwealth and in the employ of an insurance company authorized to inspect and insure steam boilers for this Commonwealth, who will examine during construction and stamp Mass. Std. upon completion a boiler constructed in strict accordance with these rules. Upon receipt of said application the Board will designate the style of stamping which it will approve, after the following model:

MASS. STD.
1
(Designation by Board.)

Lennox Serpentine Shear

MADE IN THREE SIZES

Capacities: No. 16 gauge, No 10 gauge
and 1-4 inch

The Lennox Serpentine Shear will cut accurately, economically and quickly, the shapes shown; a machine well worth your investigation.

Write for Bulletin No. 50

ESTABLISHED 1842 INCORPORATED 1888

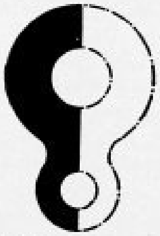
JOSEPH T. RYERSON & SON

CLYDE M. CARR, PRESIDENT JOSEPH T. RYERSON, VICE-PRES.

MACHINERY

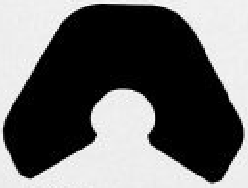
CHICAGO

SERPENTINE CUT

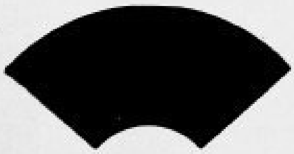


SIDE OF GEAR GUARD.

DEVELOPMENT OF CONE SHEET.

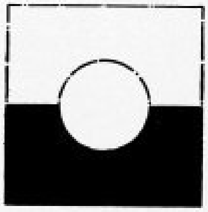


DEVELOPMENT OF SHEET FOR TAPERING BODY WITH OBLONG BOTTOM & ROUND TOP.

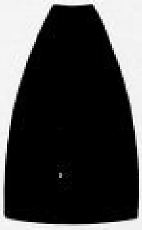


DEVELOPMENT OF CONE SHEET.

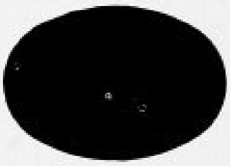
DEVELOPMENT OF CONE CUT ELIPTICALLY.



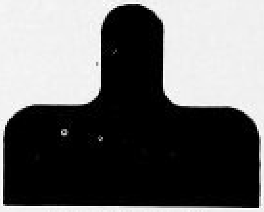
CULVERT SHIELD



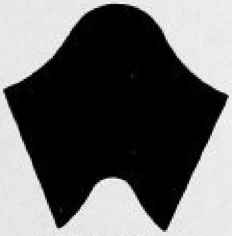
SECTION OF HEMISPHERICAL TANK BOTTOM.



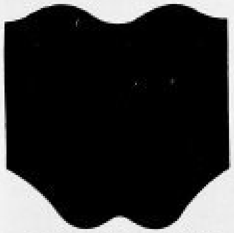
OVAL SHEET



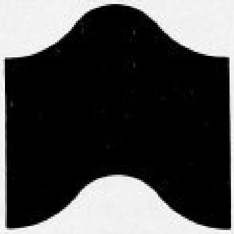
END OF CAR SEAT.



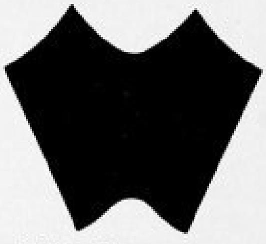
DEVELOPMENT OF OBLIQUE CONE SHEET



DEVELOPMENT OF SHEET FOR SLANTING TEE



DEVELOPMENT OF OBLIQUE CYLINDER SHEET



DEVELOPMENT OF TAPERING ARM OF Y-CONNECTION.

The manufacturer shall then submit a five-inch by three-inch (5″ x 3″) brass or copper plate, showing exactly the style of stamping designated by the Board, for approval; the height of letters and figures to be not less than one-fourth of an inch (¼″).

Page 27, Paragraph 2.—Renumber this paragraph, last six lines to read:

Each boiler shall be stamped by the builder, in the presence of the inspector, with a serial number and with the style of stamping shown in fac-simile previously approved by this Board.

Page 27.—Before present paragraph 3:

Any inspector holding a certificate of competency as an inspector of steam boilers for this Commonwealth may make final inspection and test on a boiler built under the rules of the Board of Boiler Rules of the Commonwealth of Massachusetts, provided the manufacturer of said boiler, or his representative, makes affidavit under oath that said boiler has been so constructed, and furnishes the record of a properly authorized inspector who has followed the construction of the boiler.

Page 33 (Before Paragraph 10).—The efficiency of longitudinal joint of a shell or drum when welded by the forging process shall not exceed the following:

55.0 percent when the shell plates are stamped 52,000 T. S.
54.0 percent when the shell plates are stamped 53,000 T. S.
53.0 percent when the shell plates are stamped 54,000 T. S.
52.0 percent when the shell plates are stamped 55,000 T. S.
51.1 percent when the shell plates are stamped 56,000 T. S.

(Note.—56,000 pounds will be the highest tensile strength used in calculating the maximum allowable working pressure on a shell or drum the longitudinal joints of which are welded by the forging process, this being irrespective of a higher tensile strength than 56,000, which may be stamped on the plates. The formula for calculating the working pressure is given in Paragraph 1, Section 4, Part III of these rules.)

Section 4

Page 34, Paragraph 16.—The minimum thickness of a convex head shall be determined by the following formula, excepting that said thickness shall not be less than one-fourth of an inch (¼″):

$$\frac{8.33\ R \times P}{T.S.} = t.$$

The minimum thickness of a concave head shall be determined by the following formula, excepting that said thickness shall not be less than one-fourth of an inch (⅜):

$$\frac{8.33\ R \times P}{0.6\ (T.S.)} = t.$$

Page 34, Paragraph 16.—(Addition to paragraph). The radius to which the head is bumped shall be at least equal to the diameter of the shell to which the head is attached.

The radius to which the curve shall be made close to the flange on a concave or convex head, shall be not less than four (4) times the thickness of the material in the head.

Page 5, Paragraph 18.—When a convex or concave head has a manhole opening, the flange shall be turned inward, and to a depth of not less than three (3) times the thickness of the head, measured from the outside of the boiler.

Page 37, Paragraph 25.—(Add to paragraph.) The vertical pitch of staybolts, measured from the rivets in the lower tube sheet to the first row of staybolts, shall not be greater than the prevailing pitch of staybolts.

Page 40, Paragraph 31.—When a flat-head has a manhole opening, the flange of which is formed from the solid sheet and turned inward to a depth of not less than three (3) times the thickness of the head, measured from the outside of the boiler, an area two (2) inches wide all around the manhole opening, as shown in Fig. 16, may be deducted from the total area of head, including manhole opening, to be stayed.

Present figure 17 to be renumbered 16, and similar change made in numbers of all figures, on account of omitting figure number 1.

Page 40, Paragraph 33.—(Add to paragraph.) Stay rods longer than three (3) feet, such as are used for bracing the segment of a circle, shall have not less than .7854 square inch sectional area.

Page 43.—(Before paragraph 40.) All staybolts shall be drilled, both from the outside and inside ends, to a depth of not less than one-half inch (½″) inside the boiler plate, and diameter shall be three-sixteenths inch (3/16″).

Page 43.—(Before paragraph 40.) All nozzles on boilers shall be of pressed or cast steel, when the pressure desired is greater than fifteen (15) pounds per square inch.

Page 43, Paragraph 40.—Omit the Example and the formula at end of paragraph.

Page 43.—(Before Paragraph 41.) All boilers and parts of boilers shall be securely riveted, not bolted.

Page 43, Paragraph 41.—The thickness of cast iron blank flanges shall not be less than that specified by the manufacturers' standard for high pressure.

Page 44, Paragraph 46.—The calking edges of plates and heads shall be beveled. Calking shall be done with a round-nosed tool.

Page 44.—(Before paragraph 47.) The edges of plates and butt straps, inside and outside of boiler, shall be planed to a depth of not less than one-eighth of an inch (⅛″) to remove the crystalized metal caused by the action of the shear.

Page 44.—(Before paragraph 51.) SPECIFICATIONS FOR TUBES.

Tubes for watertube boilers, pipe boilers or superheaters shall be made without welds, and shall be seamless drawn.

Tubes for firetube boilers may be welded of steel or charcoal iron.

The physical tests of all tubes shall be as follows:

Tubes shall be free from all surface defects. The defects to be particularly avoided in seamless tubes are tears, snakes, checks, slivers, scratches, laps, pits, rings and sinks.

All seamless steel cold drawn tubes shall be annealed as a final process. One or more tubes shall be selected at random from each charge of annealing furnace, and coupons cut from them for testing.

TEST ONE.—A piece three inches (3″) long, cut from the first tube, shall be flattened by hammering until the sides are brought parallel with the curve on the inside at the ends not greater than three (3) times the thickness of the metal, without showing cracks or flaws.

TEST TWO.—A flange shall be turned all around the end of the tube to a width equal to three-eighths of an inch (⅜″) beyond the outside body of the tube.

Tests one and two shall be done cold.

When hot finished tubes are furnished, the tubes shall pass the same manipulating test as cold drawn tubes, but do not have to be annealed. Each tube shall be subjected to an internal hydrostatic pressure of one thousand (1000) pounds, without showing signs of weakness or defects.

All tubes shall stand expanding, flanging over on the tube plate, and beading, without flaw or crack.

All lap-welded tubes shall be made of charcoal iron or mild steel, and shall conform to the following tests:

Tubes shall be free from defective welds, cracks, blisters, scale, pits and sand marks.

The following tests shall be made before shipment by the manufacturer:

TEST ONE.—A test piece three inches (3″) in length, cut from a tube, shall be flattened by hammering until the sides are about parallel with the curve on the inside at the end, not more than three (3) times the thickness of the metal without showing cracks or flaws, with bend at one side being in the weld.

TEST TWO.—A second tube shall have a flange turned over at right angles to the body of the tube, and shall have a width equal to three-eighths of an inch (⅜″) beyond the outside body of the tube.

All work done shall be done cold.

Each tube shall be subjected to internal hydrostatic pressure of five hundred (500) pounds per square inch, without showing signs of weakness or defects.

All steel tubes shall have ends properly annealed by the manufacturer, before shipment, and shall stand expanding, flanging over on the tube plate, and beading, without flaw, crack or opening in the weld.

The manufacturer of boiler tubes shall furnish to the purchaser of each lot of tubes a statement of the kind of material of which the tubes are made, and that the tubes have been tested and have met all the requirements of the rules. The statement shall be furnished to the boiler manufacturer using the tubes, who shall show them to the boiler inspector when shop inspection of the boiler is made.

Page 44.—(After the foregoing specification for tubes.) The first two rows of tubes exposed to products of combustion, in watertube boilers, shall be two (2) gages heavier than the prevailing thickness of tubes in said boilers.

Page 44.—(Second paragraph after specification for tubes.) No lap-welded tube shall be used in watertube boilers. No old boiler shall be retubed with lap-welded tubes.

Page 44, *Paragraph* 52.—When it is necessary to place a fusible plug in a tube, an extra thick tube shall be provided for that purpose, which shall not be less than three-sixteenths of an inch (3/16″), or number nine (9) gage.

Page 45, *Paragraph* 53.—(After the tabulation.) If the thickness of the material in the boiler is not sufficient to give such number of threads, there shall be a standard commercial pressed steel flange, cast steel flange or steel plate, substantially riveted to the boiler, so as to give the required number of threads. A feed pipe connection shall be fitted with a brass or steel boiler bushing.

Page 45.—(Before paragraph 54.) SPECIFICATIONS FOR CAST STEEL.

Chemical properties:
Phosphorus, not over 0.05 percent.
Sulphur, not over 0.05 percent.
Physical properties:
Tensile strength, pounds per square inch, 50,000 to 60,000.
Elongation in 2 inches, 23 percent.
Reduction of area, 30 percent.

All steel castings must receive such heat treatment as will produce fine grain, homogeneous and tough metal, free from slag, cracks and cavities, injurious blowholes or other defects.

Cast steel, cast iron or malleable iron boiler fittings shall not be used unless made by regular processes and by manufacturers who stamp such fittings with their trade mark or identifying stamp, and who guarantee the castings to possess the chemical and physical properties stated in these rules.

Page 45.—(Before paragraph 58.) There shall be not less than eleven-sixteenths of an inch (11/16″) bearing surface for a manhole gasket.

Page 46, *Paragraph* 64.—A vertical firetube boiler *which does not have a manhole,* except the boiler of a steam fire-engine, shall have not less than seven (7) handholes, located as follows:

Two (2) in the shell at or about the line of the crown sheet, and diametrically opposite each other.

One (1) in the shell at or about the line of the fusible plug, except a vertical firetube boiler having a manhole in the shell or head, through which the fusible plug is accessible.

Two (2) in the shell at the lower part of the water-leg, and diametrically opposite each other.

Two (2) located at or about the waterline of the boiler, and diametrically opposite each other, except a vertical firetube boiler having a manhole.

Page 47, *Paragraph* 88.—Omit the words, or cast iron, in fourth line.

Page 47, *Paragraph* 69.—Omit the words, or cast iron, in third line.

Page 47, *Paragraph* 70.—(Addition to paragraph.) No cast iron shall be used in lugs or brackets in any steam boiler.

Page 47.—(Before paragraph 71.) REINFORCING PLATES WHERE BRACKETS ARE ATTACHED.

In all cases where brackets or other fixtures subjected to any working strain are attached to a portable boiler, the plates to which these brackets are attached shall be reinforced with plates of the same thickness as the outer plates of the boiler, and securely riveted together. The outer rows of rivets attaching reinforcing plates to boiler must be at least three inches (3″) outside of the bracket. All brackets shall be properly fitted to the plates, flat or curved, with stud holes drilled to suit the holes in the brackets, which must be drilled to templets; and the studs attaching same shall be tapped through both plates where reinforced. No tap bolts will be allowed.

SECTION 5

Page 48, *Paragraph* 4.—Omit the words, and thirty-five, and change figure to 100.

Page 48, *Paragraph* 5.—Omit the words, and thirty-five, and change figure to 100.

Page 48, *Paragraph* 7.—Omit paragraph.

Page 48, *Paragraph* 8.—The feed pipe of a boiler shall have open end or ends. When one or more globe valves are used on a feed pipe, the inlet shall be under the disk of the valve.

Page 49, *Paragraph* 9.—The feed water shall discharge about three-fifths (3/5) the length of a horizontal return tubular boiler from the front head, and at or about the central rows of tubes above the tubes, when the diameter of the boiler exceeds thirty-six inches (36″) and the pressure allowed exceeds fifteen (15) pounds per square inch. The feed pipe shall be carried through the head with a brass or steel boiler bushing and securely fastened inside the shell above the tubes.

Page 49.—(Before paragraph 10.) When a horizontal return tubular boiler, the diameter of which does not exceed thirty-six inches (36″), has no manhole opening, and the pressure desired is greater than fifteen (15) pounds per square inch, the feed pipe shall enter the front tube sheet above the tubes, and below the waterline of the boiler, through a bushing, and an internal feed pipe, not less than three (3) feet in length, screwed into said bushing, the end of said pipe being open.

Page 49, *Paragraph* 13.—In fourth line, change pressure to fifteen (15) pounds per square inch.

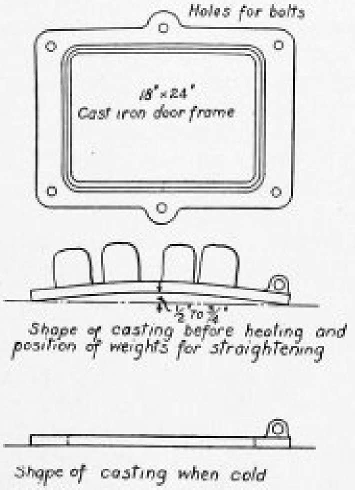
Page 49, *Paragraph* 17.—In first line, change pressure to fifteen (15) pounds.

Page 49, *Paragraph* 18.—In second line, omit the words, and thirty-five, and change figure to 100.

Page 50, *Paragraph* 23.—In second line, change pressure to fifteen (15) pounds.

Page 50.—(Before paragraph 24.) BLOWOFF ON WATER COLUMN.

On each water connection to a water column where there is a right angle turn, there shall be located at least one (1) gate valve and pipe of a diameter not less than one-half inch (½"), for the purpose of blowing out said water pipe, except a right angle turn inside of smoke box.



Sketch showing warped door frame

FIG. 1

Page 50, *Paragraph* 31.—Make this paragraph, paragraph 4, section 6, part 2, page 13.

Page 50.—(After present paragraph 31.) When a dry pipe is used in the steam space of a boiler, it shall be made of the standard thickness of pipe, and be properly secured; shall have both ends closed, and shall be slotted on the top side of the pipe. The area of the slots shall be equal to not less than four times the area of the steam outlet.

SECTION 6

Page 50.—Omit paragraphs 1 and 2.

Page 51, *Paragraph* 3.—Omit the words, passed by joint, and change the word inspection to the word inspected.

Page 52.—Omit present paragraph (a) and change other paragraphs as follows:

(a) Six (6) for boilers, the longitudinal joints of which are of lap-riveted construction, diameters up to and including thirty-six inches (36").

(b) Eight (8) for boilers, the longitudinal joints of which are of lap-riveted construction, diameters over thirty-six inches (36").

(c) Four and five-tenths (4.5) for boilers, the longitudinal joints of which are of butt and double-strap construction, age not exceeding ten (10) years.

(d) Five (5) for boilers, the longitudinal joints of which are of butt and double-strap construction, age over ten (10) years.

The hydrostatic pressure test on such boilers shall be one and one-half (1½) times the maximum allowable pressure obtained by using the above factors of safety.

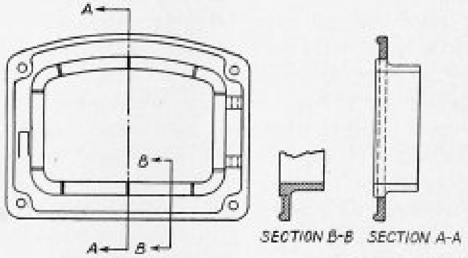
Page 52.—(Before repealing clause.)

A boiler on which a lap crack is discovered shall be immediately discontinued from service.

The ogee form of construction at the lower end of furnace sheet is hereby prohibited.

Straightening Warped, Cast Iron Cleaning Door Frames

A short time ago the writer had charge of the erection of a number of boilers. Parts of these boilers were enclosed in steel casings and about 100 cleaning door frames, as shown in Fig. 1, were needed. These frames were sent to the job direct from the foundry, and nearly all of them were so badly twisted and warped out of shape, as shown in the sketch, that they were not fit to use. As is usually the case, the owners of the boilers wanted to get them in operation as soon as possible, so there was no time to get new frames.



Sketch showing slots in furnace door frame to allow for expansion

FIG. 2

One of the blacksmiths employed by the company said that he could straighten out the frames at a very low cost. This he very satisfactorily did by simply heating each frame to a dull red heat, then placing it on a flat, sheet iron surface and placing on top of the frame sufficient weight to slowly bend the casting and bring it down to a flat surface. When the frame had cooled, the weights were removed and the frame was flat and regular, so that it was an easy matter to make a tight joint between it and the steel boiler casing by the use of a thin asbestos gasket.

PREVENTION OF CRACKS IN FURNACE DOOR FRAMES

Funace-door frames are usually made of cast iron with no provision for expansion. The frame is attached to the brickwork or steel casing of the boiler setting in such a manner that the inner part of the iron around the opening is heated by radiation from the fire. This causes the inner part to expand. The outer part of the frame remains comparatively cool and does not expand anywhere near as much as the inner portion. Due to the difference in expansion, a tension stress is developed in the outer part of the door frame casting, which in a short time causes it to crack. This action can be prevented by simply casting slots in the frame, as shown in the sketch, Fig. 2. The slots alow the inner portion of the frame to expand without straining the outer portion of the frame.

New York. G. K.

Looking After Things

The Importance of Keeping Tools Sharp—How to Grind Reamers, Taps and Dies

BY JAMES FRANCIS

"I wish you would tell me, Mr. Francis, of some good way by which I can keep tools from getting dull, so that every time a job has to be done in a hurry I won't have to stop for fifteen minutes or half an hour and put tools in shape. Now, here's a case where this shell reamer is so dull that it took fifteen minutes to ream a hole which ought to have been done in three minutes. If there was only some way of keeping tools from geting into such condition it would help one boiler maker a whole lot, and I believe it would save money for all of them!"

"The tool never was made, Mr. Rider, which will not get dull and wear out, but there is a way whereby each and every tool in the shop will always be sharp, in first-class shape and ready for instant use, day or night."

"For goodness' sake, Mr. Francis, tell me about it quick! I have been looking for years for just such a method, and it will save me $3,000 a year to have it in my shop. How do you do it, and what will it cost to put it in?"

"It won't cost you a cent, Mr. Rider, and you can start the system in your shop inside of fifteen minutes without buying a thing extra. The whole system is: 'Never work with a dull tool, and never put a tool away which is dull, and always put each tool in its place the instant you have finished using it and it has been sharpened."

"Why, Mr. Francis, I can't do that! I can't sharpen taps, dies and reamers?"

"Since when, Mr. Rider? Other people sharpen them. Isn't your shop as good as anybody else's shop?"

"Yes, the shop is all right, but how do you grind taps, reamers and dies? I would have to buy a lot of expensive machinery for that work, and you said I wouldn't have to buy anything! 'Show me,' will you?"

"I saw a pretty good tool grinder in your shop, Mr. Rider. It stands there by the window, under the stairs. I have never seen the machine in use, but it is there, and you might as well do this work with that machine, when the work is needed; then you never will be troubled with dull reamers and taps."

"Oh! You mean that little machine with two or three small emery wheels and the light-moving carriage and slides? Yes, I know. We bought that machine at a sale for $20. Thought we could rig it to grind circular saws, but it's built so confounded light that we gave up the matter of saw grinding as a bad job. Guess they never use the machine except for grinding scratch-awls and compass points."

"Well, Mr. Rider, there's a $400 machine standing idle while your reamers are dull. That machine was made for grinding reamers, taps and similar tools, and here you are going hungry with breakfast all on the table! It sure looks, Mr. Rider, like a case where somebody doesn't know enough to eat!"

"I'll admit, Mr. Francis, that I didn't know that machine could do such work, and if you'll put me wise I will see that somebody gets after our tools and fixes them up."

"That's the talk, Mr. Rider, and now, while you are about it, just put in force a new rule that tools are to go to their places sharp, instead of just as they were turned in from the job! Then you will never have any more trouble with dull tools—not as long as you enforce the rule!"

"I must see if I can find a man who can learn to run that machine. I have got two or three men who have worked in a machine shop, and perhaps one of them will be wise to the grinder."

"Say, Mr. Rider, you have a seventeen-year-old boy giving out tools when he isn't running errands or skylarking. Now, why don't you put the tool grinder right in the tool room. There's good light there; then pick out a good man and put him in there with the tools and the grinder. Let him give out the tools and also let him sharpen each one which needs attention; then let him see to it that no tool goes back to its shelf without first being put in A-1 condition.

"Wouldn't that be a little expensive, Mr. Francis? We can't afford to keep a good man at the tool window all the time. The company never would stand for it!"

"Yes they will, Mr. Rider, and gladly, as soon as they know that the man is "Looking After Things" at the rate of saving about $6 a day in time for the other men!"

"How do you figure that out?"

"Why, by keeping the tools all sharp and ready for instant use he saves five minutes on each fifteen-minute job at tapping and reaming. He also will do all the machine work which comes along, for I would put the lathe and power hack saw right in the tool room, too, and let him handle all the work which comes along for those tools. Then, when you are crowded and want more work than he can do, why, just put another man in the tool room to help him out as long as the rush holds up on that particular machine!"

"I believe I will do that. The scheme looks good to me, and I ought to save some time and a lot of loafing thereby. I'm just going to try it out. But, Mr. Francis, it's mighty lucky we had that little tool grinder, isn't it? We would sure have had to buy one if it hadn't been on hand."

"No, Mr. Rider, you would not have been obliged to buy a tool grinder had this one not been on hand. You can do all the work in a lathe. That 10-inch by 6-foot one you have will do the work, but a regular tool grinder is far better for you now will not have to take the lathe off of other work, and I don't like to do grinding in a lathe, as the emery dust does raise hob with the lathe bearings and slides, in spite of all the precautions you can take. But you can do reamer sharpening in the lathe, nevertheless—if you have to!"

"But, Mr. Francis, I don't see how you are able to sharpen such tools at all. Just 'show me,' will you?"

"To be sure! Here is the whole thing shown by Fig. 1. The wheel is shown in part, and the grinding should always be done on the front portion of each tooth at *A*. The tooth becomes dull through wear of the sharp corner between *A* and *B*, but there is no appreciable wear to either *A* or *B*, except at the corner, as stated. The face *B* has been ground flat—they call this grinding operation 'relieving' the tooth, and it is done in such a careful manner and at such an angle that the grinding of face *A*, clear back to *C*, will reduce the diameter of the reamer only very slightly."

"Say, can a reamer be ground and used until it has worn clear back to *C*?"

"Yes, that can be done, but it will require a very long time to do it, for as long as a reamer is kept sharp and properly used it wears back along *B* very slowly indeed."

"A reamer don't wear faster when dull than when it is sharp, does it? I should think the sharper the corner of the cutting tooth, the faster it would wear off?"

"No, Mr. Rider, a reamer, when kept sharp, will remove a given amount of metal from the work with less wear than when the cutting edges are dull. But there is another thing to be considered in this connection, and that is, that a reamer is not apt to be used as much when dull as when sharp; consequently it does not do as much work from day to day, for the men won't use it if they can find any other way of doing the work. And here is a great big indirect loss to you through the reamer being dull. But with a dull reamer and a sharp reamer, used the same length of time upon similar work, the sharp tool will remove more metal with less wear and with much less power and time expenditure, than can possibly be accomplished with the dull reamer. This is an unanswerable argument in favor of sharp tools all the time, under all circumstances."

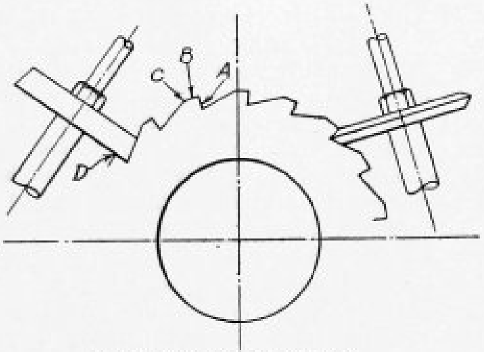


Fig. 1 Grinding a Reamer

"But, Mr. Francis, I don't seem to get the hang of how the grinding is done. How do they hold the reamer, and how is the wheel mounted?"

"The wheel is to be mounted upon a mandrel, right between the centers of the grinding machine, or between the lathe centers if that tool is to be used instead of a grinding machine. Then put the reamer between centers, or upon a mandrel, if it be a shell reamer, and arrange the reamer or mandrel upon another pair of centers at right angles to the emery wheel centers."

"But where am I to get these extra centers?"

"There is a pair of centers for this purpose, with the little grinding machine. You will find that they will fit upon the table of the machine and that the table can be raised, lowered, swung around to any angle and otherwise adjusted as required for any kind of grinding work you can think of. But if you have to do the grinding in the lathe, then you must rig up a pair of extra centers and fasten to the carriage of the lathe—to the slide rest, in fact—and, after removing the tool post, and perhaps the tool carrier, you may have to rig a slide to which the centers may be attached at the exact height required for the diameter of reamer to be ground."

"I should think the grinder would be much handier than the lathe for this work."

"It is, Mr. Rider. You can't mention both machines in the same breath as far as convenience is required, and the work can be done on the grinder in half the time required to rig up for the work in a lathe. But, all the same, you can grind reamers in almost any lathe, and grind them well, too—and once you have made up jigs and attachments for grinding reamers in a lathe, you can then turn them out pretty fast."

"But what kind of wheels are required for grinding reamers? I should think that any wheels we have in the boiler shop would grind a reamer all to pieces before sharpening it."

"That's about so, Mr. Rider. If you tried to grind a reamer upon the shop emery wheel it sure would appear as though it had been 'hammered out between thunder and a rock,' but look around that little grinding machine and you will find several little carborundum wheels three or four inches in diameter and from an eighth to a quarter of an inch thick—those are the wheels you require for sharpening reamers and taps."

"What! Those little runts? Why, I supposed those were some old wheels which had been discarded and thrown in with the machine. Are those wheels any good for sharpening reamers?"

"They are just the wheels required, Mr. Rider, and should you buy new wheels for use in a lathe you would get just the same kind of wheels for that purpose also."

"Well, I declare! That's one on me. Why, I had half a dozen minds to tell Bob to throw out those little wheels and clean out the place around that machine."

"It's well that you did not, Mr. Rider. Those wheels are first class. Hunt in the box of fittings which came with the machine and you will find a hand tool there with a little diamond set in the end of the tool. With this you can shape up the emery wheels and make them flat on the face and truly round, so they will run perfectly true. And you can do the same with the shop wheels also, and there is money to be made and saved right there in "Taking Care of Things" at that end of the business."

"But how is a small wheel like one of those with the machine set to do the reamer sharpening?"

"You can use several shapes of wheel for that purpose. One shape of wheel is shown at *D*, and another shape is shown opposite. Each shape is the better for some things, and each has its own peculiar drawbacks, and after you get into the work of grinding reamers you will pick out the wheel which best suits your particular work."

"What is the difference in the work done by the two wheels?

"Why, wheel *D* cuts on its side close to the edge, and as the wheel wears off a little and becomes rounding near its edge it will cause the edges of the reamer teeth to appear a trifle rounded instead of being straight out, as they should be. This will prevent the reamer teeth from cutting as well as if they were perfectly straight and flat. This makes it necessary to dress flat a portion of the side of the wheel, and after a while the dressed portion becomes too thin to support itself, breaks off, and there is a whole lot of wheel wasted."

"But how does the other wheel work? What is the matter with this shape which seems a sort of pointed wheel?"

"That wheel cuts well and always leaves the reamer tooth sharp and square. The great trouble with a wheel of this section is that the sharp point of the wheel does wear off very fast, making necessary very frequent dressing of the wheel to keep it in shape. But when the size of the reamer makes it possible to keep the point rounded a little, instead of sharp, and a corresponding fillet can be tolerated in the bottom of the reamer tooth, then this shape of tool is ideal and works very well indeed. But the wheel should be so thin that the side of the wheel does not reach up over the cutting joint of the reamer tooth."

"Oh, Mr. Francis, have you got time to tell me how they grind taps? Some of ours are awful dull and take a good deal of 'elbow grease' to do the work with them."

"Sure, Mr. Rider. I can tell you that story in a very few minutes, for if you once get rigged up for grinding reamers you can grind taps in the same way, and you won't know the difference with your eyes shut. Just rig the taps between centers exactly the same as you did with the reamers, and then grind off the front portion of the cutting lip or edge, same as with the reamers. In fact, a tap is nothing more than a reamer. It works in exactly the same manner, has the same shapes of cutting teeth, except a screw has been cut on the reamer after the cutting edges were shaped—or perhaps afterward—but the action of a tap and a reamer is the same as far as cutting is concerned, and they may be sharpened in exactly the same manner and with the same emery or carborundum wheel."

"Sharpen dies, did I hear you say? Sure! Sharpen them with a wheel, too. But, instead of putting dies between centers, just hold them in the hand and grind off the front of the cutting face in exactly the same manner as for reamers, and the dies are sharpened in less than two minutes each. And almost any emery wheel which runs true will answer for sharpening thread dies."

Layout of 90-Degree Elbow

The elbow, as shown in Fig. 1, is composed of three inside and three outside sections joined together by lap joints. In developing or laying out such an elbow it is necessary to lay out the development of one inside section and one outside section, as at *A* and *B*, respectively. The method of procedure is identical in each case, however, and is that commonly followed in laying out the form of any true cylindrical surface.

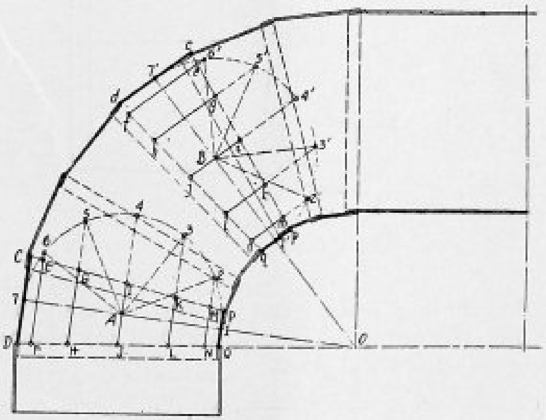


Fig. 1.—90-Degree Elbow

Referring to Fig. 1, *O*-7 and *O*-7' are drawn through *A* and *B*, respectively, *A* and *B* being the center points (neglecting the flange for the lap) of the sections under discussion. Then 1-7 and 1'-7' are the neutral diameters of these sections, and on these diameters semi-circles are constructed and divided into an equal number of parts, in this case six, by points 1, 2, 3, etc., and 1', 2', 3', etc. Through these points of division lines are drawn perdendicular to lines 1-7 and 1'-7', respectively. These cut the edges of the plates, neglecting the flange, forming *C-D*, *E-F*, *G-H*, etc., and *c-d*, *e-f*, *g-b*, etc., which are known as elements of the cylindrical surface.

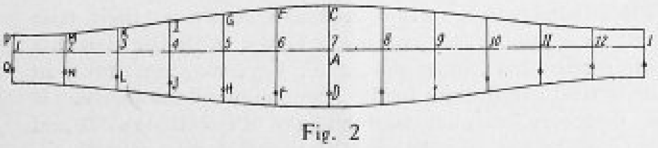


Fig. 2

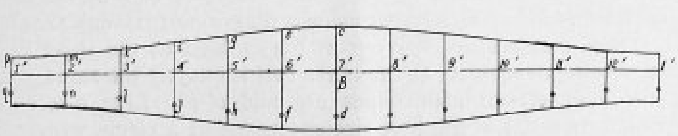


Fig. 3

In Fig. 2, 1-1 is laid off equal in length to the circumference of a circle with diameter equal to 1-7, Fig. 1. The line 1-1 is divided into twelve equal parts by points 1, 2, 3, etc., and perpendiculars erected, on which points *P*, *Q*, *M*, *N*, etc., are located by simply transferring their distances from line 1-7, in Fig. 1, to Fig. 2. These operations are clearly seen by following the numbers and letters that correspond in Figs. 1 and 2. The flange width, which is constant, is then laid off from points *Q*, *N*, *L*, *J*, etc,. Fig. 2, and the points so located joined by a continuous line to form the bottom edge of the developed section.

The same method is followed in laying out the section at *B*, Fig. 1. A comparison of Figs. 2 and 3 shows that *A* and *B* agree very closely, but that there is a slight difference. This is due to the fact that the two sections have different neutral diameters, the difference being the thickness of the material, and, since 1-1, Fig. 2, is equal to the circumference of a circle with diameter equal to 1-7, Fig. 1, and 1'-1', Fig. 3, is equal to the circumference of a circle with diameter equal to 1'-7', Fig. 1. Also, since 1'-7', Fig. 1, is slightly greater than 1-7, then 1'-1', Fig. 3, is slightly greater than 1-1, Fig. 2.

What Bessemer and Mushet Contributed to the Steel Industry

In order to explain Sir Henry Bessemer's great invention and the revolution which it brought about, it is necessary to refer to the position of the manufacture of iron and that of steel immediately before its discovery.

In 1855, when Bessemer's first patent was taken out, there was a cear distinction between iron and steel. Iron was made in the blast furnace and remelted in the cupola for castings, or treated in the puddling furnace, the forge and the mill for making rails, bars, plates, and all kinds of malleable iron products. Steel was made by the cementation process, bars of very pure iron being impregnated with carbon by heating in charcoal. Steel was iron of great purity, containing from half percent to two percent of carbon, which would harden when heated and quenched. Since Bessemer's invention the name of steel has been given to the product of the converter and the open hearth furnace; it may contain any degree of carbon and does not necessarily harden after being heated and quenched.

Bessemer's discovery arose out of his endeavor to find a stronger material than cast iron for making cannon, as the French Emperor, Louis Napoleon, was seeking a material to make better artillery than was then in use. Bessemer wanted a material as hard and rigid as cast iron and as tough as malleable iron. But the quantity of heat requisite for melting malleable iron is so great that up to this time it had been found impossible to liquefy more than a few pounds at a time. Now, the difference between the composition of cast iron and that of malleable iron is that the former contains much more carbon, silicon, phosphorus and manganese than the latter, and it is the elimination of the excess of these substances from cast iron which converts it into malleable iron. In the puddling furnace this is done slowly by oxidation, but Bessemer conceived the idea of doing it rapidly by blowing air into or through the molten pig iron, and causing rapid oxidation of the metalloids.

He succeeded in producing malleable iron in this way, but it was soon found that although sufficient of the carbon, silicon and manganese was removed the greater portion of the phosphorus was left in the iron and rendered it practically valueless. This difficulty, which could not be overcome, confined the process to iron containing very small quantities of phosphorus. No such iron had hitherto been made, but by using the pure ores of Cumberland and North Lancashire and by importing similar ores from Bilbao an iron was produced from which steel was made by blowing air through it in a molten state.

But Bessemer set out to produce an iron low in carbon. The article he had produced was steel with five percent or more of carbon, and when he tried to remove this carbon he found that he had some of the iron oxidized, which spoiled the metal. There is not much doubt that if the process had stopped at this point Bessemer's great invention would have been almost a failure, but at this juncture R. F. Mushet, seeing that, as it stood, the process could not succeed, tried the use of manganese in the form of Spiegeleisen after all the carbon was burnt out for the purpose of recarbonizing the charge. This succeeded, and the result was that, by the use of Spiegeleisen and subsequently a ferro manganese, steel was obtained containing any required percentage of carbon. The product was called mild or soft steel because it was impossible to describe one cast as steel and another as iron from the same furnace when the only difference between them was a fraction of one percent of carbon.

The object which Bessemer had set out to attain was now, by the aid of Mushet's patent, completely accomplished, and the result was a great change in the manufacture of iron and steel. The product of the Bessemer converter was of so much better quality, stronger, more homogeneous, more uniform and quite free from slag, and was also obtained at a less cost, in less time and in larger quantity than the product of the puddling furnace that it quickly superseded the latter in all the heavy trades. First the rail trade, then the plate trade for shipbuilding and boilers, and the bar, angle and girder trades succumbed to the new process and the manufacture of malleable iron declined to the position which it now occupies. —*Ryerson's Monthly Journal.*

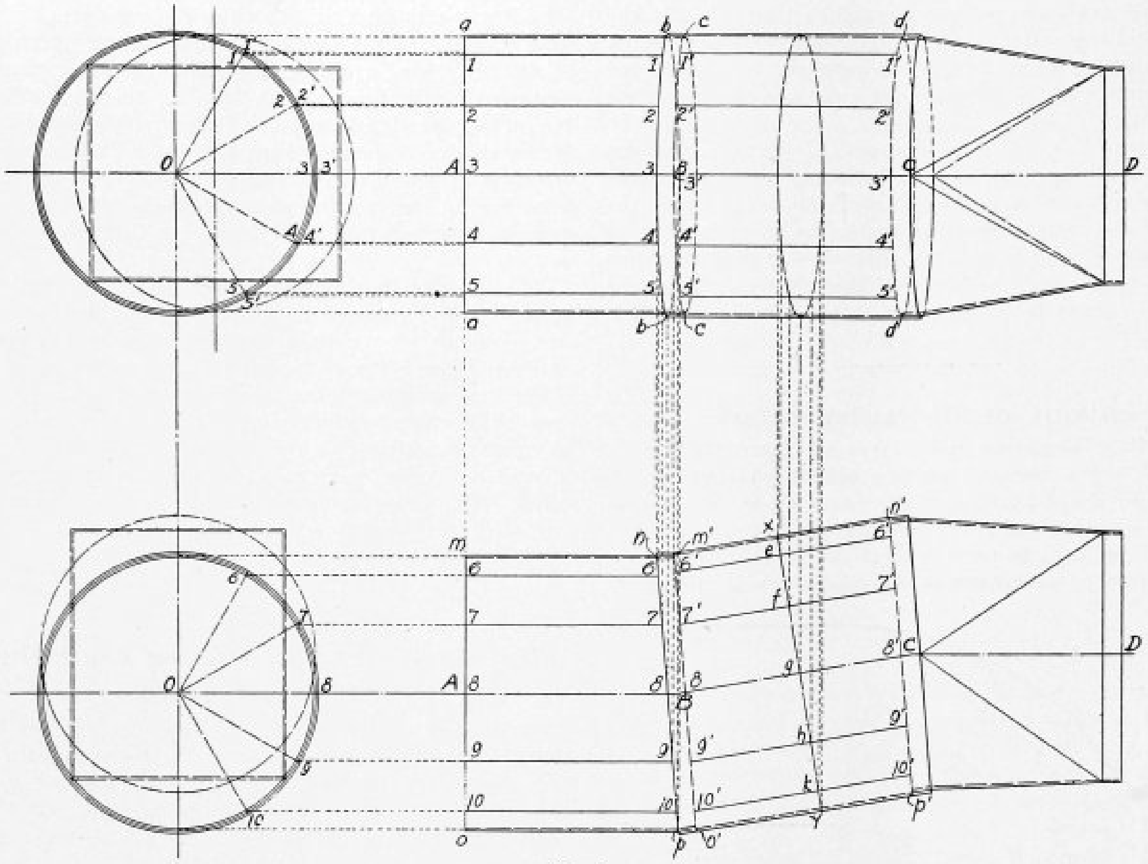


Fig. 1

A Complicated Pipe Layout

The pipe, as shown in Fig. 1, consists of an inside and an outside section, both of cylindrical form, with center lines at an oblique angle to each other, and a section, *C-D*, having one base elliptical and the other rectangular. For the cylindrical section *A-B* the circumference of the neutral surface is divided into, say, twelve equal parts by points 1, 2, 3, etc., which are projected over to give lines 1-1, 2-2, 3-3, etc., called elements of the neutral surface. The elements for section *A-B* are shown in their true lengths in both upper and lower views, while the elements for section *B-C*, lines 1'-1', 2'-2', 3'-3', etc., are shown in their true length only in the lower view of the figure. It is, therefore, a simple matter to lay out sections *A-B* and *B-C*, since the true lengths of the elements can be obtained directly; i. e., without using a diagram of triangles.

These sections are laid out in Fig. 2, half of the sheet only being developed, as the other half is exactly the same, only symmetrical about lines *o-p* and *o'-p'*. Line *o-m*, Fig. 2, is equal to the half circumference of a circle with diameter equal to *o-m*, Fig. 1, and *x-y*, Fig. 2, equals half

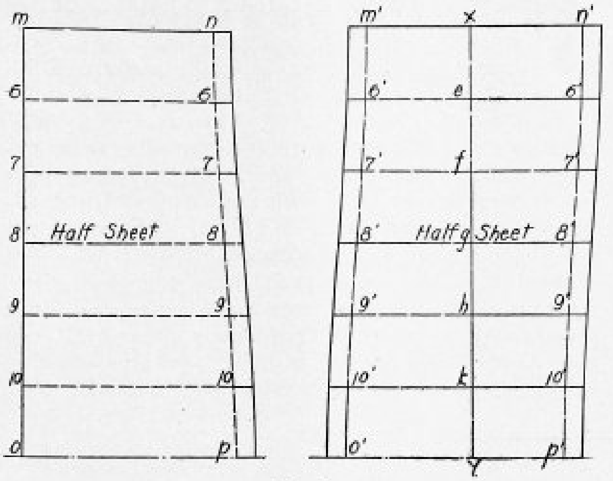


Fig. 2

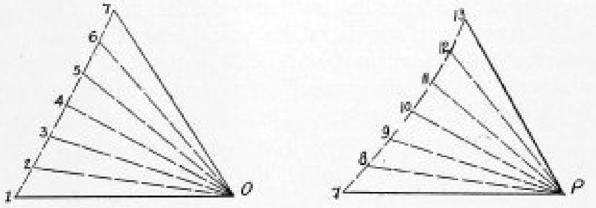


Fig. 5

the circumference of a circle with x-y, Fig. 1, as diameter. Line x-y, Fig. 1, is drawn through any point in section *B-C*, perpendicular to the axis *B-C*. Both o-m and x-y, Fig. 2, are divided into six parts, since the circles were divided into twelve parts, and perpendiculars drawn through the points of division in order to lay out the elements, which are laid out as shown by m-n, 6-6, 7-7, etc., and m'-x' x-n'; $6'$-e, e-$6'$; $7'$-f, f-$7'$, etc. Connecting these points, the outline of the plate is obtained and the width of the flange added to give the actual full outline.

Next it becomes necessary to lay out section *C-D*, using neutral surfaces only, as shown by Fig. 3. This section is formed of four triangles connected by four conical corners. The end view of 1-13 is not a circle, but is slightly elliptical, and is divided for convenience into twenty-four *equal* parts by points 1, 2, 3, 4, etc., which are projected over to the other views and joined to points *S, T, O, P,* forming elements of the conical surfaces.

To lay out the triangles, lay off, as in Fig. 4, the flange *S-T, O-P, S-T* and *O-P,* with mid-points *M, N, M* and *N,* respectively. Beginning to the left, lay off *M*-1 equal to *O*-1, Fig. 3; *N*-7 equal to *S*-7 or *T*-7, Fig. 3; *M*-13 equal to *P*-13, Fig. 3, and *N*-7 equal to *N*-7, Fig. 4, or *S*-7 and *T*-7, Fig. 3. Joining these, as shown in Fig. 4, we obtain the layout of the triangular pieces and flanges.

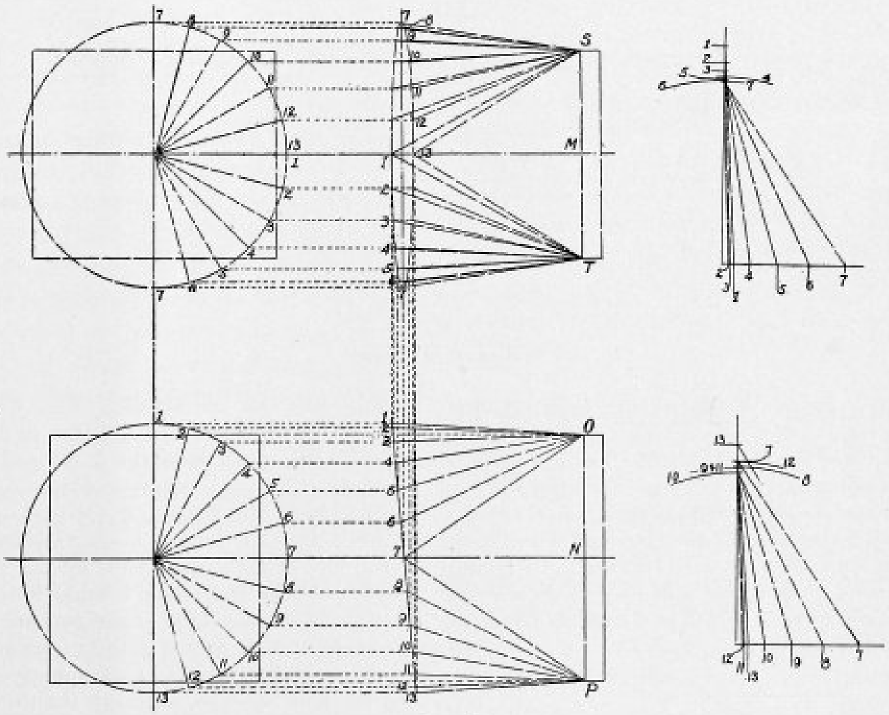


Fig. 3

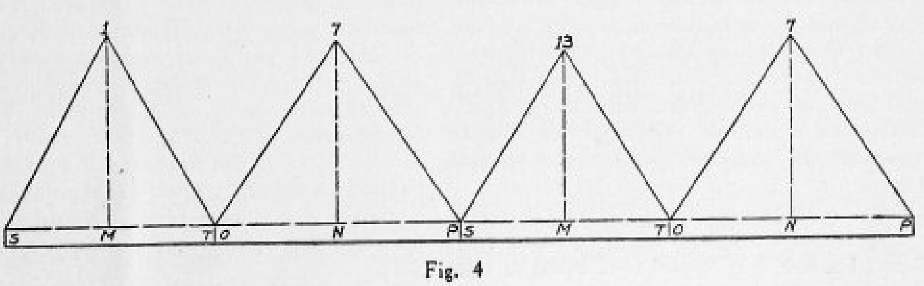


Fig. 4

Thus far we have had no need of a diagram of triangles, as all lines were shown in their true length in one or another view. Now, in the conical corners of section *C-D* we must use the diagram of triangles or some equivalent method of obtaining the true lengths of the elements. This is done in each case by laying off on a base line the deflection of the extremities of each element, points 1, 2, 3, etc., from the horizontal; for instance, the distance of each point, 1, 2, 3—7 from the horizontal line through *O* and the distance of each point, 7, 8, 9—13 from the horizontal line through *P* is laid off as shown on the upper and lower diagram of triangles, respectively. The altitudes for the triangles are obtained by measuring *T*-1, *T*-2, *T*-3—*T*-7 for the upper diagram, and *S*-7, *S*-8, *S*-9—*S*-13 for the lower diagram. The hypotenuse in each case then is the true length of the elements, and beginning with 1-1 it is laid off as *O*-1 in Fig. 5; then proceeding as by triangulation, *O*-2 equals 2-2, and 1-2 equals 1-2, and is the equal division of the base in Fig. 3.

Continuing this process of triangulation, we obtain *O*-1-7 and *P*-7-13 as the corner pieces, there being two of each exactly alike, only oppositely formed or bent. In laying out the conical corners, the flange was neglected, but can easily be added, as a strip of constant flange width from points 1, 2, 3, etc., and 7, 8, 9, etc.

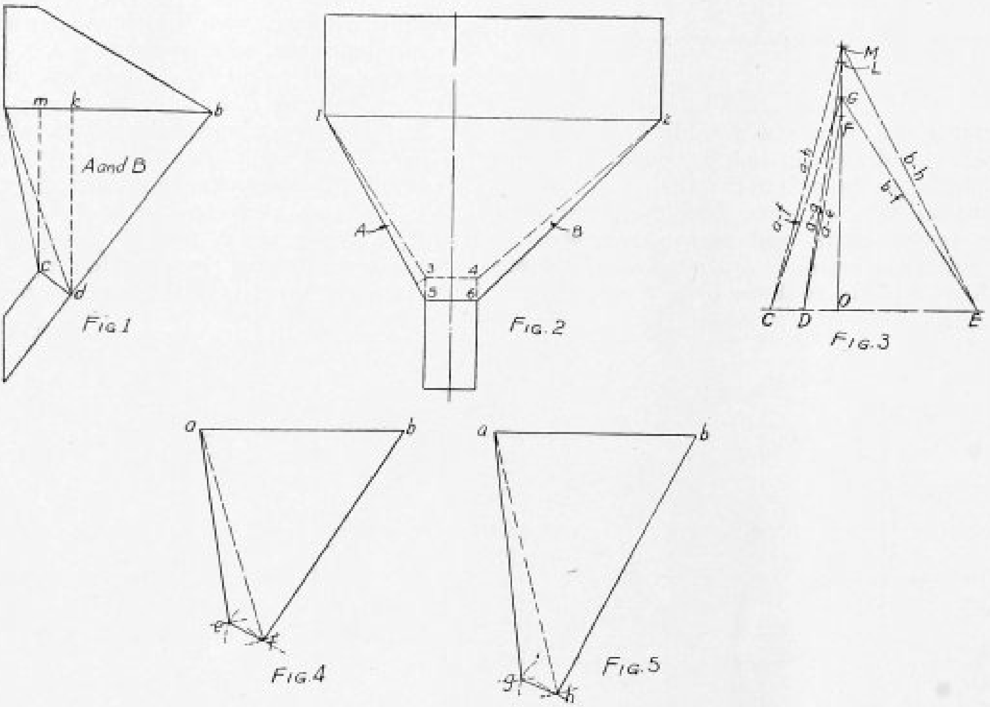
Development of Side Sheets in Hopper

In developing the side sheets of the hopper shown in Figs. 1 and 2, as *A* and *B*, it is only necessary to find the true length of the four edges and one diagonal of each sheet and construct a quadrilateral or four-sided figure, as the developed form of each sheet, with sides equal respectively to the true length of the edges as found. This presents probably the simplest form of the system of triangulation.

In Fig. 1, to find the lengths of lines *b-d* and *a-d*, lay off *O-E* in the diagram of triangle, Fig. 3, equal to *b-k*, Fig. 1, line *O-C* equal to *a-k*, Fig. 1, and *O-G* equal to 1-5, Fig. 2. Then with *E-G* and *C-G* as radii draw arcs about *b* and *a* respectively, Fig. 4, intersecting at *f*. Then *b-f* is the true length and position in the pattern of *b-d* in Fig. 1 and *a-f* is the true length and position of *a-d*.

Then lay off *O-D*, Fig. 3, equal to *a-m*, Fig. 1, and *O-F* equal to 1-3, Fig. 2, and with *D-F* as radius draw an arc about point *a*, Fig. 4, as center. About *f* draw an arc, intersecting this arc at *e*, with radius equal to *c-d*, as *c-d* appears in its true length in Fig. 1. Connecting points *a-e-f-b*, Fig. 4, we have the pattern of sheet A.

Sheet B is laid out in exactly the same way. In the diagram of triangles the same bases correspond for both sheets, while for sheet B, *O-M* equals 2-6 and *O-L* equals 2-4. With *E-M* and *C-M* as radii draw arcs about point *b*, Fig. 5, as center, intersecting at *h* and with *D-L* as radius draw an arc about *a*, Fig. 5, intersecting an arc drawn about *h*, with *c-d* as radius, in point *g*. Connecting *a-g-h-b*, Fig. 5, we have the developed form of sheet B.



Layout of Hopper

THE NEW BALTIMORE & OHIO LOCOMOTIVE.—What is claimed to be the largest non-articulated locomotive in the world has recently been built by the Baldwin Locomotive Works for the Baltimore & Ohio Railroad. The locomotive has a total weight of 406,000 pounds and develops a tractive effort of 84,500 pounds, which is greater than that of many Mallet articulated locomotives. The boiler is of the straight top type, although the third ring in the barrel is tapered with the slope on the bottom of the barrel. The firebox is fitted with a 28-inch combustion chamber, the tubes being 23 feet long. The firebox is also fitted with a Security sectional arch and a Street mechanical stoker. A Schmidt superheater, composed of forty-eight elements, is also fitted. The boiler is designed for a working pressure of 200 pounds per square inch. The heating surface of the tubes is 5,215 square feet; of the water tubes 35 square feet; of the firebox 258 square feet; of the combustion chamber 65 square feet; making the total heating surface 5,573 square feet. The superheater heating surface is 1,329 square feet and the grate area is 88 square feet.

The Boiler Maker

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Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE widespread consideration that is now being given to the question of uniform boiler construction is an encouraging sign. Although hitherto it has been difficult to secure legislation covering boiler rules and regulations, nevertheless, now that the work of the pioneers in this direction is producing beneficial results, further progress should be much more rapid and certain. Just as soon as the various classes of men whose money and energies are devoted to the building and maintenance of steam boilers began to realize that at no very distant date their work would in all probability have to conform to recognized standards, the enforcement of which would be required by law, they began to take a lively interest in the formation of that standard. Boiler makers, boiler inspectors, engineers, insurance men and steam users were heard from. Ample opportunity was given to anyone who had any suggestions or criticisms to make to present his views, and the outcome of the various conferences that have been held and of the public hearing that is now on the eve of maturing for consideration of the standard proposed by the American Society of Mechanical Engineers should be the establishment of a common basis which can be adopted in future boiler legislation. With such a basis to work from a long step will have been taken towards unifomity in boiler construction in the United States.

IT is fitting to acknowledge that the pioneer work in the movement for uniform boiler construction in the United States was performed by the boiler manufacturers who, on April 16, 1889, at the call of the late Mr. James Lappan, met in Pittsburg to form the American Boiler Manufacturers' Association. The object of this association, as expressed in the constitution adopted at its first convention, was 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 making the manufacture, sale or use of inferior materials criminal offenses. An outline of the work accomplished by the association in this direction is given in a circular letter sent out a few months ago by Col. E. D. Meier, then president of the association. The first matter that engaged the attention of the association was the question of specifications for boiler steel, and before the end of the first year of the association's existence a set of specifications was adopted whose requirements were met satisfactorily by the steel makers. Following this various committees were appointed to take up details of construction, and after nine years of preparatory work a set of uniform American boiler specifications was adopted which has since been widely used throughout this and foreign countries. Meanwhile committees on uniform boiler laws made a vigorous onslaught in the legislatures in various States in an endeavor to secure adequate legislation covering boiler construction. These attempts met with little success, however, largely on account of the opposition of small sawmill and oil-well boiler owners, and so the association confined its efforts to a campaign of education to stimulate the gradually increasing sentiment throughout the country in favor of uniform boiler construction of the highest standard. Out of this grew the Massachusetts boiler rules, followed soon after by those of Ohio and other States, all of which marks but the beginning of a new era of development towards uniformity in American boiler practice.

At the boiler manufacturers' convention just held this month, committee reports on uniform boiler laws and specifications were read and discussed and a number of men prominently identified with the movement for uniform standards addressed the convention. Although no definite action was taken by the association in this matter, other than to endorse certain recommendations for changes in the standard proposed by the American Society of Mechanical Engineers, there was, nevertheless, a good deal of interesting and valuable information brought out in the discussion from the standpoint of practical boiler makers. As a rule boiler manufacturers are willing to meet any advances for more stringent regulations that may be offered, provided they are in accordance with the requirements that years of experience have shown are feasible and desirable. It is to be regretted, however, that a greater number of the members of the association did not attend the convention, as a movement which is of such importance should have the careful consideration of the manufacturers in all parts of the country.

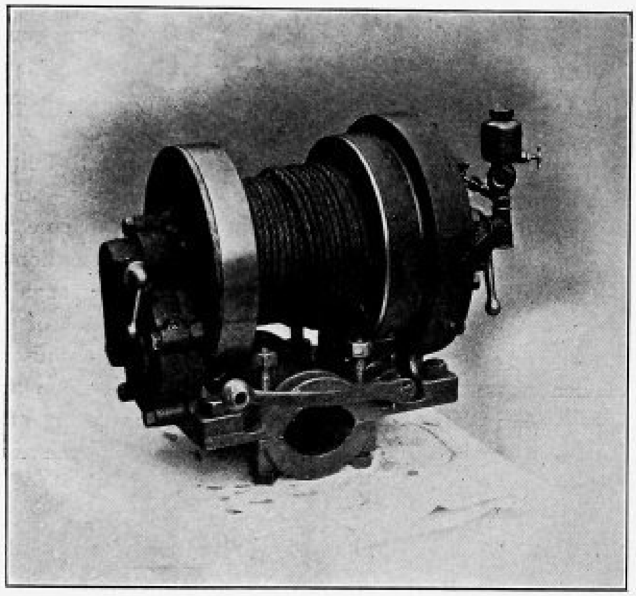
Engineering Specialties for Boiler Makers

A Handy Hoist Operated by Steam or Compressed Air—Fusible Plugs —A Suction Lubricator—Mechanical Device for Directing Firemen

The "Little Tugger" Hoist

A new type of hoist intended for light lifting work, having a capacity up to half a ton, has recently been placed on the market by the Ingersoll-Rand Company, New York. Due to its light weight, which is under 300 pounds complete, it is particularly suitable for use as a portable hoist for mines, for contract work, for manufacturing plants, for power houses and in railroad shops and shipyards, where it can be put to innumerable uses.

The main base of the hoist is arranged so that it can be bolted to a timber, and by means of a cap which comes with the hoist it can be clamped to a circular member, as a column or arm, shaft, bar or pipe. The adjustment can be made quickly. The dimensions of the hoist are 21¼ inches by 16½ inches, and the height is 20⅛ inches. The drum is 6 inches in diameter, with a space of 7 inches between flanges. This will accommodate a length of 700 feet of ¼-inch rope or 450 feet of 5/16-inch rope. The capacity is 1,000 pounds at a rope speed of 85 feet per minute and a pressure of 80 pounds. It operates with either compressed air or steam.



Ingersoll-Rand Hoist

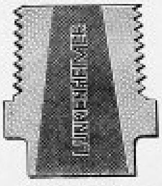
The motor or engine is of the reversible, square-piston type, giving four impulses per revolution of the engine. There are no dead centers and it is claimed that the "Little Tugger" will start in any position. The drum is mounted independent of the engine shaft and is operated through the medium of a clutch and gears. Safety is provided for by a powerful worm-operated band brake lined with "Raybestos."

Referring to the illustration, which shows a front view of the "Little Tugger" hoist, the engine is on the right-hand side, the gear case is on the left-hand side, and between the two are the brake and drum. The lever on the left controls the gears and clutch, the one on the right hand controls the direction of operation, and the bottom lever operates the brake. The speed of hoisting is entirely at the will of the operator. When he releases the throttle it returns automatically to central position, shutting off the power and stopping the hoist. Oftentimes the hoist will be used for haulage purposes, and the release feature enables one man to handle this class of work. He can leave the control lever and carry the rope to the car. Hoists without this feature require two men, inasmuch as the rope has to be released under power.

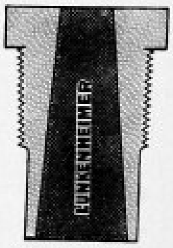
There are no moving parts exposed on the "Little Tugger" except the drum, all gears and shafts being covered. This is an especially desirable feature for operation in confined quarters where the light is none too good and where there is constant danger of workmen's clothes or bodies getting caught in machinery.

Lunkenheimer Fusible Plugs

During the latter part of July, 1914, the Department of Commerce, Steamboat Inspection Service, Washington, D. C., by means of a circular letter dated July 30, 1914, File No. 1234, published a set of rules governing the construction of fusible plugs, these rules having become effective June 25, 1914. The Lunkenheimer Company recently designed the two patterns as illustrated to comply with these rules, and they were accepted by the office of the Supervising Inspector General on August 3, 1914.



Inside Pattern



Outside Pattern

Both the inside and outside patterns are made in sizes ⅜-inch to 1½ inches, inclusive. The ½-inch size and larger also comply with the boiler laws of the States of Indiana, Ohio, Massachusetts and Wisconsin. The outside pattern, in sizes ¾-inch and 1 inch, can be had in two sizes as regards the diameter of the threads, one size being slightly larger in diameter than the standard ¾-inch and 1-inch size of pipe thread, and the other still larger. The object of these two off-size diameter threaded plugs is to accommodate incorrectly tapped or retapped holes.

A Suction Lubricator

A new and novel lubricator, made in three sizes for ¾-inch, 1-inch and 1½-inch pipe connections, for use particularly on devices operated by compressed air, has just been placed on the market by the Vulcan Engineering Sales Company, Chicago, Ill.

The principle involved is one of suction. A chamber containing an absorbent is kept saturated from another large oil storage chamber surrounding it. Air passing through the lubricator becomes sufficiently charged with oil to properly lubricate all surfaces with which it subsequently comes in contact.

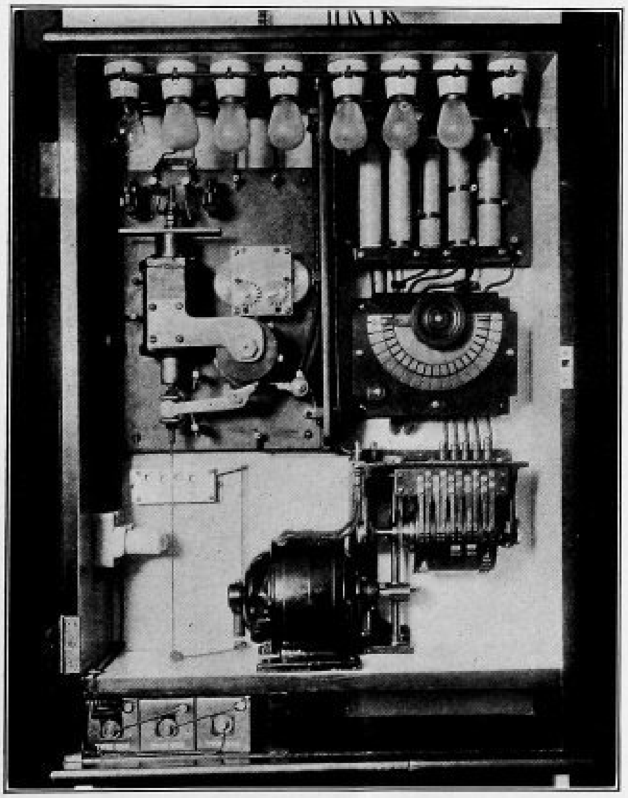
This device is entirely automatic, because suction action takes place the instant the air moves and ceases the instant the air is shut off and the take up of oil is very moderate, though continuous when air is being used. It can be attached to the air line in any position and operate in any plane or at any angle, and can be filled no matter what position it is in. It is therefore universal and foolproof.

Hanna Suction Lubricator

It is claimed the suction lubricator will prolong the life of pneumatic equipment and greatly conserve the amount of lubricant used, thereby increasing efficiency and reducing maintenance costs.

Mechanically Directed Firemen

The problem of eliminating all regulations requiring the exercise of reason or judgment and mechanically directing ignorant firemen has been solved by the Bonner Automatic Timer, an electrically actuated mechanism designated to produce in definite succession and at predetermined intervals a continuity of impulse which may be utilized for signaling purposes. This apparatus is manufactured and sold by the Merchant Engineers' Corporation, New York. The signaling is accomplished by the flashing of numbered lights or ringing gongs, or both, for the purpose of indicating the periods at which certain duties shall be performed.



Automatic Timer for Firemen

The apparatus consists essentially of four parts, or units: First, a selecting switch or rotating lever type with external knob handle and indicator and internal roving bridge, through which connection is made across the different series of contact points; second, a frequency drum operated through a high to low reduction gear train by direct current motor; third, a sequence drum constantly maintained by a compound spring motor in a condition of carefully calculated torque, this in turn being regulated and controlled by an escapement lever operated by solenoid energized by intermittent impulse from the frequency drum; fourth, the field indicators, consisting of lamp signals, gongs, semaphores or other electrically actuated mechanical apparatus arranged singly or in groups, as may be required.

When used as a signaling device, as, for instance, in directing the operation of a boiler plant, having determined by test or otherwise the frequency with which the furnace should be fired in order to produce the requisite amount of steam, the engineer can indicate his requirements by setting the index of the "selecting switch" at the point corresponding to such frequency, the apparatus automatically producing the proper signals at a nearby or distant point.

On the dial plate of the "selecting switch" of this timer there is a series of numbered registrations at which points the index may be set to secure the different indications, which vary in periodic frequency from forty-five seconds to ten minutes.

It may be noted also that this timer is fitted with a tally mechanism by means of which the engineer can easily determine the exact amount of coal or other commodity consumed or handled during a given period.

Personal

D. W. Phillips, formerly employed by the Atlantic Refining Company, Philadelphia, as a layerout, has accepted the position of general foreman for the R. D. Cole Manufacturing Company, Newnan, Ga.

Obituary

E. J. Hennessy, formerly foreman boiler maker of the New York Central shops at Depew, N. Y., and an honorary member of the Master Boiler Makers' Association, died August 9, 1914. Mr. Hennessy had been in ill-health for several years, as a result of which he was compelled to give up active duty, but he is remembered as having, during the days of his good health, been a valued and conscientious member of the Master Boiler Makers' Association.

Theodore G. Meier, treasurer of the Heine Safety Boiler Company, died August 16. Mr. Meier was born in Bremen, Germany, March 17, 1836. A year later his parents came to America, settling in St. Louis, where his father established a hardware and cutlery business. Mr. Meier received his education in Germany and at the St. Louis University, after which he entered his father's business and soon became a partner in the firm. During the Civil War he served in the 13th Regiment of Missouri, attaining the rank of major. For the last twenty-five years he has been vice-president and treasurer of the Heine Safety Boiler Company, where his financial ability and careful economy were instrumental in bringing about the remarkable growth of the business of the company.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Safe Boiler Supports

The article on "Safe Boiler Supports" in the August issue of The Boiler Maker is a very timely one. Boiler manufacturers have not given this feature sufficient attention, and usually equip 60-inch to 72-inch stationary boilers with four single side lugs for supporting the boiler and contents in the masonry. The use of a steel gallows frame for suspending the boiler independently of the side walls is not general, although it is required by the boiler laws of a few States. This places additional expense upon the boiler user, and it is not likely that its use will be recommended by the boiler manufacturer unless his advice is asked for.

Where side lugs are used upon a boiler it is much better and safer to supply it with four pair of lugs, in groups of two; this can be done at small additional expense and gives double the usual bearing surface upon the brick setting. The importance of a stable support is greatest at the furnace end of the setting, as wasting away of the brickwork at this point is liable to come about before the fireman notices it and cause the boiler to settle; this may cause the sediment to settle on the fire sheet and consequent "bagging," or, possibly, strain and break the steampipe connection and start an explosion.

Conditions at the rear of the boiler shell are not so severe upon the supports. If lugs are used in pairs and care taken with them in bricking in the wall, this method of supporting is safe and very satisfactory.

Bearing lugs should be supplied with plates of good size, and those at the rear end of the boiler fitted with rollers to allow for expansion. The lugs should not be buried in the brick setting, as is the usual practice, but covered with an iron frame with a loose cover arranged so that it can be examined at any time, and besides this has the advantage that the walls do not have to be torn down to expose lugs.

Greater care should be given to the bricking of boilers, especially where the brick comes in contact with boiler at or near the center of the shell, side lugs and rear head; the use of mineral wool at these points and about the rivets will reduce the number of cracks that usually come in a setting. Boilers are too often left altogether in the hands of masons to install, and they do the work as their fathers did before them. Boilers are being built better than ever before; why not install them better?

Clarksburg, W. Va. W. B. Osborn.

Free Trial Boiler Tools

Why it is that so many boiler makers hesitate before trying out new tools is not clearly understood by the tool maker. A new time-saving tool that combines safety with speed is a thing that every boiler maker should seek. He should not make the tool maker ferret him out, yet that is exactly what the tool maker usually is compelled to do.

Tools, nowadays, are guaranteed for periods of time sufficiently long for a good tryout. The boiler maker can therefore make the best possible selection at practically no cost for selecting. He simply writes to the tool manufacturer and says: "Please send me a ——— tool for doing ——— work on your —— day free trial basis. I understand that if I am not well satisfied with your tools I may return them at the end of that time at your expense, and the total cost to me will be nothing."

Modern tool makers are accepting letters like this from responsible boiler makers every day and are sending the tools for a free tryout. It shows that manufacturers are honest and that they trust the boiler maker. It is just another wave of the truth-is-the-best-policy idea in business.

I therefore hold that any boiler maker who sits back and does not take advantage of the liberal offers of these tool makers is not strictly "up to snuff." A poor out-of-date tool is equivalent to a dull woodman's axe Efficiency is the modern watchword in every field and it is a good one.

To be sure, there are some manufacturers who do not care to buy small tools on a trial basis because they say "It's small business." They prefer to investigate a little first and then pay cash on delivery. Or, they pay at the end of every month in the regular clock-like sequence of events. However, that is a matter that is "up to the boiler maker." If he wants to pay cash, very well. If he doesn't want to pay cash, he needn't.

The tool maker has made his proposition. It is worth looking into and accepting if you have no new tools.

N. G. Near.

Heating Rivets

Reading the article, "How to Heat Rivets Satisfactorily," by J. F. Bradbury, which appeared in the July issue of The Boiler Maker, brought to my mind the days when I was heating rivets. It was on the steamer *Peerless*, building in the Niagara Dock Yard at Niagara, Canada, in 1852, that the writer started as a heater. At that time there were no fans in use and bellows were used on nearly all fires. I started by blowing with the bellows for one heater, but on the third day this heater was given another fire and I took his place with a green boy to blow for me. We were heating for three gangs, and sometimes had three different lengths in the fire, making nine rivets in the fire at once. The heater did not run with the rivets, but threw them to the different holders-on, and they put them in the holes. Before that first day was over I was sorry that I had ever learned the trade, not that I was like Mr. Bradbury, I had had three days at it and kept close watch to see how the other fellow did it—how he fixed the rivets in the fire and the fire itself. But the different gangs were racing; each gang was driving over three hundred rivets a day. They were countersunk rivets with very little to chip off to smooth them up. When my helper went for coal or rivets he took so long that I usually had quite a time of it supplying the necessary rivets, but I came through all right in a few days. We were never allowed to heat the points of the rivets "spitting" hot, and if the boss saw one that way he made us dip the point in water.

One evening I heard the boss explain why the head and neck should be the hottest part of the rivet, and since then whenever I had the authority, no rivets would be driven having "spitting" hot points. It is almost impossible to heat the head and neck hotter than the point in an oil or gas furnace without shifting the rivets about in the furnace. Oil softens the metal, and if they are heated to a nice bright heat they are soft enough to drive either by hand or power. I do not believe in heating a "cherry red."

One morning the boss came to me and told me to heat for another gang. Four gangs to heat for was rather a stiffer proposition, but later he brought some red paint and a rivet 2½ inches long and told me that when the new gang rattled for the rivet I was to dip the rivet in the paint, run with it and stick it in the hole. I did so and they gave the rivet two or three whacks, dropped their hammers, and put out of the yard as quickly as possible. It turned out that the fellows had been helpers in a boiler shop in Buffalo, and though they could drive countersunk rivets easily, they were like many of the present day. However, that rivet was the nearest approach that I ever made to a "cherry red" in heating rivets. John Cook.

Springfield, Ill.

Fabricating a Bosh Jacket by Autogenous Welding

A good illustration of the use of modern methods in the boiler shop is in the incident of fabricating a large bosh jacket by autogenous welding with the oxy-acetylene torch.

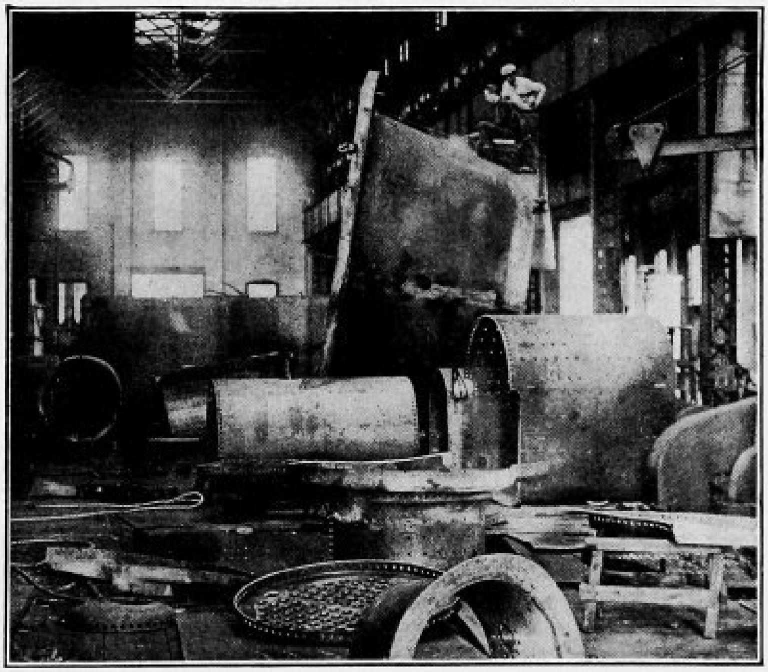
In form this bosh jacket was a truncated cone 11 feet in diameter at the bottom, 16 feet at the top, by 9 feet high, made of one-half inch metal throughout and having a 3-inch horizontal flange at the top and bottom. To eliminate the greater liability to burning, due to double thickness of metal, and to provide that the cooling water could flow over the surface of the jacket in a thin film, unbroken by seams or rivets, it was decided to fabricate this job by uniting the edges by autogenous welding.

In preparing this job for the welders the edges were first beveled on the outside at an angle of 45 degrees, sloping down to a sharp edge on the inside. Then the segments were assembled with the sharp edges in contact, and bolted in position, using straps and erection bolts through the flanges. This left an unobstructed V-groove 9 feet 5 inches long, and sloping upward to an angle of 90 degrees to freely receive the intense heat from the torch.

When the torch is applied to plate work of this kind the expansion of the progressing heated portion, followed by the continually advancing cooling portion, invariably causes the parallel edges to approach each other, and unless provision is made for this phenomenon the edges will overlap and make procedure impossible. To eliminate this difficulty, each seam was opened about 3 inches at one end opposite the point where the welding began, and as the welding proceeded the edges were allowed to approach each other until they were again in contact when the seam was finished.

The welders used the Vulcan Process Company's torch fitted with their No. 10 tip, and directed the flame into the bottom of the V-groove, melting the edges and sides away and filling up the gap with new material melted from the end of the welding rod. It was found better work could be done by welding or tacking in two places about a foot apart, and after welding the intervening space, tack ahead another foot and continue as before. Thus the welding advanced by steps of about a foot each.

The accompanying half tone shows the bosh jacket in position on its side with the V-groove turned upward and the welders at work. When the welding was completed the exterior of the seams were chipped and ground until they were as smooth as the rest of the plate, and it was impossible to distinguish the weld without great difficulty.



Welding the Joints of a Bosh Jacket with an Oxy-Acetylene Torch

This method of fabrication was eminently satisfactory in every particular. The bosh jacket has been in use for some time and given no trouble whatever, nor shown any weakness in the welds. The writer believes there should be no hesitation in using autogenous welds in any construction of this nature. C. H. Burrows.

Minneapolis, Minn.

An Up-to-Date Back Shop and Round-House

Buildings of the present day, such as shops, factories, power houses, etc., are designed not only so that they may be operated efficiently and economically, but also with consideration for the comfort and conveniences of the workmen. This fact was brought to the attention of the writer quite strongly while visiting Mr. Mark Hogan, a foreman boiler maker of the Central Railroad of New Jersey. An attempt was made to find Mr. Hogan at the old familiar back shop and round-house, but this attempt was given up when it was found that the place had been abandoned for a more modern-looking structure that had been built on a site a short distance to the southwest from the old structure.

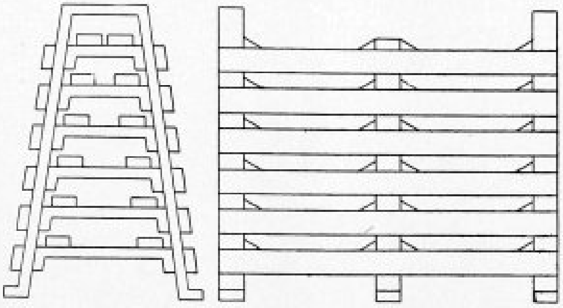


Fig. 1.—Rack for Everyday Tools

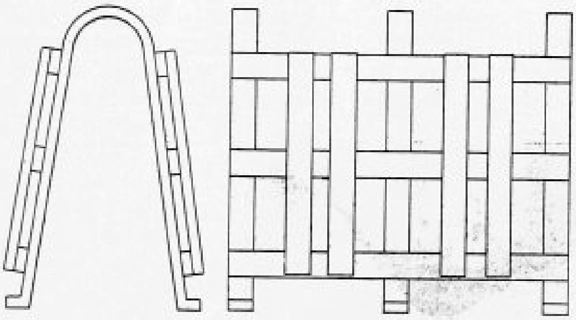


Fig. 2.—Rack for Driving Wheel Tires

This new round-house is very attractive from an architectural viewpoint, and is admirably suited for the functions that such structures are required to perform. The building resembles a many-sided polygon and is built in four main parts, so that engines may enter from four different directions, making twelve separate ways in which an engine may go through the shop. Two turntables are provided, each of which can accommodate any size of engine and tender. Steam and hot water are supplied from four boiler rooms, the chief use of the hot water being for the washing and filling up of boilers.

For the comfort and convenience of the workmen, a system is now under construction whereby a supply of hot air is produced in cold weather and a supply of cold air in hot weather. The windows throughout extend from the top of the building to within a few inches of the floor, giving all available sunlight and air.

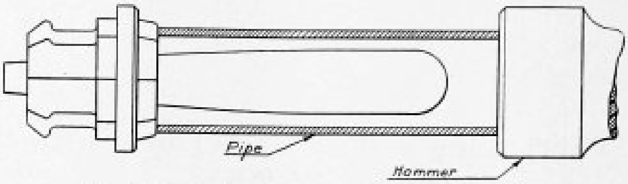
In order to maintain the general attitude of cleanliness and neatness, the foreman boiler maker, Mr. Hogan, has added a few necessary conveniences in the form of racks from his own designs. One of these, as shown in Fig. 1, is for such tools as wrenches, dolly bars and other tools for everyday use. A feature of this rack is that no dirt can accumulate on it and everything is in plain sight, making it easy to find each tool when needed. Fig. 2 shows another rack designed to hold about twenty driving-wheel tires.

Jersey City, N. J. E. Eaton.

Extractors for Sectional Boiler Tube Expanders

In expanding flues with a sectional expander one of the most difficult and time-wasting operations is that of removing the mandrel after it is driven in tight. To strike the mandrel sideways with a hammer to loosen same is not the most satisfactory method in the world. The mandrel does not loosen easily, and besides it is liable to break and injure the workman or somebody else who might happen to be near by.

The mandrel can be made to back out easily and safely by slipping a short section of pipe over the mandrel, as shown in the sketch, and rapping the pipe with a hammer, as indicated. The length of pipe, of course, must be great enough so that the hammer will at no time strike the mandrel during the process of extraction.



Handy Device for Extracting Sectional Expander

It is evident that this process of extraction makes the mandred come out on the "inertia plan." The law of inertia is that "all bodies in motion tend to keep on moving, and all bodies at rest tend to remain at rest." Therefore, when the mandrel is at rest, and when the surrounding sections are struck a sharp rap the mandrel remains at rest and the sections are moved ahead. On the "return trip," or perhaps more properly, on the "return vibration," the sections clutch the mandrel and pull it back. Thus, by repeating the raps a number of times, the mandrel backs out easily, gracefully and with absolute safety to the workman.

Best of all is the regular manufactured tool with extractor attached, which works on the same principle as the above, but is even more rapid, because no time is lost slipping the pipe on and off. An extractor is a mighty good thing to use. N. G. Near.

Course for Boiler Makers at the Murray Hill Evening Trade School, New York City

The Murray Hill Evening Trade School, Thirty-eighth street and Second avenue, New York City, will open September 14. Instruction at this school is free and includes a very thorough course for boiler makers under the direction of Mr. James H. Sheridan, for many years foreman boiler maker of the Pioneer Iron Works, and also of the McNeil Iron Works, Brooklyn, N. Y. This year Mr. Sheridan will teach laying out, boiler inspection and how to become a foreman boiler maker, as well as the regular boiler making course. In view of the fact that several insurance companies have agreed to give permanent work to graduates as boiler inspectors, this school offers exceptional opportunities to ambitious young men who are in a position to avail themselves of the courses provided. The hours for the classes and further particulars regarding the school can be obtained either from the school or from Mr. Sheridan at 115 Broadway, New York.

Selected Boiler Patents

Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,
Millerton, N. Y.

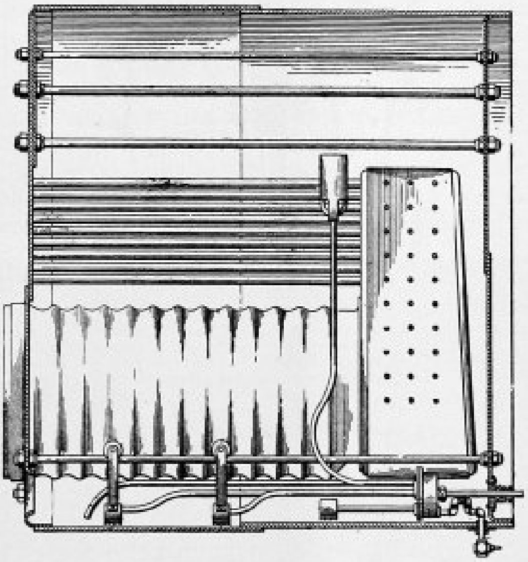
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,096,128. SUPERHEAT-REGULATOR FOR STEAM-GENERATORS. JAMES H. ROSENTHAL, OF CHISELHURST, ENGLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim 4.—The combination with a steam boiler and a superheater, of an attemperator within the boiler drum, said attemperator consisting of a box having cross tubes expanded in the side walls thereof to permit of the circulation therethrough of the water or saturated steam in the drum, and a connection to admit superheated steam to said box but out of contact with the cooling medium. 4 Claims.

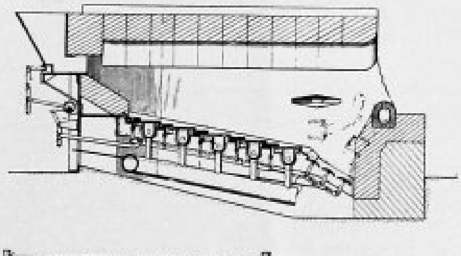
1,098,836. BLOW-OFF FOR BOILERS. GEORGE PURVIS, OF DETROIT, MICHIGAN.

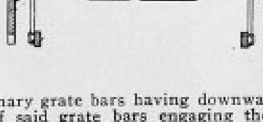
Claim 1.—A blow-off for a boiler having a set of suction members each arranged to sweep a portion of the interior of the boiler shell, an extensible outlet pipe through the boiler shell, a valve for selectively throwing the suction members into communication with the outlet pipe, and means exterior to the boiler for manipulating the valves and suction members. Fifteen claims.



1,099,682. FURNACE. FRANK H. WRIGHT, OF CHATTANOOGA, TENNESSEE.

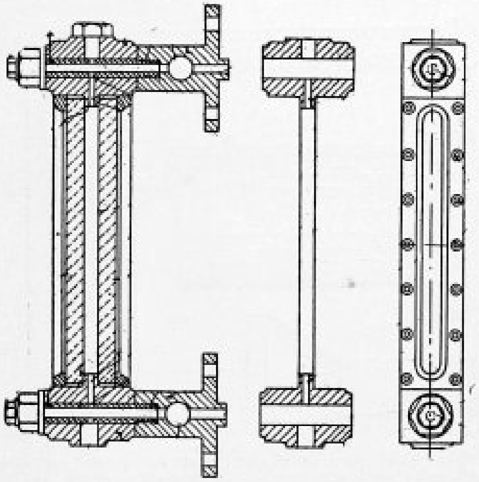
Claim 4.—In a furnace, a plurality of stationary hollow grate bars, each of said grate bars having an upper flat surface, movable grate bars disposed between adjacent stationary grate bars, both the movable and the stationary grate bars having downwardly extending flanges, the flanges on one of said grate bars engaging the upper surface of the adjacent grate bar, the engaging flanges being provided with openings, and means carried by each of said hollow grate bars for supplying air to the openings in said stationary grate bars, said last named means comprising a series of tubes carried by said stationary grate bars and arranged to extend underneath the top of the adjacent stationary grate bar, said tubes being bent to deliver air toward the openings in the flange of said stationary grate bar, the upper part of each of said stationary grate bars having grooves arranged to register with the openings in the engaging flanges of the adjacent movable grate bars. Four claims.





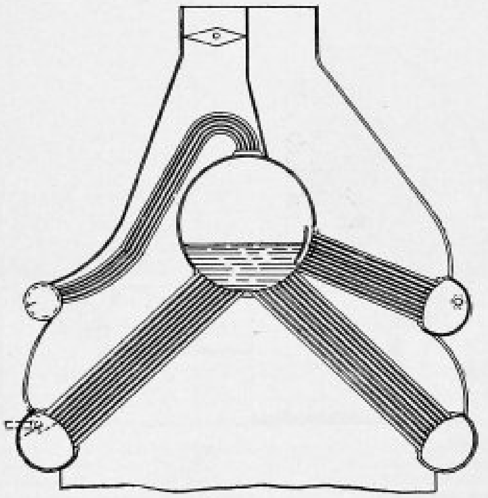
1,100,707. WATER-GAGE. NIELS THORVALDSEN BRIX, OF AALBORG, DENMARK.

Claim 8.—A water gage comprising two perforated heads connected by an integral rib having a slot therethrough, said heads having passages forming communication between said slot and the perforations above referred to, in combination with boiler connections, sleeves passing through said heads and holding the said heads in position upon said boiler connections, said sleeves being provided with perforations registering with said passages and removable plugs fitting into the outer ends of said sleeves, and having communication with the interior of the apparatus to which the gage is applied. Three claims.



1,101,606. WATER-TUBE BOILER. ALFRED F. YARROW, OF BLANEFIELD, SCOTLAND.

Claim 4.—A water tube boiler having a steam and water drum disposed substantially centrally above the furnace, two or more water drums connected therewith by generator tubes, there being one of said water drums on each side of the furnace, a feed water drum or compartment on one side of the furnace beyond the generator tubes at that side and beyond the direction of the flow of the furnace gases, a longitudinal baffle in the steam and water drum forming a pocket in the same closed along its bottom and side but communicating therewith, feed water heating tubes connecting the feed water heating compartment or drum with said pocket, at least some of said feed water heating tubes communicating with the steam and water drum below the normal water level therein, a pipe connecting the feed water heating drum with the steam and water drum near its lowest point and outside of the aforesaid pocket, a superheater upon one side of the boiler and beyond the generator tubes on that side of the furnace in the direction of the flow of gases, a flue leading from each side of the furnace, and a damper in the flue leading from the side of the furnace in which the superheater is located for controlling the flow of gases from that side of the furnace, substantially as described. Four claims.

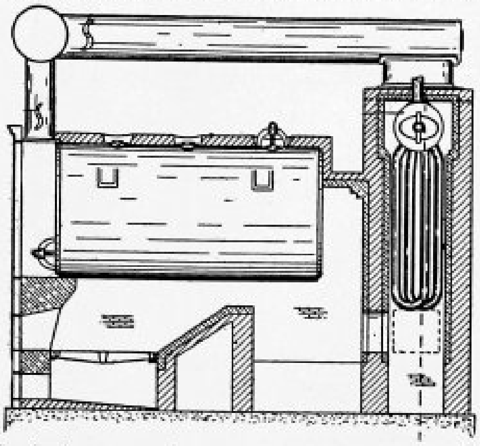


1,097,314. FLUID-JET BLOWER. TEODORO GRUENWALD, OF GENOA, ITALY.

Claim 2.—A boiler provided with flues disposed in vertical rows and having a casing extending about the open ends of the flues to form a smoke box, a hinged flap forming a door on said smoke box, side walls to said flap, a nozzle through which a cleaning fluid is ejected into said flues, a tube carrying said nozzle, a ledge-like member arranged adjacent the lower edge of said hinged flap, slots in said ledge-like member adapted to guide said tube and corresponding in their spacing to the distance apart of the vertical rows of flues, and slots in said tube adapted to engage said ledge-member and corresponding in their spacing to the distance apart of the horizontal rows of flues. Two claims.

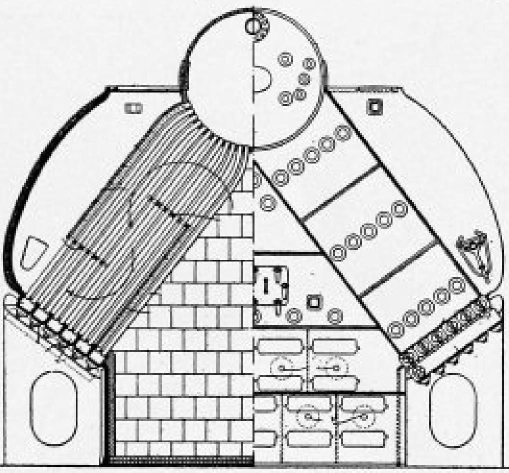
1,102,361. STEAM-SUPERHEATER. ROBERT C. STEVENS, OF ERIE, PENNSYLVANIA, ASSIGNOR TO SKINNER ENGINE COMPANY, OF ERIE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

Claim.—The combination in an apparatus of the character described, of a horizontal tubular boiler, a furnace thereunder to receive fuel to be burned, a transverse fire-wall, a wall adjacent to the rear end of said boiler having an opening therethrough below the upper edge of said fire-wall and forming a combustion chamber at the rear end of said tubular boiler, vertical side and end walls forming a chamber against said rear wall, a drum secured and inclosed within the upper portion of said chamber, super-heater tubes in the shell of said drum and depending therefrom, and a draft flue leading from said chamber above said drum, substantially as set forth. One claim.



1,102,407. WATER-TUBE BOILER. WILLIAM D. HOXIE, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim 4.—In a water tube boiler comprising two units each consisting of a bank of water tubes inclined toward each other upwardly to form between them an A-shaped combustion chamber a central steam and water drum into which the upper ends of the tubes of both banks are expanded, a plurality of boxes into which the lower ends of the tubes are expanded, in groups or rows, said tubes being curved at their upper ends and straight for the rest of their length, transverse baffles dividing each bank ino a plurality of passes and longitudinal baffles extending from said boxes to the first pass and from the steam and water drum to the last pass, and a blow-off collector box connected to the boxes into which the tube ends are expanded. Four claims.



1,097,402. STEAM-BOILER. THOMAS F. DOWNEY, OF CHICAGO, ILLINOIS.

Claim 1.—In a steam boiler, a generally circular shell having an opening from end to end thereof along its lower side and having parallel vertical supporting portions projecting at each side of the opening; a longitudinally disposed combustion chamber inclosed in the shell and comprising a top wall and two side walls, each of said walls being composed of a single transversely continuous and concave-convex plate and presenting its convex side to the interior of the combustion chamber, the side plates having their lower edge portions jointed to the shell and at opposite sides of the opening, and stay plates jointed to the shell and also to the upper edge portions of the side plates and to the side edge portions of the upper plate, no portion of said combustion chamber projecting above a horizontal plane passing through the axis of said boiler. Two claims.

1,099,990. SMOKE-CONSUMER NOZZLE. THOMAS E. McCALL, OF WILMINGTON, DELAWARE.

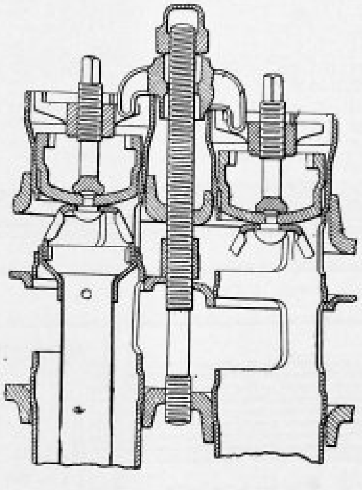
Claim.—As an article of manufacture, an air nozzle for smoke consumers, comprising a single casting having a rear flanged end for attachment to the outer wall of a fire-box, a projecting inner end formed with an outer rolled back portion spaced therefrom forming a water chamber communicating with the water leg of the fire box, and means for securing said rolled back portion to the inner wall of the fire-box. One claim.

1,100,165. BLOWER FOR BOILERS. THOMAS S. WALLER, OF DETROIT, MICHIGAN, ASSIGNOR TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

Claim 1.—The combination with a Sterling type boiler having sets of water tubes of different inclinations, baffles following the inclinations of and transverse to the several sets of tubes, and a setting with openings in the side, front and rear walls thereof, of a blower provided with nozzle pipes articulated to swing in and out of the openings and to direct jets of steam across and along the baffles and the meeting angles thereof and between and across the water tubes. Seven claims.

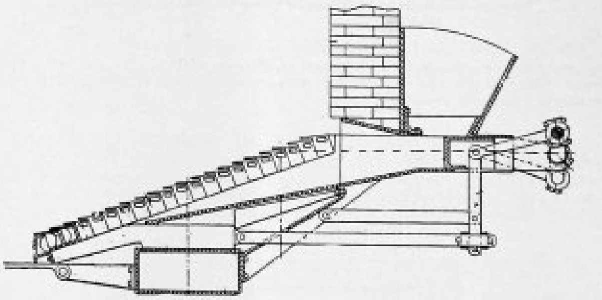
1,103,531. TUBE FOR MULTITUBULAR STEAM-GENERATORS. ALBERT NICLAUSSE, OF PARIS, FRANCE.

Claim 7.—In a multitubular boiler, a boiler tube fitted to the shell elements by coned joints and extending through the front or collector wall, an inner tube having a coned head fitting directly against the inner wall of said boiler tube to form a coned joint, a rod-supported retaining member fitting against the inner wall of the inner tube at the head by a coned joint, a plug member closing the outer end of the boiler tube by a coned joint and supporting the retaining member and means for holding the boiler tube head and plug member. Eight claims.



1,103,625. UNDERFEED FURNACE. ROBERT SANFORD RILEY, OF PROVIDENCE, RHODE ISLAND.

Claim 2.—In a furnace, a series of substantially parallel upright walls and intermediate fuel-supporting members, forming fuel-burning retorts, said walls having air emission means within their upper limits, means located near the forward ends of said retorts for propelling the fuel thereinto, and means for moving said walls, and thereby the air emission means, to effect a further feed of the fuel in process of combustion, and of refuse. Fifty-three claims.



1,101,545. BLOWER FOR WATER-TUBE BOILERS. HARRY A. HIGGINS, OF DETROIT, MICHIGAN, ASSIGNOR TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICHIGAN, A COPARTNERSHIP.

Claim 6.—A blower for boiler-tubes comprising a series of jet tubes, a steam pipe connecting the outer ends of said tubes, a head carried by the free end of each jet tube and having a series of differently-directed perforations, and means for successively opening and closing said perforations. Nine claims.

1,102,718. APPARATUS FOR REGULATING COMBUSTION IN FURNACES. JOSEPH F. CANADY, OF JERSEY CITY, NEW JERSEY.

Claim.—The combination with a boiler and its furnace, of means for supplying air under pressure to the furnace, means controlled by the boiler pressure for regulating the discharge from the furnace of the products of combustion, and means controlled by the variations in furnace pressure for controlling the admission to the furnace of air from the air-supplying means in correspondence with the variations in the discharge of the products of combustion. One claim.

THE BOILER MAKER

OCTOBER, 1914

Strength of Oxy-Acetylene Welds*

Results from Numerous Tests Show that Welds Subject to Considerable Mechanical Strain Should Be Accepted with Extreme Caution

BY PROF. A. CAMPION, F. I. C., AND WM. C. GRAY, A. R. T. C.

Welding is usually defined as "the property possessed by certain metals which, on cooling from the molten state, pass through a plastic stage before becoming quite solid and rigid, of being joined together by the cohesion of the molecules induced by the application of an external force such as hammering or compression." †

A dictionary definition of a weld is "to join together as iron or steel by hammering when softened by heat."

These definitions imply that the weld is produced while the metal is in a state of plasticity, but below its melting point, and therefore unfused.

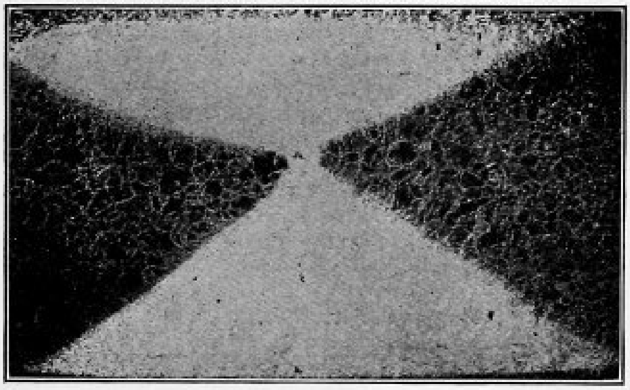


Fig. 1

In recent years the term "weld" has been applied to indicate a union of metals by fusion, either of the metal to be joined, or of a separate piece of metal used in the same manner as solder. The process is obviously an "autogenous soldering," although commonly termed "autogenous welding."

An ideal weld should exhibit not only perfect union of the pieces of metal, but the metal in the welded region should be in the same condition as that of the original material. With the exception of castings, metals which are welded are not in the condition of having simply cooled from the molten condition and become solid, but have been submitted to certain mechanical treatment, such as forging or rolling, for the purpose of removing internal stresses and looseness of texture inherent in metal produced by fusion. The strength and ductility of the material are in this manner greatly increased.

A weld produced by hammering or pressing together pieces of metal at a temperature sufficient to render them plastic only, and provided oxidation is prevented, should be as strong and reliable as the remaining metal; but in the case of autogenous welds, even if precautions are taken to guard against the presence of oxides, the welded portion cannot have the same properties as the original metal, unless it be submitted to a similar treatment to that which the original material underwent during manufacture.

The oxy-acetylene process of autogenous welding which has been largely employed of late years, owing to the comparative simplicity and the facility with which it can be carried out, has a very wide field of usefulness.

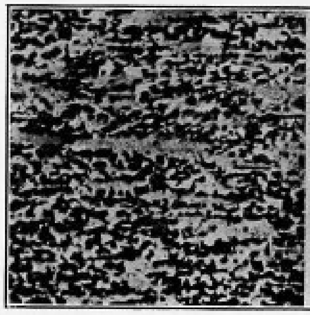


Fig. 2

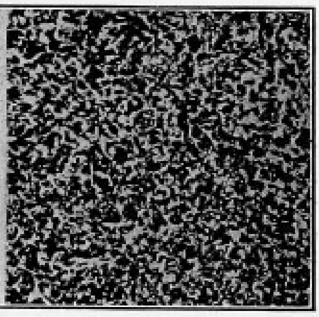


Fig. 3

The oxy-acetylene blowpipe gives a flame producing a clean and easily controlled heat, which can be adapted to almost any position. The extreme adaptability of the process has tempted some to apply it without due regard to the whole of the conditions obtaining in practice, with the inevitable result that many cases of failure have occurred.

Several accounts of failures of boilers, valves, etc., repaired by oxy-acetylene welding have been published. The failures of boilers which have been published are not confined to cases of plates cracked in service and subsequently repaired by autogenous welding, the welded part having in turn given way, but cases of the seams of fireboxes, and of the connection of crown plates to the cylindrical portion made by flame welding methods giving way, sometimes with disastrous results, have been recorded.[1]

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* A paper read at the summer meeting of the Institution of Engineers and Shipbuilders in Scotland, at Newcastle-on-Tyne, July, 1914.

† Robert Austen, "An Introduction to the Study of Metallurgy," fifth edition, page 47. C. H. Fulton, "Principles of Metallurgy," page 75.

[1] See various reports of inquiries held by Marine Department of Board of Trade, under Boiler Explosions Act.

In some of these cases the welds were clearly defective owing to the presence of oxides, on account of an excessive proportion of oxygen having been present in the welding flame, or to the use of fluxes in insufficient amount, or of an unsuitable nature.

In other cases the welds have been imperfect and spongy, owing to the presence of gas cavities, or of particles of slag included within the metals.

In view of the fact that the welds which have failed, and of which particulars have been published, all appear to have been made by experienced expert operators, it is not surprising that in many quarters the oxy-acetylene and other hot flame autogenous welding processes are considered unreliable and viewed with suspicion.

The marine department of the Board of Trade has made rules and regulations fixing the limits to the use of such processes in boiler work. The Government of Belgium has forbidden the use of autogenous welding in boiler construction, and in the case of extensive repairs.

These restrictions will probably be relaxed in the future, as the conditions effecting the strength and other qualities of the welded portion, in comparison with the original metal, become more thoroughly understood, and experience is gained of the behavior of welded material under various practical working conditions. The writers consider that until results of such experience are available due caution should be exercised in the use of autogenous welding for boiler and high-pressure work.

Fig. 4

As far as the authors have been able to ascertain the published results of investigations into the quality of welds made by fusion methods have, with one exception, dealt only with the changes brought about in the structure of the material, changes in the static tensile strength, and examinations for unsoundness and oxidation.[2] Dr. F. Carnevali, in a paper entitled "Autogenous Welding of Metals" (oxy-acetylene process for iron, steel and pig iron),[3] gave the results of transverse impact tests made in a Charpy machine.

Dr. C. H. Desch has recently directed the attention of members of this institution to the importance of the subject, and to the incompleteness of the data available as to the strength and reliability of autogenous welds in the following words: "It must be admitted, however, that a joint made in this way has not the same qualities as the original steel. It is not sufficient to show that fracture does not commonly take place in the plane of union when a mechanical test is made. It is not the weld, but the zone immediately adjacent to it, which is injured. Neither are tensile tests conclusive on this point, as the injury to the steel does not always affect the tensile breaking strength, but is revealed when the welded steel is subjected to shock or fatigue."[4] At the time when the statement was made, the authors were engaged upon the examination of a large number of welds of mild steel which had been made by the oxy-acetylene process, the object being to compare the strength and resistance to fatigue of the welded portion with that of the original material. The results of a large number of tensile tests of welded material have been published from time to time, and upon the basis of these results it has been argued that welds made by an autogenous process are as strong and reliable as the unwelded material. Tensile tests are not sufficient, for as is well known even in the case of unwelded steel, it frequently happens that excellent figures are obtained as regards tensile strength and elongation, and yet the material fails in practice when submitted to shock or vibration. If these tests are unreliable in the case of such material as plates and bars, which, in the course of manufacture, have been submitted to careful thermal and mechanical treatment, under strict supervision, it seems very unreasonable to rely upon them entirely in the case of material which has been submitted to what after all is at best only a fusion or casting process. As a writer in one of the engineering journals stated recently: "It is beyond all reason to claim that a mere melting process can produce the exact character of rolled steel."[5]

The authors, as the result of an extended experience in the testing of steel and other metals, fully realized that, although the results of static tension tests frequently indicate that the weld is almost as strong as the unwelded material, they may be quite at variance with the results of dynamic tests or the behavior of the material in practice. Working conditions are usually such that the material is liable to repeated shocks, and in the course of the examination the authors made a large number of tests in order to compare the behavior of the welded and unwelded material under repeated impact, and also to compare the results of such tests with the static tensile tests.

They gladly accepted the invitation of the secretary to present the results of the investigation, in the form of a paper, to the members of the institution in the hope that they may prove of interest to some of them.

A large number of welds of mild steel were prepared, and submitted to static tension and repeated impact tests, in the ordinary condition, and also after various treatments.

The first series of tests were made on round bars of mild steel, containing approximately 0.25 percent carbon, five-eighths of an inch diameter.

The tensile test bars were turned parallel for one and a half inches and three-eighth inch diameter, in order that fracture would take place in the weld. The elongation was measured on a one-inch length.

It was found that in most cases the fracture was much too ragged and uneven to allow of the final diameter being measured, so that no results for contraction of area at fracture have been recorded.

In Table I. the results of tensile tests of eighteen welded bars after various treatments are given, and as was to be expected, considerable differences are shown, not only between the mean results for each treatment, but between individual bars of each set. This appears to indicate that there is an element of uncertainty about a weld, even when it has been made with the greatest care by an expert manipulator.

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[2] Law, Merrit, and Digby, "Jour. Iron and Steel Inst.," No. I., 1911.

[3] "Jour. Iron and Steel Inst., No. II., 1911, and Jour. Inst. Metals," Vol. viii.

[4] "Transactions Inst. of Engineers and Shipbuilders in Scotland," Vol. lvii.

[5] "The Practical Engineer," Vol. xlix., No. 1,422, p. 507.

Table I.

Static tensile tests of ⅝-inch diameter round bars of mild steel welded in center.

Mark.	Description and Treatment.	Maximum Stress. Tons per sq. inch.	Means.	Extension on 1 inch. percent.	Means.
3	Unwelded and untreated	33.98	34.39	27.0	26.75
3 B		34.80		26.5	
3 N	Unwelded, heated to 800° C., and cooled naturally	32.40	....	29.3	....
3 W	Welded—untreated	29.8	29.1	2.5	5.9
3 W B		30.9		3.7	
3 W C		27.4		6.0	
4 W		28.5		9.9	
4 W B		29.2		7.5	
3 H	Welded and hammered	24.9	25.9	7.0	7.2
3 H B		25.9		6.0	
4 H		25.4		7.8	
4 H B		27.5		8.1	
3 H A	Welded and hammered, then heated to 800° C. for half an hour, and allowed to cool naturally	25.4	27.8	7.2	8.6
3 H A B		30.3		10.1	
3 A	Welded, heated to 800° C. for half an hour, and allowed to cool naturally	30.5	28.4	10.8	12.1
3 A B		29.7		9.7	
4 A		27.3		16.0	
4 A B		26.1		12.0	
3 Q A	Welded, quenched in water, heated to 800° C. for half an hour, and allowed to cool naturally	33.2	32.5	11.0	9.7
3 Q B		31.8		6.5	
3 Q C		32.7		11.6	

Analyzing the results in Table I., the following interesting comparisons are obtained, taking the mean results for maximum stress and elongation of the original material as 100:

Mean results of—	Maximum Stress.	Elongation.
2 Unwelded bars	100	100
5 Welds untreated	84.6	22
4 Welds hammered	75.3	26.9
2 Welds hammered and then reheated to 800° C.	80.8	32.1
4 Welds reheated to 800° C.	82.5	45.3
3 Welds quenched in water, then reheated to 800° C.	94.5	36.2
Lowest results of each set—		
5 Welds untreated	79.6	9.3
4 Welds hammered	72.4	22.4
2 Welds hammered and then reheated to 800° C.	73.8	26.9
4 Welds reheated to 800° C.	75.9	36.2
3 Welds quenched in water, then reheated to 800° C.	92.4	24.3

It would appear from these results alone that an average weld might be expected to possess something like four-fifths of the strength of the unwelded steel, and that the ductility would be about one-fifth. The maximum strength in tension would appear not to vary to any great extent, but the ductility appears to vary considerably from the average, as the lowest strength recorded is practically eighty percent of the original material, and the lowest elongation only 9 percent.

Hammering has increased the ductility, and reduced the strength slightly. Reheating after hammering has produced a further increase in ductility, and at the same time increased the maximum stress.

Reheating to the same temperature, without previous hammering, has produced a somewhat large increase in the ductility, and a further small increase in strength; while in the case of the specimens quenched in water and then reheated, the strength has risen to almost that of the unwelded material, although the elongation has been reduced. It appears from these results, and others which the authors have obtained, that under no circumstances does the ductility of the weld approach that of the unwelded portion.

A number of welded bars of the same material were tested under repeated impact in the Stanton machine. The test bars were prepared 6¼ inches long, and ½ inch in diameter at the bottom of the notch being four-tenths of one inch. The results of eighteen tests of welds after various treatments are shown in Table II., and, as was anticipated, very wide variations, not only between the mean results of each group, but also between individual tests, are shown. Analyzing the results as before, there is obtained the following:

Mean results of—	
2 Unwelded bars	100
6 Welds untreated	54.1
3 Welds hammered	84.4
3 Welds reheated to 800° C	65.3
3 Welds reheated to 900° C	59.3
3 Welds quenched in water, then reheated to 800° C	49.6
Lowest results of—	
6 Welds untreated	35.6
3 Welds hammered	74.5
3 Welds reheated to 800° C	55.7
3 Welds reheated to 900° C	50.5
3 Welds quenched in water, then reheated to 800° C	33.9

Table II.

Repeated impact bending tests of ⅝-inch diameter round bars of mild steel welded.

Test pieces 6.25 inches long × 0.5 inch diameter. Diameter at bottom of notch 0.4 inch.

One inch pound blows. Bar reversed after each blow. Notch placed in center of weld.

Mark.	Description and Treatment.	Number of Blows to Fracture.	Means.
3	Unwelded and untreated	5164	5210
3 B		5256	
3 W	Welded—untreated	3388	2819
3 W B		1856	
3 W C		3078	
4 W		2399	
4 W B		3178	
4 W C		3006	
3 H	Welded and hammered	4562	4402
3 H B		3885	
3 H C		4759	
3 A	Welded, heated to 800° C. for half an hour, and allowed to cool naturally	2902	3404
3 A B		3089	
3 A C		4222	
3 X A	Welded, heated to 900° C. for half an hour, and allowed to cool naturally	2882	3093
3 X B		2636	
3 X C		3763	
3 Q A	Welded quenched in water, heated to 800° C. for half an hour, and allowed to cool naturally	3078	2589
3 Q B		1770	
3 Q C		2918	

It would thus appear that an average weld might be expected to withstand about half as much as similar material unwelded. Hammering has apparently been the most effective treatment, so far as increasing the fatigue-resisting properties of the material, but it must be borne in mind that the heating during the welding is extremely local, and consequently the metal in the immediate vicinity of the weld is liable to be at a comparatively low temperature, and there is a danger when hammering of vibrating or jarring a portion of the metal when it is at a black heat, which, as is well known, is productive of brittleness. If hammering is resorted to, the metal should be reheated to a full red heat (800 deg. C.), in order to remove strains or brittleness which might be set up during the process.

Reheating or annealing alone appears to be of little value, so far as increasing the fatigue resistance of the welded portion is concerned.

Comparing the results in Table II with the tensile test results, it is of interest to note that the form of treatment which gave the highest strength in tension has given the lowest result in the impact tests.

The results in Table II. were obtained upon test pieces notched so that fracture occurred through the center of the weld, but in actual practice fracture frequently occurs in the material in close proximity to the weld and not in the weld itself. This is due to the fact that in heating to fusion the ends of the pieces to be joined, the neighboring metal becomes heated to a temperature sufficient to make it britle. That such overheating takes place is easily seen by examining a longitudinal section of a weld which has been polished and etched in nitric acid. Fig. 1 shows a section through a welded boiler plate magnified four diameters. Under the microscope it can be still more distinctly seen. The actual weld, where fusion has taken place, has a structure characteristic of cast metal. The portion immediately adjacent to the weld exhibits a coarse meshwork of overheated, brittle metal, as shown in Fig. 4. The structure of the original plate is shown in Fig. 2; while Fig. 3 shows the structure of the overheated portion after annealing.

In order to see exactly what influence the presence of this overheated ozone exerted upon the weld as a whole, a number of welded bars of the same material as that used for the experiments already described were tested in the same manner as those referred to in Table II., except that, instead of the notch being made in the center, it was put at the edge of the weld. The results are shown in Table III. The variations in the energy to fracture are even greater than in the case of specimens notched in the center of the weld, as is shown by the following analysis:

Mean results of—	
2 Unwelded bars	100
3 Welds untreated	57.3
3 Welds hammered	57.7
3 Welds hammered, and reheated to 800° C	78.1
3 Welds reheated to 800° C	98.7
2 Welds reheated to 900° C	74.7
Lowest results of—	
3 Welds untreated	55.5
3 Welds hammered	29.8
3 Welds hammered, and reheated to 800° C	53.2
3 Welds reheated to 800° C	83.4
2 Welds reheated to 900° C	73.0

It will be observed that the untreated and the hammered welds give almost the same percentage of the original strength, that of the untreated being higher than the result in Table II., but the hammered specimens give an average of only 57.7 compared with 84.4 percent in the case of the specimen notched in the center of welded portion. This is undoubtedly due to the lowest result being only 29.8, and bears out what has previously been stated as to the danger of producing brittleness by hammering or jarring at a low temperature. On the other hand, reheating to 800 deg. C. has, as might be expected, very nearly restored the material to its original strength; in fact, two specimens are actually stronger than the unwelded material.

Table III.

Repeated impact bending tests of ⅝-inch diameter round bars of mild steel welded.

Test pieces 6.25 inches long × 0.5-inch diameter. Diameter at bottom of notch 0.4 inch.

One inch pound blows. Bar reversed after each blow. Notch placed at edge of weld.

Mark.	Description and Treatment.	Number of Blows to Fracture.	Means
3 W D 3 W E 3 W F	Welded—untreated	3427 2896 2943	3088
3 H D 3 H E 3 H F	Welded and hammered	3230 4231 1556	3006
3 H A D 3 H A E 3 H A F	Welded, hammered, heated to 800° C. for half an hour, and allowed to cool naturally	4855 2776 4581	4071
3 A D 3 A E 3 A F	Welded, heated to 800° C. for half an hour, and allowed to cool naturally	4347 5226 6060	5144
3 X D 3 X E	Welded, heated to 900° C. for half an hour, and allowed to cool naturally	3985 3806	3895

Reheating to 900 deg. F. has been less effective, due no doubt to that temperature being such as would cause overheating and a reduction in strength of the unwelded bar.

A series of repeated impact tests was carried out on plates of different thickness, and some of the results are distinctly interesting, as shown in Table IV. The notch was made in the center of the weld in all cases, and the test bars prepared from the middle of the plates.

Table IV.

Repeated impact bending tests on steel plates of various thickness.

Mark.		Description and Treatment.	Number of Blows to Fracture.	Means.
Plate, ¾-inch thick	C B	Unwelded	2,986	
	C B W 1	Welded	1,085	
	C B W 2	Welded	987	1,036
Plate, 1 inch thick	R 1	Unwelded—untreated	2,559	
	R 2	Unwelded—untreated	2,132	2,345
	R W 1	Welded—untreated	551	
	R W 2	Welded—untreated	373	462
Plate, 1½ in. thick	S	Unwelded—untreated	1,729	
	S W 1	Welded	413	
	S W 2	Welded	451	432

These results show very clearly that the thicker the plate the less reliable is the weld, and the greater the reduction in strength. Thick material also generally shows less improvement by annealing; in fact, under ordinary working conditions, it is usually impracticable to anneal the material. In consequence of the highly local heating action of acetylene, there is considerable danger of contraction stresses being set up in the metal, and undoubtedly this contributes to the greater reduction in strength of thick material.

The case of a welded plate only ⅛ inch thick came under the author's notice some time ago. It was sent them to examine and report upon, in regard to the relative strength of the welded and unwelded material, by a firm of tank makers who had recently introduced welding of the seams instead of lapping and riveting. Transverse bending and tensile tests showed that the joint was stronger than the neighboring metal. The material being too thin to obtain ordinary fatigue test pieces, narrow strips were cut about half an inch wide, some with the joint running transversely, and some with the joint running longitudinally to the strip. The strips were placed in a vice and bent backwards and forwards through 90 degrees until fractured. It was found that the welded strips required at least as many right-angle bends as similar strips of unwelded metal to produce fracture.

The metal being thin was quickly heated locally to fusion without damaging the neighboring metal, and cooling being rapid the material in the neighborhood of the joint was probably in a much tougher condition than before the operation.

The danger of stresses due to unequal cooling being set up would also be reduced to a minimum in such material. As the thickness of the plate increases, a larger portion of the neighboring metal becomes overheated, the cooling is slower, and the danger of contraction stresses being set up increases.

The authors, as the result of a large number of tests and experiments upon autogenous welds, conclude that, although there is a wide field of usefulness for oxy-acetylene and similar processes for joining or repairing steel plates, bars, etc., which are not required to resist very severe stresses, considerable caution must be exercised, and due

(*Continued on page* 331)

John, Geometry and the Tote Pole

A Practical Demonstration of the Application of Plane Geometry to Everyday Work in the Boiler Shop

BY JAMES F. HOBART, M. E.

"Mr. Hobart, Bill Smart and his crowd are infernal liars, and I want you to help me prove it!"

"What's wrong, John? War in Europe got into your shop already?"

"No! The war isn't troubling us much. It's Bill Smart and Hen Rafferty and some of the others. Me and Bill and Sam had a job carrying some small smokestacks and piling them up on a freight car. There were more than forty sections of 14-inch stack about 15 feet long, and it made a tidy load for three men and a tote pole—each section did. We had to carry them about 200 feet, and Bill had the rear end of each section, while me and Sam wrangled the tote pole."

"Well, John, I don't see anything about that arrangement to get excited about. You do something like that nearly every day, dont you?"

"Yes, Mr. Hobart, but what troubled me was that Bill tried to make me and Sam lay the tote pole one-third of the way back from the front end of each stack section. That was 5 feet from the forward end to the tote-pole, and Bill got war mad when I kicked that me and Sam were carrying more than our share of the load. I am mighty sure, from the load I carried, that Sam and me were carrying more than our share, but I can't make Sam believe it. He says that one-third of the length to the tote pole gives two-thirds the weight on it. I'm sure that it does, and more, too, but I can't prove it to Sam. Wonder if old Geometry can help me any?"

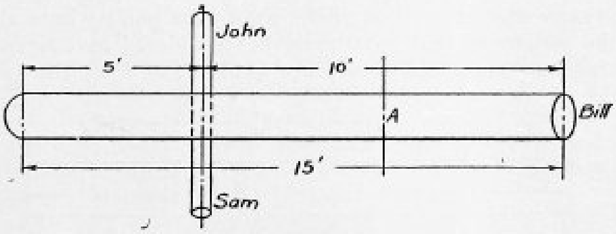


Fig. 1

"Right you are, John! Old 'P. Geometry' can help out with almost anything which comes up in the shop if we will only give him a chance."

"Old P. Geometry? What's the 'P' for? Didn't know Geometry had 'Pat' for a front name, before."

"Not quite; his name is 'Plane Geometry'—not 'Pat,' for, unlike that Hibernian gentleman, geometry can 'open its mouth without putting its foot in it!'"

"Well, perhaps he can, but I can't yet. I 'put my foot in it' about every time I open the geometry."

"Never mind, John; you are coming on. You know a whole lot more about geometry and such things than you did two years ago. Keep at it and you will have 'P. G.' thrown and hog-tied in a few years more, and once you get that broncho saddle-broke you can ride where none of the other boys can catch you unless they break in geometry mounts for themselves. Now, about this stack business—Bill wants to place the pole as shown by Fig. 1, does he? Well, that's pretty fine for Bill, but not at all good for you and Sam."

"But how can I prove that to Bill, Mr. Hobart? I've been telling that to Bill all along, but he won't believe it—not a little bit!"

"See here, John! just you get a piece of shaft, or a short length of pipe and lay it on the scales as shown in Fig. 2. Fig. 1 shows Bill's way of setting the tote pole, now hang up the bit of iron by a cord, put a lead pencil under the end on the scale, close to the end of the iron, then move the cord back and forth until exactly one-third of the weight of the iron is shown upon the balanced scale beam."

"Say, that ought to muzzle Bill, all right. I'll rig up something like that and show it to Bill, right off. That will tell the story in spite of anything Bill can say, and I'll have that gentleman dead to rights when he brings up against the scale proposition. But, how do you figure this thing, anyway? What weight does Bill carry in Fig. 1, and what is the distance from *B* to *C* in Fig. 2, and how is it found, by figures or by geometry?"

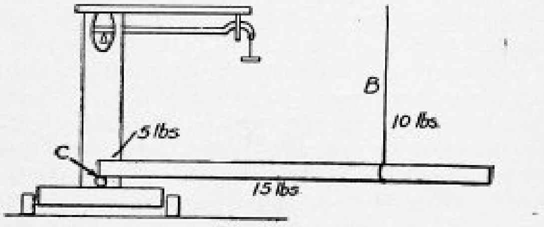


Fig. 2

"Let's look into both sketches a little, John. In Fig. 1 the tote pole is 5 feet from one end. Now let's cut the stack at *A*, Fig. 1, and fasten the parts together by a single rivet. And, John, with the stack thus arranged, isn't it evident that if each man carried one-third of the weight, that the stack would just balance at the cut portion? That John and Sam would have each one-third of the weight, while Bill would carry the other third?"

"That is sure the case, Mr. Hobart, but it don't work out that way."

"No, John, it don't, and there is where you show Bill that he is wrong. The two-thirds which John and Sam are carrying balances over the tote pole all right, but you see that in addition to their own two-thirds of the load they have to carry just one-half of Bill's load also. Therefore, you and Sam are carrying five-sixths of the entire stack, and each of you carries two and one-half times the load that Bill carries! No wonder that he wants to stick out for the one-third distance business. It makes mighty easy work for him."

"Phew! But I didn't think there was as much difference as that in the load. But it did weigh down pretty heavy with the tote pole where Bill put it Now, how can I make figures to tell just where to locate the pole?"

"Fig. 3 will help you out on that, John. With one bearing at *D* and the other at *E* there will be just one-half the weight of the pipe—or stack—carried on each, will there not?"

"Sure there will! And, with one bearing at *D* and the other at *F*, the load will all be on *F* and nothing on *D*.

Say—isn't that peculiar? Moving the bearing half the length of the stack or shaft shifts half the weight of the object, but it shifts the second half of the load—not the first half; that is, there will always be one-half the load on *E*, and after the bearing is shifted to *F* it takes the second half of the load, making all the weight."

"And that peculiarity of the question, John, is where you get all balled up in locating the tote pole. Now we will go back to Fig. 2 and measure the distances from either end of the shaft to *B*, and we find that *B* is located almost exactly one-fourth of the distance from the 'two-man end' of the shaft. That is a bit different from one-third, isn't it, John?"

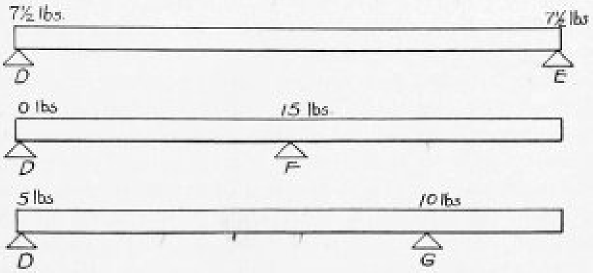


Fig. 3

"Yes, but how do you figure it? I don't see any reason for it or way of finding out where the tote pole should really be placed. And we can't stop to weigh each stack with one end on the ground."

"You won't have to. But let's investigate the measuring business a bit. In Fig. 3, Point *G* has been moved toward *D* about one-fourth the length of the shaft; and in that position we may regard the tote-pole *G* as carrying all the shaft which projects past point *G*, or one-fourth the entire length. And we may also regard *G* as carrying one-half the balance of the shaft between *G* and *D*, and one-half of three-quarters is three-eighths, which, added to the overhanging one-fourth, makes five-eighths of the shaft carried by *G*. And the half of the distance between *G* and *D*, and which is carried by *D*, is three-eighths of the weight; therefore we have three-eighths of the weight carried at *D* and five-eighths of the weight carried at *G*."

"Yes, Mr. Hobart, but that is not right, for one man is carrying three parts of the weight, while the tote-pole crowd carries only five parts. You will have to move the tote pole along a little farther, and it looks as though Bill was about right, after all, with his one-third business."

Not a bit of it, John, as we will see presently. We have seen that five-eighths of the length of shaft is supported by *G*; now, wouldn't the overhang of the end *H* tend to lighten end *D* somewhat?"

"Oh! I don't know. Perhaps it might—a very little—but don't suppose it would amount to much."

"Yes it would, John. It will amount to enough to make up the difference between three and five, which we get now in the distribution, and three and six, which we want to get, so that the weight at *G* will be exactly twice what it is at *D*."

"I don't see how you figure that, Mr. Hobart. We have got the little piece of shaft on two bearings, and what is not on one must be on the other."

"Yes, John, to a certain extent, but just look at *F*, in Fig 3. There we have the shaft resting upon *D* and *F*, but all the load is on *F*, and none whatever upon *D*, in that figure, so you see that the overhang—same as we have at *G*—does amount to considerable in increasing the load upon *G* and lightening it on *D*."

"Say, that's another of those geometrical twisters which a fellow never finds until he is tangled up in them. How are we going to work it out, anyway?"

"John, I've a mighty good mind to leave that part of the problem for you, and see what you can do with it. Now, mind: I do not say that one-fourth the distance from end of stack is the proper location for the tote-pole in order to carry two-thirds of the weight of stack, but I do say that it is close enough for all practical purposes—closer far than with the tote-pole placed one-third the distance from the 'two-man' end of the stack."

"But, Mr. Hobart, don't leave me in this muddle. Just show me how to work out that overhang business which seems to shift more of the load upon the tote-pole than the division really calls for."

"Well, John, I'll give you a clue, but I'm going to leave you to work out your own salvation. Now then, supposing the little piece of shaft, which weighs 15 pounds, is 48 inches long. We find that with *B*, Fig. 2, 12 inches fom the tote-pole end, the end *C*, which bears upon the scale, will weigh 5 pounds, as closely as the weight can be determined upon a platform scale with quarter-pound notches."

"Well, how do you figure the distance, or, rather, the effect of the overhang beyond *B*?"

"You are to figure that, John." I will give you a clue to the matter, and then you and the shop mathematical sharps can work out the rest of the business. With the shaft upon two points, as in Fig. 4, there will be 12 inches on one side of bearing *G* and 36 inches upon the other side. Now, suppose we were to find the center of gravity of each portion of the shaft—the point where all the weight of that part could be considered as concentrated in one place—that place would be at *I* for the 12-inch length, and at *J* for the 36-inch portion. As the weight of the entire shaft has been found to be 20 pounds, and there is 5 pounds concentrated at *I*, its 'moment' will be 5 × 6 = 30. And the moment of the weight at *J* will be 15 × 18 = 270 pounds. This means that a moment of 30 at *G* is working against or trying to balance a moment of 270 at *J*; or that 30 is trying to balance 270 and cannot do it. But it can balance 30/270ths of it, or exactly one-ninth. Therefore, the overhang adds about one-ninth to the load already there, or it probably takes away one-eighteenth from the one-man load and adds one-eighteenth to the two-man burden."

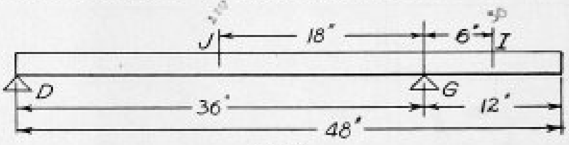


Fig. 4

"Well, I'll be totally jiggered! So that's the way they figure such things, is it? I have heard them tell about 'moments,' but I never knew what brand there was on them."

"They are pretty handy things, John. They were dug up from geometry and trigonometry by some 'sharp,' and they save us a lot of work in figuring strains, for when we find the 'moment' of a body we have cut out weight, distance and all other confusing things and reduced them all to a 'punch' in relation to a certain point or place. In this case we find that the weights of the two parts of the little shaft reduce to moments of 30 and 270 about point *G*, that's all there is about it. We can go right ahead and figure with those moments without taking into account their distances from point *G*, their weights or any other things which might mix up our calculations."

"Say! That's mighty handy, isn't it? Guess there's another thing for me to put in my note-book and in the back of my head for future use."

"No, John, not for 'future use,' but for common, everyday use, right along with hammer and chisel."

"All right, Mr. Hobart, I'll try it out. But just show me how you use the 'moments' with the shaft-balancing operation."

"John, you are a regular Blarney Stone, aren't you? Well, the load is now distributed in the proportion of 5 and 3, isn't it?"

"Yes, five-eighths on the tote-pole and three-eighths on the end man."

"And now, as we have to correct that proportion to the extent of one-ninth, we will take one-eighteenth from one side and add one-twelfth to the other side and get at results in that way. We may not obtain exactly accurate results in that manner, but it will be pretty close, and, as remarked before, your shop mathematicians may figure out the problem as exactly as you please—or can."

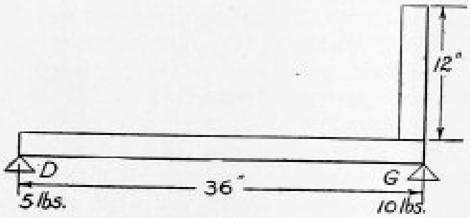


Fig. 5

"But how do you get that thee-eighths and five-eighths juggled around so they will make the loads come right?"

"Try it this way, John: Add one-eighteenth to 5 and deduct the same amount from three-eighths, and see how you come out. Call it 19/18 of 5 = 5.277, and 17/18 of 3 = 2.833. Next we will add these two results, making a sum of 8.166, and the load distribution has now become $\frac{5.277}{8.11}$ and $\frac{2.833}{8.11}$. By dividing 20 pounds, the weight of the shaft, in that ratio we obtain 13.01 and 6.9 pounds as the division figured when the tote-pole is placed one-fourth of the distance from the tote-pole end of shaft. And, John, from the fractional result it may be, as stated, that one-fourth is not the exact place to locate the tote-pole, but, as also stated, it is much nearer than one-third, or any other simple fraction, and you are safe in insisting that Bill place the tote-pole at one-fourth the distance from the two-men end of the stack when you and Sam are doing the carrying together."

"Thank you, Mr. Hobart, I will see what the boys say to that way of figuing, and I'll see if I can get the location any closer than one-fourth. But that overhang business sure gets me. It sure queers the way Bill proved that one-third was the right way to place the pole. He took a stick, weighed it, then cut off one-third the length, as in Fig. 5; placed the cut-off portion vertical, as shown, and the scale showed that he had 5 pounds and ten pounds, respectively. But he never reckoned with the overhang."

"And the overhang was where he made his mistake, John. He did not meet the conditions when he did his weighing, and that's where lots of us get left when we make tests—we don't get all the conditions, and the result surely shows it."

MASTER BOILER MAKERS' CONVENTION.—The ninth annual convention of the Master Boiler Makers' Association will be held at the Hotel Sherman, Chicago, Ill., May 24-27, 1915.

Faulty Designing of Boilers

The writer believes that many boilers are designed without due regard to their efficiency and lasting qualities. All marine boilers are designed according to rules and regulations that have the force of law, but these rules and regulations only take note of the elements that enter into the question of safety, having no regard at all to the efficiency or upkeep of the boilers. The following experiences of such faulty design are a few of the many that have come under the writer's personal observation during a period of 25 years as a marine engineer.

A leg boiler was installed in a small tugboat and in a few weeks the side sheets in the furnaces commenced to bulge between the staybolts. The builders of the boiler were notified and they immediately stated, as a reason for this, that there was grease in the boiler. Examination of the boiler failed to discover any evidence of grease at all, but they persisted in the statement that it must be grease—that there could be no other cause for this bulging. The bulging became worse and the superintendent engineer decided to look for the cause himself. This boiler foamed considerably, particularly when the safety valve lifted while the engines were running. He inserted a gage cock in the outside of one of the legs and found that when the boiler foamed only dry steam came out of this gage cock when it was opened, showing that the foaming lifted the water entirely out of the legs.

The space between the sheets in the outside legs was only 4 inches and in the center leg only 6 inches. Evidently this was entirely inadequate to allow for the proper circulation of the water in the legs under certain conditions. A much better design would have allowed 6 inches between the sheets in the outside legs and 8 inches in the center leg. The difficulty was overcome to some degree by placing baffle plates under the steam opening, which partly stopped the foaming, but by the time this was done the side sheets were bulged so badly they had to be cut out and replaced with new material.

Another case of faulty design, and one that is too frequently found, occurred on a coastwise tugboat. The sheet in the back connection of the boiler began to bulge opposite and above the mouths of the furnaces. This sheet was stayed according to the rules and regulations, which provide that the stress on staybolts must not exceed 6,000 pounds to the square inch of section. The bolts were made large and spaced 7½ inches apart, leaving a large square unsupported except at the corners. It was suggested that extra stays be placed in the bulged parts of the sheet in the center of the squares. This was vigorously opposed by the builders of the boiler, who insisted that the boiler was properly designed and did not need any extra stays, although they could not—at least would not—give any reason for the bulging. However, the extra staybolts were put in and no further trouble has been experienced from this cause. In this case it would have been better to have used smaller bolts placed closer together.

An exactly similar case occurred on a large freight steamer in which the boilers were fitted with the Howden system of forced draft. In a very few months after being placed in commission the sheets in the back connections bulged as related in the former instance, and the trouble was remedied in the same manner, by placing extra bolts in the center of the square between the regular bolts. In both of these cases this was done before the sheets had bulged to any considerable extent. The writer is of the opinion that the space between the sheets and the back heads of these boilers was too narrow, particularly where forced draft was used. It stands to reason that when the hot fire strikes the sheet it forms steam rapidly, and unless there is ample room for the steam thus formed to get up and the water to flow down, the sheets will become dry and overheated.

In another case of boilers fitted with forced draft the two furnaces in one came down without any apparent reason. No oil was used in the cylinders of either main or auxiliary engines, and the boiler was as clean inside as the day it was built. The furnaces were pumped back in place, but in a short time came down again. There was no break in the rows of tubes in these boilers, being spaced about 4 inches apart horizontally, with about 12 inches space between the sides of the shell and the end row of tubes, and the bottom row of tubes was just 4½ inches above the top center line of the furnaces. The only reason that could be assigned for the coming down of these furnaces was that the fierce heat of the fires under forced draft changed the water into steam faster than it could flow down to the furnaces, and they became dry and overheated. New furnaces were installed and the bottom rows of tubes removed, being replaced with small stay rods to brace the tube sheet, and so far there has been no further trouble with these furnaces.

All marine engineers are conversant with the fact that a boiler built by one builder will steam considerably freer than a boiler of the same size built by another builder. The reason for this can only be in the design. A slight difference in the arrangement of the tubes in a boiler materially affects the circulation, and in that way affects the steaming qualities. A couple of inches difference in the distance from the top of the furnaces to the grate bars will make considerable difference in the combustion of fuel. In one instance that came to the writer's attention a boiler in a tugboat on her trial trip would hardly make steam enough to keep steerageway on the boat. The owner naturally refused to accept her, saying that he contracted for a *steam* boat, and she wasn't that by any means. At the suggestion of a practical marine engineer, who was on the trial trip as a guest, the grate bars were lowered 4 inches, and on the second trial trip the boiler furnished ample steam with the engines running wide open. This was a clearly demonstrated case of faulty design, although on the next boat that these builders turned out the same defect was found in the boilers and remedied in the same manner. It is rather curious how designers stick to their theoretical ideas in the face of practical demonstration of their faultiness.

Another defect in boiler design that is altogether too common is restricted steam space. In many boilers the area of water level and the steam space above the water level is so restricted that the release of globules of steam at each stroke of the engines carries water over into the engines with it, due to the fact that the area of water surface is insufficient to allow the steam to escape from it without violent disturbance of the water. It is rare, indeed, where the top row of tubes could not be dispensed with, thus increasing the steam space, and adding the heating surface thus done away with by lengthening the boiler a foot or so, or slightly increasing the diameter, in many cases doing both.

The writer makes no claim to being an expert boiler designer, nor is this article written with the expectation that boiler designers will adopt any of the ideas suggested herein. Neither is he foolish enough to think that theory does not work out in practice, as so many practical men assert, but he does know that in many cases practice proves theory wrong, and these instances of experiences in practice prove the truth of this statement.

J. S.

Materials for Boiler Settings

The past few years have developed the practice of operating steam boilers at loads equivalent to 200 percent to 300 percent of their rated capacities. The furnace temperatures are high and the expense of maintaining the arches and lining of the furnace will be costly unless the setting as a whole be well designed and built by expert masons from material best suited for the purpose. This is not only true of large plants, but also of small plants containing only a few boilers. The manufacturers of boilers should furnish their customers a well-designed setting drawing and specify the best material. The writer knows of several cases of dissatisfaction with the steaming qualities of new boilers where the cause of the trouble was due entirely to a faulty design of the setting.

Not only are the present conditions of service more severe on fire brick, due to high temperatures, but to-day engineers are building very much larger combustion chambers, which, on account of the increased height and weight, cause greater compression loads. With large furnaces the contraction and expansion of the brick also cause severe stresses. At one time, not many years ago, a distance of 30 inches from grate to shell of boiler was considered ample, but to-day the shell of some return tubular boilers are set 6 feet above the grate, while many watertube boilers have a clearance of 8 to 10 feet from lower row of tubes to grate. With high furnace walls there is a tendency for the lining to bulge in toward the furnace and shear off the bonding courses if they are not made strong enough to resist this action.

Boiler Settings in General

The duty of a boiler setting is to confine to certain paths the products of combustion of the fuel so that as much heat as possible may be given to the boiler and a minimum amount lost by radiation and the leakage of air into the furnace. Boiler settings are usually constructed of red brick protected by a lining of fire brick. To improve the insulating properties and to reduce air leakage, a covering of 2 inches to 4 inches of magnesia is sometimes applied to the outside of the brick setting and the whole covered by a casing made of about ⅛-inch sheet steel.

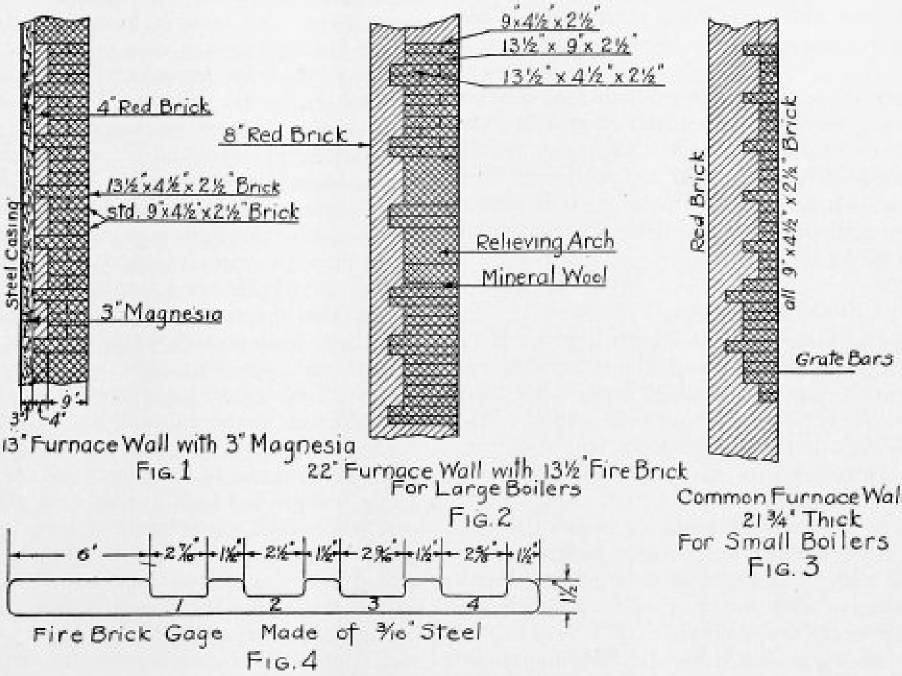
The red brick, which should be well burnt, is used on the outside of the setting and in other parts protected from the heat. The furnace lining where the temperature is the highest should be not less than 9 inches thick, of first-class fire brick. If the setting is large and stokers installed for high boiler ratings it will pay to make the lining 13½ inches thick. In any case, the fire brick lining should be bonded to the common brick by a course of stretchers every fourth course, and for a 9-inch or a 13½-inch lining it is more satisfactory to bond with 13½-inch by 9-inch by 2½-inch and 13½-inch by 4½-inch by 2½-inch bricks. If the furnace wall is large and high, as is the case with large units, two courses of bonding brick, one on the other, should be laid every six courses. This double bond will prevent the shearing of the bonding courses and the danger of the fire brick lining bulging in toward the furnace.

Proper expansion joints 1 inch to 1½ inches wide should be built in the brickwork to allow for lateral and vertical expansion. Relieving arches should be built in the walls so that the furnace lining near the grates may be repaired without disturbing the upper part of the wall. An expansion space of 1 inch to 1½ inches, filled with mineral wool to keep out soot and clinker, should be left between the bottom of the relieving arch and brickwork below.

Figs. 1, 2 and 3 show typical sections of boiler-setting walls. A standard 2½-inch thick fire brick varies in thickness from 2 7/16 inches to 2⅝ inches, so that in first-class work it is necessary to gage the bricks so that each course may be laid up with bricks of the same thickness; thus one course may be all 2 7/16-inch bricks, while the next course will be 2 9/16-inch bricks. A gage, as shown in Fig. 1, will be useful in gaging the bricks into four different sizes.

FIRE BRICK

There are a great many clays which make brick having heat-resisting properties. The brick is usually named from the element in the clay which gives to the bricks a certain characteristic; thus we have fire clay, silica, chrome, magnesia, and other fire bricks. Fire-clay bricks are most extensively used, and the clay from which they are made contains about 50 percent silica and 35 percent alumina.



13" Furnace Wall with 3" Magnesia
FIG. 1

22" Furnace Wall with 13½" Fire Brick For Large Boilers
FIG. 2

Common Furnace Wall 21¾" Thick For Small Boilers
FIG. 3

Fire Brick Gage Made of 3/16" Steel
FIG. 4

Typical Section of Boiler-Setting Walls

The melting point of fire brick arises from 1,600 degrees F. to 2,200 degrees F., but the temperature at which a brick melts is not a sure indication of its quality. In boiler furnace work a brick that becomes soft and plastic at low temperatures is of no use, even if it does not melt and run. A good fire brick must not become plastic at low temperatures, must be hard enough to resist the wear and action of furnace gases, and must have sufficient compressive strength. The chemical composition of some bricks is such that the gases from some fuels desintegrate them very rapidly, and they seem to flux and clinker badly along the fuel bed. In such cases a change in the kind of brick usually gives relief.

INFORMATION CONCERNING FIRE BRICKS

A 9-inch by 4½-inch by 2½-inch fire brick weighs 7 pounds.

One cubic foot of wall requires 17 standard bricks.

One square foot of 4½-inch wall requires 7 bricks.

To properly lay 1,000 fire bricks requires about 350 pounds of fire clay.

A cubic foot of fire clay weighs 85 pounds.

To properly lay 1,000 common red brick requires ¾ yard sand, 2½ bushels of lime and one bag of cement.

One bushel lime weighs about 80 pounds.

One barrel equals 2½ bushels or 200 pounds.

One barrel of unslaked lime will make 8 cubic feet, or 2.62 barrels of slaked lime or lime paste.

FIRE CLAY

Fire clay is used to fill the small cracks and cavities between the bricks, and in no sense can it be considered a binder or a cement, as it has very little holding power. In laying first-class brick nothing but the best quality of clay should be used. A second quality clay will not remain between the bricks, but will melt and run out under usual furnace temperatures. In some cases the melted clay will attack the fire brick and cause the destruction of the setting. In arch work the failure of the clay means the downfall of the arch. If possible, the fire clay for the mortar should be the same clay as used in the manufacture of the brick. In order to reduce the shrinkage of the fire clay the raw clay should be mixed with about one-half its volume of clay made from old fire bricks. Care should be exercised to see that the ground brick clay is finely pulverized so that the brick can be laid close together. The cementing power of fire clay can be increased by the addition of a small amount of lime—about 2 percent by volume. Fire-clay mortar should be be made and placed in tubs or barrels several days before it is wanted, so that it will be thoroughly mixed and wet throughout the entire mass.

The most common fault in laying fire brick, and the one that causes the greatest evil, is the use of a thick clay mortar joint between the fire bricks. Fire clay should be mixed with water to the consistency of a gruel or a thin batter that will readily flow. In no case should the mason be able to handle the clay with a trowel. The bricks should be dipped in the clay, then laid in place and tapped with a mallet. The thickness of clay in the joints should be almost immeasurable; for instance, twenty courses of fire brick laid in the wall should not measure ⅛ inch more than twenty dry bricks placed on top of each other. As each course of brick is laid, the mason should, by use of a dipper, pour sufficient clay over the top of it to fill any small cavities. The surplus clay should be scraped off before the next course is laid.

Mortar for Red Brick

The outer part of boiler settings are usually made of sound, hard, well-burned, uniform red brick, and for laying them a mortar composed of 15 volumes clean sand, 3 volumes unslaked lime and 1 volume of Portland cement is used. The lime should be slaked before mixing with the sand, and if possible several weeks before using. If sufficient floor space is not available for storing the requisite amount of slaked lime it can be mixed with the moist sand and put in large piles, where in due time the small particles of lime will be slaked. When the mortar is needed the lime and sand should be very thoroughly mixed with the required amount of cement and water to the proper consistency of mortar. The mortar should not stand long before using. Mortar which has stood over night is not fit for use; therefore, too much should not be mixed at a time.

The red brick should be laid not more than four courses of stretches between header courses, and should be built up together with the fire-brick lining. All bricks should be thoroughly imbedded in the mortar and all joints filled so as to reduce air leakage into the furnace. It is almost impossible to get ordinary masons who are particular about thoroughly filling in all joints.

Furnace Arches

The first step in building a furnace arch is to secure a good foundation; that is, the skewbacks must be solid and well supported for thrust and vertical load, with their faces in a common plane passing through the center of the arch. When the skewbacks are properly laid the form for the arch should be set with care and well supported. Only wedge and straight brick should be used, for, if standard arch brick are used for arches 9 inches thick or over, a serviceable job cannot be secured. Neither can a good arch be built with all straight brick by filling in with sufficient clay, because such an arch will soon ride together on the inner curve and collapse.

The bricks in the arch should not be laid in parallel rings; the joints should be broken so that the entire arch is well bonded. If 9-inch by 4½-inch wedge bricks are used a 2¼-inch bond results. This is a small amount, and in order to increase the bond, decrease the number of joints, and make a more compact arch; it is better to use a special wedge brick and tiles about 13½ inches by 9 inches, or 9 inches by 9 inches, or 13½-inch by 9-inch by 2½-inch tile may be used with a sufficient number of standard 9-inch wedge brick to form the curve. The tile and the fire brick should be made of a highly refractory clay, and should be dry when used.

The brick for the arch, as for furnace walls, should be gaged so that brick of exactly the same thickness can be laid in each row at right angles to the arch; that is, from front of arch to rear. If this is done the brick in the next row, which breaks the joint, will lay solid on two bricks without the necessity of fire clay, which otherwise would be required. In arch work, as well as in the construction of furnace walls, the fire clay must be thin and well mixed, the bricks dipped into it and shoved into place. Very little clay is needed in arch work, because the brick must be cut to fit and there should be no holes to fill. If the arch is built with care from proper material it will soon become fused into a solid mass by the action of the furnace gases.

Drying Out a New Setting

A new boiler setting must be dried slowly and properly, otherwise cracks in the wall will result. Air from fire room should be allowed to pass through the setting by opening the dampers. In a day or two the bricks will be dried sufficiently to permit of a small wood fire on the grates, when the boiler has been filled to proper level with water. The intensity of the fire should be gradually increased so that after several days the setting will be thoroughly dried and the boiler will be ready for steaming. Some engineers prefer to dry out the setting by using the boiler as a radiator; that is, steam is allowed to enter the new boiler which heats the air around the tubes, which in turn dries out the bricks. The boiler is kept free of condensation by a trap or hand regulating valve connected to the blow-off pipe. G. M. K.

Boilers and Scale

Scale is the marine engineer's bugbear. More damage is done to boilers by scale than is usually realized. All engineers know what scale is, how it is formed, and the usual means taken to keep it at a minimum. The quantity and quality of the scale depend entirely upon the chemical composition of the feed water. The importance of scale has been brought home to engineers in the same proportion as the working pressures have increased in late years, owing to the higher temperatures. Water that has been made from steam in the condenser does not form any more scale, and so it is advantageous to prevent the loss of any of this water through steam leaking at pipe connections or stuffing boxes. All of this lost water has to be made up with fresh water from the reserve feed tanks. It is, of course, impossible to keep enough water in the boilers without using a little make-up feed each watch, but it should be the object of all careful engineers to keep the quantity of this make-up water as small as possible.

About a year ago I had the opportunity of inspecting the boilers on one of the largest oil carriers in the Pacific. These boilers had been giving us a great deal of trouble and had caused a great loss of time to the owners. The pressure system of oil fuel burning had recently been installed in the vessel with good results. It was found that on the run across the Pacific it was not necessary to stop in Japan for coal and the stays in port were reduced to the small number of hours required to discharge an oil cargo, but hereon hangs the tale.

The first trouble after installing the oil fuel burners was a leaky back tube plate. This was repaired in port by rebeading the tubes. The cause of this trouble was laid to the burners, insomuch as it was thought the long flame and high-pressure caused too great a temperature in the combustion chamber. The bridges in the furnaces were built up. This seemed to help matters, but didn't overcome the trouble. The next voyage the combustion chamber backs at the furnace level showed weepings about the stays, and it was decided to build up the back of the chamber with a good lining of fire brick up to the level of the furnace crowns. Upon the vessel's next arrival in San Francisco a newer type of burner was installed which, on a twelve-hour trial, showed still better results than the old ones.

With this type of burner it was considered desirable to take out the extra bricks in the combustion chambers and reduce the bridge to its normal proportions. On the boat's arrival in the East we received word that the backs of all combustion chambers were badly buckled and one had cracked between stays. This was at Hong Kong, a port well known for good boiler makers, and it was decided to make the necessary repairs at once.

The chamber backs were straightened and extra screw stays put in where it was thought they were needed. The crack was welded up by the acetylene process successfully. This was a pretty expensive job and we hoped would last until it was time for reboilering the vessel.

Upon reaching San Francisco after a run to Calcutta, the chamber backs were again in bad shape, the stays were leaking and all the nuts on the chamber tops were burnt off. The back tube plate was again leaking and we had another big boiler job on our hands. The ship's staff was convinced that all the trouble was due to the impinging flame and the high temperatures caused thereby.

At this time I made a thorough examination of the boilers. They had just been dried out, but as yet no work had been done. After a close inspection I decided that all our trouble had been due to an accumulation of scale. The tube ends and stay ends had large deposits on them. The chamber backs were covered with a half broken off coating of scale where the most severe buckling had been, although a lot of this had been removed in making the repairs in Hong Kong. The rear tube plate was also pretty well covered. At first I could not understand how this condition came about. The boilers were small and of a design not adapted to easy cleaning, but the scaling had always been done very satisfactorily by the Chinese scaling firms.

Upon investigation I found the causes to be two in number. The first was that, owing to the oil fuel, the hours in port were very much reduced, and therefore the scaling had to be done in a great hurry. Also, owing to the rush with which the overhauling on engines and boilers had to be done, the engine staff had been forced to neglect somewhat the inspection of boilers after scaling had been done. The second reason was that boiler scaling had very recently become the object of cut prices and keen competition among the Chinese firms. The low figures in vogue necessitated the hiring of smaller boys than usual, and fewer to a job. Scaling was done day and night, as a rule, with one going on all day and another at night, but under the present circumstances the same poor boys were doing a twenty-four-hour shift. Boiler scaling is never done better than is required by the engineer in charge, and when time is so limited and the chipping boys of such a young age, it is mighty hard to get a good job. The oil fuel boats also suffer because they do not have a large gang of firemen that can be sent into the boilers to chip.

The above incident is one of the many that have caused big boiler repair bills, and is offered as a suggestion to all engineers to be sure it is not scale before looking further. The vessel in question was retubed and the unfairness in all plates removed. Since then we have been getting good scaling jobs and have had no trouble to speak of.

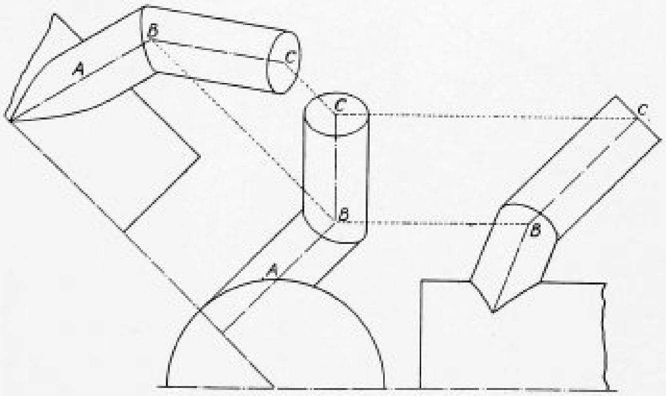
F. K. R.

Injectors, Lubricators and Boiler Attachments.—Location of all boiler attachments for safety, accessibility and convenience of operation and repairs is a matter which may appear to some to be of small importance, yet many involve great expense if not properly placed. An injector or lubricator placed beyond the convenient reach of the engineer does not receive the attention and fine adjustment that economical service would demand, or that the device might receive if properly placed. Sander valves, hydrostatic flange oilers and other boiler attachments are equally important.—*From a report on Efficient Operation of Locomotives presented before the Traveling Engineers' Convention.*

Personal.—C. R. Church, master mechanic at the Union Railroad shops at Hall, Pa., who was seriously injured over a year ago, is back at his office. A host of friends are congratulating Mr. Church upon his recovery and return to duty.

Layout of Bent Pipe Leading from a Large Cylinder

The following layout, given in reply to a request from one of the readers of The Boiler Maker, who submitted the outline of the parts as shown in Sketch A, includes a system for accomplishing, in a simple manner, 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 projecting 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.



Sketch A

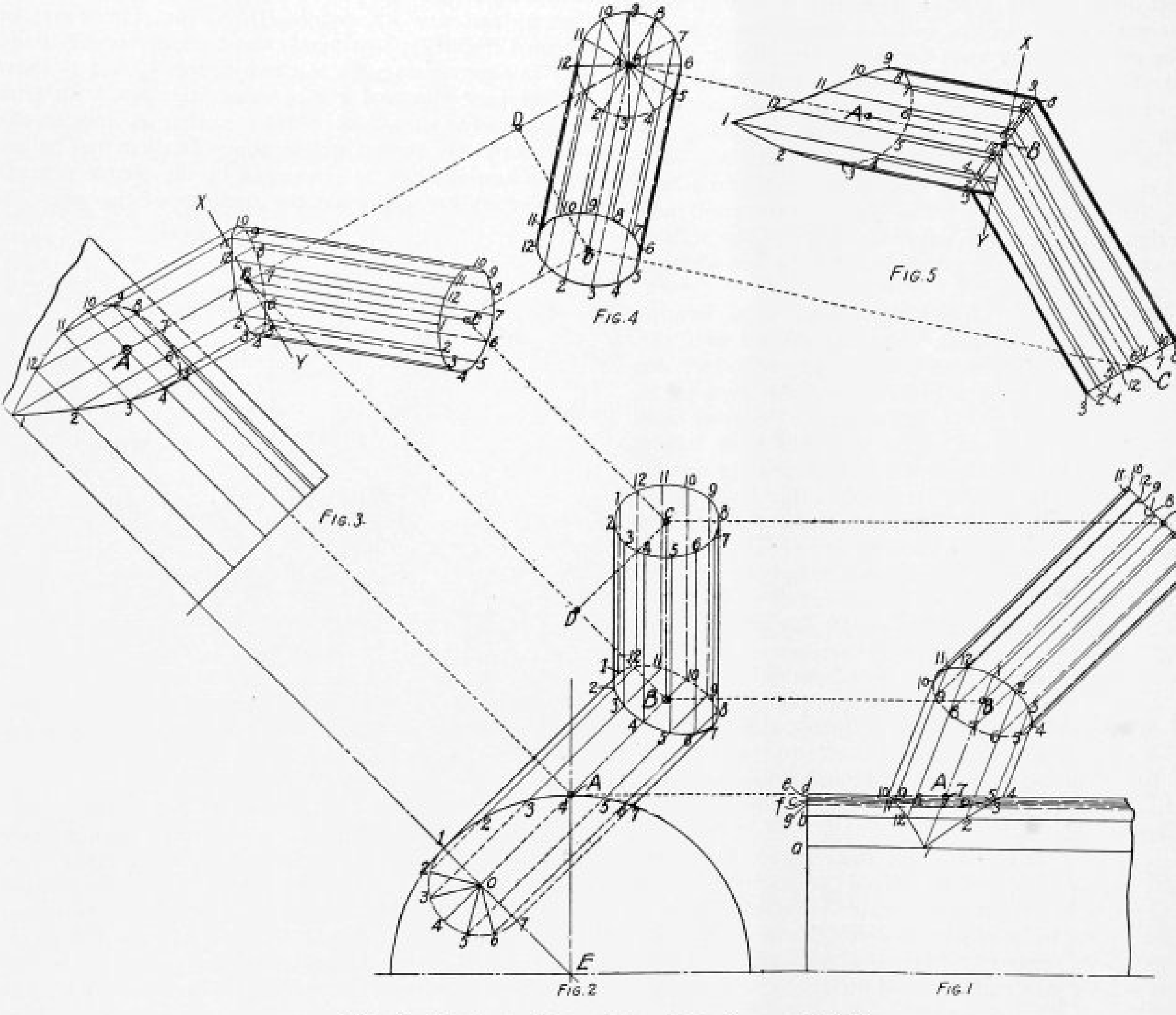
Obtaining the Necessary Views

In general, the drawings for a bent pipe leading from a large cylinder 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* and *B-C* represent the axis or centerline of the bent pipe; the part *A-B* piercing the cylinder at 45 degrees and the part *B-C* making an angle of about 120 degrees with 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 axis *A-B*, Fig. 3, and taking some point as *A-B*, Fig. 4. About *A-B*, 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-D* as shown equal in length to *B-D*, Fig. 2, and construct a perpendicular *D-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. 1.

Determining the Intersections

The drawings from which Figs. 1 and 2 are constructed will probably not show the intersections of the two pipes and pipe and cylinder in anything but approximate outline; also, if the drawings are blue-prints, these will not be accurate, anyway, and should not be transferred in laying out. To find these intersections, first in Fig. 2

draw the semi-circle 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. These points of division are then projected, as shown, cutting the cylinder and pipe in points 1, 2, 3, etc., on the semi-circle about *E*, and in 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*. Now these same elements are constructed on part *A-B* of Fig. 1 in exactly the same manner as in Fig. 2, care being taken that the proper order is followed in numbering them. By projecting the corresponding points of Fig. 2 over to Fig. 1, the intersection of the cylinder and pipe is found as shown in Fig. 1, at *A*, by points 1, 2, 3, etc. The intersection at *A*, Fig. 3, is then found in exactly the same manner.



Method of Projecting Twisted Pipe Until Shown in Full Size

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 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*. Now 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 we obtain the section about *A*, Fig. 5.

Locating Elements in B-C

In Fig. 5 draw a line through *B*, bisecting angle *A-B-C*, 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, in section at *C*, Fig. 5, giving points at *C*, Fig. 4, as 1, 2, 3, etc., forming the ellipse about *C*. Now, in Fig. 5, measure elements 1-1, 2-2, etc., for section *A-B* (not to line *X-Y*, but as shown) and lay these distances off, in Fig. 3, *from* corresponding points 1, 2, etc., in section about *A*, giving points in the outline about *B*. Then from points 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 get the section at *C*, Fig. 3. The sections at *B* and *C* can then be projected into Fig. 2 from Fig. 3, and section at *B*, Fig. 2, 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 two sections of the pipe in their true length and position relative to each other, this view represents the pipe as it would appear if taken off the large cylinder and laid on a horizontal table. 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 3-3, 4-4, 5-5, etc., are laid off equal to 3-3, 4-4, etc., of section *B-C*, Fig. 5. The curved line *R-S* is then drawn through the points obtained by so doing and line *M-N* is drawn tangent to the highest point of curve *R-S*. This tangent *M-N* will naturally be horizontal or parallel to *O-P*. The curved 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. Line *K-L*, which finishes the pattern outline, is obtained by laying off 3-3, 4-4, 5-5, etc., from line *U-V*, equal to the elements 3-3, 4-4, 5-5, etc., for section *A-B*, Fig. 5. Then the patterns for the sections of the bent pipe are represented by *O-P-S-R* and *U-V-L-K*.

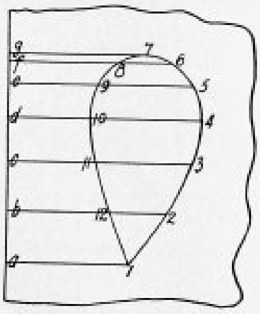


FIG. 6

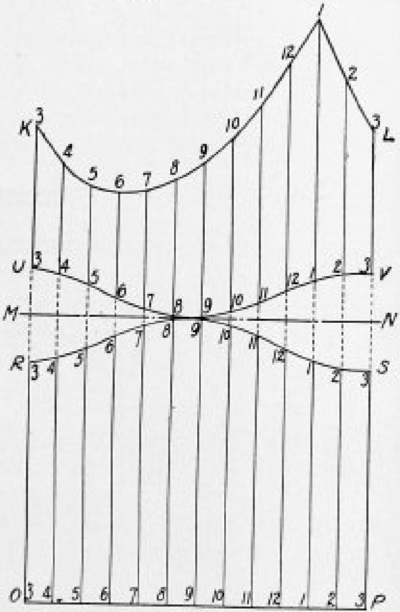


FIG. 7

Patterns

HOLE CUT IN LARGE CYLINDER

The next operation is laying out the hole in the cylinder as shown in Fig. 6. Points *a, b, c*, etc., are located on a vertical line, such that *a-b, b-c, c-d*, etc., will equal respectively 1-2, 2-3, 3-4, etc., on the circle about *E*, Fig. 2. Then from Fig. 1 to Fig. 6 transfer the distances *a*-1, *b*-2, *c*-3, etc., as shown, and obtain the outline of the hole as it would be cut from the flat sheet.

Discharge Through Safety Valve

In reply to a question asking how to figure the amount of steam which a 3-inch pop safety valve will discharge, the following answer was given in a recent issue of *International Marine Engineering*:

The data necessary are steam pressure and quality, area of opening of seat and amount valve lifts; knowing these, the discharge can be figured approximately, using the thermodynamic formulæ for flow of steam through an orifice. The best information on this subject is contained in a paper to the American Society of Mechanical Engineers, by E. F. Miller,† in which are given the amounts *actually discharged* through 3-inch and 3½-inch valves of different styles, and under different conditions. The following table is compiled from this:

TABLE OF STEAM DISCHARGES OF CROSBY MUFFLED LOCOMOTIVE POP SAFETY VALVES (WITH ROUNDED SEAT EDGE) IN POUNDS OF STEAM PER HOUR.

Valve Size.	Pressure By Gage, Lbs	Lifts (Inches)			
		.02	.05	.08	.10
2½...	160	1,819	4,380	6,599	8,078
	180	2,027	4,882	7,354	9,003
	185	2,080	5,007	7,543	9,235
	200	2,235	5,383	8,110	9,928
	205	2,288	5,508	8,299	10,159
3.....	160	2,217	5,354	8,033	9,809
	180	2,470	5,967	8,952	10,932
	185	2,534	6,120	9,182	11,213
	200	2,724	6,580	9,872	12,055
	205	2,788	6,733	10,102	12,336
3½...	160	2,647	6,326	9,437	11,361
	180	2,950	7,050	10,517	12,662
	185	3,026	7,231	10,787	12,987
	200	3,253	7,774	11,598	13,962
	205	3,329	7,955	11,868	14,288

EXPLOSION FROM A SALT CHAMBER IN BOILER OF S. S. CAMILLO.—A summary of the report of a recent explosion on board the *Camillo*, a British vessel of 5,135 tons gross, shows that the accident was due to the generation of steam underneath an accumulation of salt in the starboard combustion chamber of the port boiler, this accumulation being due to leakage from around the stays in the back plate of the combustion chamber. Trouble was experienced through the high-pressure piston-rod gland leaking, which necessitated supplementing the boiler feed from the sea, as the evaporator was unable to maintain the water level in the boilers. Examination of the explosion showed an accumulation of salt and ash about 21 inches deep, completely filling the space between the fire bridge and the back of the combustion chamber and having a thick tough crust covering, similar to ordinary cement concrete.

SUPERHEATERS AND BRICK ARCHES.—The advantages derived from high-degree superheated steam are many, and with proper handling and care superheater locomotives will produce remarkable results in increased efficiency and economy over saturated steam power of equal size and similar build. Brick arches, when used, should be kept in perfect condition in order to insure maximum efficiency from their use. Locomotives drafted with the use of an arch will, as a rule, be more severe on fuel should the arch fail and the locomotive be run without it. —*From Report on Efficient Operation of Locomotives Presented at Traveling Engineers' Convention.*

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† Results of tests on the discharge capacity of safety valves. 1910.

Hydraulic Pressing—VI*

BY C. W. R. EICHHOFF

There are many plate shops where no steam hammers are to be found which, however, are equipped with a sectional flanging machine. In such a case many forging operations can be performed on this machine. In a previous article I have mentioned the advantages of hydraulic forging over the hammer method, and it is not necessary to repeat anything in this respect.

The writer was at one time in charge of a boiler shop without a steam hammer. All forging had to be done by hand, which took considerable time and increased the labor cost to a large extent. This was especially the case with forgings for special mudrings for firebox boilers, both of the circular and rectangular form. The first experiment in this line was to find out to what extent the flanger could be used on welding operations.

Two pieces of iron 2½ inches by 3 inches were taken for the experiment. The different kinds of welds were tried and the flanging machine gave highly satisfactory results as far as the welding was concerned. The experiments also showed that in all future operations the stretching of the material had to be reckoned with. The different welds tried out were:

Fig. 1. The scarf-weld. The welding proper was very satisfactory, but when completed the stretching of material in the direction indicated by arrows was considerable.

Fig. 2. The lap-weld proved unsatisfactory on account of surplus of material, causing excessive stretching.

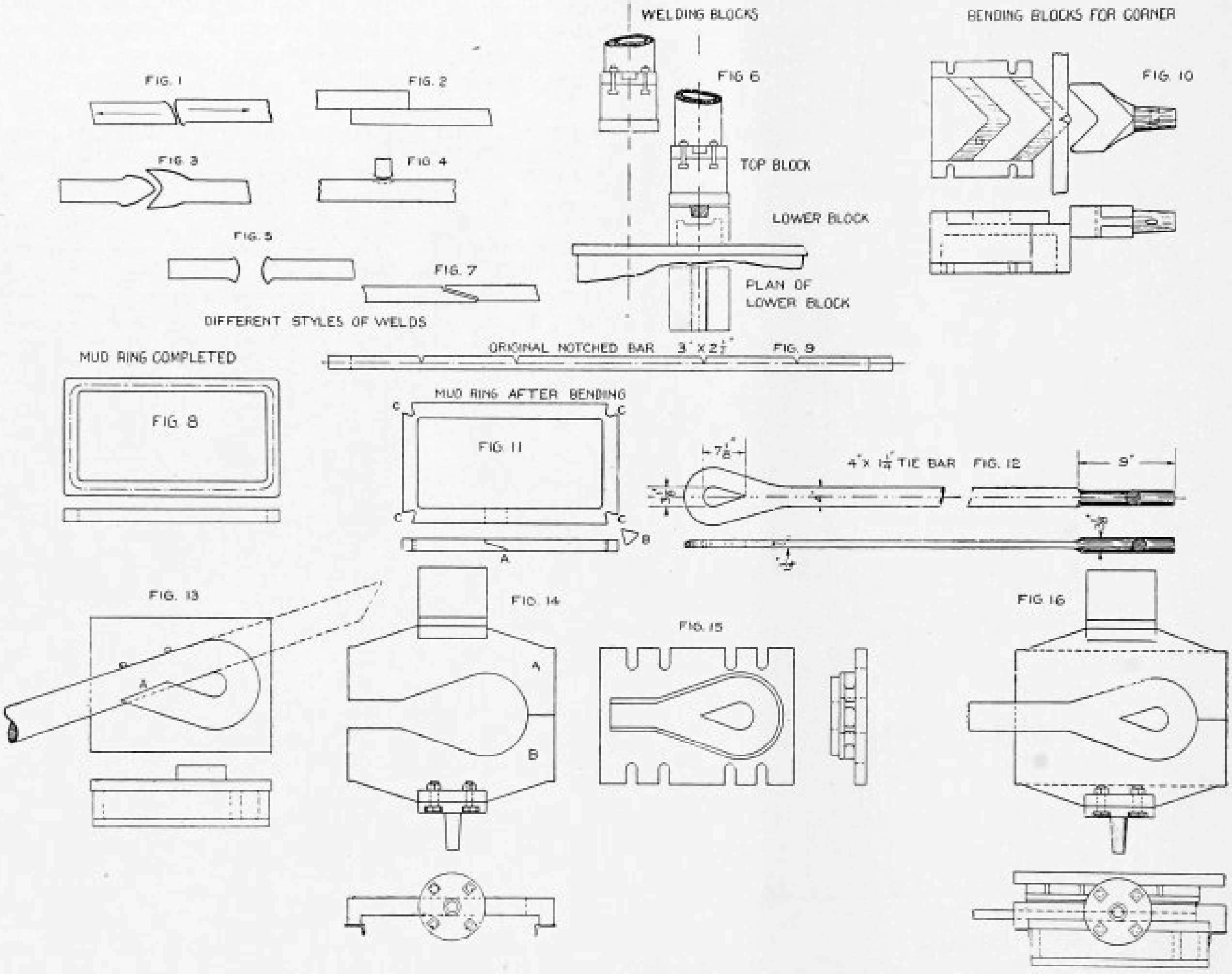
Fig. 3. The cleft weld showed the same result as the lap-weld.

Figs. 4 and 5 show the butt and jump weld. Here the shortening of the product has to be considered. Neither of the above welds were satisfactory for the purpose in view on account of the uncertainty of stretching and shortening. The welding blocks used for these experiments are shown in Fig. 6. The bottom block, fastened to the platen of the machine, was provided with a groove 2⅜ inches by 3 1/16 inches and somewhat tapered, as shown in the sketch.

The pieces to be welded together were simply placed in the groove of the bottom block and the top block brought down to squeeze the pieces together. The forging projected about ⅛ inch above the upper surface of the lower die, as indicated in Fig. 6.

A more satisfactory result was obtained when the two pieces to be welded together were similar to the shapes shown in Fig. 7.

After these preliminary experiments the writer started to forge mudrings. Let me mention here again that before going ahead with such work it should always be borne in mind that it might not pay to go to the expense of making dies and formers if only one or two pieces have to be manufactured; but for mass production it will always pay to make blocks.



Forging Operations Performed on the Sectional Press

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* Continued from July issue.

The forming of cylindrical mudrings on the sectional flanger, including the welding, is rather a simple affair; but when it comes to the fabrication of rectangular shapes the work becomes more difficult. It is very important that the man operating the machine or in charge of the work is an intelligent person, who takes an interest in the work. He deserves higher wages than the average journeyman in the shops and will always be a very valuable assistant in all kinds of new work.

After a few experiments it was found that the best method to make mudrings of the rectangular form shown in Fig. 8 is as follows:

The bar of 2½-inch by 3-inch iron, from which the ring was to be made, was notched in four places which will form the corners of the ring. This is shown in Fig. 9. Proper allowance for welding should be made. The bar was then bent in forming blocks, sketched in Fig. 10, and upon leaving the blocks it had the form shown in Fig. 11. This ring was welded together first at *A* and then wedge-shaped pieces *B* welded into the corners. All the forming and welding operations were performed in the machine. Finally the ring was run again through the forming blocks at the groove *G* to straighten and smooth it up. It then had the proper form as represented in Fig. 8.

At the beginning the fabrication of the mudrings by the sectional flanger was rather problematical, but after the men on the machine became familiar with the work very good results have been obtained and the time required reduced about 60 percent as compared with previous handwork.

BENDING OPERATIONS ON HYDRAULIC PRESS

What interesting work of complicated structure can be done successfully on the sectional flanger may be shown by the following example. It was required to fabricate a number of tie bars of from 8 to 16 feet length. The tie bar is shown in Fig. 12; it is made of 4-inch by 1¼-inch material and provided with an eye on one end and an upset 3⅛-inch diameter by 8 inches on the other end. Being of a rather odd shape, it was out of the question to sublet this work, and it was decided to manufacture same in the boiler shop. The sectional flanger was used and the work turned out very satisfactorily, standing the most severe tests.

The eye as well as the upset were both formed on the sectional flanger with properly designed formers. For the forming of the eye the bottom block, Fig. 13, was fastened to the platen of the machine under one of the vertical rams; then the 4-inch by 1¼-inch bar was heated and bent roughly by hand, lever and sledge around the bit on said block, as indicated in the sketch. The eye was then welded at *A*, using a welding compound, by bringing the top block (Fig. 15), which was fastened to one of the vertical rams, down on the forging.

The forging being welded was then finished by the use of the formers shown in Figs. 14 and 15. Part *A* of this die was fastened stationary on top of the block (Fig. 13) by dowel pins (not shown) and a tail block *T*, fastened to the platen of machine. The part *B* was fastened to the horizontally moving ram. The latter part *B* was adjusted to slide on top of the bottom die, and was guided by adjustable angle irons as shown in the elevation of Fig. 14.

The top block was brought down again and the eye was finished, showing excellent workmanship in appearance, as well as from a mechanical standpoint.

The position of the different blocks just before the eye end is removed from the machine is shown in Fig. 16.

To do the work economically, of course, it is necessary to systemize the work; that is, to rough bend all the bars first, then weld them and finally finish them. If properly handled there is no change of dies necessary.

In the next article I will describe and illustrate the forming of the upset end of these bars.

Big Things and Little Details

How Careful Attention to the Small Details Leads to Promotion to Responsible Positions—A Lesson for the Ambitious Boiler Maker

BY JAMES FRANCIS

"Oh, come on, Bill. What's the use of fussing over that job any longer? That work was done half an hour ago and you've been just puttering around there ever since. Come along out of that."

"Just hold your whist, Pat. I'll never leave a bit of job with the corners sticking out to rake yer fist agin' as this one is. And there's a bit of calking which don't set snug yet. As soon as I give that a bit of a set, I'm done and I'll be wid yees."

"Oh, pshaw, Bill. What good is it to be always fussing with corners and spots? Welt the job together, says I, and then be done with it. What do we get out of putting in a whole lot of time puttering and fooling around corners and calking?"

"You just wait, Pat, and see what good all the 'putterin,' as you call it, is. This is going on two years I've been with the company, and divil a bit of poor work has ever got out from under me hand—and faith, none of it won't get out as long as I see it first."

"Oh, come along, Bill. The boys are waiting for us at Charlie's. We want to be in with them on that racket to-night."

"And faith, Pat, that's all the likes of yees cares for—just to be in a big racket with the boys. Faith, if ye'd work half as hard for the boss as yees do for the barkeeper, ye'd be superintendent of the shop by this time."

"Quit yer blarney, Bill. There's nothing doing as super for the likes of you or me."

"An it's myself that's not so sure of that, Pat. I don't want to be a journeyman all me life; and if I don't know how to do work well, and do it that way, the manager will sure have no use for me in anything better than a journeyman's job."

"Oh! It's that way, is it, Bill? Working along to be foreman? Well, that's rich, all right. Just wait until I put the boys next to that! Why, it's the best joke I've heard this month."

"What's that, Pat? What is such a good joke?"

"Why, Mr. Francis! Bill here has got it into his head that he can work up to be foreman, and then get right in 'on the carpet' with the general manager and the stockholders. Oh, Gee! But that's a funny idea of Bill's."

"Perhaps it's not so 'funny' after all, Pat. The 'Old Man' has had his eye on Bill for some time. He knows that Bill always does his work well and won't let a job go out until it is just right. And, Pat, let me tell you something—on that new Lowder job which we commence next week, Bill is going to have charge of the whole gang under Mr. Hendie, who will be on the job part of the time, but will run the Wilkens job, too. So you see Mr. Hendie can't be around much of the time and Bill will be practically foreman of the whole job."

"Great sheets, Mr. Francis! Why, that's a big promotion for Bill. I sure would like to have one like it myself. What are the chances, Mr. Francis?"

"The chances are not very good just now, Pat. When this matter came up your name was mentioned as well as Bill's as foreman of the job, but the superintendent and the general manager both decided in favor of Bill. They said: 'We know we can depend on Bill. He never leaves a job until it is as near right as he can make it, and he will never let any poor or slighted work pass him, even if he has to stay overtime, all by himself, to set matters right.' So you see, Pat, Bill has a reputation for doing good work, and so have you, for the 'Old Man' said he thought you could get out the work quicker than Bill could do it, but he was afraid there might be something passed which would come back to them, and he knew beyond a doubt that if Bill passed a thing, that he would never have to worry over that thing any more."

"Why, Mr. Francis, I'm sure I am as good a workman as Bill is, and I have been longer with the company. It don't seem just right to pass Bill over my head like that. Now, does it?"

"Pat, the trouble is right with you, and you might have had this job just as well as Bill if you had only looked after details a bit more. And, Pat, that is all there is to engineering work of any kind—just a whole lot of detail to be carried out and dealt with—detail, detail, and then more detail. Take the detail out of a job and there would be nothing left but a few points hanging to a line—detail is the whole thing, and the better you can handle the details, the better workman, foreman or superintendent you will be. Now, that is where Bill has got a lead. He looks after the details with a sharp eye and never lets one get past until it is exactly to suit him. You and the boys laugh at Bill because he is so 'fussy' over his work, but, Pat, you see now what looking after detail amounts to?"

"I do that, Mr. Francis, and I wish I had paid more attention to such things; I would, too, if I had known what it would lead to, but I didn't know."

"Pat, when you lay out a sheet, if the straight edge slips over so little, the job is damaged or spoiled, isn't it? And when you are stepping the dividers along a line for a row of holes, a slip of a quarter of an inch will spoil the whole sheet, won't it?"

"It sure will, Mr. Francis, unless you find it out and fix things."

"Then, Pat, you see right off the reel that it's the little detail that makes or spoils the big thing; and unless we are everlastingly on the job with the least of the details, then the big things won't amount to anything and our work is wasted?"

"That's a fact, Mr. Francis. I didn't ever think of it before, but it's so all right and I would be a better workman now if I had realized it before."

"Never mind, Pat. You can begin right now. It is never too late to start a good bit of work, and a man is never too old to learn new and better things."

"Say! I've a mind to cut out that racket with the boys to-night, and put in the time studying that boiler maker's book Bill let me take last Sunday."

"Go to it, Pat. If you will do that, and keep it up, there is no reason why you should not be right at Bill's heels on the next big job which comes along. You are a good workman, and if you will only learn to attend to the little details, the general manager and the superintendent will push you right along as fast as they can. It is just the same with them, Pat. With all the big things they do, and all the large jobs they handle, they have to attend to details just as closely as Bill does. If they didn't do that way, where would the work be? How would you do anything if they overlooked sending the coal along with the rivet forge, or forget to order rivets for the job? And, Pat, just where would you and all the gang be if the office should neglect to provide the 'sugar' for the pay envelopes Saturday night? Why, if they are five minutes late and keep you standing in line at the pay window, you all think it a terrible thing; yet you think nothing of cutting things at five o'clock, leaving your hammer hanging in the air, letting a loose rivet or two go as they are, and perhaps passing a couple of crooked rivets which you know should be cut out before they are forgotten."

"I'm going to try your way, and Pat's way, Mr. Francis, and I'm just going to do the best I can to look after the details better than I have been doing."

"That's the talk, Pat. Just you do that—and stick to it—and I'll guarantee that within a year you will be drawing a fatter pay envelope than Bill will get on the Louder job! And, Pat, here are a couple more detail things: What do you think would happen if a draftsman didn't pay close attention to details when he lays out a new boiler? What would be the result if he spaced the longitudinal seam rivets ¼ inch too far apart and let the net plate section over-balance the rivet section? Wouldn't there be a howl all along the line, from customer to general manager and superintendent when it was found that some rivets were spaced too wide? You know, Pat, that a boiler is never any stronger than the weakest part, so a single slip in the design would lower the rating of a boiler just the same as would a bit of poor work in putting it together."

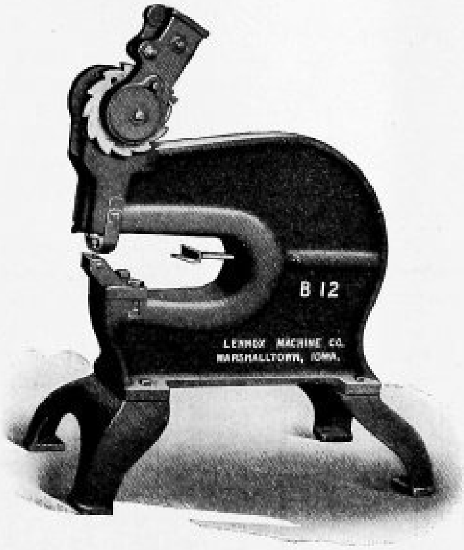
"Say, Mr. Francis, I didn't realize before how mighty important it is that every little thing about a boiler should be just so and just right. But I'm beginning to see it now, and I tell you, Mr. Francis, I never will let anything get past me after this, now that I realize how important it is."

"That's the talk, Pat. Just you stick to that and you will be in Bill's class—and stay there. Just you realize that the whole safety of a steam boiler depends upon the way in which one of the rivets is located and driven, or the manner in which a hole is laid out and punched, and you will see the necessity for taking extra good care that the hole and the rivet are exactly right."

"Yes, Mr. Francis, and I see now that the safety of the boiler and of property and of human life depends upon each and every one of the hundreds of holes and rivets in the boiler, and that sure makes a man think and take notice of what is being done in the boiler shop. Why, when I think that a bit of poor calking may start a leak and cause a section of sheet to waste away until it becomes dangerous and causes accident—when I think of that, you may be mighty sure that I will look out for all the seams and joints which go through my hands."

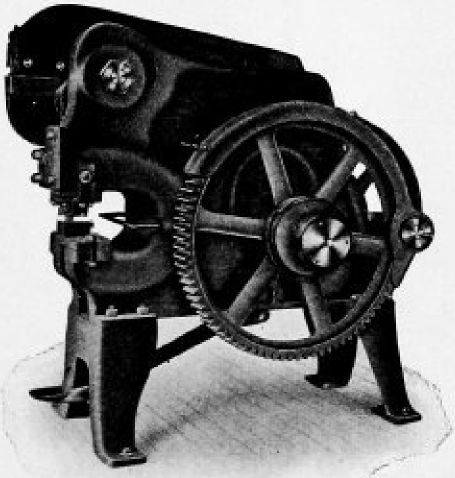
"That is just right, Pat. When you once realize that the best engineering, in the biggest jobs ever done, is only giving close attention to a whole raft of little details—things which don't seem to amount to anything when each is taken alone and by itself, but things which make up all there is to building a 10,000-horsepower boiler plant, a Panama Canal, or the boiler of a peanut roaster—that's

Small Punches and Shears



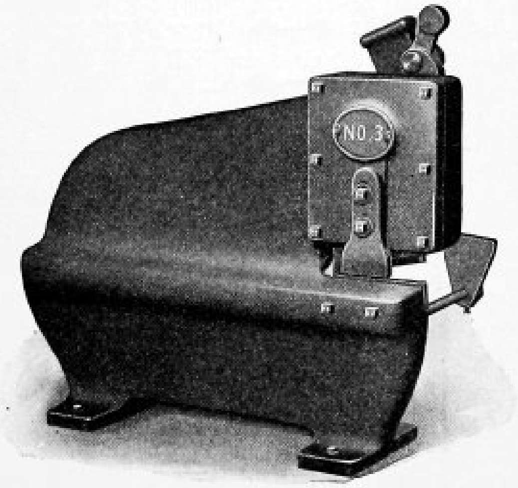
Hand Lever Punch

THESE Punches are built in capacities ranging from ¼ through ¼ inch to 1 inch through ¾ inch, or their equivalents. The throats vary in depth from 4 to 18 inches. Each machine is furnished with a stripping attachment, an improved adjustable throat gauge, a hand lever, a punch and die.



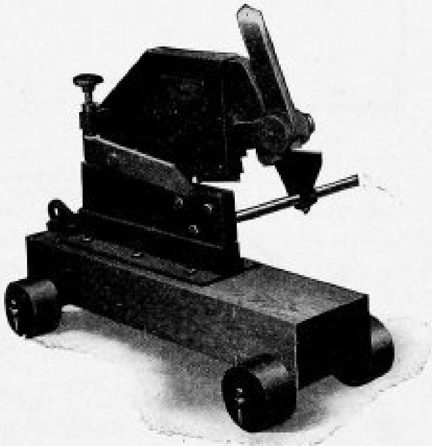
Power Combined Punches and Shears

THESE Power Combined Punches and Shears are built with punching capacity up to 1 inch hole through ¾ inch material, shearing up to 1 x 8 inches flats, 2¼ inches rounds, and 4 x 4 x ½ inches angles. The frame is built in one piece, making a much more rigid machine than if built in parts and bolted together.



Hand Lever Splitting Shears

WE build Hand Lever Shears to handle plates from ⅛ to ½ inch in thickness. The frames are offset so that sheets of any width may be split. The leverage is so arranged that these machines can be easily handled by one operator.



Universal Steel Frame Hand-Lever Shear

THIS shear is built of forged steel plates planed to size, then pined and riveted together. This makes it much stronger and lighter than the cast iron type. It is especially suited for heavy outside work, where portable machines are necessary. The machines are mounted on trucks, but can be furnished with or without as desired.

The machine will split plates up to ⅜ inch, will shear flat bars, 1 inch rounds and ¾ inch squares. Weight without truck 350, with truck 450.

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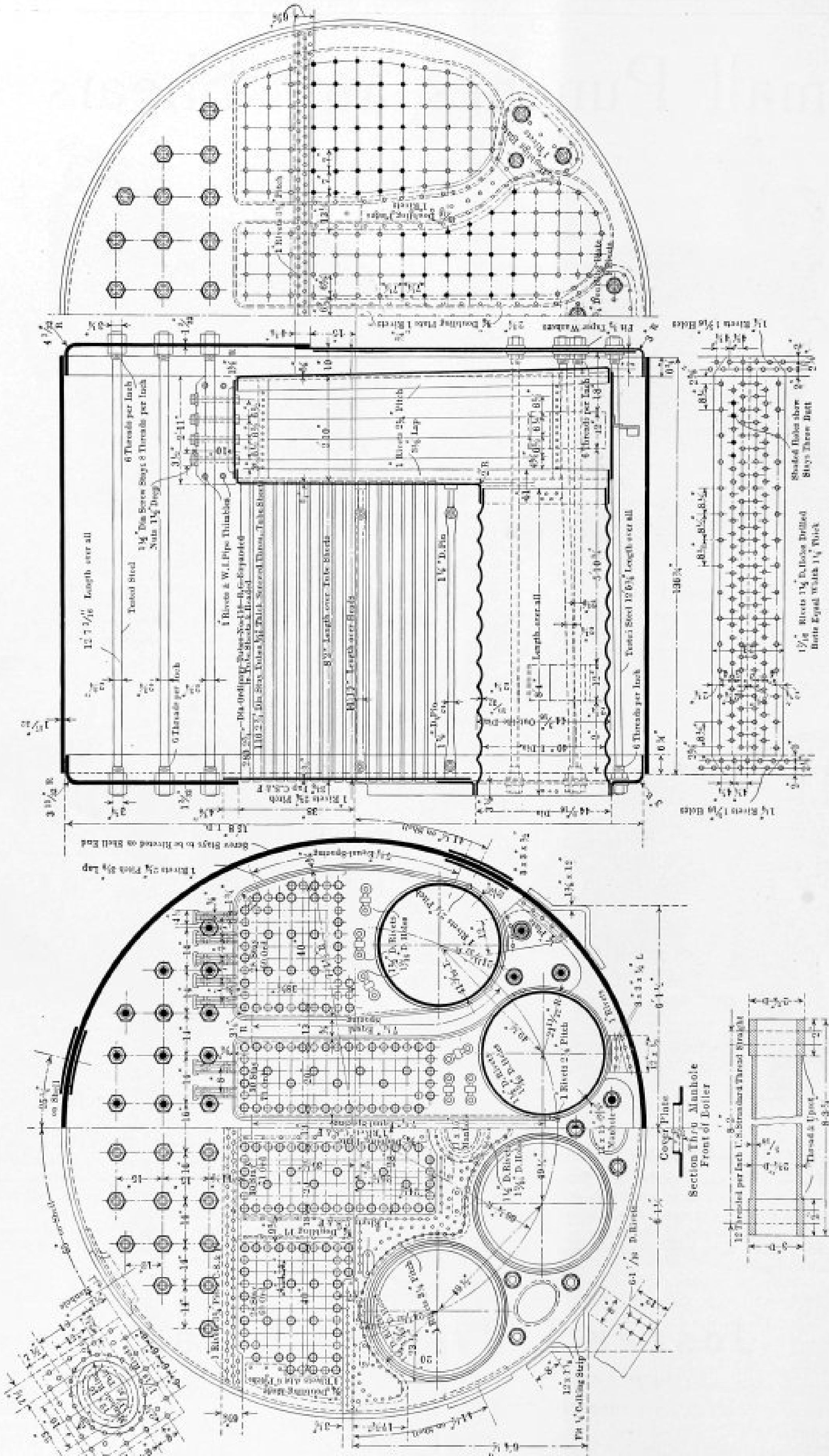

Details of Scotch Boilers Installed on the New Mallory Line Steamships *Neches* and *Medina* recently Built at the Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

what detail amounts to, Pat, and you see that if we don't make the details just right, the finished work is good for nothing, and the designer and the workmen are worthless, too."

"That is sure some truth, Mr. Francis, for if any of the details were not right, there sure would be nothing right about the whole boiler—or the whole plant, for that matter. But say, Mr. Francis, isn't there such a thing as giving too much attention to details? The general manager has got to know that the details are all handled O. K., but he can't spend the time to look at each one personally as it is made. If he did, he would be only a boiler maker, and not a bit of a general manager. How about that?"

"You are right there, Pat, but the general manager does look after the detail all right. He has the superintendent to sift out the details among a lot of foremen whom he has watched until he is sure they will each look after the parts of the work given to each one of them. He knows that the draftsman—barring mistakes, which we all have to contend with—will take care of the details of design, and that he can trust that part of the work to him and his assistants.

"And then, Pat, the general manager knows that the superintendent has men who will attend to the details of laying out, punching, riveting, calking, and all the other little things which must be watched and attended to. And the foremen, in turn, pass the matter of details along to you workmen and expect you to see that your share is done right, or reported if not just right.

"And, Pat, in this manner the work has come down the line, right to you and to Bill, and you have seen the results. You found that the general manager, the superintendent and each of the foremen were so wise to details and the way they are handled by each man in the shop, that they were able to put their fingers right upon you and Bill as two good workmen, both capable of handling big jobs, but they were also wised up that Bill gave more attention to detail than you did, and for that reason they shoved him up to the Louder job. See, Pat?"

"I do see, Mr. Francis, and see very plainly where I have been fooling only myself, where I thought I was putting it over on the boss and the company, by getting rid of a lot of hard work which didn't seem to amount to anything much, but which I now see is more important than anything else done in the shop. You may be sure, Mr. Francis, that I never slighted details with any idea of doing anything wrong. I only didn't realize the great importance of the little things, which don't seem worth thinking about twice, before you are wise to them. But you may be sure, Mr. Francis, that I am wised up now, and the details look as big as ball games to me. You may be sure that I will look after everything which comes my way, and that none of them will get away from me or from the men in my gang or under my charge.

"I realize now that I am one of the eyes of the general manager, and that a part of his work and responsibility depends upon me, and you may be sure that I'll do it, and do it right. I'm much obliged to you, Mr. Francis, for this talk, and I'll not only take care of my end of it, but I'll pass it right along to each man and boy who runs up against me. Why, if every man and boy once realized the value of the work he was doing, and of the things intrusted to him, there never would be any poor work, slighted jobs or spoiled stock. I'm just goin' to put all the boys wise to these things, Mr. Francis, and make them see things as you have shown them to me."

Scotch Boilers for New American Freight Steamships

On the opposite page are shown the detail plans of one of the Scotch marine boilers, installed in the new freight steamships recently built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Mallory Steamship Company, of New York, according to designs by Theodore E. Ferris, naval architect and marine engineer, New York. The two new ships, named *Neches* and *Medina*, are 421 feet long, 54 feet 3 inches beam, 35 feet 9 inches molded depth, and each has a deadweight-carrying capacity of 6,600 tons of freight. They are designed for a speed of 14 knots and are propelled by triple-expansion engines of 4,100 indicated horsepower, driving single screws.

Steam is supplied at 200 pounds per square inch working pressure by four four-furnace Scotch boilers, 15 feet 8 inches inside diameter and 12 feet long over heads, fitted with heated forced draft. Each boiler has 2,843 square feet of heating surface distributed as follows: Tubes, 2,293 square feet; furnace, 222 square feet; combustion chambers, 328 square feet. The grate area of each boiler is 73.5 square feet, making a ratio of heating surface to grate area of 38.8 to 1. The boilers are designed to evaporate 235 pounds of water per square foot of grate area, or 17,270 pounds per hour per boiler.

The boiler shells are 1 17/32 inches thick, the upper heads 1 3/32 inches thick, and the tube sheets 3/4 inch thick. The tubes, of which there are 396 to each boiler, are 2 3/4 inches outside diameter and 8 feet 1/2 inch long between tube sheets. The furnaces are 40 inches diameter, with grates 5 feet 6 inches long.

The forced-draft equipment consists of two Sturtevant multi-vane fans located in the engine room, driven by vertical 6-inch by 5-inch blower engines. The fan-wheels are 3 feet 4 3/4 inches diameter, and are designed to maintain a combustion of 25 pounds of coal per square foot of grate, creating a pressure of at least 1 1/2 inches of water at the boiler furnaces. The air is drawn from the fire rooms.

The ash-handling gear consists of an endless-chain conveyor, with a sheet-iron casing, dumping the ashes into a hopper on the main deck.

Repairing Boiler Tubes

BY A. N. LUCAS

The subject of repairing locomotive boiler tubes while out of boiler is an old one and has been brought out at different times. Still I find there are a number of roads that do not appear to make use of the best practice in caring for flues and preparing same ready to go back in the boiler.

It has been the practice of the Chicago, Milwaukee & St. Paul for a number of years, when tubes are taken out of a boiler, to rattle same carefully; that is, not to rattle them any longer than necessary. One or two hours should be ample, but many times flues are placed in the rattler and allowed to hammer themselves to pieces four or five hours, and sometimes longer, and when they are removed from the rattler they are shown to be highly polished and in many cases cracked and badly split. This is due to the poor judgment in rattling flues.

When flues are taken from the rattler we make a careful inspection for pitting and light weight. If any show indication of being light, flues are weighed up on scale that we have for that purpose near flue rattler. Two-inch flues weighing less than 1 2/3 pounds to the foot are not put back in a locomotive boiler. Two and one-fourth inch flues weighing less than 2 pounds to the foot are not put back in a locomotive boiler. The best of these flues are assorted and used in stationary or pump boilers.

Our next operation is to cut the flue to length for welding. This is an extra operation, due to the fact that we weld on both ends of our flues alternately, and to avoid having a weld come too close to the front flue sheet, which might bother when rolling same, we find it absolutely necessary to cut flue to length for welding.

We cut our steel flues up in pieces 5 inches to 7 inches, 8 inches or 9 inches, as the requirements may be, for welding on or safe ending. These pieces are cut off on a machine we have for that purpose, which cuts off the piece, bevels and removes the burr at the outer end in one and the same operation.

We believe in taking the burr off of the inside of the safe-end piece at the firebox end. This so that flue will pass over flue mandrel on welding machine readily. By removing this burr it also allows us to use a larger mandrel on flue welding machine. This helps us to keep the flue the original size.

Many roads do not take time to remove this burr or use the larger mandrel, but their flue shows to be contracted at each weld. We are using for a 2-inch flue a 1 11/16-inch mandrel, which is about the original inside diameter of flue.

After the flue is cut to length we heat and open up all flues at front end to fit flue hole in front flue sheet. This to avoid shimming, which takes time and is poor practice.

Many roads are still welding on but one end of the flue, in some cases as many as five and six welds, and every weld on a flue is one more chance for a failure.

Many times flues are slightly overheated at weld and become quite thin just back of the weld. Leaks do develop at these points and flues do break in two at these welds, sometimes in the rattler and other times while in service. So I say the less welds you have on a flue the better.

A flue with five or six welds at one end might weigh up all right, but the old part or the original would not be good for further service.

As I stated before, our practice is to weld on both ends of the flue alternately, and flue put in service to-day with safe end at firebox end. This flue may run from two to three years, and when removed the bead is cut off at firebox end, and at the front end with flue cutter about 1½ inches from end of flue.

Now before welding this flue we cut to length for welding and apply the safe end piece on the opposite end of flue. Then, when flue is welded, we cut to proper length to go in the boiler, but only have to cut 1 inch or 1½ inches off of the original safe end.

This flue again goes into service for another two or three years, and when flues are taken out bead is cut off at firebox end and at front end with flue cutter as before, is then cleaned and cut for welding. This time we cut the original weld off and the new piece or safe end is again welded on the front end, which leaves the flue with but two welds, and this operation continues throughout the life of the flue. It always gives us a good new safe end at firebox, the old safe end at front flue sheet.

By following this method we don't know what it is to split a flue in the front end or to damage a flue in the rattler and we have a better flue at all times than where safe end has been repeatedly welded on one end.

A great many might object to the cutting of this flue for welding, but unless you do this you cannot tell where the old weld will come at the front flue sheet.

The cost for cutting flues to length for welding is less than ½ cent per flue, or about 50 cents per 100. I believe if this practice was carried out you would have a flue that is worth that much more to you at all times.—*Railway Master Mechanic.*

Advantages of Mechanical Stokers*

The advantage to be derived from stoker firing of locomotives is the ability to fire the engine continually up to its capacity, and it is found that the stoker-fired locomotive can either take the same tonnage as the non-stoker over the road in less time, or a larger train can be handled in the same time. As a concrete example of this fact we note that in a recent test for the capacity of locomotives a stoker-fired engine was operated for six hours, firing an average of 7,800 pounds of coal per hour, which means a continual capacity of the locomotive firing in excess of that which could be maintained by hand firing.

It has also been demonstrated that mechanical stokers have permitted the enlarging of the exhaust nozzle area from 5 to 5¼ inches, which means an increase of about 3 square inches, thus giving the locomotive greater efficiency. Other advantages are obtained by not opening the fire doors, viz.: doing away with the glare or dazzling light which is produced after dark and which makes the observation of signals more difficult. It also prevents sudden change in firebox temperature, which produces contraction of sheets or tubes.

A properly adjusted mechanical stoker will reduce the use of fire hook or rake on the fire bed, as the distribution of coal can be regulated to prevent banking. This is an advantage, as the frequent use of the rake disturbs particles of fuel which are carried by the draft onto the brick arch or lodged in the flues, reducing the draft.

The application of the stoker has proved to be a benefit from the standpoint of smoke abatement, and there are some stoker locomotives at present being used in the heavy transfer service within the limits of large cities, resulting in practically complete elimination of smoke. Although all types of stokers are not showing an improvement in smoke prevention, the good results of some types indicate that future development may be expected to produce good results along this line.

Those engaged in stoker firing do not have to devote as much time and attention to the use of the mehods employed in hand firing, but are required to operate the mechanical stoking machine, which furnishes them with a practical experience in the care of steam-driven machinery. This mechanical education should greatly aid in the development from fireman to locomotive engineer. This, we believe, is an improved condition and should greatly increase the possibilities of securing a higher type of candidate for the position of locomotive engineer.

We have not received any information which indicates that the development of the mechanical stoker has reached a point where the utilization of cheaper fuel has been accomplished.

In conclusion, we will not attempt to state the cost of installation and maintenance of the mechanical stoker, as the different types will vary in these items, but from the developments up to date it is safe to say that the advantages may be expected to greatly multiply with the service of the machines and by the efforts of the various stoker manufacturers.

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* Report presented before the Traveling Engineers' Association.

Boiler Shop Devices, Clinton Shops of the Chicago and Northwestern Railway

Mr. Wm. Kerr, foreman boiler maker of the Chicago & Northwestern Railway at Clinton, Iowa, has devised a flexible crown stay for radial stayed boilers, of the form shown in the illustration herewith. The purpose in making the stay in the form indicated is, in addition to securing flexibility, to avoid the necessity of making enlarged holes in the wrapper sheet in order to apply the bolts. By using jigs for getting the proper angles of the stays, the holes can be drilled and tapped before the firebox and the wrapper sheets are assembled. The short ball-ends of the bolts, with the coupling nuts, can be inserted in the crown sheet prior to assembling, and after the firebox is in place the top ends of the bolts can be inserted in successive rows from the inside and uniform tension on all bolts can be secured in the tightening process by means of a wrench. The shape of the bolt permits of its being readily forged on a bolt machine. For the coupling nuts it is proposed that cast steel be used. The application of this idea in the construction of longitudinal braces is also illustrated.

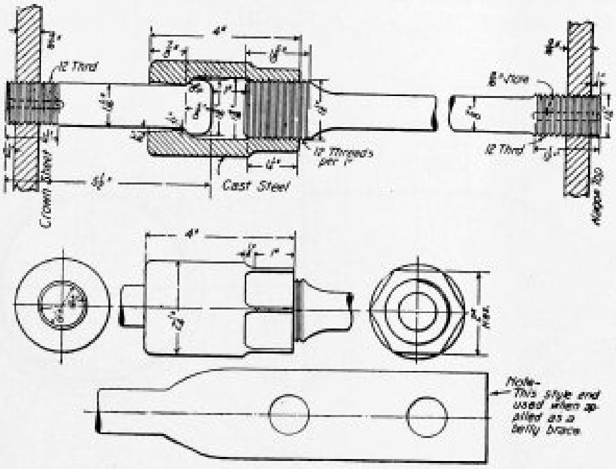


Fig. 1.—Kerr Flexible Crown-Stay

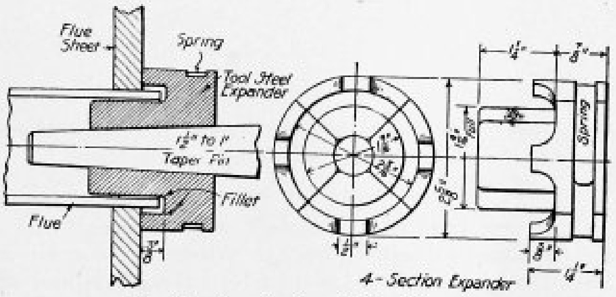


Fig. 2.—Kerr Sectional Flue Expander

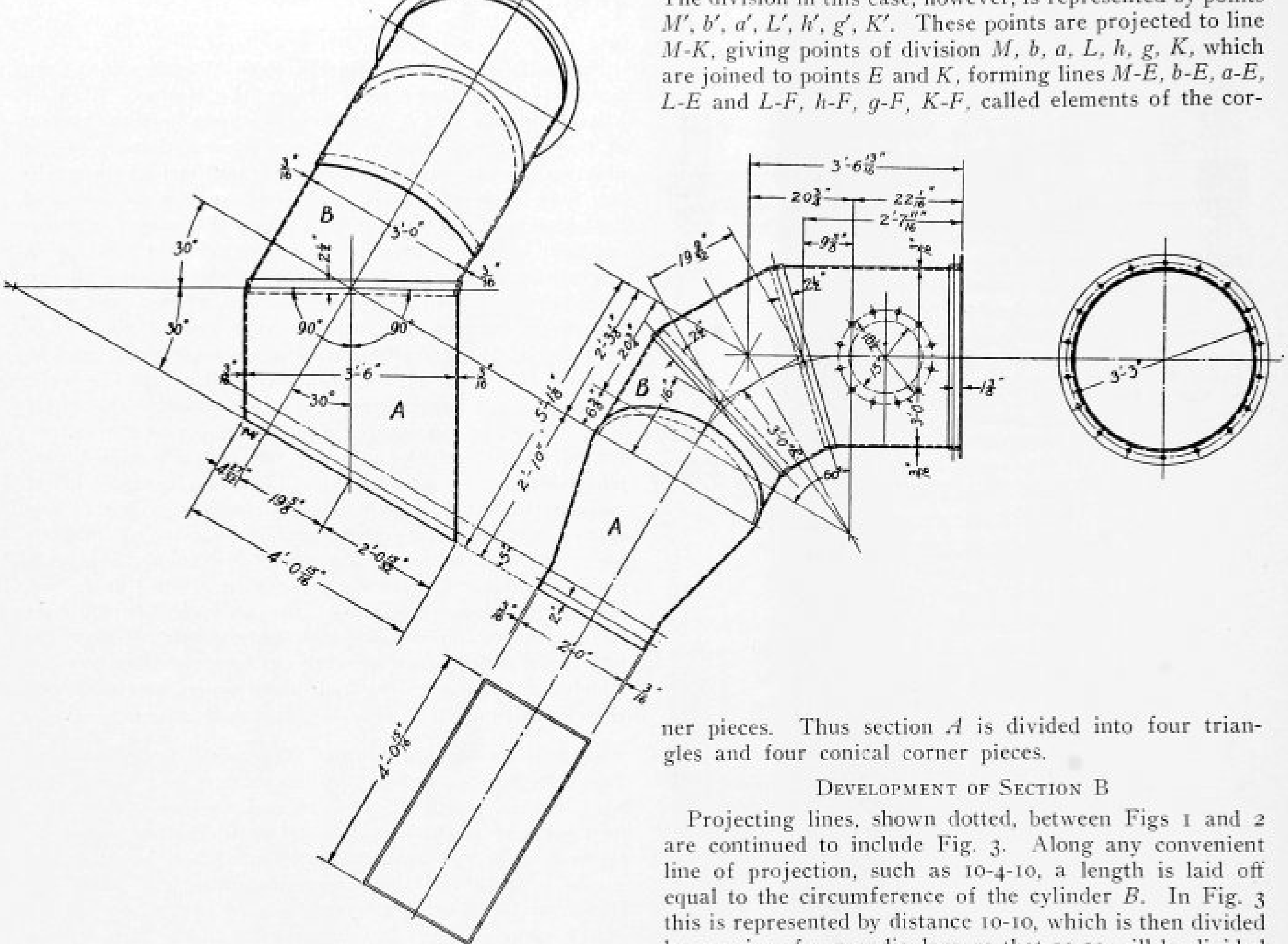
An improved form of flue expander, also devised by Mr. Kerr, is in use at Clinton and elsewhere on the Northwestern system. Its construction is such that the ends of the flues, which are allowed to protrude through the sheets for the purpose of furnishing material from which to form the beads, are not injured in the expanding process. This is accomplished by providing each of the four segments of the expander with a three-eighth-inch projection, which serves to keep the body of the expander that distance from the flue sheet. This expander is likewise useful for roundhouse work, as when flues are tightened by means of this device, the beads are non-flattened or cracked, as is likely to happen with those forms of expanders that allow the force of the blow from the air hammer to be taken on the end of the flue. A somewhat unusual advantage derived from the use of this expander results from the effect of contact between these lugs and the bridges between flues, it having been found that considerably greater quantities of scale are dislodged than when the usual forms of expanders are employed. This device has been used at various points on the lines of the Chicago & Northwestern Railway continuously for the past two years with very satisfactory results.—*Railway Review.*

Some Ill-Effects of Boiler Feed Water and Their Causes.—In a paper read before the Railway Club of Pittsburgh, Mr. W. A. Converse discusses both the theory of boiler scale formation and corrosion and some of the practice. A number of analyses are outlined which establish some very interesting facts about scale formation and corrosion. In one case it was found that water containing quite a large amount of carbonate of soda produced a deleterious effect on the condition of the gaskets, due to their being soluble in alkaline solutions. In another analysis where the water contained a large amount of sulphate of lime, a strong formation of scale was found, and in addition there was serious corrosion underneath the scale, disproving the assumption that scale protects the metal from corrosion. In another analysis the contention is confirmed that ill-effects of water are not exclusively attributable to the quantities of substances contained, but more particularly to their relative amounts. Thus in two cases water contained considerable amounts of chloride of magnesia. In one there was considerable corrosion above the water line, in the other none. The former was due to the decomposition of the chloride of magnesia and the formation of dilute hydrochloric acid, while in the latter case there was also some carbonate of lime present which combined with the hydrochloric acid and produced chloride of lime.

Marine Boiler Explosions.—(From British Board of Trade Reports.) Report No. 2254 refers to a steam-pipe explosion on board the *Wray Castle*, whereby four firemen succumbed to their injuries before they could be rescued. The explosion was attributed to a latent defect in the brazing of a longitudinal seam near a bend, the spelter at that part not having run properly into the lap of the seam. Report No. 2259 refers to the failure of a manhole door joint on the *Pavia* at Liverpool, caused by the spigot of the door being a bad fit in the hole, which was further weakened by the use of a lubricant on the joint. Report No. 2286 deals with the fracture on the main steam pipe of the *Kelvingrove*, a cargo vessel with triple expansion engines and two Scotch boilers. The starboard main steam pipe cracked close to the flange next the stop valve on a circumferential line 9¼ inches long. Report No. 2287 also deals with a fracture in the main steam-pipe of the *Bavaria*, of Liverpool, followed by a further fracture a few days later. The pipe from the starboard boiler fractured close to the tee-piece connecting port and starboard boilers to the main engine pipe. A blank flange was inserted between the pipe and the tee-piece. These fractures were ascribed to vibration. Report No. 2300 deals with the bursting of an auxiliary steam valve chest on the *San Gregorin*, whereby an engineer was killed and three firemen scalded. Previous use of the auxiliary had left condensation in the pipes, causing water hammer when the fifth engineer opened up to empty the two forward ballast tanks.

How to Lay Out Twisted Pipe Having Rectangular and Circular Ends

The drawings for this pipe were submitted by a reader of The Boiler Maker, who asked for the layout of sections *A* and *B*, shown in the drawing. The problem involves the development of a cylindrical surface by projection, and also the development of an irregular transition piece by triangulation, both of which are simple operations, easily understood. What makes the problem appear complex, however, is the bend between sections *A* and *B*, combined with the elbow of 60 degrees above section *B*.



Shop Drawing of Pipe to Be Layed Out

Subdivision of Surfaces

The views shown in Figs. 1 and 2 were redrawn from the sketch, and to simplify matters the measurements were taken to the center of the thickness of the material of which the sections are made, the flanges being omitted, as they can be added to the patterns after they are developed.

Section *B* is divided as shown by constructing semicircles, which represent half end-views of the cylinder *B*, and dividing the half circumference into a number of equal parts by points 1′, 2′, 3′, etc., the number of equal parts being the same for Figs. 1 and 2. These points of division are then projected down to section *B*, giving lines 1-1, 2-2, 3-3, etc., called elements.

The same is done for section *A*, only that the half end-view of its upper base *M-K* is a half ellipse. This ellipse is constructed by projecting *L*, Fig. 2, up to *W* and drawing two semi-circles, one with a diameter equal to the diameter of cylinder *B*, and the other with a diameter equal to line *M-K;* then a series of lines is drawn through *W*, such as *s′-W*, cutting the larger circle at *s′* and the smaller one at *r′*. Through *s′* a vertical line, *s′-t′*, is drawn, and through *r′* a horizontal line, *r′-t′*, is drawn; and where these intersect, as at *t′*, is one point on the ellipse. By finding a number of points, such as *t′*, a half ellipse can be drawn through them, representing the half view of *M-K*. This half view is divided into a number of equal parts, the same as the half end-view of section *B*. The division in this case, however, is represented by points *M′*, *b′*, *a′*, *L′*, *h′*, *g′*, *K′*. These points are projected to line *M-K*, giving points of division *M*, *b*, *a*, *L*, *h*, *g*, *K*, which are joined to points *E* and *K*, forming lines *M-E*, *b-E*, *a-E*, *L-E* and *L-F*, *h-F*, *g-F*, *K-F*, called elements of the corner pieces. Thus section *A* is divided into four triangles and four conical corner pieces.

Development of Section B

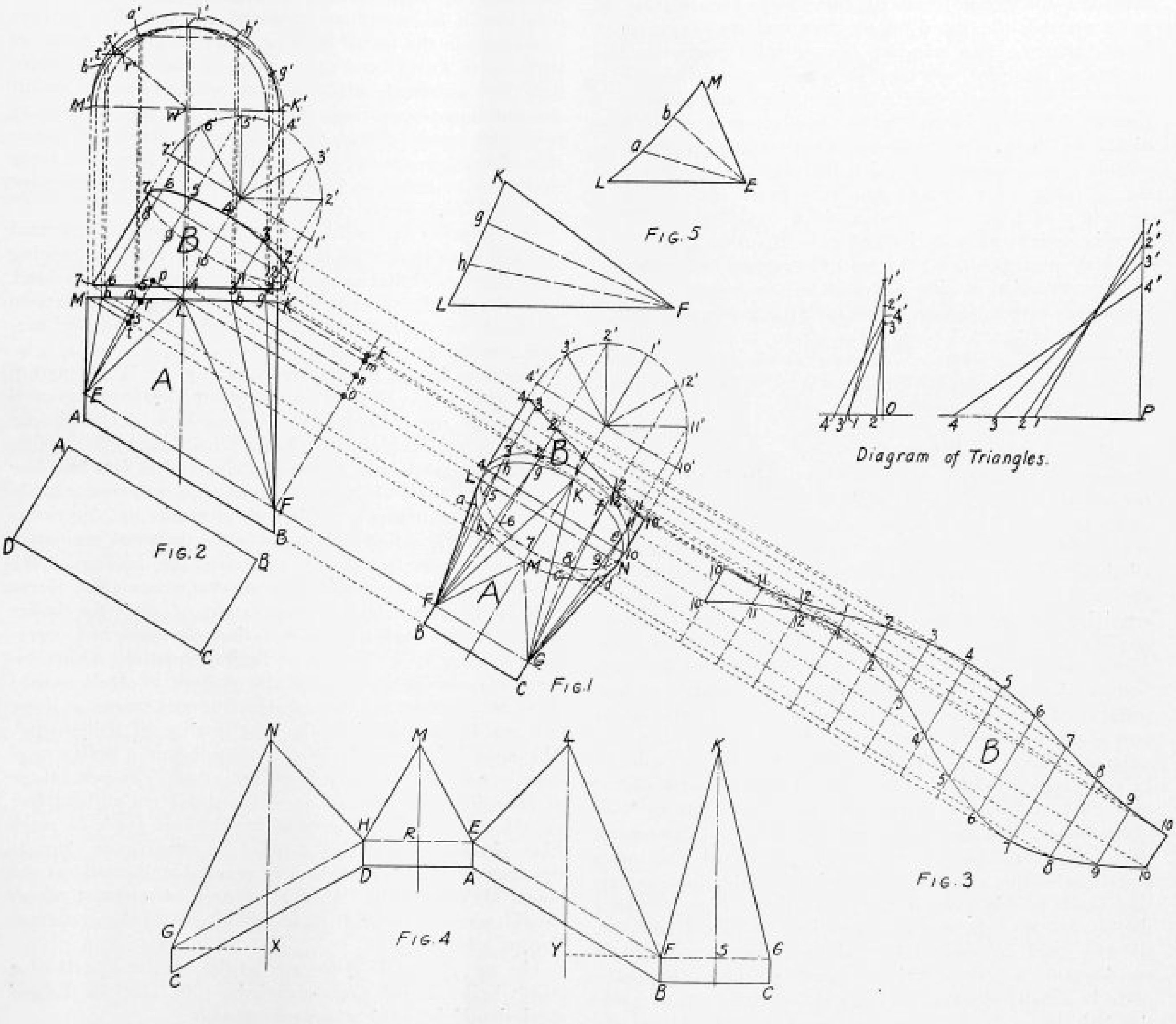
Projecting lines, shown dotted, between Figs 1 and 2 are continued to include Fig. 3. Along any convenient line of projection, such as 10-4-10, a length is laid off equal to the circumference of the cylinder *B*. In Fig. 3 this is represented by distance 10-10, which is then divided by a series of perpendiculars, so that 10-10 will be divided into the same number of parts as the cylinder. Elements 10-10, 11-11, 12-12, etc., are projected as shown from Fig. 1, and curved lines drawn through the points thus found, forming the pattern of section *B*. As previously noted, this does not include flanges, which can be obtained by adding the width of the flanges along the edge at various points and drawing a new curve through the points obtained.

Development of Section A—Triangular Sides

Beginning with triangle *M-H-E*, Fig. 4, *H-E* and *D-A* are laid off equal to *D-A*, Fig. 2, and *E-A* equal to *E-A*, Fig. 2. The height of the triangle *R-M* is equal to *E-M*, Fig. 2. Then *E-F-B-A* is laid off equal to *E-F-B-A* Fig. 2, and at the same inclination, in this case 30 degrees with the horizontal. Point *L* is determined by finding the intersection between two arcs with *F-L* and *E-L*, Fig. 4, as radii and drawn about points *F* and *E*, Fig. 4. These radii are not equal in length to *F-L* and *E-L* in Fig. 2, but must be found as in the diagram of triangles.

Lines *F-K* and *E-p* are drawn through *F* and *E* perpendicular to *E-F*, and lines *L-p* and *L-o* are drawn perpendicular to *E-p* and *F-k*. *L-p* is then laid off in the diagram of triangles as *O*-1, and *L-o* is laid off as *P*-4. Then, from Fig. 1, *F-L* is transferred as *P*-4′ and as *O*-1′ in the diagram of triangles, so that 1-1′ equals *E-L* and 4-4′ equals *F-L* in Fig. 4.

On the other side *N-G-C-D-H* is drawn the same size, but in the opposite way. To check these two triangular sidepieces, vertical lines *N-X* and *L-Y*, drawn through *N* and *L* respectively, should divide lines *G-H*, *C-D*, *E-F* and *A-B* at their mid-points. To complete the side pieces in Fig. 4, *F-G-C-B* is drawn exactly the same as *H-E-A-D* and *S-K*, the altitude or height of the triangle, is made equal to *F-K*, Fig. 2.



Patterns of Twisted Pipe

Development of Corner Pieces

In laying out the corner pieces *F-L-K* and *E-L-M*, Fig. 2, the true lengths of *F-K*, *F-g*, etc., and of *E-M*, *E-b*, etc., are found by the diagram of triangles. For instance, in the same manner that the lengths of lines *F-L* and *E-L* were found, lay off, in the diagram of triangles, *P*-1, *P*-2, *P*-3 and *P*-4 equal to *k-K*, *m-g*, *n-h* and *o-L*, respectively. Then, from Fig. 1, *F-K*, *F-g*, *F-h* and *F-L* into the diagram of triangles as *P*-1′, *P*-2′, *P*-3′ and *P*-4′. This gives 1-1′, 2-2′, 3-3′ and 4-4′ as the lengths of the lines *F-K*, *F-g*, *F-h* and *F-L*, which are used in Fig. 5 for corresponding radii in triangulation combined with radius equal to *L′-h′*, Fig. 2, which equals *L-h*, *h-g* and *g-K*, Fig. 5. By joining the points obtained we have the outline for *F-K-L*, and going through the same operations for the other corner piece we get *E-M-L*, Fig. 5.

There are four corner pieces, but only two need be developed, since there are two of each pattern exactly alike. It will be noted that the flange has been left out entirely, but can be added wherever necessary, depending on the method used in joining the several parts together.

The remaining parts of the pipe can be laid out by rolling the various sections out into a pattern, as was done for section *B*. No difficulty should be found except in noting that the sections will have alternately one diameter, and then another for inside and outside sections. This will only vary the length of the pattern and the size of the equal divisions around the surface.

Steam Boiler Construction and Inspection*

BY H. A. BAUMHART

When steam boilers were first used as a unit of power, and in fact until many years later, boiler manufacturers and engineers gave the subject of proper construction and inspection little consideration. When about to install a power plant it was customary to ask boiler manufacturers for propositions to cover only the number of units wanted, the rated horsepower and steam pressure. In the absence of a standard law or rules governing the quality of material, workmanship and factor of safety, it resulted in a great difference in prices and usually a greater difference in the quality and factor of safety furnished by the various builders. One manufacturer might submit a proposition to furnish boilers based upon a factor of safety of 5; others would be based upon a factor of safety of 4 or less, resulting in a considerable difference in weight of material and cost of production.

Great progress has been made in steam boiler design and construction during the past twenty years. In fact there are but few, if any, boiler manufacturers who would to-day construct a boiler for a given pressure without taking into consideration safe rules as adopted by some of the States and municipalities or as recommended by good steam engineering practice.

The first question to be considered is a proper design. A boiler must be so designed that the shell or drum, including the covering strips at the longitudinal joint, be formed to a true circle to avoid bending, however slight, under pressure. This would exclude the lap seam form of construction. The lap seam form of joint should be eliminated in every case, excepting in shells of small diameter and a comparatively low pressure. Flat surfaces requiring staying or bracing are a source of considerable anxiety to a boiler inspector. Solid staybolts are commonly used. The factor of safety recommended for such bolts varies from 7 to 8 according to the quality of material used. If staybolts were subjected to a tensile stress only, failure would rarely occur. There is, however, another condition of service in connection with staybolts to be recognized, and that is unequal expansion and contraction. When fires are lighted the inner box plate or tube sheet becomes heated first, and expands in advance of the outer plate. Later, as steam is generated, the outer plate expands up to or beyond the inner plate, thus making two bends of the bolts at each operation. It is true that the bend is only slight, but of sufficient frequency to break the bolt, and, in some cases, where the fireboxes are of considerable length, within a month's time. The outer plate is usually thicker than the inner plate, which holds the bolt more firmly, causing bending and ultimately breaking of the bolt where joined to the outer plate. In addition to the breaking of the bolts there is another serious problem to be considered in connection with staybolted surfaces. The stress due to unequal expansion and contraction causes movement of the bolt in the hole of the outer sheet, producing corrosion or flaking off of the material at the inner end of the staybolt hole until frequently the riveted end of the bolt is the only portion holding. In lighter material this stress sometimes produces slight bending of the plate with such frequency that it produces cracks extending in every direction from the staybolt holes. These cracks are only visible from the inside, and because of the limited space cannot be seen without first removing some of the bolts and, therefore, may not be detected until leakage appears. The best solution as a remedy for such a condition is a flexible bolt. The hollow bolt is an improvement only because leakage will appear when the bolt is broken, and therefore is recommended by some inspectors in preference to the solid bolt.

The heads for drums or domes should be of the convex, or what is commonly known as bumped head type. Great care should be exercised in forming the head in order to obtain a true curvature and avoid the possibility of the head bending under pressure. Such heads having a manhole should be made of material not less than ⅛ inch heavier than the blank head in order to give it sufficient stiffness to avoid bending because of the manhole opening. For extremely high-pressure, such as carried on air storage tanks operating under 1,000 pounds per square inch, the heads should be made cone shape. A cone-shaped head is stronger than the bumped head, but more expensive to construct, and is seldom used excepting for extremely high-pressures.

The question of bracing flat heads is also an important one and care should be exercised to see that the bracing is so distributed that each will carry its share of the load. Care should also be exercised in attaching the braces to the heads or shell plate to avoid double thickness of material on the heating surface.

The next important step in boiler design is the quality of the material to be used. Until about 1880 iron was used exclusively for boiler plate. A very high-grade of iron plate was manufactured. It had a tensile strength varying from 42,000 pounds to 45,000 pounds, and in fact in a few cases 50,000 pounds was obtained. It was not readily susceptible to attack by acids and, therefore, its deterioration, even in locations where the water was contaminated, was comparatively slow as compared to modern steel. Steel boiler plate replaced iron several years ago. Great care is necessary in the preparation of steel for boiler plate. It is a well-known fact that the principal ingredient in steel is carbon but in limited amount. Other ingredients besides carbon are also present in steel; two of these are sulphur and phosphorus, but only traces of these two can be permitted in the best quality of boiler steel. The most injurious of these is phosphorus. Boiler steel must be made by the open hearth process. The percentage of phosphorus should not exceed 0.03 percent and sulphur should not exceed 0.04 percent for the best grade of steel. The physical properties require a maximum tensile strength of 60,000 pounds per square inch, and 54,000 pounds is preferable. A certified copy of mill test report should accompany each plate entering into the construction of a boiler.

The use of cast iron for any of the pressure parts of a steam boiler is not recommended. Cast steel or forged steel should be used wherever possible.

The question of workmanship is, in our judgment, the most important item. The best material may be so handled by an incompetent workman as to render it unfit for service. This is especially true in connection with forming the shell plate and butt straps. If the shell plate and straps are not formed to the proper circle, either by a rolling or a pressing process, and the boiler maker attempts to make the proper fit with the aid of a sledge hammer, it would probably result in fractured plates. Such cracks may be so slight at first as to defy detection even by the aid of a glass, but will extend in dangerous proportions after the boiler is in service.

No rivet hole or tube hole should be punched. Such holes should be drilled. State and municipal laws permit the holes to be punched small and reamed to size, which

(*Concluded on page* 330)

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OSCAR M. PICKRUHL.

(My commission expires March 30, 1915.)

Although the extensive use of oxy-acetylene welding in recent years has demonstrated that there is a wide field of usefulness for this process in boiler shops, there has been, nevertheless, an element of uncertainty as to the strength of a weld made in this way. For this reason the investigations into the strength of oxy-acetylene welds recorded in this issue are of great value. For an ideal weld there should be a perfect union of the pieces of metal which are welded, and the metal in the welded region should be in the same condition as the original metal. If the welding is done by hammering or pressing while the metal is in a plastic condition, it should be as strong and reliable as the original metal, provided oxidation is prevented. An autogenous weld, however, cannot have the same properties unless it is submitted to similar treatment. From the failures which have been recorded, it is evident that many of the welds were defective, owing to the presence of oxides due to the use of an excessive amount of oxygen in welding or the use of unsuitable fluxes. As a matter of fact, the tests made indicate that there is bound to be an element of uncertainty in the weld even when the weld is made by an expert.

In determining the strength of an autogenous weld, it has been proved that tensile tests are not sufficient, for excellent figures were obtained for both tensile strength and elongation of the welded metal, although when the weld was subjected to repeated shocks or vibration, the metal gave way. The results of tests made, however, seem to indicate that an average weld might be expected to possess something like four-fifths of the strength of unwelded steel and about one-fifth of the ductility. The tensile strength does not appear to vary very much, but the ductility varies considerably. Hammering has increased the ductility and decreased the tensile strength slightly, while reheating the welded portion has still further increased the ductility and at the same time increased the maximum stress. Under no treatment, however, does the ductility of the welded portion approach that of the unwelded portion.

Impact tests showed that an average weld might be expected to withstand about one-half as much as the unwelded metal. In this respect, hammering is the most effective treatment, but, if hammering is resorted to, the metal should be reheated to a full red heat or about 800 degrees C., in order to remove any strains or brittleness that might be set up during the heating process. Reheating or annealing alone appear to be of little value in increasing the fatigue resistance of the welded portion. Boiler makers are fully aware that working soft steel by hammering or otherwise, at a low temperature or black heat, involves the danger of producing brittleness. On the other hand, reheating to a full red heat very nearly restores the material to its original strength. This has been found to apply to the welded metal as well as to the unwelded metal. As the tests made included tests on thick plates, it was found that the thicker the plates the less reliable will be the weld and the greater the reduction in strength. Usually it is impractical to anneal thick metal satisfactorily.

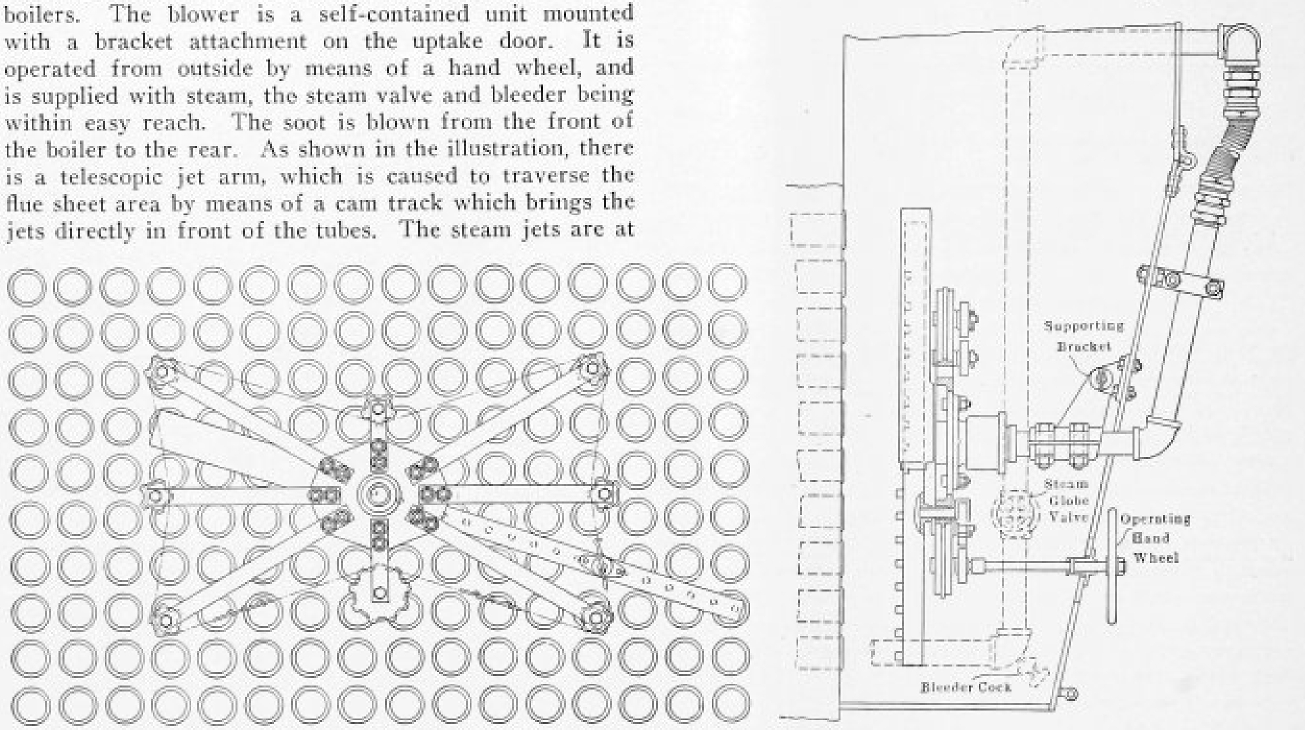
So far there seems to have been no evidence to show that autogenous welds in boiler work where the parts welded are likely to be subjected to considerable mechanical strain, can be absolutely relied upon. For this reason, the British Board of Trade has limited the use of autogenous welds in boiler work, and the government of Belgium has prohibited it in new construction or in extensive repairs where a failure would be likely to be disastrous to human life or property. In any event, on pressure vessels such welds should be accepted with extreme caution.

Engineering Specialties for Boiler Making

New Soot Blower for Scotch and Return Tubular Boilers—Compact Rotary Air Compressor—Convenient Rack for Small Tools

The Planet Soot Blower

The Bennett-Dluge Company, Detroit, Mich., has placed on the market a device known as the Planet blower for cleaning the tubes of horizontal return tubular or Scotch boilers. The blower is a self-contained unit mounted with a bracket attachment on the uptake door. It is operated from outside by means of a hand wheel, and is supplied with steam, the steam valve and bleeder being within easy reach. The soot is blown from the front of the boiler to the rear. As shown in the illustration, there is a telescopic jet arm, which is caused to traverse the flue sheet area by means of a cam track which brings the jets directly in front of the tubes. The steam jets are at close range to the flue sheet, and, on account of the number of jets which are blowing directly into the tubes at the same time, a strong draft is set up, which insures a thorough cleaning of the tubes.



Planet Soot Blower Applied to a Stotch Boiler

Rotary Air Compressor

An air-cooled, rotary air compressor that can be directly connected to a high-speed electric motor or driven by a belt, and that is claimed to give a large delivery with a low power consumption, is being manufactured by the Wernicke-Hatcher Pump Company, Grand Rapids, Mich.

The pump consists essentially of a rotor and a rotor case, both of which revolve on eccentric centers; a shaft with intake and discharge ports, the rotor being keyed to the shaft; and bearings for the shaft and casing. The space between the rotor and casing is divided into a number of pockets by means of sliding vanes which pivot on shoes fitted to the face of the rotor. Each pocket is provided with an intake and a discharge valve connecting through suitable passages with the intake and discharge passages in the hollow rotor shaft.

Rotor and rotor case both revolve, one within the other, in the same direction and at the same number of revolutions per minute and each on its own axis or centerline. Since the rotor and casing are eccentric, so that they practically touch at one point, it is easily seen that during one-half of a revolution the pockets are expanding and drawing in air, and during the other half revolution the pockets are contracting and compressing the air.

It is claimed that the cooling for this pump is very effective, since the heat of compression is practically eliminated at its source by radiation due to the very large proportion of radiating surface to air contained. Also the area of cooling surface is constant and the effective part of it, the outer, exposed surface of the rotor, is cooled by revolving at high speed.

Fastened to a bracket at one end of the pump is a small gear pump for automatic forced lubrication. This gear

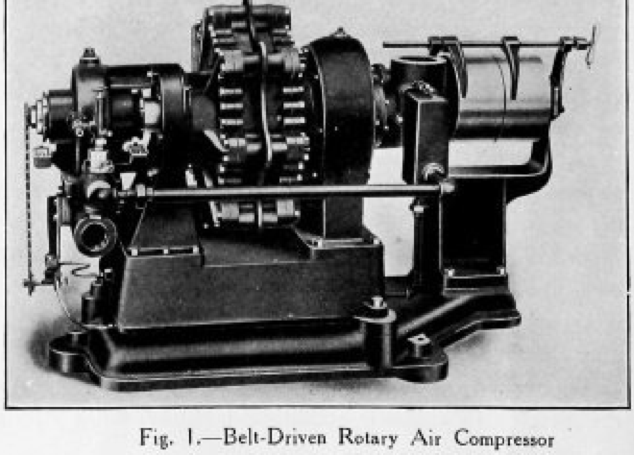


Fig. 1.—Belt-Driven Rotary Air Compressor

pump is driven by chain and sprocket from the rotor shaft and takes oil from a reservoir in the base and delivers it to all bearings and working parts.

The intake valves are positive and mechanical in their operation. The main bearings are of the roller type, to reduce friction and make smooth running.

The entire pump is light, very compact and requires no heavy foundation, making it easy to install. Also, since there is no connection to a water supply, it is practically portable.

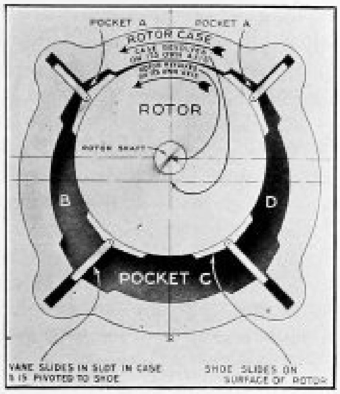
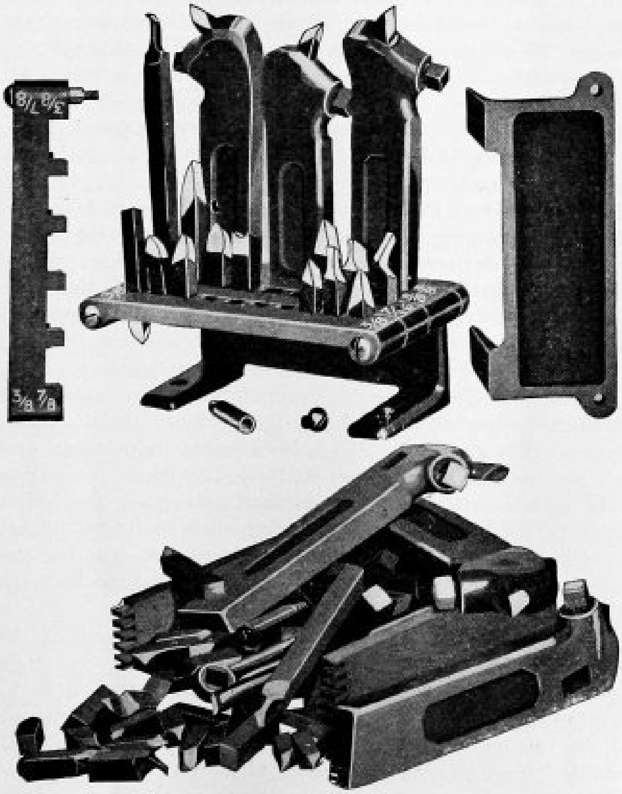


Fig. 2.—Cross Section of Rotary Compressor

Many important advantages are claimed for this new principle in air compressors, such as smooth running, even wear, cool operation, large deliveries of air at high-pressures, low power consumption running and starting, light and compact, easily installed, choice of drive, efficient at all speeds up to maximum, and steady flow of air without pulsations.



Tool Rack Manufactured by C. H. Driver, Racine, Wis.

A Convenient Tool Rack

A tool rack, providing a place convenient for the tools that it is made to hold and that automatically arranges the tools as to size when they are put into the rack, is being manufactured by C. H. Driver, Racine, Wis. The rack is made for the purpose of holding tools for lathes, planers, shapers and automatic machines, also for holding drills, reamers, taps and mandrels, most of which are used in boiler shops.

The rack is made up in sections affording an arrangement by which racks can be made up to hold any desired shape or size of tools or holders and to hold as many of the different tools as are required for each machine that is to be equipped with them. Each section is made so that it will hold only the size of tools that it is made for, so that larger tools will not fit in the rack and smaller tools will fall through. In this way the tools are kept conveniently and systematically and are automatically arranged according to size. The racks can be fastened on the side wall, posts, tool boards or any convenient place on the machines that are to be equipped with them. This not only furnishes a means of keeping tools, etc., within easy reach and in a compact form, but it greatly reduces the chance of tools being lost and finding their way to the scrap heap.

Public Hearing on A. S. M. E. Uniform Boiler Code

On September 15 the committee on uniform boiler laws and regulations of the American Society of Mechanical Engineers, held a public hearing at 29 West Thirty-ninth Street, New York, for the discussion of a preliminary boiler code which this committee published several months ago and distributed broadcast throughout the country to engineers, boiler manufacturers, boiler inspectors, boiler users and other interests associated with the construction and operation of steam boilers. Prior to the public hearing, written criticisms of the proposed boiler code were asked for, and at the public hearing a general discussion of the various sections of the proposed code took place.

In opening the hearing, Mr. John A. Stevens, chairman of the committee, drew attention to the large number of boiler explosions which occur in the United States each year, and pointed out the necessity for better boilers and better operating conditions. This, he stated, can be accomplished only by the establishment of a uniform code for the construction and operation of steam boilers. The causes of the enactment of boiler legislation in Massachusetts were not only the serious boiler explosions which had occurred in that State, but also the difficulties which resulted from the lack of uniformity in various States.

Mr. Edward H. Wells, president of the Babcock & Wilcox Watertube Boiler Company, stated that he was heartily in accord with the movement for uniform boiler legislation because it would result in safer and better boilers and the uniformity obtained would do away with much of the confusion and annoyance resulting from lack of uniformity.

Mr. Thomas E. Durban, general manager of the Erie City Iron Works, Erie, Pa., showed the far-reaching effect of the present lack of uniformity. He agreed that uniformity is a necessity and that immediate action is necessary, as five States are now preparing to enact legislation of this kind.

Those who had submitted written discussions of the proposed code were heard first. Some of the important topics discussed in Parts I and II of the code were boiler ratings, the shearing strength of rivets, factor of safety, length of life of lap seams, safety valve formulas, safety valves for superheaters and fusible plugs.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Boiler Explosions

An appreciable proportion of boiler explosions are caused by the giving way of stayed, flat plates. Tests have been made on such plates and analyzed; the results appear to show that when flat plates are secured by stays the ends of which are merely riveted over (and these would include stay tubes) bending, torsional and shearing stresses occur. Of these the second and third are the more serious, the one leading to radial cracks at high pressures, and the other to early permanent sets and to subsequent stripping of threads. Both these stresses can be reduced by enlarging the diameter of the stays, even if this should entail making them hollow.

The shearing stresses are negligible when the stays are fitted with single nuts, but the torsional stresses are probably quite as serious as before, as four out of five cases of cracked holes have nutted or riveted stays. These stresses are proportional, not to the squares of the pitches, but to their cubes.

The ordinary bending stresses are now also intense, while the permanent sets are probably due to them, depending, therefore, on the squares of the tangential diameters. When the stays are fitted with double nuts, or with washers and double nuts, the zones of the torsional stresses are shifted far away from the stays, whereby they are much reduced, though it is doubtful whether they are negligible. In these cases the noticeable permanent sets are also probably due to ordinary bending stresses. In Great Britain about 100 explosions occur yearly, and it has been suggested that when complicated and interesting explosions occur, the technical questions which arise should be exhaustively inquired into. These inquiries are made in Germany and a large volume of useful information has been accumulated. Should an accident occur in that country which cannot be explained, the manufacturer, if possible, is induced to make experiments. German engineers are therefore authorities on boiler engineering in all its various phases. G. L. S.

"The Atmosphere is Harmless"—Mechanical Expert

The other day I was in the waiting room of a small railroad station—one of those places where the "agent" does everything, from running the telegraph key to hustling freight. I overheard this conversation between the agent and an alleged (so the agent said) mechanical expert:

Agent—"Mr. Johnson, you are a mechanical expert, I know; and I would like to ask a question. That boiler lying out there belongs to ——— & Co.; but they haven't paid the freight yet, and so I won't let them haul it away. It has been there for six months. Now ——— & Co. say they won't take it because it is ruined from being exposed to the atmosphere. They claim they can collect damage. As a mechanical expert, what do you say? Has the boiler been hurt any?"

Expert—"Ha! Ha! That's a good one. Of course not. I never heard of a boiler being spoiled without being used. The air can't hurt a boiler when it sometimes takes twenty years for fire and water to do it."

Agent—"Good. That's what I thought. I'll tell those fellows to come across with the money pretty quick, or I'll ship the boiler back or sell it for scrap. We can get the freight out of it, all right."

My interest being naturally aroused, I strolled over to the boiler to see how kind the elements had been to it. It was a new boiler, all right; but it didn't look the part—a horizontal tubular design. It was brown with rust and the rust was so thick the shell looked almost spongy. Rain, sun, cold, wind—all took alternate whacks at it. I don't think it had ever been painted. I couldn't see the inside because all manholes were in and pipe openings were bolted shut. A couple of years at that rate and the boiler would be about rusted to pieces.

As the "mechanical expert" came out of the depot whistling "Dancing Around," I looked in another direction as disinterestedly as possible.

One cannot help being amused, sometimes, at the way the world's work is done. N. G. NEAR.

The Apprentice

For some time past there has been much written in the various mechanical journals upon the subject of the modern apprentice. The several writers have advanced their opinions as to what the proper course of instruction should be (and what the salaries of the instructors should be), and have shown what has been done by some of the large railroad systems and manufacturing companies towards supplying the demand for good mechanics and retaining them in their service when they graduate.

Looking at the subject from the viewpoint of one who is in almost daily contact with men, graduates of some of the large railroad shops in this neighborhood, I am convinced that their systems are anything but modern. By applying the word modern, we are led to expect something better from the present-day methods than that turned out by the old-time system. In the old way, a boy with a fair education (and many times without one) was indentured, legal papers drawn up, the parents, one or both, signing on behalf of their son, who spent the allotted time in going through the shops, learning all the various branches that go to make up a good boiler—that is to say, flanging, chipping, calking, fitting up and riveting, especially hammered riveting, and generally this part of the business interested the apprentice more than all the rest; and when his time was completed, and with his papers in his inside pocket, he set out as a journeyman; he was prepared to take a job of any kind offered him.

Of course, in the early days of the trade laying out seldom if ever fell to the lot of the ordinary boiler maker, unless the apprentice had been extra-industrious and studied in his spare time; while to-day there are firms who follow very closely the method of turning out boiler makers; and should an apprentice wish to learn the art of laying out, he must bind himself to the firm for another three or four years and pay the firm $100 to learn the art.

Some time ago I saw an advertisement by one of the large manufacturing companies who, desiring to draw special attention to their line of air hammers, did so by saying that the days of the hand-driven rivets had passed. I, for one, am glad to say that the hammered rivet is still on deck and cleared for action, although it is a thing of the past in many of our large shops, as the management prefers calking the rivets after they are driven with an air gun, to driving by hand and making a job of it at once.

Some time ago, while on a trip to Maine, I visited a shop in B—— and found that they did a lot of their riveting, especially on repair work, with the old-time side hammer; and good work it was—rivets cut clean down to the sheet—and minus the butterflies usually found around rivets of this kind. This shop was equipped with a good supply of modern tools, yet they preferred to drive on old work this way, for they did not damage old plates when attaching new parts; and as the firm expected to get more work in the future from the same people, they did good, substantial work.

Again, some time ago I met a boiler maker, the product of one of our Southwestern roads, who, when put to drive a few counter-sunk rivets, did so just like a trip hammer, straight up and down. It was quite impossible for his partner, although an expert riveter with either hand, to get a blow on the rivet without running the risk of their hammers kissing, with possible injury to one or both men. The same man, sent to patch the tank of a steam shovel, did not know how to get out the patch, and when gotten out did not know how to apply it, and had to be shown; but when it came to cutting out flues, or riveting with the air gun, he was quite at home.

Still another case: a man applied to the writer for a job, saying he was a locomotive boiler maker and could show his indentures. Thinking the man was a good catch, I put him to work plugging up holes in a sheet that had been mispunched—a very simple job for any man that had spent any length of time in a boiler shop. When he was applying the plugs I tried them to see if they were in tight, and, to my surprise, I found them quite loose. Upon explaining to the man that I wanted a tight fit, etc., he admitted that he had served his time on locomotive tank work as a calker.

I cannot understand how any superintendent of apprentices of a railway company, or the management of any manufacturing company, ever grants papers to men of this kind, unless it is to get rid of them at the expiration of their time of apprenticeship—for men of this kind are only in the way and injure the trade.

While in the East I met a boiler maker staying at the same hotel. He was from one of the large shipbuilding yards, and was installing a set of condenser tubes in one of the tugboats. During the course of conversation the all-round boiler maker cropped up, but he was a stranger to this man, who said that in his yard and all of the shops he knew each man had one job, either riveting, calking, fitting, etc., and that he had never seen a man capable of doing any or all of the jobs mentioned, yet he was a graduate of one of those yards.

It may here be said that this system of apprenticing works to the good of the firm, for men capable of working at one branch only are very loth to leave and will hang around for weeks at a time, when work is slack, rather than strike out and look for work elsewhere. I am like Mr. Forbes, in that a son of mine, to learn the trade of boiler making, should do so in a shop that makes boilers, not manufactures them.

There is no question in the mind of the writer that the trade of boiler making is overrun by unskilled men, that they are here to the detriment of the skillful mechanic and the legitimate graduate apprentice—for the lack of a Federal law of indenture, or a law of registration, like that of the plumbing craft.

To the advanced apprentice I would say, if possible learn all of the old-time methods of doing work. If it is not done in your shop, ask the old-timer about the way he used to do various jobs before the introduction of modern machines and methods, and, I am sure, that it will give him pleasure to tell you how they did work formerly; for, believe me, there are shops scattered around in out-of-the way places that are working to-day in the most primitive way, without rolls, shears, flanging blocks or clamps, and other modern tools usually found in the poorest boiler shops. Above all, learn to be a boiler maker, and a good one. Don't always think of the jobs held by the foreman or superintendent. If you are qualified as a boiler maker, knowing all of the details of the work, promotion will come your way in due time.

Flex Ible.

Safety First as Applied to Steam Boiler Construction

William H. Boehm, M. E., superintendent of the boiler department of the Fidelity and Casualty Company, is authority for the statement that every year there are over 1,300 serious boiler accidents in the United States, annually destroying over one-half million dollar's worth of property, injuring over 700 and killing more than 400 persons. One accident alone destroyed a quarter of a million dollar's worth of property, injured 58 and killed 117 persons.

Such an enormous waste of property and life has led to investigations concerning the causes of boiler explosions. R. N. Blackburn, Chief Inspector of Steam Boilers, in the Province of Saskatchewan, Canada, published in *The Power House* of May, 1913, a tabulation of the causes of over 1,000 accidents. These causes may be classified according to the manner in which they may be overcome, or might have been prevented. It is to a consideration of the "reasons why" behind these causes that we invite your attention.

Accidents accountable to lack of care on part of operator:

External corrosion	152
Overheating	133
Over-pressure	118
Fracture	80
Internal corrosion	72
General deterioration	58
Absence of safety valve	7

Accidents accountable to lack of care on part of manufacturer:

Malconstruction	51
Bad material	11

Accidents accountable to lack of care in design of details:

Weakness of flues	106
Weak manhole	23

Accidents accountable to lack of care in selection of type:

Deposit	27
Grooving	31
Defective stays	54

Accidents accountable to causes not understood or ascertained:

Explained by various theories	156

In dividing these accidents into the above classes it will be clear that we have considered the entire field of accidents to be covered by four distinct chapters or stages of development, thus:

Invention of type	Inventor
Design of details	Engineer
Manufacture of boiler	Manufacturer
Operation of boiler	Operator

Considering now the first class of accidents, or those due to lack of care on the part of the operator. It is impossible for the inventor, engineer or manufacturer to anticipate such accidents.

Absence of a safety valve is most likely to be attributed justly to gross ignorance or negligence on the part of the operator, as no reputable manufacturer would omit same from the boiler, even if same were not called for by the plans of the inventor or details of the engineer. Government laws are, also, requiring proper safety valves, and thus safeguarding the public more and more.

External corrosion, fracture, internal corrosion and general deterioration are all prolific causes of accidents which can be overcome only by rigid and continual vigilance, applied by the operator himself. Periodical government examinations also assist in safeguarding along these lines. Such inspection should not, however, be depended upon to take the place of the operator's own inspections and vigilance. Disinterested inspectors will never be as thorough in their work as are the men whose lives and property are at stake. When employer and employee both realize that their own welfare is vitally interested in proper inspections and safeguards, there will be less need for the government inspectors.

While plenty of time is afforded for investigation of the above causes, on the other hand causes such as those of overheating and over-pressure must be guarded against while the boiler is in operation. Accidents due to overheating are likely to be due primarily to low water. Those due to over-pressure may be due to carelessness in the care of steam gages or to pure negligence on the part of boiler tender. For accidents of this kind the best, and practically the only, remedy is found in the selection of careful and honest help. Such devices as low and high-water alarms, automatic feed-water regulators, etc., are not cure-alls, though immense safeguards when in the hands of efficient men.

Passing on to the second class of accidents, or those due to lack of care on the part of the manufacturer, we find those which cannot be anticipated by the inventor, engineer and operator.

Malconstruction and bad material mean lack of proper specifications and inspection. Government inspection is furthering the safeguarding of the public in this direction.

Neither the inventor, manufacturer nor operator can be expected to investigate the strength of the various parts and materials which enter into the finished boiler. It is within the province of the engineer to so design all details that they will be reasonably safe. Weakness of flues, manholes, etc., fall to the engineer.

The last class of accidents includes those which might have been taken care of in the general design of the inventor.

A design which lends itself to faulty or impeded circulation is more likely to cause accidents, due to deposits, which are thus more readily formed. It is, of course, impossible to make steam from impure waters without leaving behind the solids which were in that water either in solution or suspended. Such solids will have to be removed by the operator whenever the boiler is off duty, and the boiler should be taken off duty at intervals frequent enough to prevent too great an accumulation. Where an accumulation does occur, however, that boiler which has the best circulation will best keep the solid matter from settling, tending to cause pockets and rupture by overheating locally.

In some types of boilers it is possible for deposits to collect directly over the fire. This is the most dangerous design, as the liability to local overheating and burning is thus greatly increased. The drums or parts which are intended for the collection of mud and sediment should be so located as to be placed out of the direct flame—those surfaces upon which mud can collect.

In eliminating the use of flat surfaces which require stays, the inventor can again anticipate and prevent many accidents. There is little excuse for taking unnecessary risks where human lives are concerned, and the above statistics show that the elimination of stays means the elimination of over five percent of the boiler accidents.

In the same way the accidents due to grooving can be almost entirely eliminated by eliminating the lap-riveted joint, using instead the butt joint, which is much less prone to this trouble.

Fractures, while classed among those causes which should be discovered by the operator, may be largely prevented in the first place, also, by the elimination of the dangerous lap joint.

In general, those purchasers who have little or no knowledge of the principles underlying the designing and operation of boilers should consult high-class architects or engineers as to the features of different boilers, if they wish to place safety before dollars. One of the greatest dangers to the public lies in the short-sighted policy of some purchasers, who place dollars before anything else, selecting their boiler purchases on the basis of price alone.

Government inspection is at present applied only in certain localities, because the laws are municipal or State, except where the boiler is for the use of the National Government itself. The existing laws are, therefore, full of many unnecessary small differences, which places the industry of manufacturing boilers under an unnecessary burden, inasmuch as the boiler built for stock cannot be shipped but to the territory under whose laws it was built. At the present time there is much agitation for the passing of a National Government law or set of rules to replace all State and municipal rules. Such a law would give greater safety, in that there would then be no territory to which Government rules would not apply, and the manufacturers would be able to give their entire energies to one set of rules. C. R. Morrison.

Chicago, Ill.

Steam Boiler Construction and Inspection

(Concluded from page 324)

is in my judgment only a compromise arrangement. My advice to you when ordering a boiler would be to insist upon having every hole drilled from the solid. While it is true that reaming does remove a considerable portion of disturbed molecules it does not remove all of them.

The calking edege of the plate and butt straps should be prepared on a planer. Bevel shearing should not be permitted, because it produces the same bad result as punching a hole in the plate; that is, it disturbs the material for a considerable distance from the edge, producing numerous minute cracks, always an element of danger.

There is a vast difference of opinion among mechanical engineers and boiler manufacturers also about the various laws governing the construction of boilers with reference to the proper factor of safety. Modern rules adopted by the various States and by the Provinces of Canada require a minimum factor of safety of 5, the U. S. Marine Rules not less than 4. In my judgment a factor of safety of 5 should be the minimum. To illustrate this point more clearly, I would refer to a record relating to a test of material and which is a part of the records of the American Society of Mechanical Engineers. At a factor of safety of 2, the number of repetitions of stress required to produce rupture were 20,000; at a factor of safety of 2.5, 210,000; at 3, 700,000, and at 3.5 more than 1,600,000. It would therefore follow that boilers operated under a factor of safety of less than 4, because of the so-called fatigue of metal under stress, should not be used. A boiler operating under a factor of safety of 4 or less could be expected to fail many years before another boiler operating under a factor of safety of 5 or greater.

The subject of a proper retiring age for old steam boilers is one which comes frequently to light and is a most fruitful source of controversy. Of course, there can be no question as to the propriety of condemning to forced retirement those boilers whose diseases of one sort or another have reached the chronic stage, and are no longer curable, but there is at once the basis for a deal of argument when an inspector approaches the owner of a boiler with the statement that it must be replaced because of old age, especially if it is known to have all the apparent qualifications, except youth, for many additional years of service. In the past many curious properties have been attributed to old boilers; one of the most interesting was the notion that they could not explode violently. It was supposed that an old boiler would merely rupture, allowing the pressure to be relieved much as if the safety valve had opened. This idea was definitely disapproved many years ago, along with many other fallacies and much popular mystery concerning boiler explosions.

We all know that steel used in boiler construction will deteriorate with use. It undergoes a slow loss in strength and ductility. The process is hastened by the presence of a moderate excess of phosphorus. Deterioration of this character cannot be determined by the usual method of inspection. It is, therefore, difficult to state definitely at what time in service the boiler should be abandoned. It places a great responsibility upon the inspector. He must consider, in addition to the general appearance of the boiler, the conditions under which it has operated, and he must also make allowance for defects in the material which are not visible. Experience shows that boiler plate, subjected to the high temperature of the furnace, does deteriorate to the extent that after about twenty or twenty-five years' service, the boiler should (if we follow the motto "Safety First") be taken out of service. Because an inspector reports that he considers the boiler unsafe for further use, it does not imply that he can predict the day and the hour when it will explode; it does mean, however, that the factor of safety is too low, and to continue the boiler in service for any considerable length of time presents a hazard too dangerous to be undertaken.

No mysterious agency enters a boiler to cause an explosion. A steam boiler explodes or fails from one cause only, and that is the fact that the boiler or the part which fails could no longer resist the strain placed upon it. The applied pressure may have reached such a state of deterioration that the ordinary working pressure becomes an over-pressure. In the majority of serious explosions the primary cause was due to the lap seam form of construction.

Many accidents are due to over-heating of the shell plate or tubes. The overheating may result from various causes. The common cause is due to a deposit of scale, sediment, oil, or a combination of oil and scale on the internal surfaces. The presence of oil or grease, although in moderate amounts on the internal surface of a shell plate or tube is a dangerous condition, and, unless removed promptly, will result in a damaged or possibly an exploded boiler. Great care should be exercised to prevent oil entering a boiler.

By referring to the records of the Hartford Steam Boiler Inspection and Insurance Company, I find the following for the United States:

Year	Boiler Explosions	Persons		
		Killed	Injured	Total
1911...........	499	222	416	638
1912...........	537	278	392	670
1913...........	499	180	369	549

The annual property damage is estimated at one-half million dollars. The above records include boiler accidents of every description, some of which were of minor importance. This record is not an alarming condition and in fact, we are very much encouraged because of the great interest now taken by engineers everywhere insisting upon proper construction and inspection of steam boilers. In many locations compulsory inspection is required by law. The situation, therefore, as regards safety is gradually improving. We have not yet reached the stage of no boiler accidents. Such a condition will never exist. There will be boiler explosions as long as steam boilers are used as a unit of power. We have not yet reached the stage of perfection in the manufacture of material, neither have we reached perfection in the art of boiler design. We learn as much from the result of failure as from the result of success. Further experiences in the operation of steam boilers may teach us that some radical change in design or character of the material is required to make boilers that will not explode under constantly increasing pressure and temperature.

Another condition which must be considered in connection with the safe operation of steam boilers is their care and management. It frequently happens that a boiler explosion, or some other calamity resulting in loss of life, occurs at places where it is least expected. This proves that, in spite of the advanced precautions that science has provided, reliance must still be placed in human intelligence and faithfulness to a large degree and that sometimes these fail.

It is recommended that boiler owners and users provide every possible method of safeguarding human life and property by purchasing only such boilers as have been thoroughly inspected during courses of construction and by seeing that they are also inspected during the life of the boilers. Fortunately in the State of Ohio such conditions now prevail. It also devolves upon the owner or user of a boiler to select only such persons as are fitted to care for them.

Strength of Oxy-Acetylene Welds

(*Concluded from page* 304)

regard paid to all the conditions before making use of them. A very serious responsibility attends the use of autogenous welding in cases where the parts are likely to be subjected to considerable mechanical strain. In any case, where failure tended to endanger life and limb, welds, if not entirely prohibited, should be accepted with extreme caution.

Autogenous welds always represent a somewhat uncertain quantity, as there is no means, except by destructive tests, of ascertaining whether a weld is good or bad.

Fatal Boiler Explosion on a Tug.—According to a report from Tampico, Mexico, the tug *Gertrude*, owned by the Mexican Gulf Oil Company, was destroyed by a boiler explosion early in September. With one exception the entire crew was killed.

Personal.—J. M. Hall, locomotive boiler inspector for District 28 of the Inter-State Commerce Commission, has been transferred to District No. 9, with headquarters at Philadelphia, Pa.

Selected Boiler Patents

Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

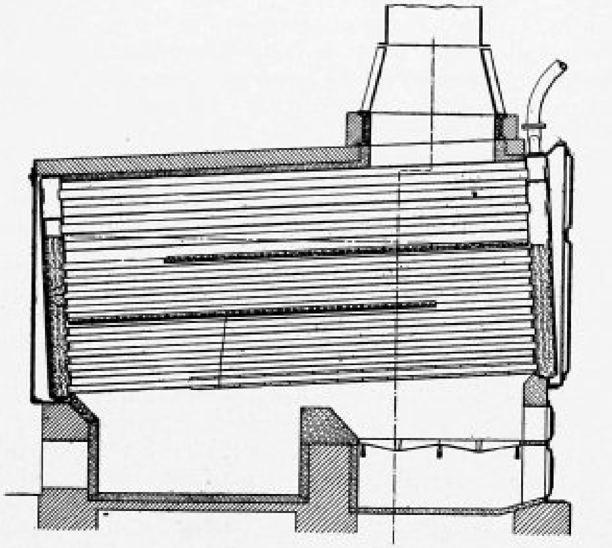
Readers wishing copies of patent papers, or any further information regarding any patent decribed, should correspond with Mr. Decker.

1,100,125. FORCED-DRAFT HOLLOW GRATE-BAR. JOHN H. DIETZ, OF KANSAS CITY, MISSOURI.

Claim 3.—The combination of a hollow grate bar provided in its top with a plurality of circular openings and with projections at the edges of the respective openings a support secured to the bar; a plurality of blocks adapted, by vertical movement, to control the respective openings, each block being provided with depending arc-shaped lugs having inclined faces resting on the support and with arc-shaped inclined slots in its periphery engaging the respective projections; and means for simultaneously rotating the several blocks. Three claims.

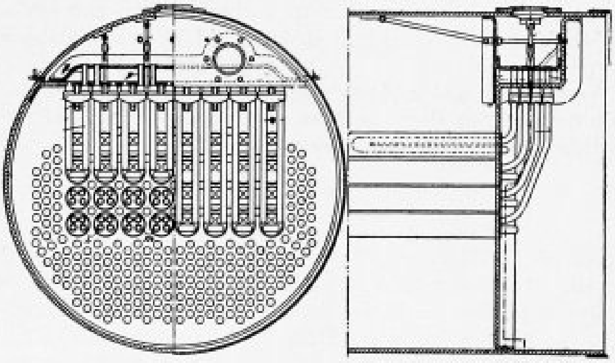
1,102,836. SUPERHEATER-BOILER. JOHN E. WHITTLESEY, OF PITTSBURGH, PENNSYLVANIA.

Claim 3.—A drumless superheater boiler having a plurality of banks of water tubes arranged one above another in successive longitudinal passes of the gases, a bank of superheating tubes arranged above the water tubes in the last pass of the gases, a box header at each end of the boiler, all of said water and superheater tubes opening at their ends into the said headers, the headers having baffling between the successive rows of superheater tubes whereby the steam is compelled to pass in parallel through the tubes of each horizontal row but in series with successive rows, the last rows of tubes opening into an equalizing chamber in one of the headers, and a delivery pipe leading from said equalizing chamber substantially as described. Three claims.



1,104,756. BOILER WITH FIRE-TUBE SUPERHEATER. SIMON HOFFMAN, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO LOCOMOTIVE SUPERHEATER COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

Claim 1.—In a steam boiler provided with fire tubes, a superheater comprising a pair of headers, one of which employs a part of the front tube sheet as part of its wall, superheater elements held within some of the fire tubes, each of said elements having a pair of ends, one of which connects with a header, while the other passes through said header into the remaining headers, and steam connections between the headers and the steam supply and engine cylinders, respectively. Five claims.

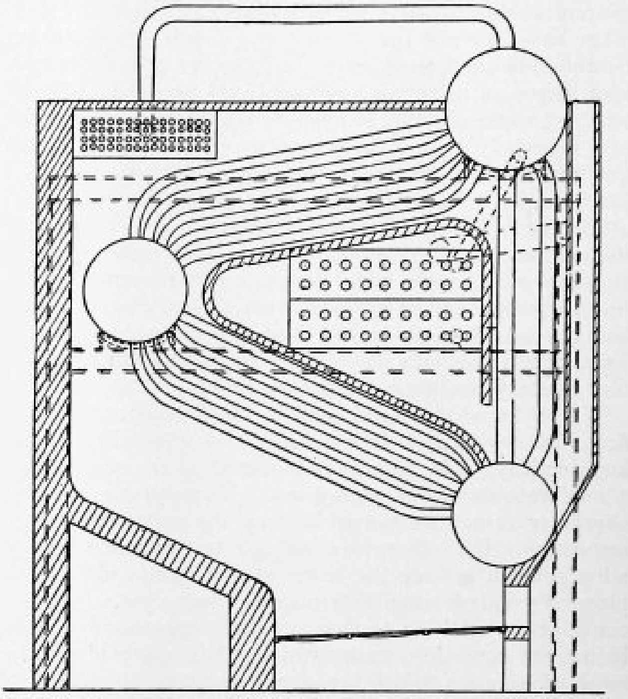


1,103,232. FURNACE-GRATE. FRANK L. O. WADSWORTH, OF SEWICKLEY, PENNSYLVANIA.

Claim 6.—In a furnace, the combination of an upwardly swinging holdback, a downwardly swinging dumping grate, a swinging operating member, a link connecting said member and said holdback, and connections between said operating member and said grate, said link and said connections being so arranged that during the first portion of movement of said member said holdback is fully elevated and said dumping grate is partially lowered, the pivot connecting said link and operating member being so disposed that during further movement of said operating member said pivot travels across a line intersecting the pivots about which said member and holdback swing, whereby said grate can be oscillated without appreciably varying the position of said holdback. Seven claims.

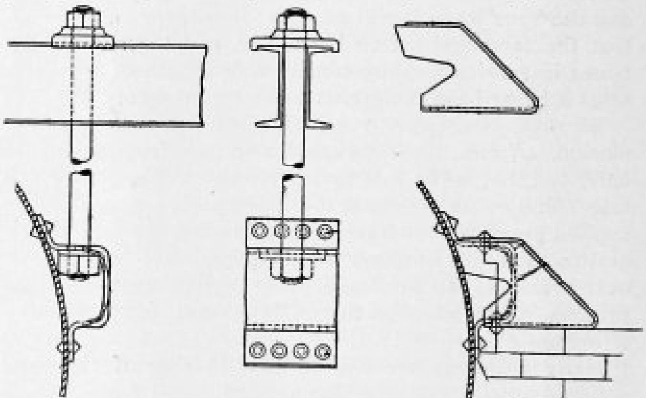
1,109,483. STEAM GENERATOR. ORLANDO SUMNER, OF LONDON, ENGLAND.

Claim 1.—In combination with a furnace and the combustion chamber thereof, a steam generator, comprising drums, tubes connecting the drums, an economizer supported between the drums, means for substantially housing the economizer, said means having an opening for admitting products of combustion to the economizer. Four claims.



1,104,144. BOILER-BRACKET. EDWARD P. SELDEN, OF ERIE, PA., ASSIGNOR TO ERIE CITY IRON WORKS, OF ERIE, PA., A CORPORATION OF PENNSYLVANIA.

Claim 6.—A boiler bracket comprising perforated ends adapted to engage the boiler shell; an outwardly extending intermediate loop, the opening extending horizontally through the loop and the upper wall of the loop having a perforation for a gallows bolt; an extension formed with a bottom plate riveted to the bottom wall of said loop; a top plate bent up from the bottom plate to the top wall of the loop; and a web bent up from the bottom plate and extending to the top plate. Six claims.



1,109,351. BOILER WASHING AND FILLING SYSTEM. FRANK W. MILLER, OF CHICAGO, ILL., ASSIGNOR OF ONE-HALF TO CLARENCE D. BAUERS, OF CHICAGO, ILL.

Claim 1.—In a boiler-washing and filling system, the combination of a reservoir, means for maintaining a predetermined level of water in said reservoir, means for conducting the blow-off steam and water of a boiler to said reservoir, and thermostatically controlled means for preventing said blow-off steam and water from entering said reservoir when the water in the reservoir is above a predetermined temperature. Thirteen claims.

THE BOILER MAKER

NOVEMBER, 1914

Gigantic Surge Tank

Description of the Largest Surge Tank in Existence, Built for the Salmon River Power Company by the Kennicott Company

On the Salmon River, which is a stream forty-four miles long, flowing from the foothills of the Adirondacks in a westerly direction through the northern central part of New York State into the eastern end of Lake Ontario, with a fall of 650 feet in the seventeen miles between Stillwater and the lake, the Salmon River Power Company has developed a 30,000 horsepower hydroelectric plant operating under a head of 245 feet. In connection with this plant at Altmar, N. Y., which is about fifteen miles from Lake Ontario, an interesting piece of sheet metal work has been carried out in the construction of a surge tank, 50 feet in diameter and 105 feet depth, placed on a tower at an elevation of 80 feet above the ground. This is the largest tank of its kind ever built, the work being done by the Kennicott Company, Chicago Heights, Ill.

The surge tank is connected to the lower end of the pipe line which conveys the water from the dam at Stillwater to the power house. The pipe line is approximately 9,500 feet long, ranging from 11 to 12 feet in diameter. The surge tank constitutes a hydraulic regulating device, as when the power plant is in operation and a constant demand for more power occurs, necessitating an increased supply of water, the water is temporarily supplied to the turbines largely from the surge tank, while the velocity of the water in the line pipe is increasing to the desired degree. On the other hand, when the power load is constantly thrown off the plant, the surplus water will surge


Fig. 1.—Bowl Bottom of Tank

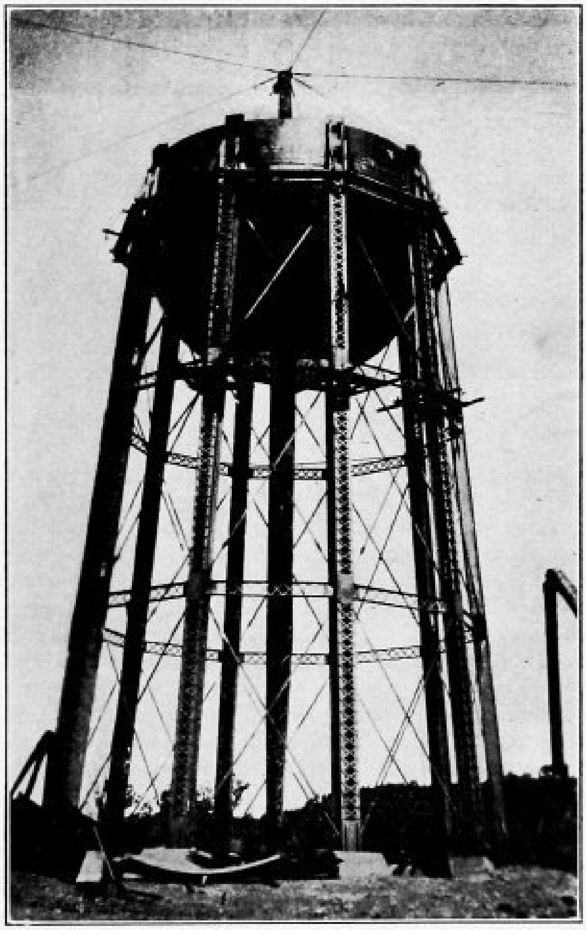


Fig. 2.—Tower Supporting Tank

upward and spill over the top of the riser leading to the surge tank, and will be caught and stored in the main bowl of the surge tank, while, at the same time, the velocity of the water in the pipe will be gradually reduced. The rise of pressure in the pipe line will, at the same time, be limited to that due to the water rising to the top of the riser.

So-called differential ports are provided at the bottom of the tank, the principal function of which is to retard the flow from the main tank to the turbines when the load on the tank is suddenly increased, so as to apply the full accelerating head to the pipe suddenly. Another function of the differential ports is to check the rise in pressure more gradually than would be the case without such ports when the load is thrown off.

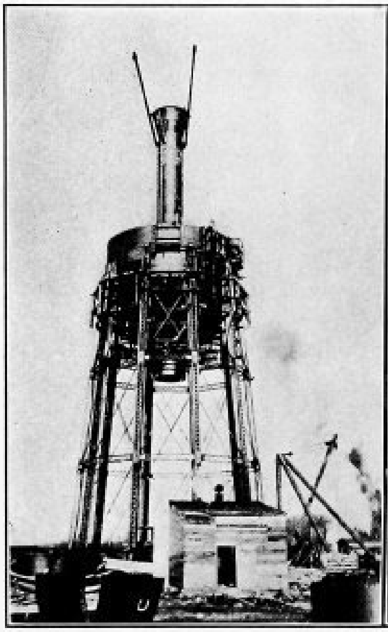


Fig. 3.—Inner Riser

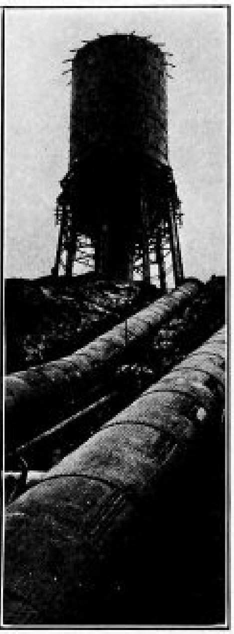


Fig. 4.—Penstocks

In actual operation, the water level in the main tank fluctuates considerably quite frequently, and the water level in the riser may frequently be considered above or below that in the main tank for short intervals.

The tank proper is constructed with a cylindrical shell, 50 feet in diameter and 80 feet high, mounted on a hemispherical bottom 25 feet deep, making the total height of the tank from the bottom of the bowl to the top of the shell 105 feet. Above the tank is a roof 20 feet high, and as the elevation of the bottom of the tank is 80 feet above the ground, the total height from the ground to the top of the roof is 205 feet. The bottom riser leading up to the tank is 12 feet in diameter, while inside of this is an inside riser 10 feet in diameter with a 15-foot funnel at the top.

The tank is supported on ten columns, each column consisting of two 8-inch by 8-inch by ¾-inch angles; two 6-inch by 6-inch by 1-inch angles; two 24-inch by 15/16-inch plates; one 34-inch by ¾-inch plate in the form of an open box with 3-inch by ½-inch cross lace bars.

The longitudinal seams in the bowl bottom are triple riveted butt strap joints, while the horizontal seams are quadruple lap joints. The first course of the shell is of 1-inch plate with triple riveted butt joints, while the thinnest plates in the tank are ½-inch thick with double riveted butt joints. The cylindrical shell and bowl bottom are connected by two ⅝-inch by 36-inch plates. The top riser is stiffened by 4-inch by 4-inch by ½-inch angles to take care of the difference in elevation of the water inside the riser, and in the tank proper. The 12-foot riser is connected to the bowl bottom by means of a special 12-foot expansion joint.

Wood Casing

The bottom riser, bowl bottom, shell of the tank and roof are encased by a two-ply wood casing allowing an air space of one foot around the tank and the bottom. The air space is heated by means of electric coils and a special heating system is located at the bottom of the riser. The casing is attached to the steel shell by means of angle clips. Ladders are provided encircling the bottom riser with walkways to the tower and a straight ladder outside of the shell to the top of the tank and also down inside of the tank to the center of the bowl bottom.

Roof

The roof is made of steel girders, covered with wood sheathing. The top flooring of the tank is provided with a special air-tight floor equipped with air traps so as to relieve the air pressure when the water surges in and out of the tank. The shell is reinforced with two angles inside of each course, so as to prevent collapsing when a partial vacuum is created by the sudden drop of the water in the tank.

The connections between the tank and the columns are made by two hundred and fifty-six ⅞-inch rivets on each of the ten columns. The total number of rivets in the complete structure is approximately one hundred thousand, while the weight of the complete structure is 810 tons.

Hoisting Derrick

Special hoisting equipment was necessary for erecting the tank, and this consisted of a derrick with a mast 140 feet long and a boom 125 feet long. With one setting of this derrick the columns, bottom and first course of the tank were hoisted and placed into position.

Operating Features

The water flows to and from the surge tank through a section of 12-foot steel pipe at about the ground level. This pipe is called the distributor, as it is the pipe which distributes the water to the several penstocks and turbines. A 12-foot by 12-foot by 12-foot steel tee incased in concrete constitutes the connection between this distributor and the riser to the surge tank.

The water enters and leaves the tank through a section of the riser which is a vertical pipe 12 feet in diameter connecting the distributor tee with the bottom of the surge tank. An expansion joint is located in the section of the riser immediately below the bottom of the tank. Inside the tank there is another section or extention of the vertical riser, which is for the most part 10 feet in diameter, flaring out at the top to a diameter of 15 feet and also flaring out slightly at the bottom.

At the bottom of the portion of the riser inside the tank, the construction is such that the water flowing up toward the tank flows partly into the main tank through the differential ports and partly into the interior riser, and, conversely, water flowing downward through the 12-foot riser flows partly from the 10-foot riser and partly from the main tank through the differential ports.

Loads

The tower supporting the tank is designed to carry the maximum possible dead-load, consisting of the entire weight of the materials of the structure, including the housing and the tank full of water, and, in addition to this, a roof load and live load as well as a wind load, computed on the basis of wind pressure amounting to 20 pounds per square foot for the maximum projection in a vertical plane of the entire structure, including the housing and roof. The hemispherical bottom of the tank supports the portion of the riser which extends up inside the tank proper.

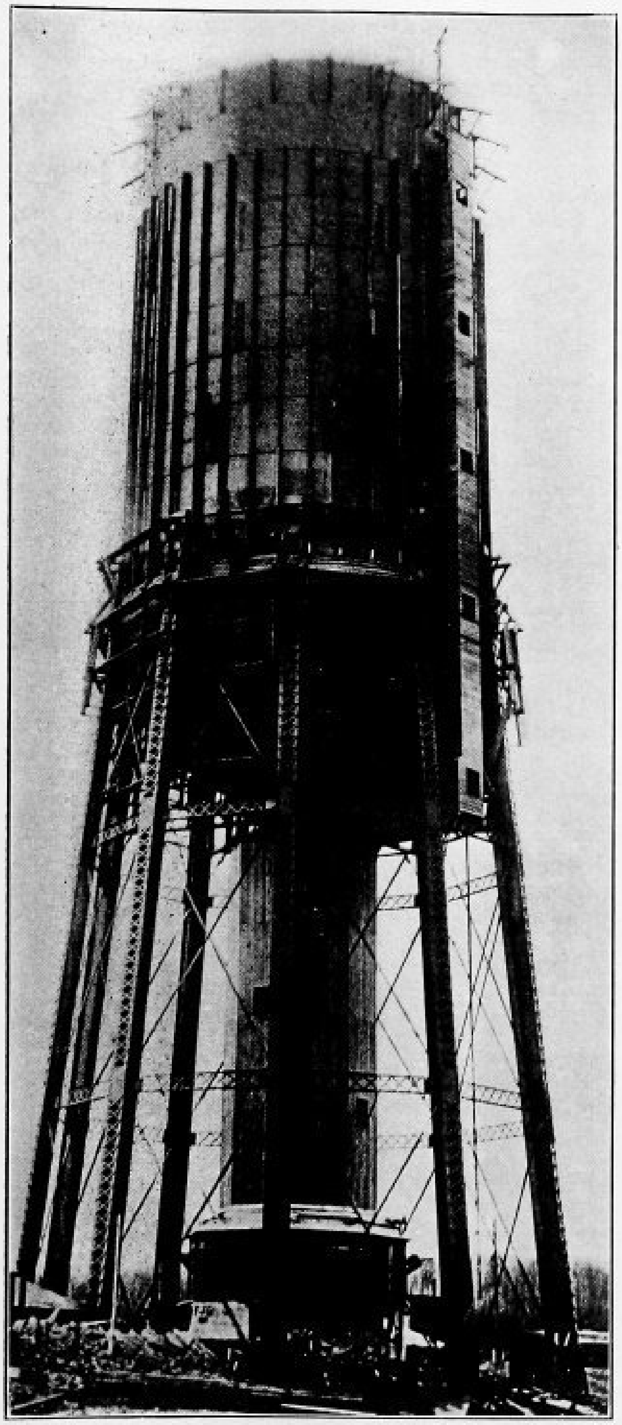


Fig. 5.—Surge Tank

The upper 60 feet of the interior riser is designed to withstand an external hydrostatic pressure, due to a water level 5 feet above the top of the riser. From a point 60 feet below the top of the riser to the bottom the riser is designed to withstand safely the external hydrostatic pressure due to not less than a 65-foot head of water, while the portion of the riser which is below the hemispherical bottom of the tank is designed to withstand an internal hydrostatic pressure due to a water level at the top of the tank.

The side and bottom plates of the tank proper are designed to withstand an internal hydrostatic pressure due to the tank being full of water.

In all compression members the unit working stress does not exceed 15,000 pounds per square inch. The unit stresses in the plates composing the sides and bottom of the tank do not exceed 14,000 pounds per square inch of net section, and plates less than ½ inch in thickness are not used. For other tension members in the structure, including the bracing, the working stress does not exceed 12,000 pounds per square inch of net section. The working stress of the members in shear does not exceed 9,000 pounds per square inch, while the rivets are proportioned for unit stresses not to exceed 15,000 pounds per square inch.

All of the metal in the structure, except the rods, which require welding or forging, are of open-hearth steel. The steel plates used in the construction of the tank cylinder are of flange or boiler steel, while all plates in the hemispherical bottom of the tank are of extra soft steel. The sway rods and rivets are of the grade of steel known as rivet steel.

STARTLING RESULTS OF NAVAL TESTS.—The official comment made by Lieutenant H. G. Bowen, U. S. Navy, on the investigations on the gage glasses at the naval engineering experiment station at Annapolis describes the results as "startling." The ordinary dipping tests will not indicate the ability of the glass to resist disintegration. The glass of tubular and reflex gages corrodes in high-pressure steam under usual service conditions, coating the glass with an opaque siliceous deposit. If this action continues long enough the glass will dissolve until it fails under pressure. The only certain and efficient method of protecting the gage is to cover the pressure side of the glass with a thin sheet of mica. By this means the glass remains transparent and unattacked as long as the mica covering is intact. In the test of valves and fittings experiments have established the fact that superheated steam does not erode valve fittings, but corrodes them, and that monel metal resists this corrosive action better than class "A" or class "B" steel. In all valves tested, however, the valve seats showed the impress of the disk, and both were scarred by scale and grit which had been caught between disk and valve on closing. It has been demonstrated for all time that the disk type of bottom blow-off valve is unfit for naval use. Comparative tests are now being made on several of the so-called seatless types, one of which, a bureau design, has been found highly satisfactory.—*Army and Navy Register.*

UNUSUAL METHOD OF REPAIRING RIVETED STEEL PIPE.—A riveted sheet steel siphon ten feet in diameter carries water to Los Angeles across the Antelope Valley. Recently a great storm visited the valley and the resulting flood undermined the supports of the aqueduct, causing it to break in two. The shell being unsupported by internal pressure and being subjected to external pressure due to the flood, collapsed for a distance of nearly two miles. Apparently the pipe would have to be reconstructed at great expense, but the engineer in charge decided that it could be restored to shape by simply stopping the broken ends of the pipe and turning the water pressure into it. This was done, the result being that the pipe assumed its normal shape and very few leaks developed.—*Machinery.*

Development of Round Top Tank

Explanation of a Method, Similar to Triangulation, of Laying Out the Patterns for an Hemispherical Tank Head

The following method for laying out an hemispherical tank-head is similar to the method of triangulation used in laying out many curved surfaces. As it is impossible to develop accurately the surface of a sphere—i. e., to lay out the pattern of a sphere on a flat surface—we must assume that the surface of a sphere is made up of a great many flat surfaces joined together.

In practice, such a division and joining together of parts would be out of the question and the usual method employed is that of dividing the surface into zones or courses and dividing each course into a convenient number of sheets. The number of courses and sheets in a course depend on the size of the tank.

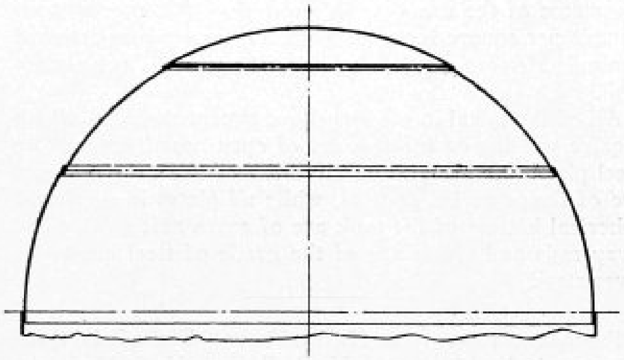


Fig. 1

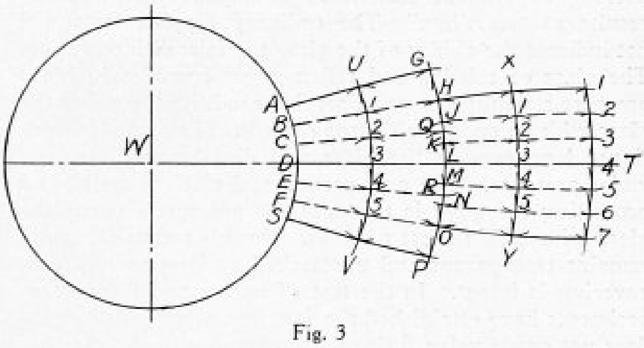


Fig. 3

Division of the Surface

If the tank were small enough the head could be made of one sheet, and when this becomes impractical the number of sheets used increases with the size of the tank. The tank-head, developed, of which a cross-section is shown in Fig. 1, is about 22 feet in diameter and is made up of two courses and a dished plate.

The division of the courses is shown in Fig. 2 by the diameter *A-B* and the two chords *E-F* and *J-K*. Points *E* and *J* divide the arc *A-O* into three equal parts. Chords *G-H* and *C-D* divide each course as a center line, being half-way between the course lines, and are used only as construction lines. In the plan view about O_1 these chords are all shown as circles with O_1 as a center.

In this view the courses are divided into sheets by radiating lines, so that there are eight sheets in the top course and twelve in the bottom course. These twenty sheets, together with the dished plate, make up the whole tank-head and, since all the sheets in the same course are the same in size and shape, it is only necessary to lay out one sheet for each course and the pattern for the dished plate.

Division of the Sheets

The outline of sheet a_1-g_1-t_1-h_1 in the plan view, Fig. 2, is projected into the elevation as *a-g-t-h* and the upper and lower edges divided into a number of equal parts, six in this case. This gives points *a*, *b*, *c*, etc., and *h*, *j*, *m*, *o*, *q*, *s* and *t*. Arcs a_1-g_1 and h_1-t_1 are divided into the same number of equal parts and radiating lines drawn to join corresponding points on both arcs.

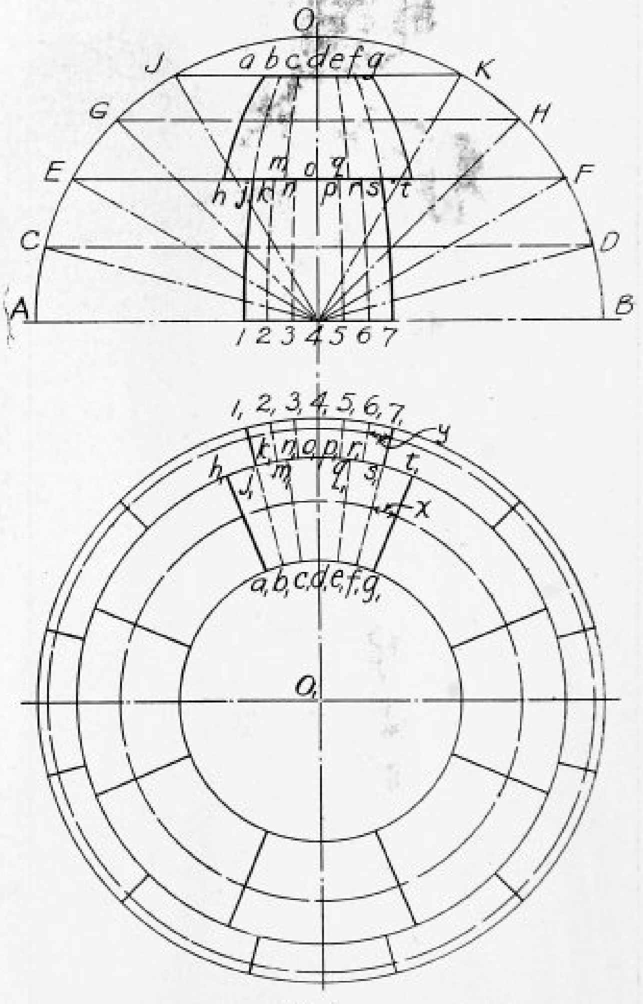


Fig. 2

These lines are projected into the elevation, as *a-h*, *b-j*, *c-m*, etc.; but instead of appearing straight, as in the plan, they appear as arcs of ellipses. These lines, which are projected arcs of great circles, divide the sheet from left to right into six equal parts. That part of the chord or small circle *G-H* subtended between *a-h* and *g-t* completes the subdivision of the sheet, dividing it, not into two equal parts, but in a line every point of which is equidistant from the top and bottom edges of the sheet.

The corresponding sheet in the bottom course is subdivided in the same manner, and, in this case, into the same number of parts.

LAYING OUT THE PATTERNS

It is good practice to make the bottom of the head or dished plate in one piece, so that it forms an outside sheet. The diameter of this dished plate before dishing will be more than the length of the chord *J-K*, but less than the length of the arc *J-O-K*. Then, if a circle is drawn, as at *W*, Fig. 3, with chord *O-J* as a radius, it will form the nearest approximation to the pattern of the dished plate and can be used for all practical purposes.

In order to lay out the sheets it is necessary to know how, or in what form, some lines on that sheet will develop when the sheet is flattened out. The center line, of course, will develop as a straight line *D-L*, Fig. 3, but we must determine some line crossing this as a sort of base line:

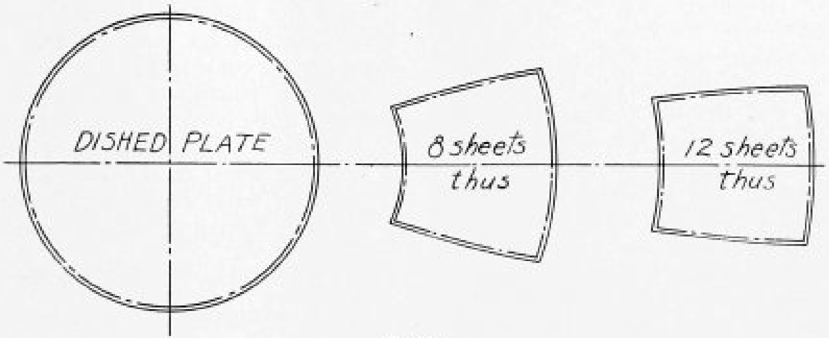


Fig. 4

Considering arc *A-S*, Fig. 3, in order for these two sheets to join properly when dished, it would seem that the arc *A-S* for the sheet in the first course should be more acute than the arc *A-S* for the dished plate; i. e., it should have a smaller radius. But the arc *A-S* of the sheet in the first or top course should be more obtuse; i. e., have a larger radius, to allow for its own dishing, since dishing would take more material from the center of the arc at *D* than from the corner of the plate at *A*. Therefore, if a mean is taken of these two considerations, which are both of a practical nature, we get exactly the same curvature for one arc as we do for the other. That is, the upper edges of the sheets in the upper course have, on their pattern, a radius equal to the radius of the dished plate, as shown by *W-D*, Fig. 3.

Now along *W-T* as a center line, *D*-3, 3-*L*, *L*-3 and 3-4 are spaced off so that each will be equal to the length of arcs *K-H*, *H-F*, etc., Fig. 2. Arc *A-S*, Fig. 3, is made the same length as arc a_1-g_1, Fig. 2, and divided by points *B*, *C*, *D*, etc., into the same number of parts as the latter. Then about point 3 on *D-L*, Fig. 3, arcs are drawn on opposite sides of *D-L* with a radius equal to x, Fig. 2. With a radius equal to *D*-3 or *K-H*, Fig. 2, arcs are drawn about points *C* and *E*, Fig. 3, intersecting the smaller arcs in points 2 and 4. This is continued on opposite sides of *D-L* until points 1, *U*, 5 and *V* are determined, so that 3-2 equals 2-1, etc., and *D*-3 equals *C*-2 equals *B*-1, etc.

The same is done to determine points *Q*, *H*, *G*, etc., except that distances *L-Q*, *Q-H*, etc., are made equal to s_1-t_1, Fig. 2, or one-sixth of arc h_1-t_1. The outline of this sheet is then defined by *A-S-V-P-L-G-U*.

An analysis of the operations will show that lines *U-V* and *G-P*, Fig. 3, are not arcs of circles with centers at *W*, although they are nearly so. The difference cannot easily be seen on such a small scale, but would be quite noticeable at full size.

In developing the sheet for the lower course, the same discussion holds for the curvature of adjoining arcs of that and the upper sheet as held for the upper sheet and dished plate. Then *H-O*, Fig. 3, is the upper edge of the lower sheet and is divided exactly as arc j_1-s_1, Fig. 2, by points *J*, *K*, *L*, *M* and *N*. The same method is then used in laying out this sheet as was used in laying out the upper sheet. Care should be exercised, however, in using the correct radii for arcs in determining points, 1, 2, 3, etc. The lower sheet is then defined by *H-L-O-Y*-7-4-1-*X*.

FINISHED PATTERNS

In laying out the sheets as above it was assumed that the neutral surface for each course was the same. In practice, Fig. 2 would be drawn so that arcs *J-O-K*, *A-E* and *F-B* had an increase of half the thickness of the plate in their radius. Also arcs *E-J* and *K-F* would have a decrease of half the thickness of the plate in their radius. It will also be necessary in practice to allow material for flanging, depending on how the sheets are to be joined, so that the finished patterns will appear similar to Fig. 4.

Talks to Young Boiler Makers

BY W. D. FORBES

Chemistry is a study in which boiler makers, young or old, are but little interested—that is to say, directly—yet in the production of the material used by boiler makers chemistry is of the greatest importance. It is rather a strange study, as what is done can rarely be directly noted. To illustrate what I mean by this and to show the peculiarity of chemical procedure, we will take the gas known as oxygen; it is much lighter than air. Now, if the boys send out the "growler" for a couple of quarts, the man brings back the pail, holding it by the handle, and he sets down the can on the bench with the open mouth up; and if a man wants a cupful of beer, it is poured out of the side of the "growler" into a mug. If, now, they sent out for a "growlerful" of oxygen, they would have to reverse all this and the man would have to bring along the canful of oxygen and set it down on the bench with the bottom up; and if a mugful of oxygen was wanted, they would have to hold the mug upside down and tilt the can and pour the oxygen up into the mug. If this was not done, the oxygen, being lighter than air, would, of course, rise out of the "growler" and disappear into the air.

Oxygen is a gas which has no color, taste, feeling, or odor, and at first it would seem pretty difficult under the circumstances to know whether you had any of it or not; but it is a simple matter to find out. This is one way the highbrows find out if they have got a mug of oxygen or not: They take, for instance, a piece of stick, light one end and let it burn for a few seconds, then blow it out and quickly stick it up into the mug where they think the oxygen is. If oxygen is there the stick will immediately burst into flame again.

Years ago there used to be a lot of old codgers who were called alchemists. They had some very strange notions. One was that a substance could be made which, when it was brought in contact with, for instance, iron or copper, it would turn the iron or copper immediately into gold. They called this article they were searching for the "touchstone," and the change of iron into gold the "transmutation of metals." To-day this idea is pretty well abandoned, but the idea of touching a fellow for gold, or its equivalent in greenbacks, is still quite prevalent.

Strange Notions of the Alchemists

Another thing these alchemists were chasing all the time was a "universal solvent." They tell a story of Abraham Lincoln, that he once got lost in the woods, and after night came on he saw a light which he found was in a kind of little shack, and when he knocked at the door a voice within told him to go away; but Lincoln pleaded that it was dark, it was going to rain, and he did not know where to go, and he was admitted. The owner proved to be an old man, and after a while became quite chummy and told Mr. Lincoln he was a chemist and was trying to find the universal solvent. Lincoln said he did not know what that was and asked the old man to explain. "Why," said the old fellow, "it is a liquid which will dissolve anything you put into it, and it would be of great value to the world." Lincoln thought a minute and then said, "Look here, my friend, if that liquor is going to dissolve everything, what would you keep it in?" The old man gave a yell, rushed out of the cabin and was never heard of again.

These two ideas show that some pretty foolish things used to be done in the chemical line. Now, there is a substance which every boiler maker uses more or less, and that is water. It is rather strange, or rather interesting perhaps, to know that this almost incompressible liquid is the result of the chemical combination of two very elastic gases. A highbrow when he writes about water does not call it water, but H_2O. The reason for this is that these symbols, as they are called, tell what goes to make up water, and the symbols stand for hydrogen, a gas, and oxygen, another gas, the H standing for hydrogen and O for oxygen. If these two light, elastic gases are allowed to flow together in the proportions of two parts of hydrogen and one part of oxygen, the result is water.

Physical Properties of Water

Water, like everything else in the way of a liquor, can have various degrees of purity, distilled water being the purest. Distilled water is taken as a standard in comparing the weights of all other substances. We say a thing is lighter or heavier than water. If lighter, it will float on the surface of the water; if heavier, it will sink beneath it. Boiler makers see water in three different forms. Ordinarily it is a fluid, but if heated up to 212 degrees Fahr. it becomes a vapor or gas, and it is called steam. If it becomes as cold as 32 degrees Fahr., it becomes a solid and is known as ice. So we have three different conditions of water—a solid, a liquid and a gas.

Of course, besides being lighter or heavier than water, a substance may be just the same in weight. If we take a cubic inch of distilled water at a temperature of 39.2 degrees Fahr., it will be found that it weighs .0361 pound, or 62.425 pounds per cubic foot. A cubic foot of ice weighs 57.25 pounds, and a cubic foot of steam, at 1 pound pressure, weighs .0030 pound. Water acts quite curiously in passing from one state to another; for instance, from 40 degrees down to 12 degrees it expands in bulk .00236, from 40 degrees to 212 degrees it expands .04012 or .0002325 for every degree, equaling an increase in volume of $\frac{1}{.04012}$. One cubic inch of water expands into 1,700 cubic inches of steam at 1 pound gage pressure.

Water is measured by cubic feet, Standard gallons or Imperial gallons. As a cubic foot of water weighs 62.425 pounds, a gallon of water weighs 8.338822 pounds, while an Imperial gallon of water weighs 10 pounds. The Imperial gallon is used in England and it would be convenient to use it universally, as its weight is an even amount and therefore easy to remember. The Standard gallon contains 231 cubic inches, while the Imperial contains 277.274 cubic inches. A barrel of water, which is an amount we commonly see, weighs 262.654 pounds, and contains 4.789 cubic feet, or 31.5 gallons.

A ton of water contains 34.83 cubic feet.
A ton of water contains 2,174.2627 gallons.
A ton of water contains 8,201 barrels.
All these figures are handy to remember.

An Ideal Medium for Testing Boilers

In boiler testing, water is an ideal medium, as it is practically incompressible and transmits the pressure on 1 cubic inch to all the square inches of the surfaces which confine the water; that is, if you have a boiler chock full of water and apply with a force pump a pressure of 1 pound to the confined water, every square inch which is wetted with the water will have on it 1 pound pressure, and of course the total pressure on the ends of the boiler or tank becomes an enormous total pressure.

To illustrate this: if the boiler were 10 feet in diameter the head would have an area of 11,309.76 square inches, on which the total pressure at 1 pound per square inch would be 11,309.76 pounds.

Now, if we took this boiler and stood it on its head, and if we supposed the shell were 20 feet high, the pressure, if it were filled with water on the lower head or bottom, could be found by multiplying the height—i. e., 20 feet—by .434, which would equal 8.68 pounds.

Now, there is one thing to remember in this connection, which is that the pressure per square inch on the bottom of a cylinder such as the boiler described, due to the weight of the water, has nothing to do with the diameter of the boiler, but only with its height; that is to say, if the boiler were 2 feet in diameter the pressure on each square inch would be just the same as though it were 20 feet in diameter; but of course the total pressure on the boiler head or bottom of the 2-foot diameter would not be as great as the total pressure on a 20-foot diameter, simply because the area of the 2-foot boiler head is much less than that of a 20-foot head. For rough calculations it is usual to say that the pressure per square inch of water on the bottom of a standpipe or tank is equal to half its height in feet; that is, a 20-foot standpipe would have a pressure of 10 pounds per square inch on its bottom. The pressure on the sides of a standpipe varies, of course, with each inch of height.

I have often been asked why it was that the head of a boiler had to be stayed while the shell did not have to be. The head of a boiler presents a flat surface and can be compared, to illustrate this problem, to a number of I-beams which are supported at each end. The longest of these I-beams would be the one that stretches directly across the center of the boiler head; the other I-beams which we suppose go to make up the head would get shorter and shorter as they approach the edge of the head; if the I-beams were deep the head would be quite strong for obvious reasons, but if these I-beams were very shallow they would be weak. The pressure, therefore, in the boiler against the head is resisted by strips of metal which are long and shallow.

This idea can be more clearly illustrated, perhaps, by supposing that we lay across a 10-foot shell a 1-inch ordinary board. This would break, of course, with the weight of a man, but if we turned it up on edge it would support a very considerable weight. This board on edge corresponds in its action to that of the ordinary strong back, which is used in certain types of boilers; it is therefore evident that if we put a single stayrod through the center of a 10-foot boiler head, we practically shorten the distance between the supports of our supposed I-beam construction to one-half, or 5 feet.

Now, the shell of the boiler is circular and the water in it, not being compressible, forms a continuous support, so to speak, and there is no "deflecting" effort as there is in the head; and if you put a staybolt from one side of the shell to the other, it would not strengthen the boiler, as the pressure is equal in all directions. Consequently the circle with the confined incompressible water in it has a continuous support, unlike our supposed I-beam head, having two or more supports. The strength of the shell, then, is the tensile strength of the material when considered with its area.

It may be asked if, with an elastic fluid like steam, the same argument holds good for the shell. It certainly does, as the steam pressure, as well as the water pressure, is equal in all directions.

Atmospheric Pressure

In this connection I will go back a little way and refer to the matter of the weight of water in regard to its depth. Now the world is entirely enveloped with an atmosphere. This great envelope of air which surrounds the world follows a law which is similar in effect to that described as pertaining to water, which is that the pressure at the bottom of the standpipe or tank is greater than at any other point in the total height. The highbrows went to work and, by means of a vacuum pump, exhausted or pumped out all the air in a tank; and when they did this they discovered that if the tank was not of a certain strength it would cave in or collapse. This, of course, showed that there was some pressure exerted from the outside which was unbalanced, which proved to be the weight of the air; and on further investigation it was found that the weight of the atmosphere at sea level was 14.723 pounds per square inch. Now this, when you consider the number of square inches of skin that cover a man is a pretty tidy sum in the way of pressure, but the reason why a man does not collapse by this weight or pressure is that it is inside as well as outside of him and therefore balanced.

The higher you go up into the atmosphere the less this pressure becomes, because there is less depth of air above you. The water of the oceans is salt, and it is self-evident that it must have greater weight per cubic foot than fresh water, and is therefore more buoyant. The average weight of a cubic foot of salt water is 64.1088 pounds.

When I wrote earlier in this article about a staybolt from one head to the other of a boiler in order to give a shorter length between supports of the head, I did not mean to convey the idea that the staybolt would strengthen the heads to any great extent if the pressure were from the outside, as would be the case if a vacuum were produced in the boiler; but the staybolts would strengthen the heads when the pressure was on the inside, as the tendency of the two heads to bulge out or go away from each other would be counteracted by the staybolt, and the amount that it would strengthen the heads in the center would be the amount of material in the staybolt.

Staybolts

BY GEORGE L. PRICE

At present three kinds of staybolts are being used in locomotive boilers—the rigid, the hollow and the flexible bolt. Staybolt breakage has been eliminated to a great extent since the introduction of the flexible bolt. In fact, staybolt breakage and the remedies for eliminating breakage have been live topics of discussion for many years.

Years ago expansion and contraction were not taken care of by the use of flexible bolts, but an attempt was made to restrain the expansion and contraction by the use of heavy sheets, large staybolts, heavy bracing, etc. Before the flexible staybolt put in its appearance, the rigid bolt, threaded on both ends and riveted over, was made from a solid bar of iron of the best quality, but, nevertheless, led to breakage regardless of all modifications in form, shape and size, with additional changes in quality to strengthen the bolts. From this it is natural to conclude that it is not so much a question of quality in the material as it is a question of too much rigidity in construction.

Flexible Staybolts

The flexible staybolt has proved a large factor in the elimination of inequality of expansion in locomotive boilers. It is impossible to restrain or restrict the expansion of material without disturbing its structure. A rigid staybolt under normal conditions, considering the tensile strength and the stress under pressure, has a large factor of safety, but, owing to the vibratory stresses due to the expansion and contraction of the firebox sheets, and due to the fact that the bolt being threaded opens an avenue for a fracture which will result in a break, the rigid staybolt has always given a great deal of trouble.

I have often been asked the question, why is it that a rigid staybolt generally breaks flush with the inner surface of the outside sheet? While I have never seen anything authentic in regard to this, the following reasons seem to me to be logical: As the inner firebox sheets are generally about one-half the thickness of the outside sheets, they become heated before the outside sheets and start to expand first, thus causing the inner, or firebox, end of the staybolt to travel in the direction of the stress, while the outside end of the bolt, which is at a lower temperature and is held more rigidly, moves only a comparatively small amount at first, but eventually travels a greater distance than the inner sheet, owing to the fact that the outer sheet is a larger and thicker sheet, and consequently expands a greater amount when the temperature is increased. The continuous vibration upon the staybolt, together with the tensile stress, or load, due to the pressure on the bolt, will eventually break the staybolt. Breakage in this way generally takes place when the engine is being fired up after a washout, therefore it is logical to believe that the hot water system of washing out wouold lessen the breakage of rigid staybolts.

Staybolts not only act as a connecting agent to hold the outer and inner firebox sheets together against boiler pressure, but they are also compelled to withstand excessive bending stresses, set up by the unequal expansion and contraction of the inner and outer sheets. The load upon a staybolt, due to the boiler pressure, is comparatively small as compared to the stress induced by the inequality of expansion and contraction.

Strength of Staybolts

The strength of a staybolt should be calculated from its smallest area. Staybolts are made from wrought iron on account of its fibrous structure, which will stand more abuse from the different stresses acting upon the bolt than will steel, which is of a crystalline structure. All staybolts become more or less crystallized by the rapid blows of the hammer in riveting, although it is impossible to judge the amount of crystallization occasioned by the riveting process.

Inferior installation of flexible staybolts often gives us considerable trouble. We have been calking the flexible bolt thimbles or bushings in the roundhouse for the last three years, and, furthermore, we have not finished calking yet, and probably will not have finished until we have gone over the entire lot of bolts. We may attribute this defect to inferior installation during the construction of the boiler in the locomotive works. This is an expensive item for our railroads to contend with, and it should be eliminated.

Application of Flexible Bolts

When applying flexible staybolts, the adjustment of the bolts should be taken into consideration, although this is not uniform for all types of boilers. When firing up a locomotive boiler, the inner firebox sheets expand more rapidly in an upward diagonal direction than the outer sheets. As steam is raised to its working pressure the outer shell expands in a direction which extends longitudinally to a greater extent owing to its larger dimensions and greater thickness. The difference in the amount of expansion between the sheets varies in different types of boilers and, for this reason, bolt adjustment should be based upon data obtained by tramming the firebox for the difference in sheet expansion. However, the writer is of the opinion that the following course of adjustment is adaptable for fireboxes 8 feet long and under:

Adjustment for Side Sheet and Back Heads

Taking into consideration the first, second and third outside rows and the same across the top, the bolts in row No. 1 should be given a half turn back; those in row No. 2, three-eighths of a turn back, and those in row No. 3 a quarter of a turn back. For fireboxes 8 feet in length and over, the bolts in row No. 1 should be given three-quarters of a turn back; row No. 2, one-half of a turn back; row No. 3, three-eighths of a turn back.

For the adjustment of the throat sheet, taking the first three rows above the mudring, the first row above the mudring should be tight; the second row, three-eighths of a turn back; all other rows, three-quarters of a turn back.

When large areas are covered by flexible staybolts, all bolts inside of the three outside and the three top rows should be turned back off of their seats one-eighth of a turn, because riveting has a tendency to draw the bolt up to its seat.

Staybolts should have a larger factor of safety than the boiler shell or plates, on account of its being subject to both a direct and an indirect pull, as well as an unequal vibratory stress. For this reason I do not think it is practical to admit staybolts in the rivet line when applying a patch to firebox sheets.

Examples

What load is carried by a staybolt when the bolts are spaced 4 inches between centers and there is a steam pressure of 150 pounds per square inch? The load carried by the staybolt is equal to the area it supports multiplied by the steam pressure per square inch, which, in this case, will be $4 \times 4 \times 150 = 2{,}400$ pounds. This is, of course, disregarding the area of the bolt itself.

If we allow 6,000 pounds stress per square inch for staybolts, what area would a staybolt support, the least diameter of the bolt being ⅞ inch and the allowable working pressure 200 pounds per square inch? First determine the area of the staybolt as follows:

$$.7854\ (.875)^2 = .6013.$$

Then multiply the area of the staybolt by the allowable stress per square inch, and divide the result by the allowable working pressure, giving the area as follows:

$$\frac{.6013 \times 6{,}000}{200} = 18.03.$$

Finally extract the square root of the quantity representing the area, and you will have the spacing or pitch of the staybolts:

$$\sqrt{18.03} = 4.25, \text{ or } 4\tfrac{1}{4} \text{ inches.}$$

What force will a staybolt resist whose smallest diameter is ¾ inch, the diameter at the root of the thread being ⅞ inch, with a 3/16-inch telltale hole, and the allowable working stress 6,000 pounds per square inch? First the area at the root of the threads must be determined. From this value deduct the area of 3/16-inch telltale hole, or $(.875)^2 \times .7854 - (.1875)^2 \times .7854 = .5737$ square inch.

The area of the staybolt at its ¾-inch diameter will be $(.75)^2 \times .7854 = .4418$ square inch. The area for the ¾-inch diameter being less than the area at the root of the thread minus the area of the telltale hole, the load allowed is computed from the ¾-inch diameter and is: $.4418 \times 6{,}000 = 2{,}650$ pounds.

The Hammer Test

Boilers are sometimes put under pressures of from 40 to 50 pounds per square inch to aid the inspector in locating a broken staybolt with the hammer. Putting the pressure on the boiler causes the two parts of the broken staybolt to separate, thus permitting the broken staybolt to be more readily found.

All staybolts, crown-bolts and radial bolts should be placed so as to be at right angles or 90 degrees to the sheet they support. When the pitch of the staybolts is excessive, the pressure will bulge the sheets and thus create a deformation.

Staybolts should project beyond the sheet about two threads to form a head in driving the bolt. Excessive allowances make it difficult to upset the staybolt in the hole. The smallest size staybolt advisable for high-pressure boilers is ⅞-inch diameter.

In the distribution of staybolts and braces, every effort should be put forth to distribute them so that each staybolt or brace will have the same working stress per square inch; that is, as nearly so as practicable. In arranging staybolts, attention must be paid to the size of the staybolt, the pitch and the thickness of the plate it supports. It may be possible that the staybolt or brace will be large enough to support the area allotted to it, but the plate may be so light that the pitch will be excessive and cause deformation of the plate. In deciding upon the pitch it is necessary to know the formula generally adopted for this purpose.

Furnaces for Hand-Fired Tubular Boilers[*]

Experiments with Furnaces Designed Especially for Installation with Hand-Fired Return Tubular Boilers—Boiler Settings

BY SAMUEL B. FLAGG, GEORGE C. COOK AND FORREST E. WOODMAN

Although most of the large steam power plants to-day have mechanical stokers, yet the total number of hand-fired furnaces still exceeds by far those in which such stokers are used. This statement is true not only as regards commercial plants, but as regards plants operated by the Federal Government.

For many years it was the practice in this country to set practically all hand-fired boilers, both watertube and fire tube, according to certain standard designs without regard to the character of the fuel to be used. Most of these standard settings were developed in the eastern States where the fuel used was, as a rule, either a small size of anthracite or a bituminous coal containing relatively little volatile matter. The adoption of such furnace designs for plants where the more gaseous coals were to be used resulted not only in large losses from incomplete combustion, but also in the production of much dense smoke.

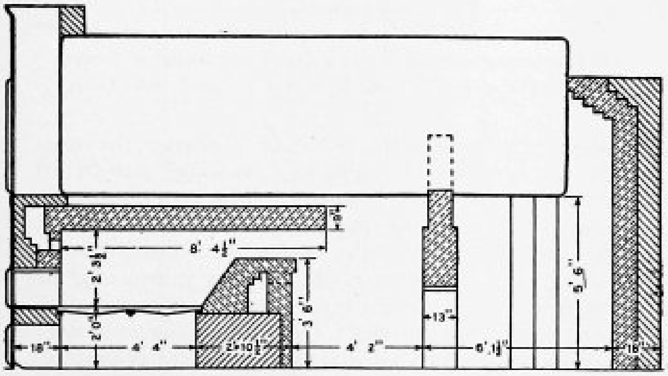


Fig. 1.—Arrangement of Furnace for First Series of Tests. Boiler 60 Inches by 16 Feet, With Forty-four 4-Inch Tubes

With the increased opposition to smoke came a greater demand for its elimination. This demand was directed first at the larger plants, and because of the greater possibilities of reducing operating expenses and the greater assurance of smoke prevention by the use of mechanical stokers, these plants generally abandoned hand-firing. Various devices were also developed and sold for hand-fired boilers, but most of them took little or no account of furnace design. Within the last few years, however, the demand for reduction of smoke emission from hand-stoked furnaces has become more insistent and much more attention has been given to the design of hand-fired furnaces, including those for small plants.

The tests reported in this paper were undertaken for the purpose of determining the effect on furnace efficiency and on smoke emission of certain features of furnace design and of different methods of operation.

The results of the tests show that it is possible to develop furnaces that will, if properly handled, meet the requirements of city smoke enactments. With the proof of this possibility will come further improvement in all hand-fired boiler furnaces.

General Condition of Tests

The furnace used in the tests was connected with a small horizontal return tubular boiler having rather large fire tubes. Six series of tests were made. In the first series there was an arch over the grate and the bridge wall; in the second series a deflecting baffle was added back of this arch; in the third series there was no arch directly over the grate, but the part over the bridge wall and the deflecting baffle were retained; in the fourth and fifth series of tests there were mixing wing walls and heat-retaining masses in the combustion space back of the bridge wall; and in the sixth series a lengthened passage for the gases through the boiler tubes was provided.

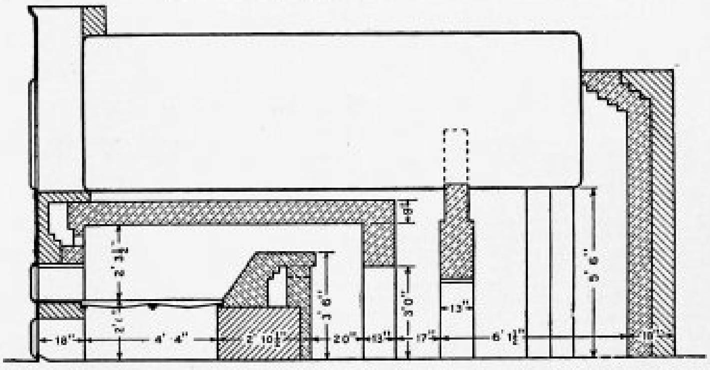


Fig. 2.—Arrangement of Furnace for Second Series of Tests. Boiler 60 Inches by 16 Feet, With Forty-four 4-Inch Tubes

Deductions from Tests

Certain conclusions drawn from the results of the tests are believed to apply to the settings of practically all hand-fired boilers of the return-tubular type, when fired as described in this paper. These deductions are as follows:

1. The operation, at rating, of hand-fired boilers of this type in most American cities without violation of their smoke ordinances is physically possible, and with proper boiler-room supervision can be accomplished, although it requires an attention to firing methods not given by the average fireman.

2. The prevention of smoke may be more easily accomplished when the coking method of firing is employed than when the spreading method is used.

3. The use of supplementary air immediately after firing tends to increase the overall efficiency and to abate smoke.

4. A brick arch directly over the fire and underneath the boiler shell results in lower overall efficiency and in the production of more smoke. The screening of heating surface in the combustion chamber from direct radiation from the brickwork tends to lower the combined efficiency.

Further conclusions as regards the effects of certain types of arch are presented at the end of this paper.

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[*] Extract from Technical Paper 34, Department of the Interior, Bureau of Mines, Washington, D. C.

The Fuel

The fuel used throughout the experiments was slack coal from two mines near Pittsburgh, Pa., that were working the Pittsburgh bed. The coal was selected as being representative of that used for steaming purposes throughout the Pittsburgh district, and, because of the proportion and character of its volatile matter, as being typical of coals difficult to burn without smoke in a hand-fired furnace.

The proportions of nut and fine coal varied considerably in the different shipments received, but the fuel for the tests was used just as it was taken from the cars, no selecting nor screening being done at any time. An ultimate analysis (moisture free) of the coal from each mine is given below:

Ultimate Analyses on Moisture-Free Basis of Coals Used in Tests.

	Percent.	
Hydrogen	4.93	4.8
Carbon	74.33	72.4
Nitrogen	1.38	1.4
Oxygen	4.44	6.7
Sulphur	2.79	1.7
Ash	12.13	13.0

Boiler and Setting

The principal data relative to the boiler and setting are given in Table 1. The figures in this table apply to all tests.

Table 1.—*Principal Dimensions of Boiler and Setting.*

Boiler:	
Type	Horizontal return tubular
Rated capacity, at 10 square feet per boiler-horsepower, horsepower	83
Length of shell, feet	16
Diameter of shell, inches	60
Number of tubes	44
External diameter of tubes, inches	4.00
Internal diameter of tubes, inches	3.75
Water-heating surface of tubes, square feet	688
Water-heating surface of shell, square feet	126
Water-heating surface of tube sheets, square feet	19
Total water-heating surface, square feet	833
Furnace:	
Kind of grate	Plain
Length of grate, feet	4.5
Width of grate, feet	5.0
Area of grate, square feet	22.5
Width of air spaces, inches	[illegible] to [illegible]
Proportion of air spaces to grate surface, percent	43
Height of boiler shell above grate, inches	42
Least draft area (over bridgewall), square feet	2.5
Depth of ash pit, inches	24
Stack:	
Construction	Steel, supported by guy wires
Height of top above grate, feet	128
Diameter, inches	30
Area, square feet	4.9

In the first three series of tests the side walls of the setting were of brick. Each wall consisted of two 9-inch walls with an air space 1 inch wide between them. In the last three series the setting had a concrete outer wall 9 inches thick and a 9-inch fire-brick lining, separated by one thickness of tar paper.

Air-Admission Devices

The admission of extra air after firings in series 1, 2 and 3 was accomplished by means of 14 rectangular openings equally spaced across the front wall of the furnace above the firing doors. These openings had a total area of 46 square inches, or about 2½ square inches per square foot of grate area, and were connected to a common duct or air passage in the wall that was approximately 8 by 10 inches and extended out through the side wall. A sliding door at the outer end of this duct enabled the fireman to cut off the air supply entirely or to regulate the volume of air admitted.

Eight rectangular openings having a total area of 115 square inches, or about 5 square inches per square foot of grate area, were used in the last three series. These openings were equally spaced across the front wall of the furnace and were divided into two separately controlled groups, one for each half, each group being equipped with a sliding damper in the boiler front for control of the air admission.

In each of two openings, one on each side of the furnace front and about over the centers of the firing doors, a high-pressure steam jet was placed. The jet pipe extended to within 1 inch of the inner face of the front wall and was pointed at the rear line of the grates. The direction of the jets was maintained the same throughout the tests. It was the intention also to keep the size of the opening in the jet pipe constant, and to this end the tips were removed as soon as they became burnt or badly corroded. The jets were made by plugging the one-fourth-inch jet pipe with a pipe plug, in which was drilled a hole one-eighth inch in diameter.

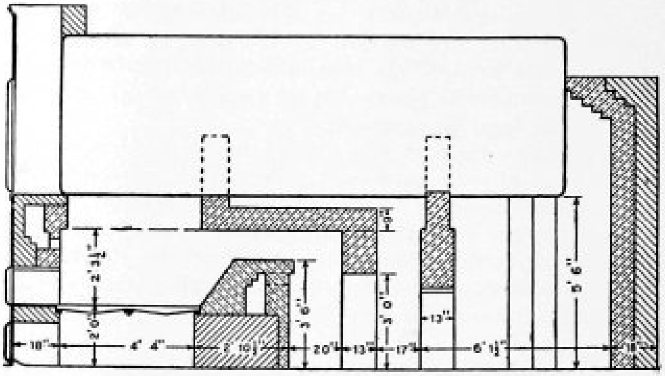

Fig. 3.—Arrangement of Furnace for Third Series of Tests. Boiler 60 Inches by 16 Feet, With Forty-four 4-Inch Tubes

In some of the tests the supplementary air was admitted through the rear face of the bridge wall, instead of at the front end of the furnace, 18 openings with a total of 67 square inches, or about 3 square inches per square foot of grate area, being provided. The duct, approximately 8 by 10 inches, to which these openings were connected, is shown in Figs. 1, 2 and 3. The air admission was regulated by a sliding door similar to the one used for the duct at the front end.

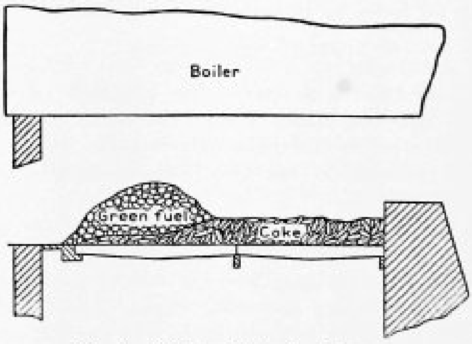

Fig. 4.—Coking Method of Firing

Fig. 1 shows the furnace arrangement throughout the first series of tests. It will be noted that the furnace arch extended from the front wall to about 1 foot back of the bridge wall. Before the second series of tests was started, the furnace arch was extended as indicated in Fig. 2, and a deflection arch was added back of the bridge wall for the purpose of deflecting the gases downward and causing them to mix better. For the third series the deflection arch and the rear part of the furnace arch were left unchanged, but the part of the furnace arch directly over the grates was removed, as shown in Fig. 3. After the removal of the front part of the furnace arch a 4-inch curtain wall was built on top of the rear part so as to prevent the passage of gases between the arch and the boiler shell. In the setting for the fourth series, a brick pier dividing the combustion chamber into two parallel gas passages was substituted for the deflection arch and baffle wall. For the better mixing of the gases, wings were added to the side walls and to the front end of the brick pier, as shown in Fig. 5. A curtain wall, extending from the top of the shell, was erected at the front end of the pier, and tiles were laid horizontally from the top of the pier to the side walls. The setting for the fifth series was identical with that of the fourth, except that in the fifth series the horizontal tiles in the combustion chamber were removed. The setting in the sixth series was the same as in the fourth, except that a baffle was erected across the back of the shell to cause the gases to pass through the lower 24 tubes to the front, return through the upper 20, and leave the boiler through a breeching at the rear. This setting gave the gases a double pass instead of a single pass through the boiler tubes.

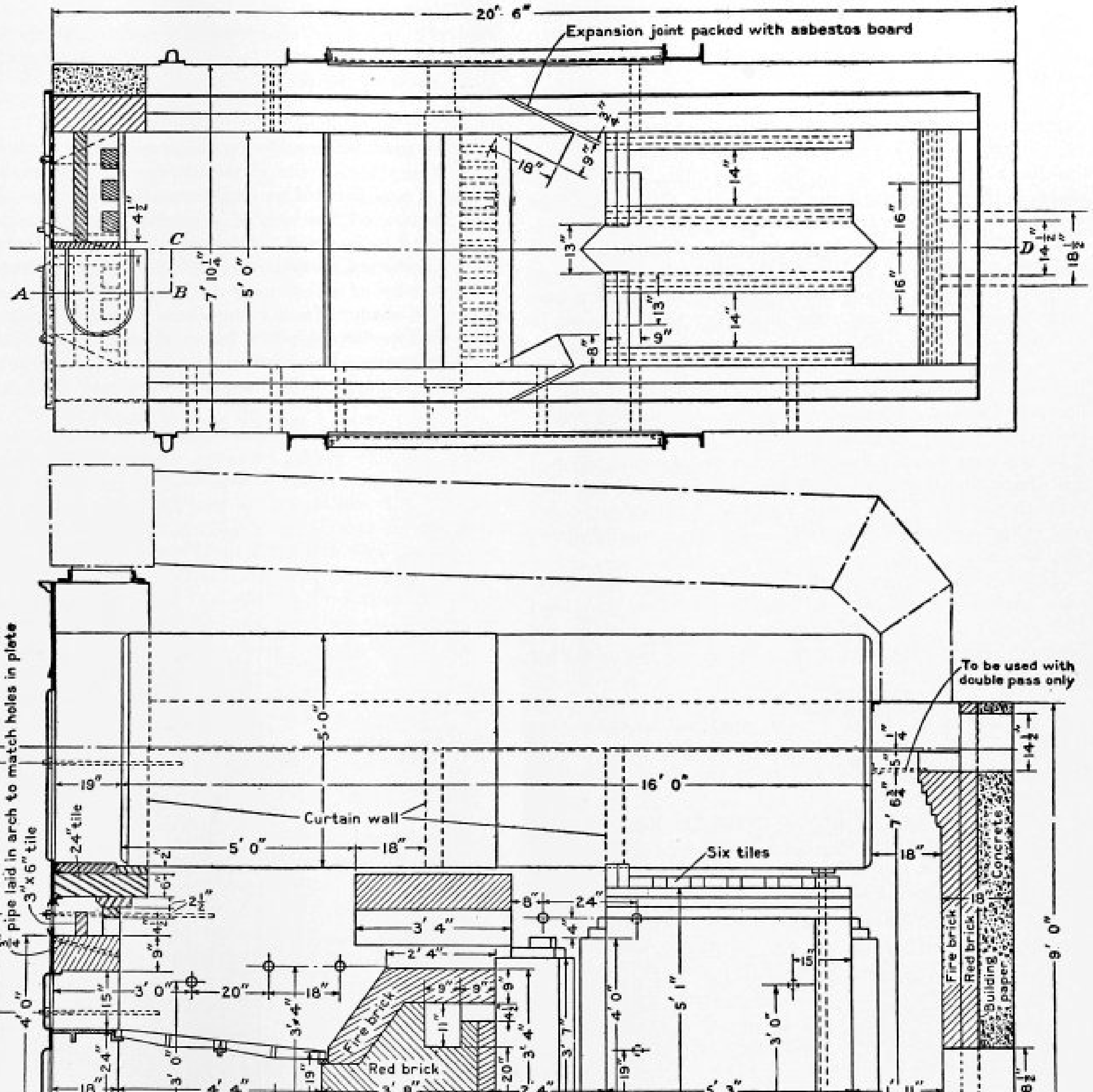

Fig. 5.—Sections of Furnace Showing Arrangement During Fourth Series of Tests

Method of Conducting Tests

The unit used in these tests was operated for the sole purpose of the investigations and the load was therefore practically constant throughout any one test, control being obtained by throttling an outlet delivering to the atmosphere.

Starting and Stopping the Tests

In starting and stopping the tests a modification of the "alternate method," as described in the American Society of Mechanical Engineers' code of 1899 for boiler trials, was used.

The fire was built up from a banked condition and the setting was heated to a temperature corresponding to normal running conditions. Soon after this condition had been reached the fire was cleaned. For the next 45 minutes or so the furnace was operated in the same manner as it was to be operated during the test, then starting readings were taken and the test was begun. At the close of the test the same method of procedure was followed, especial care being taken to have the fuel-bed conditions as they were when the test began.

Methods of Firing

Each series of tests was divided into two groups. The coking method of firing was followed throughout the tests of one group and the alternate-spreading method throughout the other.

Coking Method.—In firing by the coking method comparatively large charges of coal are fired at intervals of 15 minutes. The coal is heaped in a pile extending across the furnace and just inside the dead plate, where it is allowed to remain until the next firing (Fig. 4). The volatile matter is slowly driven off by the heat of the furnace and at the end of 15 minutes the coal at the front should be coked. At the next firing the coke at the front is broken up and pushed to the rear by means of a hoe, care being taken to cover up any holes or thin spots in the fuel bed at the rear; then more green coal is fired, as previously described. The volatile matter distilled from the green coal passes over the incandescent coke at the rear and is consumed without smoke, provided it is intimately mixed with the necessary air.

In the tests recorded in this paper the time required to push back the partly coked charge and fire the fresh coal through the two firing doors was about 1½ minutes, except when conditions made slicing or other special attention necessary.

Alternate-Spreading Method.—In firing by the alternate-spreading method, small charges of coal are fired at intervals of 5 minutes on either side, thus making the interval between the consecutive firings of any one door 10 minutes.

The purpose in firing one side at a time is to allow the temperature of the furnace to be sustained by the incandescent fuel bed on the other side at such a point that the volatile matter driven off from the freshly charged fuel will be consumed.

In the tests recorded in this paper the time taken to make each firing was ordinarily between 15 and 30 seconds. In firing an effort was made to place the coal so as to maintain a uniformly level fuel bed and to prevent thin spots developing.

Attention to Fuel Bed

The quantity of coal charged at any one time varied according to the method of firing and also with the rate of combustion, but was kept as nearly uniform as possible throughout any one test. The fuel bed was sliced or raked only when necessary, and the records show that the frequency of slicing was about the same for both methods of firing. When the coking method was employed the fuel bed was necessarily leveled each time the fuel was charged, but this was considered part of the regular firing routine, and, as no other raking was necessary, none was recorded.

These auxiliary devices were in use 2 to 4 minutes after each firing, the time necessary depending on the device used and on the method of firing employed. In no instance was any device used continuously throughout the test.

Smoke Observations

Smoke observations were taken every 15 seconds during alternate periods of 15 minutes throughout the first 7 hours of the test and at intervals of 15 seconds throughout the last hour during which the cleaning period occurred. The effort was made to control conditions so as to develop about 100 percent of the boiler's rated capacity each day and to keep the load fairly constant.

Sampling and Analysis of Flue Gases

During most of the tests gas samples were collected continuously over half-hour periods and analyzed with the Orsat apparatus. In a few of the tests the gases were analyzed by a CO_2 recorder and a number of check samples analyzed with the Orsat apparatus to establish the correctness of the recorder readings.

Use of Steam and Water in Ash Pit

On account of trouble experienced during some of the preliminary tests from clinker sticking to the grates and walls, it was decided to introduce steam into the ash pit, and because of the lack of available exhaust steam, live steam had to be used. All tests of the first three series were conducted in this manner, but no measurements of the quantity of steam used nor any corrections for such use were made. In the last three series of tests water was used in the ash pit in place of steam.

A summary of the principal results of each series of tests is presented in Table 3.

Table 3.—*Principal Results of Furnace Tests*

		Auxiliaries used									
		None		Air over fire		Air through bridge wall		Steam jets over fire.		Steam jets and air over fire	
	Series No.	Coking Method	Alternate Spreading method	Coking method	Alternate spreading method	Coking method	Alternate spreading method	Coking method	Alternate spreading method	Coking method	Alternate spreading method
Efficiency of boiler and grate, percent	1	55.9	60.0	59.7	62.6	56.0	61.4	57.7	58.4	60.4	58.9
Do	2	57.1	59.7	59.6	60.4	61.1	61.8	57.0	58.8	60.2	60.8
Do	3	62.1	60.9	62.6	63.4	62.3	64.5	62.0	61.7	66.1	64.6
Do	4	....	....	57.9	61.6	....	....	....	....	58.6	62.5
Do	5	....	....	65.7	67.0	....	....	....	....	68.0	65.5
Do	6	....	....	64.7	64.3	....	....	....	....	63.0	63.4
Average density of smoke (percent of black)	1	4.1	20.0	3.0	15.8	4.0	20.8	7.0	33.6	11.0	27.3
Do	2	10.4	25.4	11.1	20.0	9.0	16.1	14.3	31.0	9.7	21.2
Do	3	15.7	23.9	10.8	14.6	7.8	15.8	13.0	28.2	8.0	21.4
Do	4	....	....	4.9	14.0	....	....	....	....	3.0	11.3
Do	5	....	....	9.8	12.6	....	....	....	....	4.8	16.5
Do	6	....	....	4.2	20.4	....	....	....	....	3.8	13.6
Maximum minutes of dense smoke per hour	1	2.5	14.5	2.0	13.5	2.0	14.5	6.2	30.0	7.5	23.0
Do	2	10.0	18.5	8.5	18.0	7.0	14.0	10.5	23.5	6.5	16.5
Do	3	13.5	18.5	7.0	11.0	4.5	8.0	9.0	23.5	6.5	18.0
Do	4	....	....	6.0	17.5	....	....	....	....	4.0	14.5
Do	5	....	....	6.0	7.0	....	....	....	....	3.0	11.0
Do	6	....	....	3.5	16.5	....	....	....	....	3.0	15.0
Temperature of flue gas, °F.	1	601	554	575	536	576	541	581	545	549	556
Do	2	630	550	581	559	576	565	577	542	587	534
Do	3	568	561	526	537	549	529	542	526	534	500
Do	4	....	....	588	583	....	....	....	....	587	563
Do	5	....	....	574	559	....	....	....	....	526	547
Do	6	....	....	537	563	....	....	....	....	560	559
Carbon dioxide in flue gas	1	8.4	11.5	8.0	11.5	8.2	12.3	8.9	12.3	10.0	12.3
Do	2	9.2	10.7	9.6	10.8	9.3	11.4	8.5	12.6	9.4	11.6
Do	3	10.8	11.9	11.0	11.1	9.8	12.1	11.0	12.8	10.7	14.0
Do	4	....	....	8.9	10.4	....	....	....	....	8.4	10.5
Do	5	....	....	10.6	10.4	....	....	....	....	11.4	11.1
Do	6	....	....	11.6	12.6	....	....	....	....	10.3	11.6
Draft at breaching, inches of water	1	.33	.20	.33	.18	.30	.15	.27	.17	.20	.14
Do	2	.30	.17	.23	.18	.22	.15	.24	.12	.23	.13
Do	3	.19	.19	.18	.18	.25	.17	.21	.12	.17	.12
Do	4	....	....	.23	.18	....	....	....	....	.24	.18
Do	5	....	....	.15	.13	....	....	....	....	.13	.12
Do	6	....	....	.34	.30	....	....	....	....	.41	.34
Quality of refuse, percent clinker	1	49	70	52	67	49	72	58	64	59	66
Do	2	52	58	53	66	55	62	62	70	63	69
Do	3	65	63	46	58	58	61	56	59	54	64
Do	4	....	....	41	43	....	....	....	....	32	39
Do	5	....	....	38	50	....	....	....	....	45	49
Do	6	....	....	35	52	....	....	....	....	27	55

DISCUSSION OF TEST RESULTS

Effect of Construction of Furnace.—In the single-pass tests the significant results are much the same as series 1, 2 and 4, whereas, with a few exceptions, they are uniformly better for series 3 and 5. In general, the percentage of clinker in the refuse, the amount of smoke emitted, and the flue-gas temperatures are less, and therefore more favorable, in the third and fifth series than in the other three; the water evaporated per pound of fuel, the efficiency of the boiler and grate, and the percentage of CO_2 in the uptake gases are greater and also more favorable.

In the third series the removal of that part of the combustion arch directly over the fuel bed exposed the comparatively cool boiler shell to the radiant heat from the incandescent coke, thus lowering the temperatures of the furnace, the fuel bed, and the gases entering the tubes, resulting in lower flue-gas temperatures and higher overall efficiency. In explanation of this result it may be stated that so long as combustible gases are kept at a temperature sufficiently high to allow of their combination, the advantages to be gained by a further elevation of their temperature are partly if not entirely offset by the resulting disadvantages.

The lower temperature of the fuel bed resulted in the formation of less clinker, and although no measurements of furnace or fuel-bed temperatures were made, the difference was decidedly evident, especially to the fireman when stoking or cleaning fires.

In the fourth series the effect of the removal of the arch over the fire was apparent in the low percentage of clinker formed, but because of the screening of a part of the water-cooled surface in the combustion chamber from the direct radiation, the temperatures of the gases entering the tubes were greater, so that flue-gas temperatures were higher and the overall efficiency was lower.

In the fifth series the removal of the horizontal tile in the combustion chamber exposed the shell to considerable radiation from the hot brickwork and resulted in higher efficiencies than were attained with any of the previous settings, and without the emission of any objectionable amount of smoke. It is believed that this freedom from objectionable smoke results from the adequacy of the mixing devices and the sustaining of the temperature of the gases above the ignition point by the action of the brickwork remaining in the combustion chamber.

The results of the sixth series with the double pass showed a substantial gain in efficiency over those of the fourth, owing to the extra length of gas travel, the furnace construction being the same, but because of the increased resistance of the gas passages, the maximum capacity that could be developed with a given available draft was less than with a single pass.

The decreased smoke emission during the tests of the last three series is to be explained largely by the fact that the lower furnace temperatures, owing to the removal of part of the arch, produced a more gradual distillation of the volatile or gaseous part of the coal, but without cooling to such a degree as to prevent proper combustion. As the combustible gases were more slowly and gradually driven off, it was possible to obtain a better mixture of the air with them, which in turn resulted in less smoke being produced. The observations showed the duration of the smoke emission to be about the same for the tests of all six series, but in the last three series dense smoke was emitted immediately after firing for much shorter periods than in the earlier tests.

The higher average carbon dioxide content of the gases in the tests of the last three series is due largely to the freedom from clinker troubles, which has already been mentioned. The deflection arch, which was added for series 2, can probably be credited with a general, though not marked, reduction of smoke in the tests of that series as compared with those of the first. This is not a true indication, however, of the effect of the deflection arch, because the baffle or curtain wall which was in the combustion chamber throughout both series of tests produced somewhat the same effect—a mixing of the gases—that the deflection arch was designed to accomplish.

Attention is also called to the smoke observations for the first four tests of series 1. These tests do not support the conclusions drawn relative to the effect of various changes, in so far as smoke is concerned. The lesser amounts of smoke produced in these tests as compared to that produced in the rest of the tests are doubtless due in part to the greater amount of air supplied for combustion, as indicated by the gas analyses, and possibly also to a slight difference in the coal used.

Effective Method of Firing.—A comparative study of the two groups of tests in each series shows that less clinker was formed and less smoke emitted when the coking method of firing was employed. On the other hand, the results of tests conducted with the alternate-spreading method of firing generally show greater evaporation per pound of fuel (higher efficiency), higher percentages of carbon dioxide in the uptake gases, and lower exit temperatures of these gases. With a given draft, higher rates of combustion and higher capacities can be obtained with the alternate-spreading method, because the resistance of the fuel bed to the passage of air is lower and the drop in draft through the boiler is less with the smaller quantity of gases handled when the higher percentages of carbon dioxide are obtainable.

These relations of higher carbon dioxide content and lower uptake temperatures are the reverse of those which are usually believed to obtain in boiler practice. The rates of combustion for the tests of any one series are so nearly constant that they may be so considered, and there is nothing to indicate serious error in either the gas analyses or the temperature measurements. The authors offer the following explanation for the seeming incongruity in the results of the two groups. With the spreading method of firing the carbon dioxide content is higher, indicating that a smaller quantity of hot gases is being formed. The gases, although at a higher temperature over the fire, are reduced in temperature more rapidly both before and after entering the boiler tubes than the larger quantities formed by the coking method are. The result is that the temperature of the gases entering the tubes is only slightly higher in the tests wherein the spreading method of firing was used, and as the quantity of gas is less the fall of temperature through the tubes is more rapid and the gases therefore emerge with a lower final temperature. If the curves for the two series of average temperature drop along the tubes were plotted, they would cross each other possibly somewhere near the middle. The difference in uptake temperatures would grow less with increased rates of combustion or increased length of tubes, and might even be the other way with sufficiently high rates of combustion.*

The continual raking and stirring of the fire incident to the coking method of firing shook more of the ash through the grates and left less of it on them to fuse into clinker than the procedure in the other method of firing did. The tabulated results of the tests show a marked difference in the amount of clinker formed under

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* For further discussion of these relations see Ray, W. T., and Kreisinger, Henry. The transmission of heat into steam boilers, Bull. 18, Bureau of Mines, 1912, pp. 144-165.

the two methods of handling, and the analyses of the samples of refuse also show that the loss of combustible matter in the refuse was no greater from a fire so raked and stirred than from one fed by the spreading method.

The smaller percentages of carbon dioxide in the flue gases when the firing was done by the coking method may be explained in part by the fact that the interval between firings was longer in such tests than when the other method of firing was employed, and consequently the tendency for the fuel bed to burn through in spots and let more air pass was also greater. Another possible explanation for the greater excess of air admitted in firing by the coking method is that there is evidently more of a tendency for the fuel bed to burn through at the back.

With the particular furnace arrangements and the other conditions under which these tests were conducted a comparison of the two methods of firing as regards smoke prevention shows decidedly in favor of the coking method. The greater amount of smoke emitted when the alternate-spreading method of firing was used is probably due to two causes, namely, inadequacy of the supplementary air openings to admit the required air immediately after firing and insufficient facilities for mixing the air and combustible gases before they reached the tubes. Had the supplementary air openings been of greater capacity the amount of smoke produced by the spreading method would doubtless have been lessened. A further disadvantage of the spreading method of firing is the more frequent attention required by the firemen to attain the same degree of smokelessness, which, in case one fireman had to tend more than one boiler, would introduce operating difficulties.

Effect of Auxiliary Devices.—The results of the tests show that an increase in efficiency and a decrease in the time of emission of dense smoke resulted from the admission of the supplementary air. With the furnace and combustion chamber arranged as shown in Figs. 1, 2 or 3, it seemingly made little difference whether the extra air were admitted through the openings at the front of the furnace or through those in the bridge wall. The effectiveness of admitting air through the bridge wall is, however, more largely dependent on the facilities for mixing the gases in the combustion chamber than that of admitting air over the firing doors, and this point should be kept in view when the relative value of the two methods is considered in the design of boiler furnaces. This conclusion is substantiated by the results obtained in several trials of bridge-wall air admission with the setting shown in Fig. 5. The supplementary air is admitted below the gases coming over the bridge wall, and the mixing devices do not intimately mix the air and gases in a vertical plane, resulting in stratification and the failure of this method of reducing smoke.

As already stated, only one position and one design of steam jet was tried, but under the conditions of these tests the results seem to discourage rather than to encourage the use of the steam jet as an auxiliary mixer of gases. It is quite possible, however, that better results might have followed the use of steam jets differently arranged. The authors believe that further experiments with hand-fired furnaces for this type of boiler show the possibility of constructing a furnace that will produce practically the same results with supplementary air alone as with air and any arrangement of steam jets. In view of the prejudice of many engineers against the use of steam jets, the development of a furnace that, without excessive initial or maintenance costs, will give as good results without jets is greatly to be desired.

Summary and Conclusions

Certain conclusions have been drawn from the results of the tests described in this paper. As previously stated, some of these deductions are general and are believed to apply to the settings of practically all hand-fired boilers of the return-tubular type when fired as described in this paper. Other conclusions are more restricted in application, and may not be true under conditions other than those described herein. A summary of the general deductions has been given, but is repeated here.

The operation at rating of hand-fired boilers of this type in most American cities without violation of their smoke ordinances is physically possible and with proper boiler-room supervision can be accomplished, although it requires an attention to firing methods not given by the average fireman.

The prevention of smoke may be more easily accomplished when the coking method of firing is employed than when the alternate-spreading method is used.

The use of supplementary air immediately after firing tends to increase the overall efficiency and to prevent smoke.

A brick arch placed directly over the fire and underneath the boiler shell results in lower overall efficiency and in the production of more smoke.

The screening of heating surface in the combustion chamber from direct radiation from the brickwork tends to lower the combined efficiency.

A deflection arch of the form shown in Figs. 2 and 3 produces a better mixture of the furnace gases and thereby aids in obtaining proper combustion conditions; the same effect is produced by the wings and piers illustrated in Fig. 5.

The following statements are based upon the tests described in this paper, but may not be true under different conditions:

The devices for admitting air at the bridge wall and at the front of the furnace, shown in Figs. 1, 2 and 3, appear to be equally effective in reducing the amount of smoke and to result in approximately the same overall efficiency.

Although no complete tests were made on the furnace arrangement shown in Fig. 4, using air admission at the bridge wall, enough trials were made to prove that with this furnace such a method of admitting supplementary air was not effective in reducing the amount of smoke.

Steam jets, as arranged in this furnace, fail to show a sufficient gain in efficiency or smoke reduction to justify their use.

The Thermal Properties of Steam, by G. A. Goodenough, has been issued as Bulletin No. 75 of the Engineering Experiment Station of the University of Illinois. The bulletin presents a critical discussion of the experimental investigations of the various thermal properties of steam, an outline of the thermodynamic relations that must be satisfied, and finally the development of a general theory of superheated and saturated steam. As a basis for such a theory the well-known Munich experiments on specific volumes and specific heats are taken and properly correlated through the Clausius relation. The assumed characteristic "equation" for steam is shown to fit the experimental points with extreme accuracy, and other tests are given to show the superiority of the equation over Lunde's equation.

The result of the investigation is a formulation of the properties of steam, for which the following claims may be urged: (1) absolute thermodynamic consistence; (2) extreme accuracy; (3) simplicity; (4) flexibility; (5) great range of validity.

Selling a Boiler to Dashley

Instructions for a Boiler Salesman—How to Interest a Difficult Customer and Secure his Future Business

BY JAMES FRANCIS

"William, this morning you had better pack up and go to C——— and call upon the Close Deal Manufacturing Company. See Mr. Dashley and sell him a boiler. We have had reports that they are in the market for one or perhaps more boilers; so get busy, William, and sell them some goods.

"You want me to go to C———, Mr. Francis, and tackle the Close Deal Company? Why, say! they are the hardest propositions between the Golden Gate and Hell Gate. I will go, of course, but hadn't you better send Mr. Slock or Mr. Closer?"

"We've decided to send you, William, and I'm ready to give you instructions right now. Are you ready for them?"

"I certainly am, Mr. Francis, but I'm rather scared already. That Mr. Dashley is the toughest proposition a salesman ever tackled, at least so all the boys say, and I don't know what I can do when I'm up against him; but you can just bet to the limit, Mr. Francis, that I'll do all I can, and then some, to sell that gentleman some of our boilers."

"That's the talk which wins, William. Just keep in that frame of mind and you will win out. Now, here are your credentials, plenty of cash and all the office 'dope' you will need. And here are your 'instructions.' Go down there, get a room at the best hotel, and study Mr. Dashley a week or two before you go near him. Find out all about the gentleman. Learn his habits, what clubs he belongs to, what he does out of the factory, and, in fact, 'gumshoe' the gentleman until you know his habits, and where he goes and what he does all the time he is out of his office."

"I can do that all right, Mr. Francis, and I'll guarantee that in three days I can tell his family history and be all ready to call upon him and talk boilers straight from the shoulder. Let's see, this is Monday. About Thursday morning I'll be ready to walk into Mr. Dashley's office and talk with him as though I had known him for twenty years. I'll have that order on ice, Mr. Francis, and be back here by Saturday morning."

"You will not, William. If you land that order in three weeks from to-day you will be doing well and we will all be satisfied. The Close Deal Company is a big concern and we want their business, and it can only be had through Mr. Dashley, and he had rather turn down a salesman than to smoke a 50-cent cigar. He takes as much pleasure in baiting a strange selling representative as any of us would in trying to catch a 12-inch speckled trout in a mountain stream. Now then, William, how much chance would you have for Mr. Dashley's order when you walked into his office and called upon the man when he had never seen or heard of you before? You might as well kick against the wind as to try that kind of business on Mr. Dashley."

"Then what shall I do, Mr. Francis? You have told me to learn all about the gentleman, to rake up his personality with a fine-toothed comb—and I can do that—but what then? Somehow I don't seem to get next to the game as you want it played."

"Next, William, after you have learned Mr. Dashley's habits, peculiarities, likes and dislikes, get acquainted with him in a social way, outside of his office, and just make yourself so agreeable that you pass some time with the gentleman while he is off duty. Don't let out a word, William, that you are a boiler salesman, or that you represent us or any other concern. Just register at the hotel as if you were a tourist-visitor, or anybody else other than a man who had something to sell."

"I get you, Mr. Francis, and I'll work the game for all it is worth. Trust me for that."

"That is good, William; and once you have become acqainted with Mr. Dashley, watch your chance—and if you can't find a chance, then make one—to do him a favor or to become such a jolly good companion that he just takes to you and your presence as though he loved you. Study his tastes and work them. If he plays golf, then get into his club, and let him bump up against you in a pleasant way every time he visits the links. If he is a billiard 'sharp,' then make it your business to get into his club, or where he plays, and be "Johnny on the spot' whenever it will do the most good—and—let him beat you!"

"Say, Mr. Francis, that's queer salesmanship, but I'm on the job every minute; and if I can't land the business it won't be because I haven't worked for it."

"That's good, William. If you find Mr. Dashley is an automobile enthusiast, then—say, William! I tell you what you do right now. You take our big '60' and drive down in that; then you can have it there and make use of it in getting next to Mr. Dashley. That machine will give you just the 'tone' that you need and make it possible for you to get acquainted with the gentleman much easier than if you were without the machine."

"Say, Mr. Francis, that will be fine. With a machine I will be all right, and with the big '60' I can swing everything my way in fine shape. But, say, Mr. Francis, why will not the company supply us salesmen with little automobiles? We can cover a whole lot more ground with a machine than with a train or trolley service, and then there is always a lot of carriage hire at the end of a run getting from train to factory and back again. Very often we have to drive a couple of miles to reach some country plants. If the company would supply its salesmen with automobiles there would be a larger percentage of sales, and the efficiency of the sales force would be increased from 40 percent to 60 percent right off the reel."

"We have been considering that matter, William, and a scheme is now being worked out, founded upon a method first used by an Indianapolis salesman of Ford machines. He worked out a scheme whereby he sold a large number of machines to manufacturers, or rather to their salesmen through the manufacturers. The way he worked it was to have the manufacturer guarantee the sale of the necessary number of machines, each salesman having the machine sold to him on instalments, payments to be made regularly as agreed upon. Then the salesman had his minimum selling limit raised about 40 percent, or as agreed upon, with the understanding that the automobile was to be paid for from the increase of salary or commission to be derived from the increased 'radius of action' due to the use of the automobile."

"That's some scheme, Mr. Francis; but it seems to me that the salesman has to stand the cost of the automobile, and that the manufacturer gets the benefit of the deal, and does not have to put up a cent for the increased efficiency of its selling force, or for the larger amount of business turned in. How about it?"

"It looks that way at first sight, William, but there's another side to the matter. When the company owns the automobile, the salesman doesn't always take as good care of it as he does when it is his personal property. Neither does the salesman keep the machine in as good repair when he has no personal interest in it. Furthermore, the salesman feels that the machine has not cost him a cent—that it has been paid for entirely from the increased business made possible by its possession and use. In fact, some of the men paid for their machines and owned them free and clear within three months after they received them, and since that time each one has been making more money than ever, just through the use of the automobile in getting to business easier and quicker, also through the prestige derived from arriving at a customer's office in a nice little car, instead of afoot or in a hard-looking livery rig. Style will tell, William, with most customers, though you will doubtless find a few old fossils who will turn up their noses at the auto-riding salesman, and say: 'I'll buy boilers from a company which doesn't make me pay for automobiles for lazy salesmen to ride around in.'"

"Yes, there are some people like that, and I find them occasionally, but the majority appreciate the value of the automobile in business as well as for pleasure, and look at it in the proper manner as a business-getter—not as a bit of extravagance. But, Mr. Francis, is not this a pretty expensive campaign which you have planned for me to carry out? Why, it will cost half the value of one boiler to 'get next' to Mr. Dashley in the manner you have outlined for me to follow. I'll do just as you say, of course, but I wondered if you have fully realized what it will cost?"

"Yes, William, we have been over that matter pretty thoroughly, and have estimated the cost pretty closely, and we have decided that you sell a boiler to Mr. Dashley no matter what the cost of the sale may amount to as far as selling expenses are concerned. It is not as though his company wanted only one boiler. Instead of that they purchase dozens of boilers and are needing them almost continually in their several plants. Now, our boilers are as good as any other boilers made in the United States; and as the Close Deal Manufacturing Company is our immediate neighbor, it is a positive detriment to us not to have their trade. Therefore, we have decided that you get it, even though you work all summer to land their business."

"I see, Mr. Francis. Partly a matter of principle as well as of trade. But do you know that after I get next to Mr. Dashley I may find his company tied up for years in a contract with some concern to furnish them with boilers?"

"Certainly, William, such things are to be expected, and we will deal with that phase of the situation after we are up against it. Time enough then for that part of the business."

"I begin to grasp the situation, Mr. Francis. You want me to get at Mr. Dashley and 'live with him' until he opens up socially, and then watch for the 'psychological moment' to open upon him with the boiler business."

"That's the scheme exactly. And make him open it if possible. Above all, don't be in a hurry. Better let days go past rather than force matters. When boilers are finally brought up, let it come so naturally that he never dreams but what he has opened the subject himself. Try all sorts of ways—perhaps a grand opening would come at a dinner after a game of golf—dinner at Mr. Dashley's own club at your expense; the little dinner being the wager between you regarding the playing of a game of golf, billiards or tennis, in which you saw to it that Mr. Dashley was the winner and that the dinner was on you. A man is pretty apt to feel mighty comfortable toward himself and toward you, William, at such a time and under those circumstances, and you will probably be able to use such an opportunity to get Mr. Dashley talking about his business and to casually mention that he must buy a boiler. And then, William, then is your opening; and see to it that 'tact' is your middle name, and make the opportunity count.

"But don't overdo things. If he doesn't lead up to the point the first, the second or the third time, then wait patiently for the next time, be it third, fourth or fifth. The opportunity will come sooner or later, and it is up to you, William, to be on the spot, and to recognize the opportunity when it does come."

"I'll do my best, Mr. Francis, and I'll work Mr. Dashley so quietly and gently that he will never realize that he is being 'worked.' I see your method now, Mr. Francis. In ordinary practice, I would call upon Mr. Dashley time after time, gradually getting acquainted with him, and visiting until the proper moment arrived for making a sale. But now I am to devote my whole time and attention to cultivating him working in a logical and natural manner toward the casual introduction of shop and boiler matters, and to work from a social standpoint only, with each business advance delicately masked so as to defy recognition as a business proposition."

"That's the scheme, William; work into the social esteem of Mr. Dashley, and stay there until he gives you an opportunity to take a rise out of him for a boiler order. I'll wager that, after you once get to know the gentleman, you will find it very easy and pleasant to work him around to the point where you can sell him not only one, but a large number of boilers in the immediate future."

"I'm going into it for all I am worth, Mr. Francis, and if tact and consideration can do any good I ought to pull off the deal in good shape. I know I can meet the gentleman in a social way and handle him all right in that direction; and I don't care which way his hobby heads, I can play up to his lead and make him think I am 'it' in that particular field. Oh, yes, I'll work Mr. Dashley so he thinks me the best fellow in the world, and will want to buy out our whole shop product as soon as he finds that I am your 'ambassador of commerce' out on a little vacation. Yes, Mr. Francis, I'll work Mr. Dashley into line or I'll never take another order for you!"

"That's the talk, William. But above all things, don't forget that you are a gentleman. Don't work by underhand methods, and never use deception or deceit, and don't run anybody else down in trying to build us or yourself up. 'Never say anything of a person unless you can say something good,' is a mighty fine rule to follow; and above all, it particularly applies to your chief competitor in business. It never pays to 'run down' anybody, much less to belittle a competitor or his goods. And a particularly safe lead is to discreetly praise the output of the factory with which your prospective customer is connected. That is a theme which always interests your man, no matter what his disposition may be."

"All right, Mr. Francis; I'll be off in the morning. I am going to have a mighty good time down there with Mr. Dashley, and I see where I work the hardest job of my life; but I don't mind that as long as I win out. Good bye, Mr. Francis, the Close Deal Boiler order for mine!"

OLD-TIME BOILER INSPECTIONS.—Boiler inspections, as conducted by the officials ordained by municipal legislative enactment in many cities, consisted, until comparatively recent years, wholly and exclusively in applying the hydrostatic test; and in some communities the practice still adheres even in this enlightened day. The results of such inadequate methods, however, speak for themselves.

MEN WANTED

Who Don't Talk War Instead of Business.

At a time like this:

—When the principal nations of the world are plunged into the worst war the world has ever known,

—When the United States of America is the only first rate power at peace,

—When the whole world is trying to stagger out from under the first blow this war has struck its commerce,

—When all nations are trying to readjust themselves, secure new sources and open new markets,

—When the smaller countries and nations are turning to Uncle Sam to buy their produce and sell them manufactured goods,

—When our own nation is in good financial condition,

We ought to act and act promptly. The rush is not yet on but it's coming. Those best prepared will make definite, lasting gains.

What have you done? Are you ready for increased business? Is that much needed equipment installed? Is that addition to your plant completed? Have you the material on hand to start work at once?

Germany was prepared for war and secured an early advantage.

The manufacturer likewise who is ready for peace will secure the business.

Joseph T. Ryerson & Son maintaining three great warehouse plants in New York, Chicago and St. Louis offer everything in iron, steel and machinery for immediate shipment, and stand ready to aid in your urgent needs.

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Hydraulic Pressing—VII

BY C. W. R. EICHHOFF

In the October issue of The Boiler Maker the writer did not show how the upset ends of the 4-inch by 1¼-inch tie-bars were made. As the upsetting of rods and bars is frequently needed in boiler shops, for instance on stay-rods for Scotch marine boilers, Clyde boilers, etc., I have shown the blocks which were used to upset the flat bars, 4 inches by 1¼ inches in size, in greater detail.

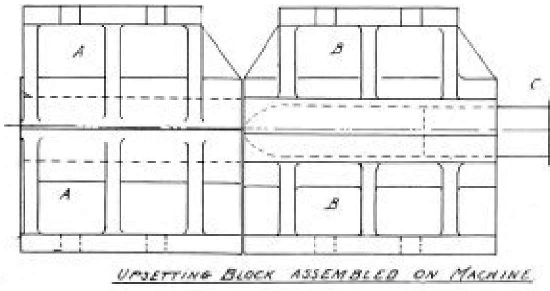


Fig. 1a

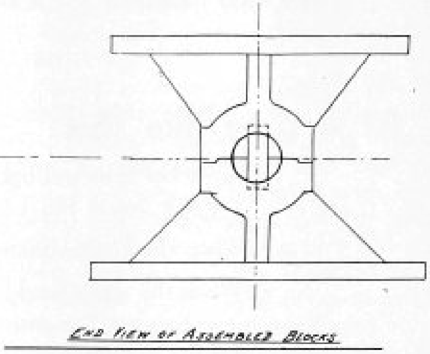


Fig. 1b

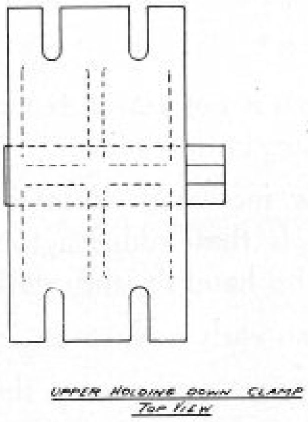


Fig. 2

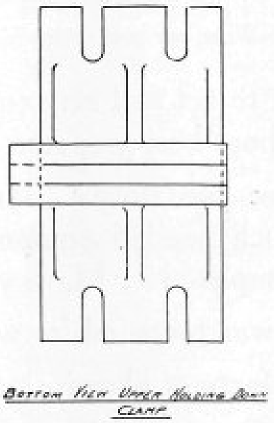


Fig. 3

It is very easy to change the formers in such, which can be used for the upsetting of round bars. I have designed such blocks for upsets as high as 3¼ inches and as low as 1⅛ inches in diameter. Figs. 1 *a* and 1 *b* show the blocks assembled on the platen of the sectional flanger. *A A* are the holding down clamps and *B B* the upsetting formers. *C* shows the plunger which forms the upset. It is made of tool steel and is attached to a head, which is fastened to the horizontal ram. The operation is as follows: the holding down blocks, Figs. 2 and 3, are attached to the front, vertical ram and the platen of the flanger, as are also the upsetting formers, Figs. 5 and 7, to the platen and the rear vertical ram. The assembled upsetting blocks are shown in Fig. 6.

Much care should be exercised in seeing that the different parts are lined up properly and free to move. Before beginning to forge the bars, see that everything is in proper alinement. This should be done by frequent trial and will prevent breakage of the costly castings. By a preliminary calculation, determine how much of the flat 4-inch by 1¼-inch material has to be used to make up the round 3⅛ inch by 8 inches. This and a little more has to be heated—the proper quantity can be determined only by trial—and rounded roughly. The part of the bar next to the heated end, which, of course, should be cold and kept cool by the use of water, is inserted into the slot of the holding down blocks and the round part extended into the round hole of the upsetting formers. The round unfinished part will, of course, extend further than the blocks. The steel plunger, Fig. 4, is then moved toward the heated end of the rod and steadily moved into the hole of the block. It will then upset the rod and fill the round hole.

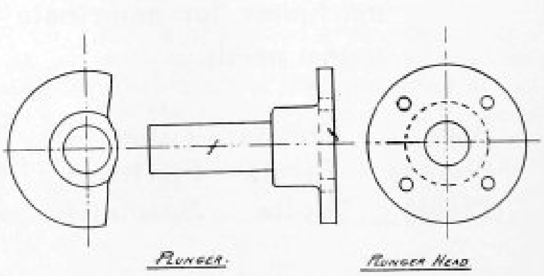


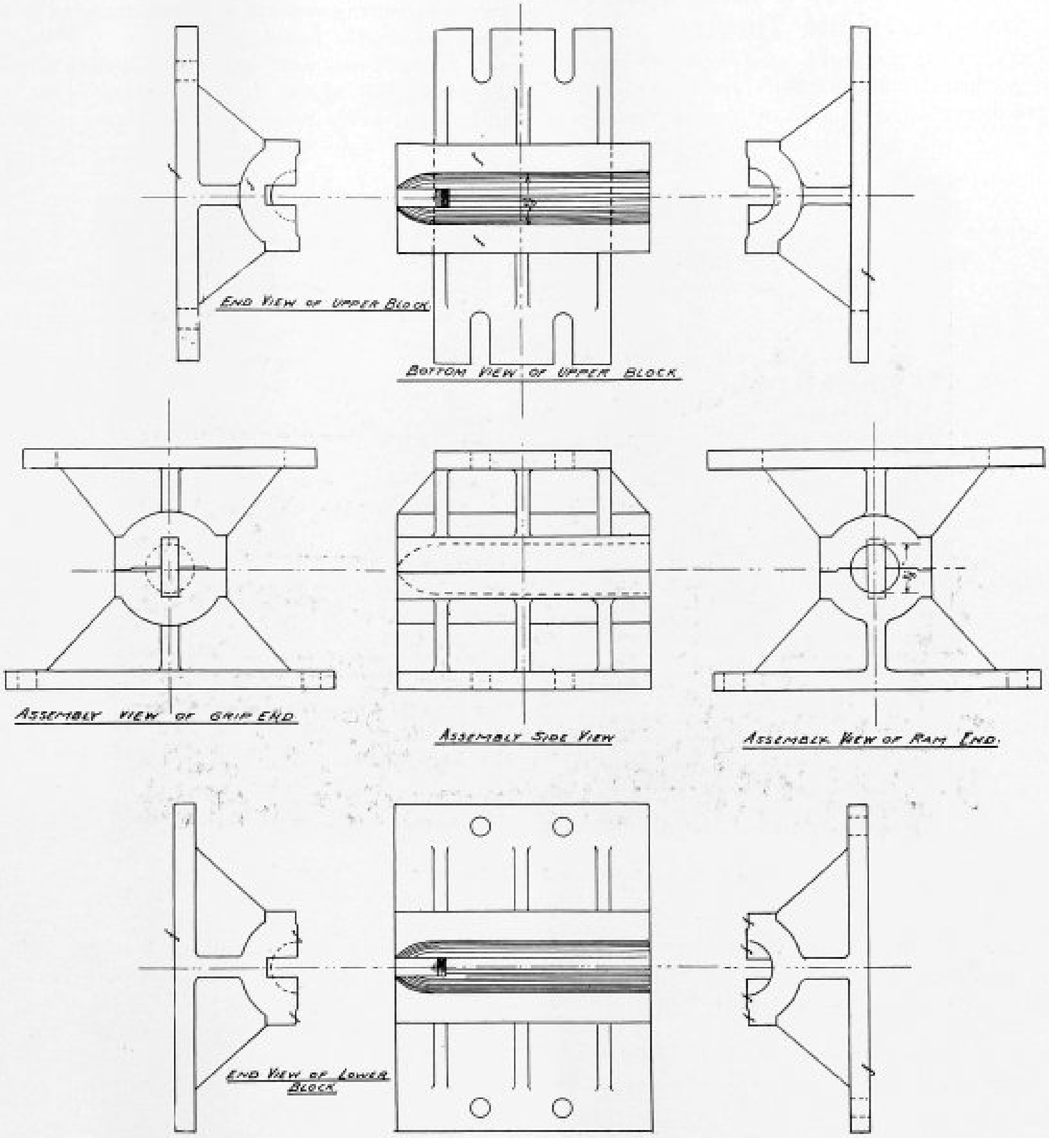
Fig. 4

Before I tried to upset rods on the sectional flanger the smaller sizes were made by hand and the larger sizes had to be done outside of the shops. The rods made in the sectional flanger, however, were far superior in regard to workmanship and strength.

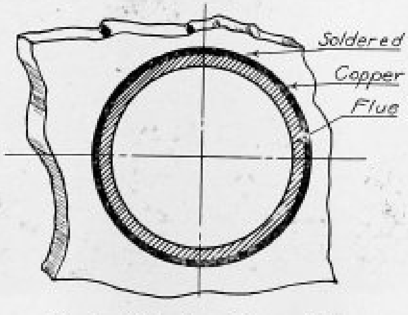
(*To be continued.*)

A Repair Experience

One of the first jobs the writer ever did in flue setting was a "special job," as often happens when tools and equipment are sadly lacking. I had a batch of flues to put in and found that the holes in the tube sheet had been enlarged to such an extent from frequent prossering or rolling that there was between 1/16 and ⅛-inch clearance all around.



Figs. 5, 6 and 7.—Details of Upper and Lower Blocks



Ferrule Made from Copper Wire

The tubes were presumably made of good material, and I thought I could stretch them into place all right without damaging them; but not so. The first one popped early in the game. I thought it might be due to poor material in that particular flue, but the second flue did the same, and so did the third. By that time I had concluded that something was wrong with me and not the flue, and that I had better put in some sort of ferrule.

At that early date in my career I did not know that copper ferrules are often used in flue setting, but the idea came to me that copper should be pretty good stuff as a "filler" in the case in hand. So I found some flat copper wire in the power plant that was kept in stock for use on the switchboard as bus bars. The wire was just about the right thickness, but too wide. It was easy to slice it down to proper width, though, which I did, and then I soldered together the ends of carefully measured and scarfed lengths, making the ferrules circular in form, just as they should be. I then rolled them into place with edges projecting a little on each side of the tube sheet. The ends were so well soldered that they did not break loose.

The rest was easy. No more flues popped. The appearance of the finished job was about as indicated in the sketch herewith.

New York. N. G. NEAR.

Cutting Boilers Out of a Ship with the Oxy-Acetylene Torch

The oxy-acetylene cutting torch was employed recently to cut two large Scotch marine boilers out of the hold of the U. S. revenue cutter *Seminole*, while the vessel was undergoing repairs at the depot of the U. S. Revenue Cutter Service at Arundel Cove, Md. The work involved about 1,000 feet of cutting in plate averaging 1 inch in thickness.

These two boilers comprised the complete original battery placed in the ship when she was built and before the deck was laid. In overhauling the vessel, they were replaced by new boilers of the Babcock & Wilcox type. Since the small boiler hatch did not allow sufficient clearance for the removal of the old boilers without dismantling, and since they had reached the limit of their useful service, it was determined to cut them out, using the oxy-acetylene cutting process to reduce them to sections which could be readily handled.

A Milburn oxy-acetylene plant, which forms a part of the equipment of the revenue cutter depot, was moved on board and two ironworkers belonging to the depot were detailed to operate the cutting torches. The acetylene generator was placed on the main deck beside the boiler hatch and the oxygen supply cylinders were placed on the boiler deck convenient to the operators. Long hose lines for the gases gave the torch operators sufficient freedom of movement to reach any point on the boilers.

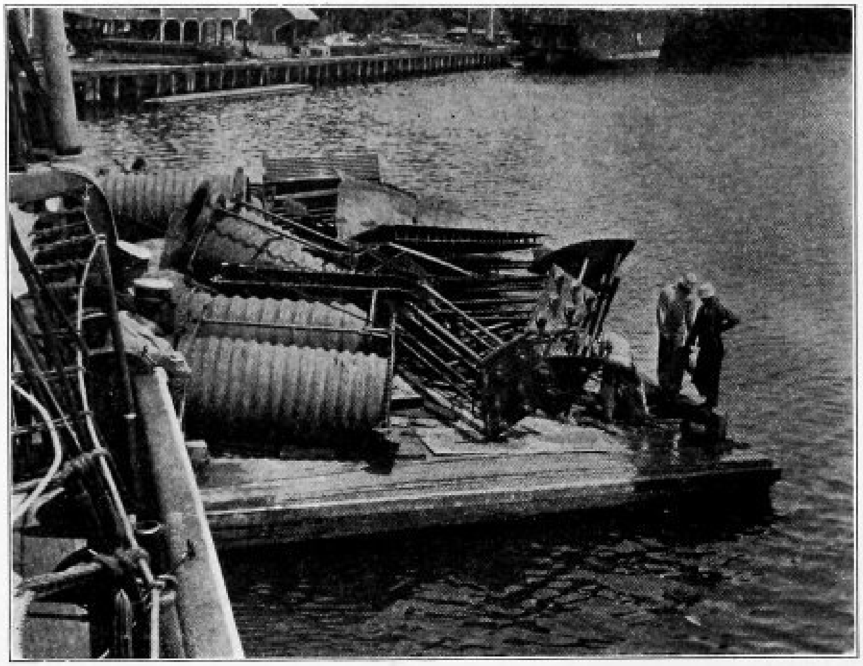


Fig. 1.—Scow Alongside the *Seminole*, Loaded with Sections of Dismantled Boilers

Fig. 2.—Cut Across Head of Boiler

Fig. 3.—Torch Operators Finishing Cut Across Boiler Head

Each of the boilers was about 13 feet in diameter and 9½ feet long. The boiler shell was 1¼-inch steel and the heads 15/16 inch, while the plates making up the back connection of the furnace section were ⅝-inch metal. Cuts were made on each of the two boilers as shown in Fig. 4. The top was first removed by making a cut around the upper third of the circumference, front and back, and then making five longitudinal cuts across the free section, front and back. The upper third of the front and back plates was then cut in three sections, as shown, and each section lifted out complete, without removing the stays.

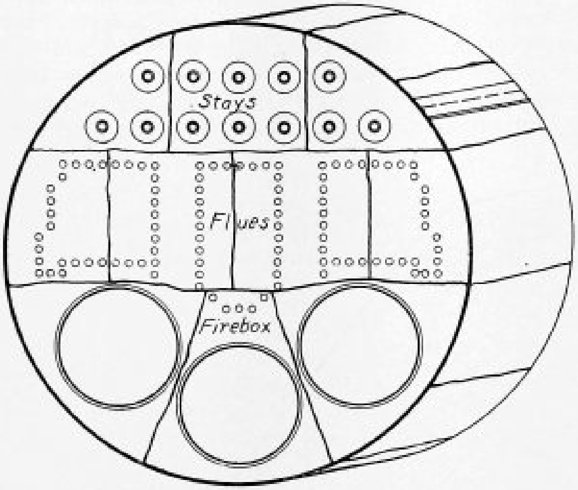


Fig. 4.—Location of Cuts on Boiler

The work then proceeded similarly on the middle or tube section, this being cut out in four parts, after removing the shell at the sides. This section of the boiler required cuts in the back connection plates corresponding with those on the front and back heads. The boiler tubes remained in place in each of these four sections and may be seen in the photographs of the parts on the scow.

Fig. 5.—Lowering Sections to Scow

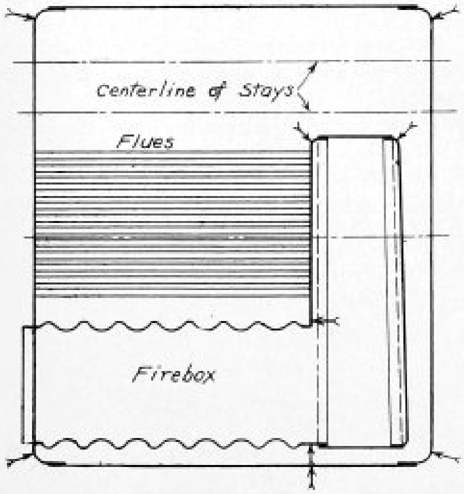


Fig. 6.—Longitudinal Section (Arrows Show Cuts)

The lower or furnace section was removed in three principal pieces, each piece being cut loose at the ends around one of the furnaces. The bottom section of the boiler shell was finally removed in four pieces.

As fast as the pieces of steel were cut free, they were hoisted through the hatch with the aid of a gin pole rigged on the dock and were loaded on a scow alongside the *Seminole*.

The removal of the two boilers involved the cutting of

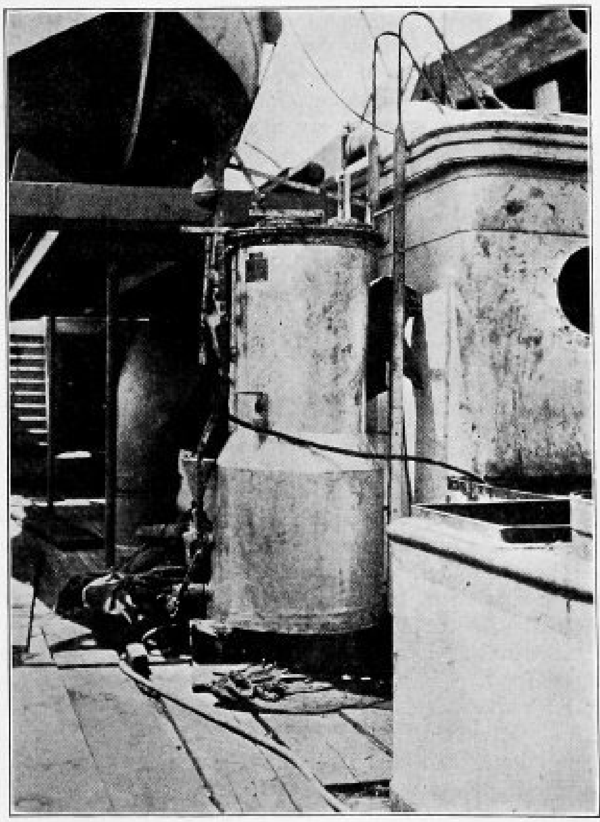


Fig. 7.—Acetylene Generator on Deck

a total of approximately 1,000 feet of plate, which averaged 1 inch in thickness and reached a maximum of 3¼ inches at points where there were butt joints in the boiler shell reinforced by 1-inch straps on both sides. The cutting was rendered difficult by the presence of a thick layer of paint on the entire outside of the boilers and a coating of scale on the inside. In spite of these obstacles, however, the oxy-acetylene flame made clean, even cuts through the metal and the work progressed rapidly without interruption.

The total time occupied in cutting up and removing the two boilers was eight working days of eight hours each. Inasmuch as about half the time was occupied in working out and clearing away the sections released by the cuts and in preparing for new cuts, the actual cutting time was approximately thirty hours. Even more rapid progress would have been made had it not been for the cramped working quarters. This plan of removing the boilers proved a great saving in time and cost over other available methods.

The acetylene generator was of 50 pounds capacity, made by the Alexander Milburn Company, Baltimore, Md. Oxygen for the work was secured in the usual way in steel storage cylinders. The work was carried out under the direction of Captain Charles F. Nash, U. S. Revenue Cutter Service, engineer in charge at the depot.

Duplicating Back Flue Sheets

BY W. E. O'CONNOR

One of the troublesome repair jobs, which is often met with by the layer out in the railway repair shops, is the renewing of back flue sheets. The troublesome part may well be attributed to the fact that the contour of the flanged portion of the sheet bears no definite relation to the center line or axis with respect to symmetry.

Prior to the introduction of hydraulic pressing machines, for flanging boiler plates, the practice for renewing back flue sheets was slow and cumbersome. Many methods have since been brought forth by the leading repair men as to which is the most expedient and reliable way for handling repairs of this sort.

At the shops where the writer is employed patterns covering the disposition of flue-holes, staybolt, brace and foundation ring rivet holes have been established to suit the several classes, so that when engines pass through the shops for classified repairs, including a new back flue sheet, the new sheet is gotten out, in so far as the punching of the pilot holes for flue holes, staybolt, brace and foundation ring rivet holes is concerned, as shown in half-view, Fig. 1. In the meantime, the old sheet being removed, special templates of light bar iron, one-fourth inch by one inch in section, are shaped to either side of the old sheet from points at the top center to the rivet line at the foundation ring. Next the templates are placed on the new sheet, as shown in the half-view, Fig. 2, so that point *a*, the vertical height, and points *x y*, the horizontal width at the rivet line, are cut by similar points on the templates taken from the old sheet. Now the brake and trimming lines for the flange are drawn in.

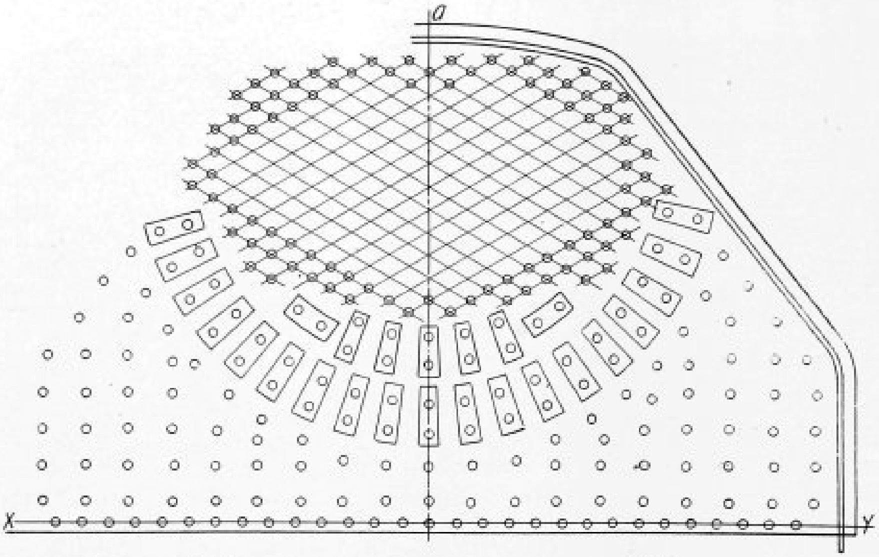


Fig. 1. Fig. 2

The flange turner checks up the shaping of the flange with the templates, cutting similar points as explained in the layout after annealing the sheet, etc. Also points for the disposition of the rivet holes on the rim of the flange are lifted from the old sheet on the templates and transferred to the respective sides on the rim of the new sheet, completing the layout.

Why Do Crown Stays Break in Wagon Top Boilers Which Are Not Fitted with Cross Stays?

Will some of the readers of The Boiler Maker please explain in the next issue why the crown stays break in some wagon top boilers and not in others?

The fireboxes are of the O. G. type and the construction of the boiler is practically the same in both cases, with the exception that in the boilers where cross stays are fitted the crown stays do not break, while in the boilers where cross stays are not fitted the crown stays do break.

Subscriber.

Roundhouse Destroyed by Fire.—The roundhouse at the Texas Midland shops in Terrell, Texas, was destroyed by fire October 18, and four locomotives were badly damaged, entailing a loss estimated at $30,000.

New Roundhouse and Repair Shops.—It is announced that a new roundhouse and repair shops will be built next spring at Lexington, Ky., by the Chesapeake & Ohio Railroad.

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Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

The Boiler Maker *is one of the original members of the Audit Bureau of Circulations.*

5,600 *copies of this issue were printed.*

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

In a report on autogenous welding, presented by C. L. Dickert, assistant master mechanic, Central of Georgia Railroad, at the recent convention of the International Railway General Foremen's Association, the following conclusions are drawn:

"Experience now indicates that the two methods, electric and oxy-acetylene welding, have advantages over each other in certain different operations. For welding flues to the back flue sheet, filling in on calking edges, reinforcing small corroded parts, or where it is important to confine the high temperature to as small an area as possible, due to contraction, the electric process is superior.

"For large boiler patchwork, new half or whole side sheets, long cracks or any work where suitable provision for contraction can be readily provided and in cutting or removing defective parts on old sheets the oxy-acetylene excels. It is, therefore, clear that in large shops the installation and use of both methods is not only desirable, but an excellent paying proposition."

These conclusions are fully substantiated by the experience gained by master boiler makers in many different shops, and further emphasize the advantages of the welding devices which are to-day available for boiler work.

Some interesting facts regarding the recent progress and improvement in the efficiency and capacity of steam locomotives are given in a report to be presented at the annual meeting of the American Society of Mechanical Engineers, in New York on December 2. Systematic progress in the capacity of locomotives began twenty years ago when an eight-wheel American passenger type locomotive, weighing 116,000 pounds and producing a tractive effort of 21,290 pounds, was built for an Eastern railroad. This was the first of a chain of passenger locomotives leading up to the recent designs of the "Mountain" type, the largest of which to-day weighs 331,500 pounds and produces a tractive effort of 58,000 pounds, or about three times the tractive effort of the first design of the series built twenty years ago. In freight locomotives the report points out that the largest and most powerful locomotive in 1898 weighed 330,000 pounds and gave a tractive effort of 53,300 pounds, while to-day the most powerful freight locomotive weighs 410 tons and gives a tractive effort of 160,000 pounds.

While this progress has been rendered possible by the corresponding developments of factors making for the greatest efficiency in boilers and engines, it is interesting to note that the principal factors have to do with the design or operation of the boiler. Chief among these are boiler design and the relationships of the factors making up heating surface, firebox design, front-end design, draft appliances, exhaust nozzles, ash-pan design as to air openings, superheating, feed water heating, fire brick arches and circulating supporting tubes, mechanical stokers and labor-saving devices for the enginemen and firemen. The main possibility for improvement, it is claimed, is the use of powdered fuel, which promises an ideal method of complete combustion under control more perfect than is possible with present methods of oil burning, and perhaps with economies impossible to obtain with oil.

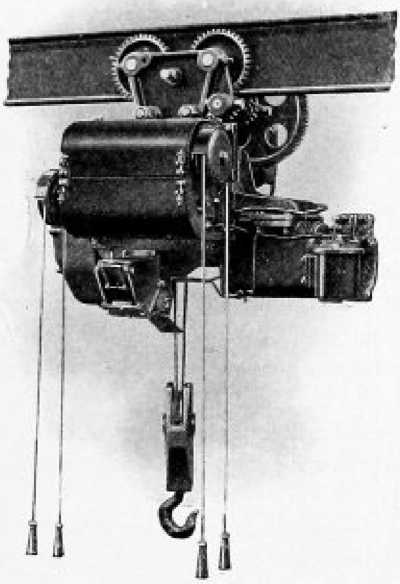
To show the progress in efficiency in modern locomotives comparisons are drawn from the best results of ten years ago and of to-day. At the Louisiana Purchase Exposition in 1904 tests made by the Pennsylvania Railroad showed that it was possible to obtain an equivalent evaporation from and at 212 degrees of 16.4 pounds of water per square foot of heating surface when the boilers were forced. When the power was low, the evaporation per pound of coal was between 10 and 12 pounds, whereas the evaporation declined to approximately two-thirds of these values when the boiler was forced. In steam consumption the St. Louis tests showed a minimum of 16.6 pounds of steam per indicated horsepower hour. In coal economy the lowest figure was 2.01 pounds of coal per indicated horsepower; the minimum figure for coal per dynamometer horsepower was 2.14 pounds. Since that time, however, further progress has been made, and the results obtained to-day show that during the last ten years reductions of 10 percent in fuel and 12 percent in water have been obtained. The committee points out, however, that the end of the development of the steam locomotive is by no means in sight, and it is to be hoped that a full discussion of the complete report will be made at the coming meeting of the Mechanical Engineers' Society.

Engineering Specialties for Boiler Making

A Convenient Electric Traveling Hoist Equipped with Safety Devices to Prevent Accidents—Kerosene Torch of Novel Design

Traveling Electric Hoist

A traveling electric hoist designed to handle all kinds of material of every weight, size and description, in and about manufacturing plants, is being manufactured by the Pawling & Harnischfeger Company, Milwaukee, Wis. Even where large cranes are used, the hoist, which runs on the lower flanges of an I-beam attached to the ceiling or supported by frames, has the advantage of getting into corners or irregular areas which cannot always be reached by a large, heavy crane.



The hoist is symmetrical in appearance, the drum being in the center, surrounded by a frame of cast steel with the motor fastened to one side and the gear case to the other side. The drum is flanged and provided with grooves to a depth equal to the diameter of the rope, so that the rope is not apt to jump the grooves if the pull becomes sidewise. The rope is of plow steel, designed with a factor of safety of five. The lift, for type V, as illustrated, is 15 feet, unless otherwise specified. The hoist gears and the load brake are enclosed in a dust and oil-tight gear case and thoroughly lubricated by splash oil. Worm gearing has been avoided and the drive consists exclusively of spur gears. All gears are of cast steel, all pinions of forged steel hardened, and all bearings are bronze bushed. The load brake runs at a moderate speed and is so located that the fewest number of parts are interposed between it and the drum. The load is claimed to be automatically sustained at all times, so that it cannot run down through carelessness of the operator or interruption of the current, but must be let down by reversing the motor.

The truck is bolted to the cast steel drum frame and is provided with drop-forged and roller-bushed truck wheels. On motor-driven trucks, all four truck wheels are driven, which facilitates running over short curves. A substantial, asbestos-lined, clam-shell solenoid brake is provided for the purpose of bringing the motor to a prompt stop after the controller has been returned to the off-position. If this motor brake were omitted, it is claimed that the hook, after the power is shut off, would drift to such an extent as to make accurate spotting of the load impossible. When the bottom block reaches the highest position it strikes a limit switch which interrupts the motor current and brings the motor to a quick stop by means of the motor brake. The load cannot, then, be hoisted any further, but it can be lowered in the usual manner and the limit switch resets automatically.

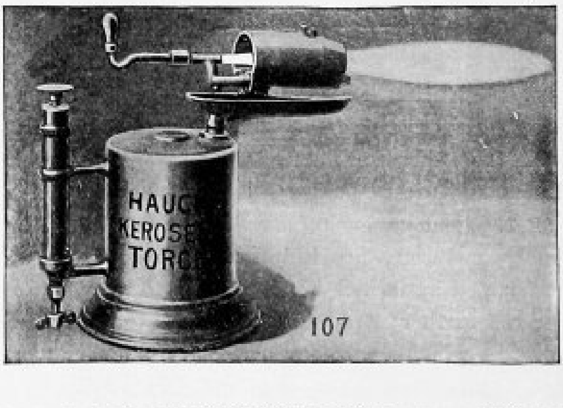
The direct current motors used in these hoists are made by the same company and are especially designed for crane service. All motors are completely enclosed and can be operated outdoors. Direct current motors can be furnished for 110, 220, 500 and 600 volts, while alternating current motors can be furnished for 2 or 3 phase, 25 or 60 cycle, 110 to 550 volts, and are of the slip ring type.

The hoists are fitted with controllers of the drum type, made entirely of non-combustible material. These controllers are provided with a spring return, which automatically shuts off the power when the operating rope is released. The hoists are further provided with current collectors and are wired according to the rules of the National Board of Fire Underwriters.

These hoists are furnished, for use in a monorail system, with or without following cages for the operator. They are also arranged for hook suspension and may be provided with magnets, hooks, etc., for any particular purposes.

The Hauck Kerosene Torch

A kerosene torch of new and novel design, especially designed to take the place of the gasoline torch, has just been placed on the market by the Hauck Manufacturing Company, of Brooklyn, N. Y. This torch should prove of special interest to railroads and boiler shops where the question of safety is foremost. The most important feature is the construction of the bronze burner. The oil passageways are especially large and so arranged that only one plug has to be unscrewed in order to clean the whole burner instantly. By a special oil regulating valve the flame can be adjusted to any size from 8 inches long by 1 inch in diameter to the finest point.



As kerosene contains more heating units than gasoline, the temperature obtained with this torch is much higher than that of the gasoline torch, which makes it especially suitable for burning paint and grease off boiler plates and sheets, taking the chill out of plates, expanding tight boiler and pipe fittings in taking them off, melting solder or lead out of joints, brazing and general heating purposes. It is also claimed that strong wind or cold weather will not affect the flame in any way, and it is therefore especially recommended for outside work.

The torch is also furnished in connection with a light furnace for melting solder and heating soldering coppers.

Technical Publication

Hendrick's Commercial Register of the United States for Buyers and Sellers. Twenty-third edition. Size, 7½ by 10 inches. Pages, 1,600. New York, 1914: S. E. Hendricks Company. Price, $10.00.

The twenty-third annual edition of Hendricks' Commercial Register of the United States for Buyers and Sellers, which has just been issued, is by far the most complete edition of this useful work that has been published. Many new features have been added; thousands of trade names and titles of identification have been inserted, and numerous duplications expunged. "The Assistant Buyer," formerly published by the Sullivan System, has been incorporated with it, and the entire work has been thoroughly revised and improved in every detail. This publication lists manufacturers of everything made from iron, steel, brass, bronze, copper, aluminum, platinum, zinc, lead, etc., whether cast, rolled, drawn, pressed or forged, including bar, plate, sheet, wire, structural and other shapes; pipe, tubes, bands, hoops, high speed, high carbon, tool and other high grade steels, bolts, nails, nuts, rivets, screws, rods, spikes, chains, shafting, etc., and castings of every description, from all metals, including every machine, tool, furnace, etc., required in their production. It numbers some 1,600 pages and contains about 350,000 names and addresses, with upwards of 45,000 business classifications, while 138 pages are required to index its contents. It is used extensively throughout the United States and many foreign countries for purchasing purposes by corporations, governments, associations, manufacturers, exporters, puchasing agents and sales managers.

Personal

J. H. Brooks, formerly of Little Rock, Ark., has been appointed layer out at the main shops of the Erie Railroad at Meadville, Pa.

Paul Zitterman has been appointed foreman boiler maker of the Santa Fe Railroad at San Bernardino, Cal.

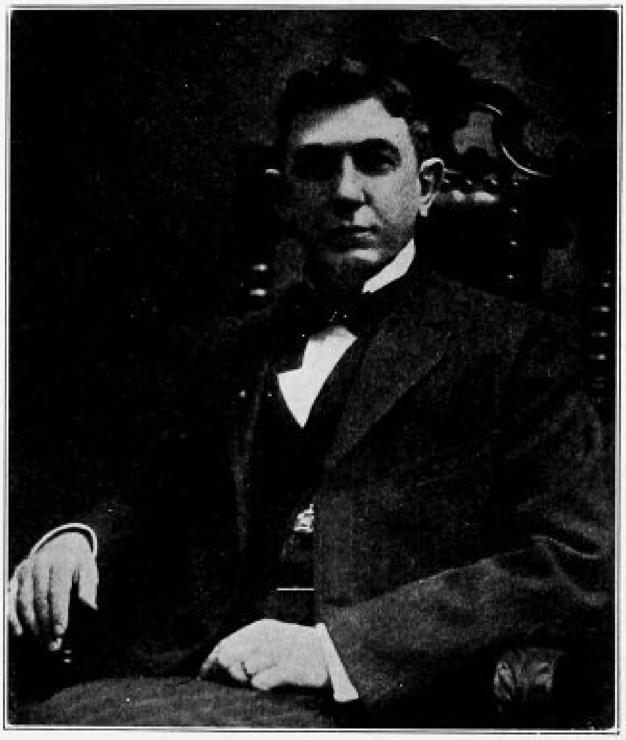
A. Anderson has been appointed foreman boiler maker of the Chicago, Rock Island & Pacific Railroad at Manly, Iowa.

Thomas Stewart, assistant foreman boiler maker and inspector of the San Pedro, Los Angeles & Salt Lake Railroad at Los Angeles, Cal., called at our office recently while on a thirty days' leave of absence from his work. Mr. Stewart has traveled across the continent, visiting many of the large locomotive and railway shops, including the Eddystone works of the Baldwin Locomotive Works, investigating the latest boiler shop methods and appliances.

Charles Hyland, formerly foreman boiler maker of the Michigan Central shops at Jackson, Mich., has resigned to accept the position of boiler expert with the Flannery Bolt Company, manufacturers of the Tate Flexible Staybolt, Vanadium building, Pittsburg, Pa. Mr. Hyland succeeds Mr. Tom R. Davis, deceased.

H. H. Hodell was elected president of the Van Dorn & Dutton Company, Cleveland, Ohio, at a special meeting of the board of directors, held October 12, to fill the vacancy caused by the death of James H. Van Dorn.

Tom R. Davis, mechanical expert of the Flannery Bolt Company, Pittsburgh, died in his sixty-first year at his home, Dravosburg, Pa., on October 12. When eighteen years of age, after a public school education, he began work as a machinist's apprentice with the Allegheny Locomotive Works. In 1875 he secured a fireman's position and the following year was promoted to that of engineer. The following year he entered the employ of the Crosby Gage & Valve Company as special agent. He left that company in 1880 to accept the position of manager of the Monongahela Manufacturing Company at Monongahela City, but later he returned to the employ of the Crosby company, with whom he continued until 1892, when he was employed by the Garlock Packing Company. In 1898 Mr. Davis was employed by the Homestead Manufacturing Valve Company as special expert, leaving that company in 1904 to enter the employ of the Flannery Bolt Company as mechanical expert, which position he held at the time of his death. He is survived by his wife, Mrs. Mathilda Homer Davis, and Joseph H., T. Randolph and Mrs. J. W. McConnell. Mr. Davis was prominent as a member of Monongahela Lodge No. 537, F. & A. M., Past Eminent Commander of St. Omar Commandery No. 7, K. T. of Brownsville, Pa., and also a member of Monongahela Lodge No. 455, B. P. O. E.



Tom R. Davis

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

The Apprentice Question

When we read the various articles on training apprentices and hear of what the railroad companies are doing to educate their young men in the different trades, it seems there should be an abundance of first-class mechanics. Yet from many sources the cry is heard, "We want good boiler makers." I have read several articles lately in which the authors speak of the "old-time boiler makers" and ask what has become of them? Judging from this the old-timers must have had some class to them, at any rate. Yet we older ones say, if we could only have had such chances in our day as the youngsters have now, what boiler makers we would have been! Perhaps some few of the older ones did have equally as good chances but did not recognize them. However, I am sure the great majority had very few, if any, of the golden opportunities now put squarely up to the apprentice, not only in the boiler, but in other trades as well.

With the old-timers the boiler trade meant harder work than to-day, for there were no pneumatic tools and other conveniences with which the modern shop is equipped. Everything was accomplished by the "armstrong" process. You never saw a man attempt to chip a seam with a poor chisel. No, there were six or eight flat chisels in his pan, ground just so. Neither would they attempt to cut out a staybolt with a cape chisel indifferently ground. Experience soon taught them that carelessly ground tools meant harder licks and more of them. But these men are fast giving way to younger ones, who handle only air tools, and I have seen many cases where they did not care a rap what condition the chisel or drill was in just so it did some kind of cutting, and they got by the boss with it and got their day's pay. If you put these same fellows on piecework, they will either quit or naturally try to do as much as they can in the least possible time, and will scheme in every way to attain this end. It is then that they will learn to grind their tools properly and keep them in good shape, and you have your "specialist." Many "specialists" are also obtained from that vast army who never learned a trade in their younger days, either through lack of opportunity or lack of ambition, and who realize their mistake when they, perhaps, have a family dependent upon them, and so quickly adapt themselves to whatever they can make the most out of.

Yes, they are boiler makers, but only in one line; perhaps they can chip and calk or fit up or rivet, and so on. These men will make $4 to $5 per day of nine hours in their line, while you perhaps pay your general boiler maker, who works day rate at odds and ends, 38 cents per hour. Can you blame him for going to some other shop and hiring out as a specialist?

You may not have the piecework system in your shop, but train your apprentices strictly at day work; but when they get out of their time and become journeymen, they drift to the piecework shops and take hold of whatever seems easiest to them.

Or, as is often the case, they have by this time opened their eyes to the fact that a noisy, hard lot will be theirs if they continue at the trade, and so they desert it entirely for some easier, cleaner, lighter trade. I have met and handled many men and heard many different tales. One bright young man I knew, after serving nearly four years, came in one morning and quit. He said that he was going to learn the barber trade—no more boilers for him. He did learn it in a few months and made good so far as I know.

I could tell of dozens of boys who, after serving one or two years in the boiler shop, quit and went to business colleges, and later secured the lighter and cleaner work, and did as well and better financially than they or anyone else could have done in the boiler shop as a workman. Many who quit have openly told me, "I see no chances here except to lose my eyes and hearing." When we sum up the whole trade this is only too true.

Do you advance your apprentices when they know the boiler trade? "Oh, yes!" you say, "as quick as they are capable they will get the journeyman's rate." But how about promoting them to be assistant foreman, foreman, general foreman, master mechanic, division superintendent or superintendent of motive power? Do they have the same chances at these promotions as the machinists do? No! The number of boiler makers you will find in the higher positions is very limited. You want an assistant or foreman for your boiler shop, and maybe you have some one in your boiler shop that gets the place. He may after a time work his way to be general master boiler maker of the road. On the other hand, if a roundhouse foremanship or general foremanship is open, it is ten to one that a machinist will get the place; and yet a boiler is one of the most important things on the whole engine. Surely a man capable of building a thing so complicated as a locomotive boiler has as much brains to handle the machine end of a locomotive as a machinist has to handle the boiler end of the job. These chances, too, are quickly summed up by bright, would-be apprentices, and this seems to me another good reason for balking at entering a boiler shop.

Let us investigate a little further along these lines. Who is your apprentice instructor, a machinist or boiler maker? If he is a machinist, how can he properly instruct a boiler maker? Has he ever laid out a locomotive boiler, and could he explain this to an apprentice? How could he tell an apprentice how to flange a sheet, never having done the work himself? How would he know where the material will bunch or flow? It was my good fortune a few years ago to see an apprentice-instructing system as I have just described.

The instructor was a machinist, a good mechanic and a fair draftsman. In the morning he instructed the various apprentices in drawing and the afternoons he spent in the shop; always in the machine shop on some machine, never in the pipe, smith or boiler shops; yet he had these apprentices in his care as well as the machinists. As an instructor for boiler maker apprentices this man was a failure.

I think, and many will no doubt side with me, an instructor for boiler apprentices should by all means be a boiler maker, and a good one at that; one who has the trade at his finger ends, so to speak; has a good education and unlimited patience. He must be able to lay out any work and understand blue prints thoroughly, yet he need not be a draftsman. The apprentice can get all the drafting part of his education in the drawing room, and, if he's the right kind of a boy, he will get some of it at home by night study.

In the shops, while at work, is the time that the apprentice needs help. Think of yourself as an apprentice! Would you enter in on the trade? Remember the Golden Rule, then, and do all you can for the boiler makers; advance their pay and give them equal chances with other craftsmen and your boiler shop will soon have "old-timers" in it again.

BENT FULLER.

Layout of Wrapper Sheet for Locomotive Fireboxes

In the form of fireboxes illustrated, the door sheet is lower than the flue sheet. A sectional and end view is shown in Fig. 1, with dimension and construction lines used to lay out the pattern. The outline of the door and flue sheets, and hence the shape of the wrapper sheet, is made up of a series of curves having as radii *b*, b_1, *e*, *f*, *g* and g_1, as shown in Fig. 1. To insure a high degree of accuracy in developing the pattern, good practice requires that the spaces into which these arcs are divided should, in a measure, correspond to the length of the radii. That is, the shorter the radius the narrower the spacing. Similar points on the arcs, Fig. 1, as 1-1_1, 2-2_1, etc., are joined by solid straight lines. Dotted straight lines are used to connect alternate points such as 1-2_1, 2-3_1, etc.

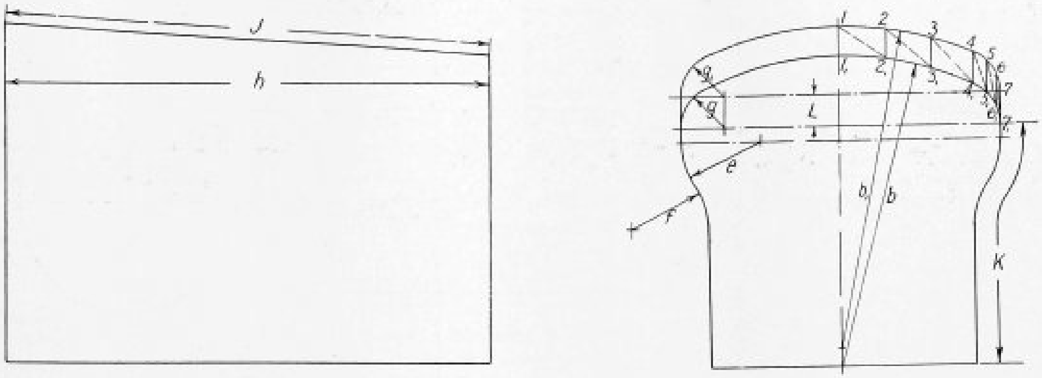


Fig. 1

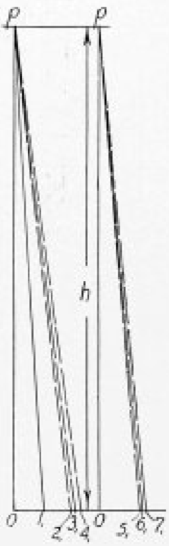


Fig. 2

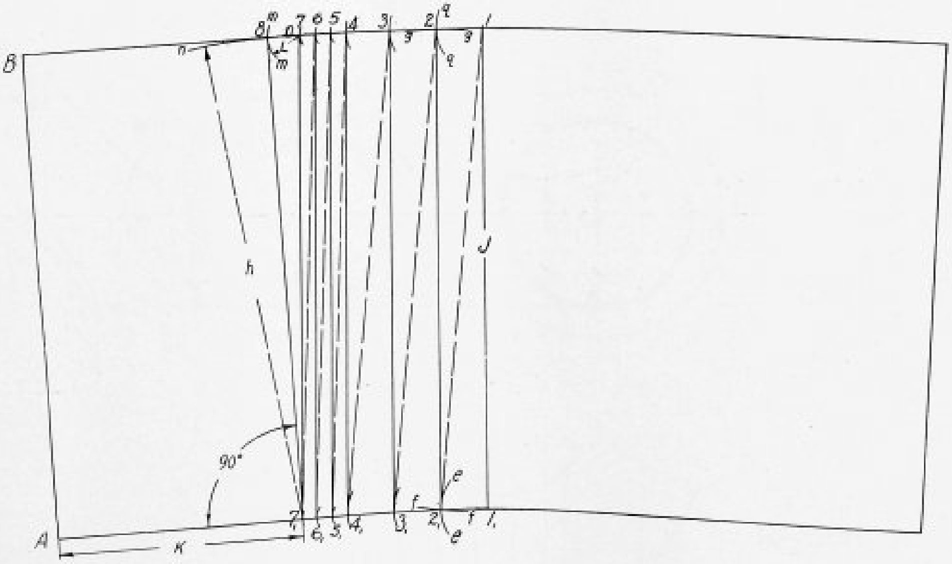


Fig. 3

The true lengths of these connecting lines are determined by drawing the triangles shown in Fig. 2. The height *h*, Fig. 2, is equal to the length *h*, Fig. 1. From the point *o*, Fig. 2, the horizontal distance, *o*-1_1, is laid off equal to 1-1_1, Fig. 1, which is also equal to 2-2_1, 3-3_1, etc., Likewise *o*-2_1, Fig. 2, is made equal to 1-2_1, etc., Fig. 1. The slant lines from the vertices *p*, *p*, Fig. 2, to the points on the horizontal line, give true lengths of the respective solid and dotted lines shown in Fig. 1.

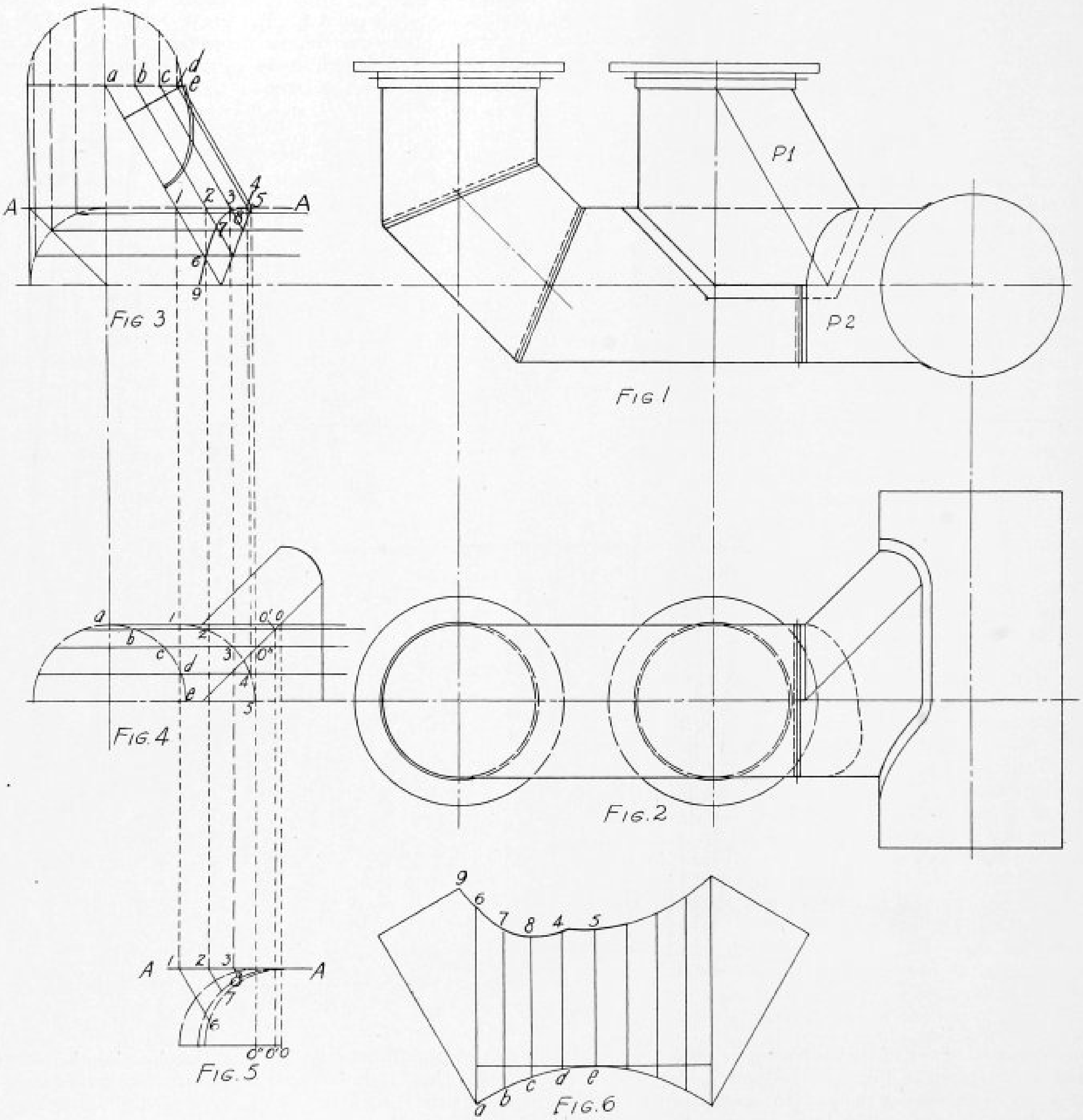
The pattern in Fig. 3 is laid out by drawing the center line *J* equal to *J*, Fig. 1, or equal to *p*-1_1, Fig. 2. With 1_1, Fig 3, as a center and a radius equal to the arc 1_1-2_1, Fig. 1, describe the arc *e*-*e*. Then with 1 as a center and a radius equal to *p*-2_1, Fig. 2, describe the arc *f*-*f*, cutting the arc *e*-*e* at the point 2_1. The line 1_1-2_1, Fig. 3, will then form part of the rivet line on the pattern. Then with 1 as a center and the length of the arc 1-2, Fig. 1, as a radius, draw the arc *q*-*q*, and, with 2_1 as a center and the line *p*-1_1 as a radius, draw the arc *g*, *g*, thus locating the point 2 on the rivet line. Continue the construction in the same manner until the points 4 and 4_1 are located. Then change the radius to correspond with the shorter arcs in Fig. 1, from 4 to 7, and complete the layout to points 7-7_1, Fig. 3.

With the point 7 as a center and *L*, Fig. 1, as a radius, draw the arc *m*-*m*. Then with 7_1 as a center and a radius equal to *h*, Fig. 1, draw the arc *n*-*n*, thus locating the point 8 on the rivet line. Finally the length *K*, Fig. 1, is laid out, as shown in Fig. 3, to form the rectangle 7_1-*A*-*B*-8. We now have the pattern for one-half of the wrapper sheet, and the other half is laid out in a similar manner but in the opposite direction.

Miles City, Mont. L. L. Lane.

Development of Irregular Shapes

The following layout is that of a section of cold blast pipe used on a blast furnace. The section is made of 3/8-inch plate, double riveted with 5/8-inch rivets. There is nothing unusual in it except in laying out the course marked *P* 1, which fits on another course, *P* 2, of a similar design. The development is the same as shown on page 261 of the August number of The Boiler Maker, except on the quarter where the two flaring parts intersect. This quarter is developed in Figs. 3, 4 and 5.



Layout of Section of Cold Blast Pipe

Fig. 4 shows where the lines *a*-1, *b*-2, etc., intersect the horizontal plane of *A-A*, Fig. 3. By inspection it can be seen that two of these lines, *e*-5 and *d*-4, strike on the flat surface of *P* 2, which determines their length.

To find the length of the other three lines, three views must be developed through *P* 2 in the directions of *a*-1, *b*-2 and *c*-3, Fig. 4. Since the flaring part of *P* 2, is a semicircle around the top, and slopes at an angle of 45 degrees, sections through it perpendicular to the top are also semi-circles. These sections are shown in Fig. 5 in their relative positions. Then produce *a*-1, *b*-2, *c*-3, Fig. 5, distances equal respectively to 1-6, 2-7, 3-8, Fig. 5. With lengths *a*-6, *b*-7, etc., proceed with the stretchout as shown in Fig. 6. Stock must be added to Fig. 6 to allow for flange and double rows of rivets in the seams.

Ensley, Ala. C. G. Reem.

Causes of Deterioration of Boilers

There are several causes which tend to destroy or shorten the life of a boiler; part of these are chemical and part mechanical. One of the most important factors in connection with the durability of a boiler is the feed water. If this is impure it may injure the plates by corrosion, or it may deposit a sediment that forms a scale. Pure water which is free from air and carbonic acid has no bad effect on iron, but all natural waters, whether from rain, lake or river, contain air in solution and a little carbonic acid. Water that contains gases or acids attacks iron readily.

There are two forms of corrosion, external and internal. The first is caused by exposure to the weather, moisture from the ground, or leakage of joints or fittings. Much damage due to external corrosion comes from the practice of setting boilers in a mass of brickwork, which holds any moisture that may come in contact with the plates. It is impossible to tell from the external appearance the condition of the plates resting on the brickwork; and and though the edges may appear to be in good condition, the center portions may be badly eaten.

Internal corrosion appears in various forms, such as general corrosion or wasting, pitting or honeycombing and grooving. General corrosion and pitting are the result of chemical action from the feed water, while grooving is a combination of chemical and mechanical actions. General corrosion is hard to discover, because it acts uniformly on a large surface. Sometimes the rivet heads waste equally with the plates, so that the damage done to the plates is not noticeable. Uniform corrosion is the hardest to detect of any of the forms. Water may attack the plates only at the water line, or may, in some cases, be confined to a belt six or eight inches wide at the water level. Sometimes a few rivets or a part of the seams may be corroded and the rest may be in perfect condition. The stays or braces are usually weakened more rapidly than the shell plates. The uncertain action depends upon the specific gravity of the corrosive agents, the difference of temperature, the variation in the structure of the iron, etc.

The most reliable way to measure the amount of wasting is to drill through the plates. If the thickness of the plates is found to be considerably reduced the working pressure should be proportionally lowered.

Pitting is clearly shown by the edges of the pits or holes. From this appearance both the extent and depth are indicated. Pitting appears in the form of small holes or patches from one-half inch to twelve inches in diameter, or in irregular shaped depressions. If the holes are small and close together, the plate is said to be honeycombed.

The reason why plates become pitted instead of uniformly corroded is not fully understood, but is supposed to be due to difference in the structure of the iron or steel.

The cause of grooving is not always apparent, but is usually due to the springing or buckling of the plates aided by local corrosion. The straining of the plates may be due to improper staying, which causes them to spring back and forth as the steam pressure varies. It appears on the flat end plates around the edege of the angle iron, or in the root of the angle iron. Too rigid staying of the ends or too great difference in the expansion of the tubes and shell is almost sure to cause grooving.

Internal grooving is a direct result of excessive calking, which by injuring the surface of the metal exposes it to the corrosive action of the feed-water. Sometimes grooving is so fine as to appear as a crack or fracture, and may extend into the metal for a considerable depth, even when it shows at the surface as only a fine line. On account of the minuteness of the cracks they are hard to discover, and, when once formed, rapidly enlarge from any acidity in the feed-water.

The best way to prevent internal corrosion is to use water which has no corrosive effect on the plates. If it has begun, a change of water will often prolong the life of the boiler. In some cases it is cheaper to install a new boiler every few years than to use a different water supply. This is not always best, for there is a tendency to use the boiler as long as possible, even after it has become unsafe. Thicker plates are sometimes used at the points where corrosion is the most severe, but these are apt to produce unequal strains.

Where the feed-water is acid it is sometimes neutralized by adding some alkaline substance, such as soda or soda-ash, before it enters the boiler. The amount of soda to be used varies with the acidity of the water. If there is considerable salt present, the introduction of soda is injurious.

CHAS. MILLER.

Albany, N. Y.

Flexibility in Fireboxes

I have read carefully the articles on boilers in your October issue, and am more than pleased to see the attention paid, and the different views and recommendations; but through all I see no recommendation for improving the construction in order to relieve the permanent set in the plates which make up the firebox part of the boilers.

On the other hand, the disease of what are wrongly termed "flexible" bolts, seems to be in the nature of an epidemic. I read on page 321, of the issue referred to, of still another new kind invented by Mr. Kerr, F. B. M. on the Chicago & North Western Railway at Clinton, Iowa, using the old turned buckle with the socket end. And I am glad to hear the inventor state that by the use of this old socket the necessity of enlarging the holes for the regular socket, which absorbs so much area of the plate and weakens the outside wrapper sheet, is done away with. This is surely an admission from a foreman boiler maker on one of the railroads whose motive power is considered somewhat up to date.

Every month seems to bring us to a new realization of the weakness of locomotive boilers as at present constructed, and also to the fact that the trouble all lies in the flat plates being used. The effort to relieve the situation with the articulated stay has, as it were, become the only means possible in the minds of many, whereas the real problem lies in the formation of the plates by shallow corrugations, so that the permanent set is dispensed with, and the equal distribution of stresses put in its place. However, not only are the stresses neutralized, but the parts forming the flexible construction are made stronger, something which can never be procured by the movable stay.

I see on page 318 of the same issue an illustration of the Scotch marine boilers for the Mallory Line Steamship Company with corrugated furnaces, the design of which covers all points with stays, giving an allowance for movement to the combustion chambers. It is to be hoped that in the near future the surfaces between the staybolts in the combustion chambers will be corrugated and also the ends wherever the tubes could be encircled. This would reduce the leakage of tubes and relieve the stresses on the staybolts, besides adding strength to the respective parts.

Media, Pa.

WILLIAM H. WOOD,
Mechanical and Consulting Engineer.

Selected Boiler Patents

Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,
Millerton, N. Y.

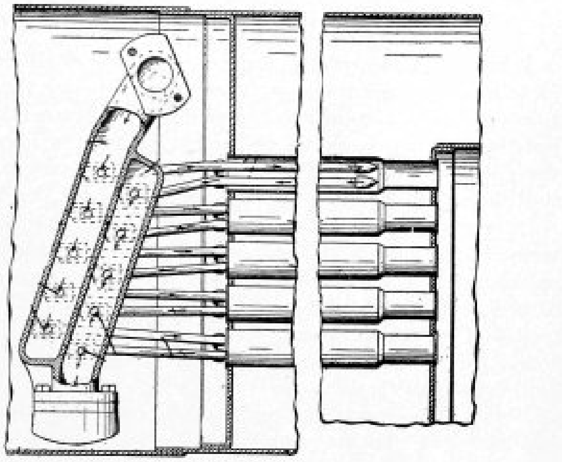
Readers wishing copies of patent papers, or any further information regarding any patent decribed, should correspond with Mr. Decker.

1,103,447. BOILER-ARCH CONSTRUCTION. ENOCH P. STEVENS, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE ARCH BRICK COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

Claim 1.—A boiler arch construction, comprising, in combination with a firebox having a plurality of arch tubes extending longitudinally therethrough, an arch having its main portion supported by said tubes, and a side brick supported by one of the outer arch tubes and having a rounded outer side resting against the side sheet of the firebox, said side brick being inclined upwardly and outwardly from the adjacent arch tube, whereby said side brick adjusts itself to variations in the distance between said outer tube and said side sheet, substantially as described. Seven claims.

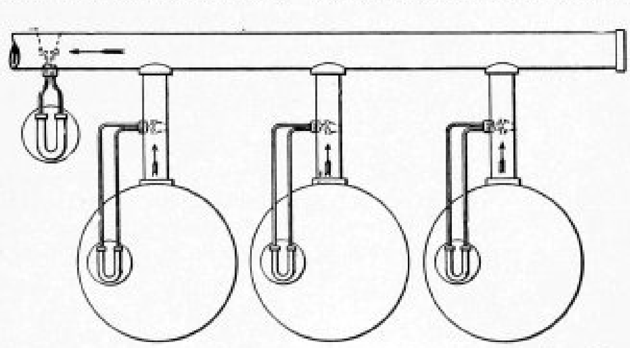
1,105,634. SUPERHEATER. GEORGE H. EMERSON AND HENRY YOERG, OF ST. PAUL, MINN., ASSIGNORS TO LOCOMOTIVE SUPERHEATER COMPANY, A CORPORATION OF DELAWARE.

Claim 1.—A superheater header having saturated and superheated steam chambers formed therein and external bosses formed on the side walls of said steam chambers and projecting laterally therefrom and separated from one another and having sockets communicating with said chambers, respectively, the bosses communicating with one chamber being staggered with respect to those communicating with the other chamber on the same side of the header, and superheating tubes communicating with said chambers through said sockets. Three claims.



1,105,736. BOILER-FEED SYSTEM. JAMES WILKINSON, OF BOSTON, MASS., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—The combiation with a battery of boilers having a common header and connections whereby the boilers feed into said common header, of a master steam flow meter for said header, an auxiliary flow meter for each connection, and means for indicating at each auxiliary meter the variations of the master meter. Six claims.



1,103,098. FURNACE FOR BOILERS. ROBERT FINDLAY STURROCK, OF DUNDEE, SCOTLAND.

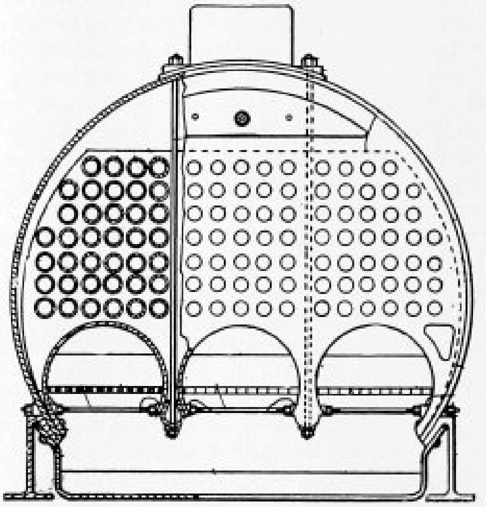
Claim.—In a furnace bridge, in combination, a plate provided with a horizontal upper surface, and a plurality of inverted U-shaped bridge bars arranged side by side and having their lower ends engaging said plate, the front limbs of said bars being provided with air passages, the rear limbs of said bars being free from air passages, the rear limbs of said bars and said plate being provided with co-acting locking means to hold said rear limbs against movement transversely of said plate, the front limbs of said bars and said plate being free from co-acting locking means, whereby said front limbs are free to move transversely of said plate, each of said bars being provided with a lateral recess and a laterally extending projection, the projection engaging the recesses of adjacent bars to lock the bars together. One claim.

1,100,545. BOILER ATTACHMENT. JOHN S. DELVIN, OF NEW YORK, N. Y.

Claim 7.—A boiler attachment, comprising a casing arranged within the boiler at the entrance to the draft flue, a skeleton support in the entrance of the said casing, a series of bell-shaped retarding members attached to the said support and spaced apart, a movable grid having polygonal openings for the reception of the said retarding members, guideways on the said casing and slidingly supporting the said grid, a crank shaft journaled on the said guideways and provided with an angular arm connected with the said grid, an automatic damper in the draft flue, and a connection between the damper and the crank shaft to rock the latter on opening and closing the damper. Seven claims.

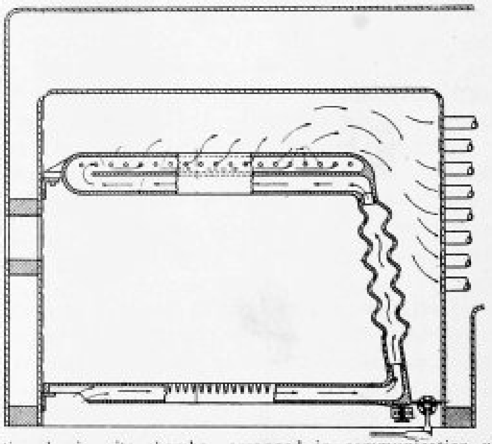
1,105,896. STEAM-BOILER. ANGEL FERNANDEZ, OF HABANA, CUBA.

Claim 1.—In boilers of the character described the combination of an exterior mantle for said boiler cut away at its lower part, fireboxes at said cut away part of the boiler, mantles of said fireboxes also cut away at their lower parts, and inverted horse-shoe pieces riveted to the ends of two adjacent of the intermediate fireboxes, and means for connecting the ends of the exterior boiler mantles with the ends of the two lateral fireboxes. Three claims.



1,106,583. APPARATUS FOR PROMOTING COMBUSTION IN FURNACES. EMERY C. READ, OF FRANKLIN, PA.

Claim 1.—An apparatus for promoting combustion in furnaces, consisting of a plurality of sectional by-pass units, each of said units being composed of the following sections: a hollow grate section arranged for the intake of air at one end into its chamber, a vertically-disposed baffle flue section having its chamber arranged in communication with said grate chamber, and a hollow crown-bar arranged horizontally across the upper section of the combustion chamber of a furnace with its chamber in communication with the chamber of said flue, said crown bars being arranged with intermediate spaces, there being apertures in said crown bar leading from its chamber into said spaces for the purpose of causing air passing through said several sections to mingle with the gases of combustion, and said flue sections being arranged to direct the gases of combustion upward through said spaces, for the purpose set forth. Four claims.



1,109,342. SYSTEM OF BURNING LIQUID FUEL. ANDREW LAING, OF NEWCASTLE-UPON-TYNE, ENGLAND.

Claim 1.—A liquid fuel burning system comprising a combustion chamber, a plurality of liquid fuel burners, means adapted to feed the liquid fuel to said burners, a valve box distributing the fuel to said burners, means therein for regulating each burner independently and means for simultaneously cutting out a predetermined number of burners, substantially as described. Eight claims.

THE BOILER MAKER

DECEMBER, 1914

Boiler Tube Troubles

Cause of Tube Leakage — Setting Plain and Stay Tubes—Tube Spacing

BY C. W. R. EICHHOFF, M. E.

One of the most frequent troubles met with in power plants is that of "leaky tubes" in tubular boilers. The manufacturer of boilers often hears complaints when new boilers are installed and put in operation. It is essential that the tubes in tubular boilers be fastened substantially and tightly. Where the tubes are fastened to heads great stresses are set up by the steam pressure in the boiler, and also by the difference in temperature existing in the tubes as well as between the tubes and the shell of the boiler.

In certain kinds of boilers leaky tubes are of more frequent occurrence than in other types. Why such is the case these lines are intended to explain. It is the object of this article to explain the causes of such trouble, and the writer hopes that it will help to bring some light on the subject and prevent as much as possible such an annoying occurrence. Right at the start let me say that temperature conditions cause more leaky tubes than other causes. This trouble is increased when the boiler tubes are exposed to a very high heat where they are set in the heads.

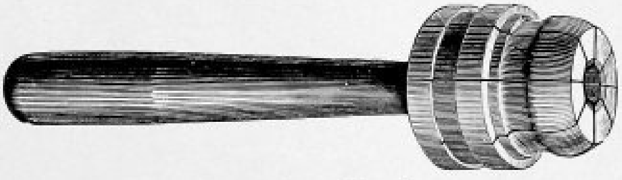


Fig. 1.—Prosser Expander

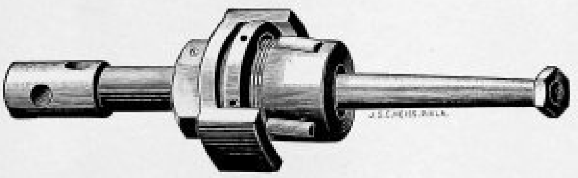


Fig. 2.—Dudgeon Expander

Setting Tubes

The setting of tubes is the last operation in the manufacture of the boiler before it is removed to the testing block in the boiler shop, providing all seams are calked. The tubes are placed in position by pushing them through the tube holes in one head and then placing the same in the corresponding holes of the other head.

To facilitate this it is essential that the tube holes be drilled a trifle larger than the outside diameter of the tube. The outside diameter determines the size of the tube. The diameter of the tube holes should be made from 3/32 inch to ⅛ inch larger than the diameter of the tube. In first-class work tube holes should be drilled from the solid and not punched, or first punched small and then reamed to the proper size. There are boiler makers, strange to say, who advocate punched or punched and reamed holes.

Even when such holes are punched small and reamed afterwards to size, it is uncertain to what extent the structure of the material is impaired through dislocation of the molecules causing cracks, etc. Research has shown that such cracks can be found extending ½ inch and more from the edge of a punched hole. These cracks have not only a radial, but sometimes also a circumferential, concentric direction.

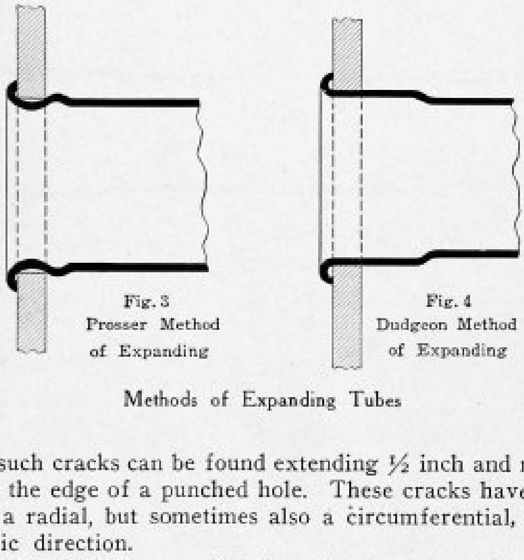


Fig. 3
Prosser Method
of Expanding

Fig. 4
Dudgeon Method
of Expanding

Methods of Expanding Tubes

It is, of course, essential that the tubes should have a reasonably smooth surface, be free from laminations, pits, cracks and blisters; also they should not show any kinks, bends and buckles or other injuries caused during manufacture or in handling. In addition to the above, tubes when inserted in the boilers must stand expanding and beading without showing cracks or flaws or opening at the weld. There should be the smallest possible limit in the variation of the diameters on the same tube. Generally the mean outside diameter should not vary more than fifteen one-hundredths of an inch from size in question.

Boiler specifications should be very explicit and strict in regard to boiler tubes. The writer remembers a case where a certain boiler manufacturer bought a lot of boiler tubes at a so-called bargain, being under the impression that he could make more money on his product by buying inferior material. When the tubes were to be set, the manufacturer learned a lesson that I think he never will forget. The additional labor cost to insert these tubes was more than the saving on the price of the material.

The tube holes in one head should also be larger than in the other head, as in time it might become necessary to replace old, worn-out tubes by new ones. By observing this precaution the withdrawal of same, especially when covered with scale, is made easier.

Expanders

The tubes are fastened to the tube sheets by either expanding alone or by expanding and beading. In many cases, especially in marine practice, tubes are screwed or screwed and expanded afterwards into the tube sheets. There are a number of different expanding tools in the market, but the two mostly used are the "Prosser" (Fig. 1) and the "Dudgeon" (Fig. 2) expanders. The results obtained by these two tools are shown in Figs. 3 and 4.

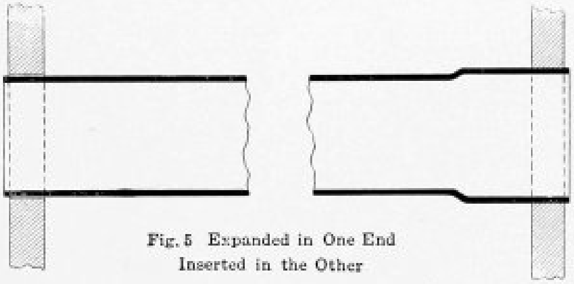


Fig. 5 Expanded in One End Inserted in the Other

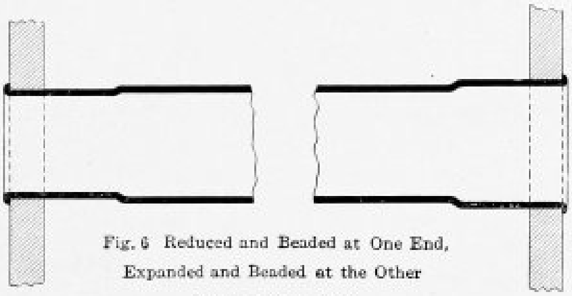


Fig. 6 Reduced and Beaded at One End, Expanded and Beaded at the Other

Setting Plain Tubes

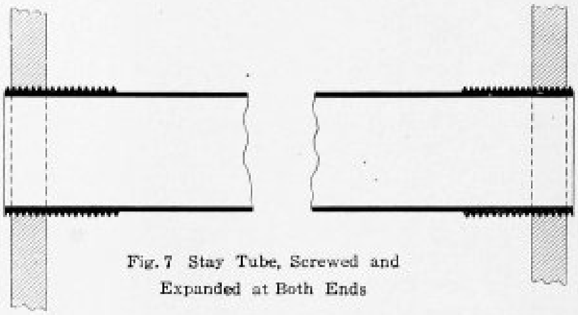


Fig. 7 Stay Tube, Screwed and Expanded at Both Ends

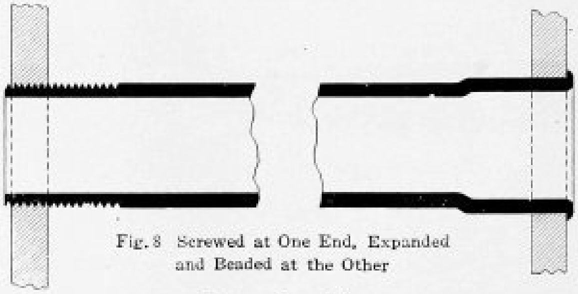


Fig. 8 Screwed at One End, Expanded and Beaded at the Other

Setting Stay Tubes

Both methods of expanding tubes have their advocates. In the "Prosser" method the tubes act as struts, should the external pressure on the boiler be greater than the inside pressure, when, for instance, a partial vacuum exists in the boiler. The tubes have a small corrugation on the end, which gives them more flexibility, but this corrugation might be the cause of the tube giving way sooner or later by repeated expansion and contraction. Leakage will show sooner, as the tube does not bear on the entire thickness of the head. When the replacing of a tube is attended to in proper time, the leakage might not have any injurious effects on the tube sheet. In this method the tubes have to be beaded to be tight.

In the "Dudgeon" method the tubes are enlarged at the ends and made to bear against the entire thickness of the tube sheet. There, leakage might only show up after injury has been done on the tube sheet, as the separation of tube from sheet might be gradual. The "Dudgeon" way will act by friction only.

Stay Tubes

As stated before, another way to fasten tubes into the tube sheet is by screwing them into the head. Those tubes are upset so the strength of the tube is not impaired. The upsetting consists in increasing the thickness of the wall either on the inside or on the outside or on both sides of the tube.

Figs. 5, 6, 7 and 8 show different styles of fastening tubes to the tube sheets. Fig. 9 shows a tube end upset on the outside; the inside of tube is straight. In Fig. 10 the tube end is upset on the inside; outside it is straight. In Fig. 11 the tube end is expanded, without any upset. Fig. 12 shows a tube end upset on the outside and then expanded, while Fig. 13 shows a tube with external and internal upset.

These upset tubes are threaded and screwed into the threaded tube holes. The threads are fine, say 10 to 12 per inch, and should be of the sharp V shape. These stay tubes are used in marine practice, about one-fifth to one-sixth of all tubes are screwed into the tube sheets. In land practice stay tubes are seldom used.

Beading

After common tubes (not upset) are expanded, they are usually beaded over at the ends by special tools called "beading tools." Such beading acts as a grip on the tube sheet when they serve as stays. This beading also assists in keeping the tube ends tight should the bearing of tube on head become loosened by the effects of heat.

On the other hand, it is evident that the beading of tubes with the tools used for this operation has a rather determined effect on the bearing against the full thickness of the tube sheet. For this reason some engineers do not recommend beading the tubes, but simply expand them.

I have found that tubes not beaded, but simply rolled, have not given any more trouble than those that have been beaded after expanding. Where tubes do not act as stays beading can be dispensed with. Experiments (W. H. Shock, 1877) have shown that tubes expanded can safely carry a load equal to one-fourth of the tensile strength of tube before they give way in the joint. By providing the tube sheet with conical holes the strength can be doubled. It should be mentioned that these experiments were made while the material was cold; when the same is subjected to heat the strength is decreased.

LEAKAGE OF TUBES

Leaking of the tubes is probably the most annoying occurrence in the operation of the boiler. Such leaks are caused in different ways. In some cases it can be traced back to bad workmanship in the boiler shops. But such cases are mostly to be blamed on punched holes. The boiler shop, as a rule, is blamed for many defects in the boiler, but I have found that the expanding of tubes with our modern tools is, as a rule, done carefully by the flue setters, and the men on the testing block see to it that the setters do their work properly, as this saves work on the testing block.

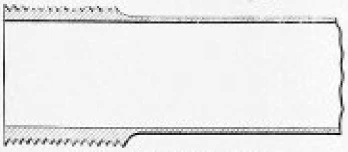


Fig. 9 External Upset

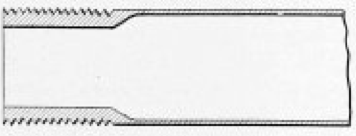


Fig. 10 Internal Upset

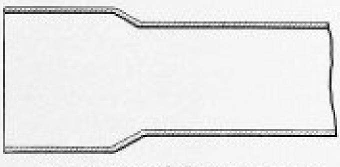


Fig. 11 Expanded without Upset

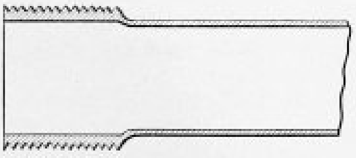


Fig. 12 External Upset Expanded

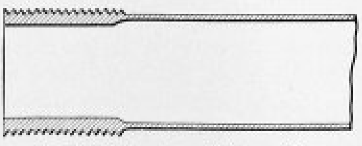


Fig. 13 Internal and External Upset

Methods of Upsetting Tubes

Leaking of the tubes can also occur with first class workmanship in setting. Many complaints come to the boiler manufacturer concerning tubes leaking after a new boiler has been started. In ninety percent of such cases the trouble can be traced back to careless starting of the boiler. I have found in my experience that such things usually happen in places where skilled engineers and firemen were scarce. If the fires are forced in a new boiler, leaking of the tube may be expected, as a rule.

A boiler newly installed should be heated up gradually; in fact, days should be allowed for this gradual heating up of even a small boiler before steam is raised to the full working pressure. In these days of haste and chase after the almighty dollar this precaution is too often sinned against.

It can happen that after a boiler is in operation for some time the tubes begin to leak. This can often be laid to forcing the boiler, an occurrence which frequently happens on marine and locomotive boilers. In land practice, therefore, ample boiler capacity should be provided so a forcing will not be necessary. In most cases where such forcing has taken place the boiler, if not burned, can be made tight by re-rolling.

When boilers are fired in a moderate way leakage in good boilers will seldom occur. If in such case, after one re-expanding, leaks should show up frequently, the cause is to be looked for in accumulation of scale at the tube ends and tube sheet. Here is a place where scale accumulates. Scale is a poor conductor of heat. The heat is not absorbed fast enough by the water, and overheating at the joints takes place, destroying the frictional force, and slippage of tubes may occur, or even the tube end and tube sheets might become burned by the effect of the flame.

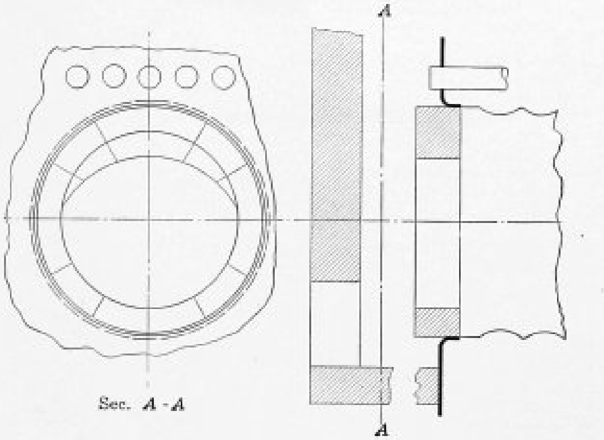


Fig. 14.—Baffle and Protector Wall

EFFECT OF IMPURE FEED WATER

Where the feed water is bad, provision should be made for the purification of the water before it enters the boiler. If such purification facilities are not at hand, the boiler should be cleaned frequently and the scale be removed as often as necessary. Boiler compounds, if used, should be bought only from reliable concerns after a feed water analysis has been made. The writer does not believe in the use of any compound, and is an advocate of a reliable water purification and softening system.

Many arrangements have been recommended to avoid leaky tubes, and the protection of the tube ends and tube sheets. One of the most common is to protect the tube sheets by providing so-called baffle walls before the place of the joint, as shown in Fig. 14. This arrangement serves another purpose, viz., to deflect the flame.

COPPER FERRULES

Another device is shown in Fig. 15. A copper ferrule is inserted between the tube and tube sheet before the tubes are expanded and beaded. It has been found that in many cases where tubes have given trouble on account of leaking the insertion of such copper ferrules has given satisfactory results. It seems that the difference in the coefficient of expansion of copper and steel has a favorable influence. It is for this reason that the fireboxes of locomotives abroad are constructed of copper plates.

It has been found that the greatest heat is not directly on the outside of the tube sheet, but some distance away from it, inside of the tube. It seems that the gas is contracted at this place; and afterwards, when the gas leaves, the tube expansion takes place, having a cooling effect on the outside of the tube sheet. According to this it would be more advisable to protect the tube ends instead of protecting the tube sheet. Fig. 16 shows how tube ends are protected by the insertion of a ring. This ring does not touch the tube where bearing on the tube sheet, and protects the tube end by a layer of air or gas between the ring and tube. This arrangement, of course, interferes with the draft, and is therefore only applied where a strong draft is advisable, especially where artificial draft is used. It is needless to mention that the frequent opening of the fire doors has a detrimental effect on the tube ends and might cause leakage.

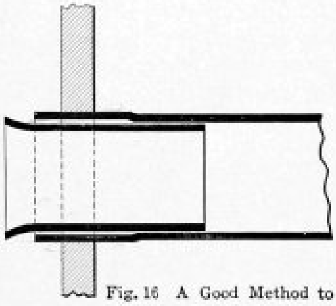


Fig. 16 A Good Method to Prevent Leaks

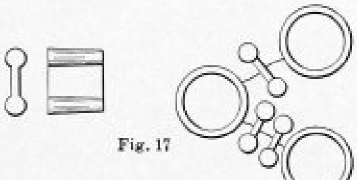


Fig. 17

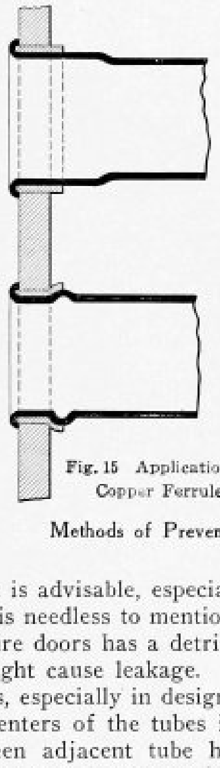


Fig. 15 Application of Copper Ferrule

Methods of Preventing Leaks

It happens, especially in designs where the distance between the centers of the tubes is small, that the bridges crack between adjacent tube holes. These cracks are caused by frequent rerolling of the tubes, but might also have had their origin where the tube holes have been punched instead of drilled. Boiler makers repair such defects by simply plugging the cracks with copper wire, a very inefficient method. A good way to repair such defect is shown in Fig. 17. It is to be avoided to have bridges between the tubes too small. When the tubes are crowded too closely together the circulation is much interfered with and the steam production sluggish.

SPACING OF TUBES

Designers fall too often into the mistake of overcrowding boilers with tubes with the intention of getting as much heating surface as possible. The smaller the diameter of a tube the more heating surface can be gotten in a certain space. Small diameter tubes transmit the heat more efficiently than those of large diameter; but, on the other hand, tubes with small diameters have many disadvantages. The resistance to the passage of gases is greater, the tubes are filled with soot faster, and, if not cleaned very often, render the heating surface of the tubes inefficient. Cleaning tubes is a very annoying job. Small bridges between tubes are an obstruction to the free circulation in the boiler. In marine and stationary practice no tubes less than 3 inches should be used.

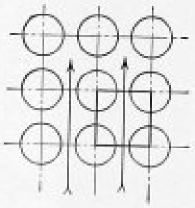


Fig. 18

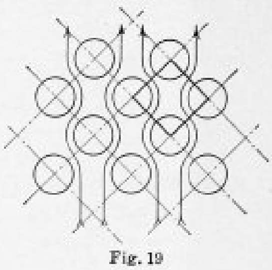


Fig. 19

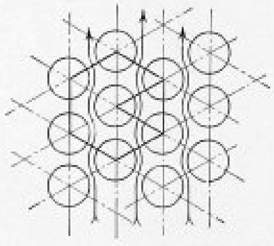


Fig. 20

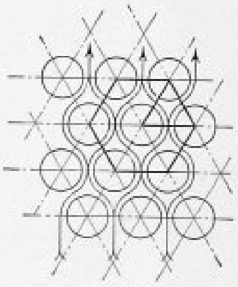


Fig. 21

Tube Spacing

Now a few words in regard to the tube layout in boilers. It is imperative in any boiler design that a free passage is provided to the rising steam bubbles, and the least obstruction given to the free liberation of same. Where such obstruction is offered, the circulation is sluggish and the surface of the water is rendered turbulent.

In Figs. 18, 19, 20 and 21 different layouts are shown. Fig. 18 is the best arrangement. The tube centers when connected form a square with horizontal and vertical sides. The distance between the tubes should not be less than one inch. The rising steam bubbles have a free passage.

An arrangement less favorable is shown in Fig. 19. When it is absolutely necessary to put a large number of tubes in a boiler (locomotive or marine practice), the arrangement in Fig. 20 and Fig. 21 can be used. The centers of the tube when connected form an equilateral triangle. It can be plainly be seen that the arrangement in Fig. 20 is better than in Fig. 21. The passage of the steam bubbles is indicated by the arrow lines.

COMPOUND ARTICULATED LOCOMOTIVE.—In a paper by Anatole Mallet, read before the Institution of Mechanical Engineers at the Paris meeting, the author gives diagrams showing the essential characteristics of several types of two-truck articulated engines, including the Mallet type. The Mallet type is discussed and its application reviewed, together with tabulated characteristics of its applications in the United States and elsewhere. In conclusion the author quotes an extract from a paper read before the Franklin Institute by Mr. Grafton Greenough. This, the author feels, expresses the opinion of American engineers that, wherever continuous heavy road service or heavy pushing service is required, the Mallet compound articulated locomotive has done more than what was expected of it. Also it is found that, in all heavy service of a nature which enables an engine to work a considerable portion of its time to anything like maximum efficiency, in addition to being more effective than other types, the Mallet locomotive is by far the most economical design of locomotive yet devised. Its advent has eliminated the necessity—for a time at least—of widening the gage of our railroads, and furthermore it has justified the retention of steam locomotives as motive power on economical grounds alone, where, in a number of cases, electricity generated by water power bids fair to invade.

An Interesting Case of Boiler Corrosion

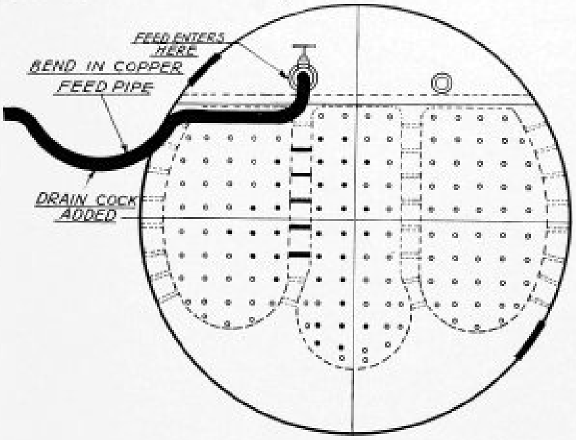
BY F. KILIAN

Some time ago, while serving as assistant engineer on a large cargo boat, the writer ran across a rather interesting and instructive case of boiler corrosion. Boilers are a great problem to engineers and the wherefore of corrosion has caused us many sleepless nights. Some problems are fairly easy to solve, but, then again, a great many go unsolved; again, we sometimes find the cure without getting at the bottom of the trouble, but the only real satisfaction is experienced when we find the trouble and remedy it. The writer believes that a freer exchange of experiences between engineers would be very helpful to us all.

A brief description of the vessel's machinery will help in explaining the difficulty we had in this particular case. We had a triple-expansion engine of about 1,800 indicated horsepower, which ran at 65 revolutions per minute. The air and circulating pumps, both of the bucket type, were run off the intermediate crosshead by the regular link arrangement. On either side of these pumps were arranged in pairs a feed and a bilge pump, both of the plunger type. The feed pumps drew from the hot well and discharged first through a closed type feed heater, where the feed water was heated to a temperature of about 180 deg. F. The feed was then passed through a cartridge type filter and then into the boilers. The boilers were of the ordinary Scotch type, three in number, coal burning, natural draft with a working pressure of 180 pounds per square inch. The pumps and heater were on the port side of the engine and the boiler which gave us trouble was the starboard boiler. The check valves were in the engine room, for the boilers projected through the bulkhead between the engine room and boiler room. The arrangement brought the check valves very high up on the boiler and very close to the combustion chamber side and back stays. No internal feed pipe was fitted.

The first signs of corrosion we found were on the stays from the combustion chamber back to the boiler back head on the center chamber. The stays from the center chamber to the port chamber were also affected. All of these stays were nearly directly under the check valve. The stays were badly wasted away and some were down to less than half the original sectional area. At first it was puzzling that this corrosion should be so marked locally, but when the location of the check valve is considered, along with the fact that the feed pumps were of the plunger type, and that the feed was heated in a closed heater on the pressure side, and thus only to 180 degrees, it is easily understood. Plunger pumps of this type directly coupled to the main engine are as conducive to mixing air and water as they are to pumping, and the closed heater combined with the low final feed temperature did not remove a great deal of the air and, when finally this comparatively cold water was pumped into the boilers and onto the hot combustion chamber plates, conditions for local corrosion were ideal.

However, this did not explain why the corrosion was so much more apparent in the starboard boiler. Of course, its location relative to the pumps and heater would account for a slight amount of extra corrosion, but the difference was too great to be explained in this way. The chief engineer asked for the installation of a pump for an independent feed pump, believing that it would do away with pretty nearly all of this corrosion. The owners, however, were not convinced that this was necessary, so the pump was not installed. All the corroded stays were replaced by new ones before the boilers were set off for another voyage.



Arrangement of Feed Pipe

Upon opening the boilers again after reaching the end of a long trip we still had this excessive wasting away in the starboard boiler, and we were up against it to find the cure.

Finally, after eliminating all other possible causes, we hit upon that of galvanic action. At first we could not find anything that would cause this action because the boiler was well supplied with zinc plates. The real trouble we hit upon more by accident than intent. The feed pipe just before entering the starboard check valve had a downward bend, as shown on the sketch. This was, of course, to take up any expansion in the copper pipe, but it also formed a water pocket. When the pumps were stopped a certain amount of water collected in this pocket and could not be drained off. The water was warm and was permitted to stay there for a week or more at a time while we were in port loading or discharging part of a cargo. The pipe being copper, caused a small chemical action between the pipe and the water, which caused the latter to become very acid. When the pumps were again started all this acid was pumped into the starboard boiler and onto these combustion chamber back and side stays and caused this excessive and rapid corrosion. This theory seemed perfectly logical, so it was decided to fit a small drain cock at the lowest part of this bend, as shown on the sketch. The cock was opened when the pumps were stopped and all the deposited water was drained out. After making this simple and inexpensive repair the boiler showed no more signs of any further local corrosion.

F. Kilian.

John, Geometry and the Joke

A Practical Joke Proves Costly to his Shopmates—How to Straighten Out a Kinked Plate

BY JAMES F. HOBART

"John, what is this I hear about you and some other men being laid off for two weeks? Is business getting dull in your shop? Has the war panic hit your business, or what is the matter?"

"Nothing of that kind, Mr. Hobart; it was all on account of a joke. Then the 'Old Man' got sore, saying if there was any joking to do, he was the one to do it. Then he raised the pay of Sam Smart, Bill Smith, Ted Long and myself, and two days afterward he fired Ted and suspended the rest of us for two weeks just because we had a little fun."

"So, he raised your pay, then fired one and suspended the rest of the bunch, eh? Something of a joker himself, isn't he?"

"I suppose so, but I don't like that kind of a joke. It is pretty tough to be laid off for a couple of weeks right when you need the money most; but to have a fellow's pay raised, and then be laid by the heels, that's tough."

"It was rather a sarcastic bit of work, to be sure, but what did you fellows do that started the superintendent to such action?"

JOHN'S IDEA OF A JOKE

"Why, we just had a little fun with the layer-out and a couple of the foremen, that's all. This foreman is a fussy old codger, is always fussing around that he is in a great hurry. Ask him for something and he might say: 'Too much of a hurry to do it now, John; awful hurry right now—such a hurry that if the shop got on fire, we couldn't stop to put it out!' He always wears a pair of loose, low shoes around the shop, slips off his street shoes and pokes his feet into the shop shoes and starts off with one motion, so we just nailed those shoes to the floor, and he went full length on the floor when his head started to work and his feet didn't follow. He got awful sore at that, so next day we just changed places with the shoes—put the right where the left belonged, and he wore'em all the afternoon that way and complained all the time that his feet hurt him awfully, and that he would have to go to a corn-doctor that night."

"No wonder the foreman got sore at you fellows, John; but is that all you did?"

"Not quite, Mr. Hobart; we did chop up a little horsehair and mixed it with the tobacco we found in some of the fellows' pockets, and then we found an order to the blacksmith for a six-sided wrench to be forged, and Ted Long just rubbed out the 6 and inserted 5 in its place, so that the smith forged a five-sided wrench, which wouldn't fit anything around the shop except the fire hydrant. Then Ted changed a couple of figures on one of the layer-out's sketches and made a sheet come a couple of feet too long. That sure made things hot and Ted got the G. B. and we got hung up for two weeks."

"And served you all right, John, sure as steel is heavy. You sure have got that foreman sore on you and your bunch, and it will take a long time and mighty good behavior to get yourselves back into his good estimation again. What possessed you, John, to work such fool tricks? There are dozens of ways of having fun and playing jokes, without destroying property and getting the foremen down on you."

"Destroying property? Why, we didn't destroy anything. What do you mean?"

"Why, that wrench. You spoiled a lot of stock, used a lot of time—the most expensive time in the shop, that of the smith, and you held up an order a whole day on account of that fool 'joke.' And then, changing the figures in the lay-out sketch; that cost the company a piece of boiler plate, the time of the men in undoing the error and the delay in the work—probably ten or fifteen dollars, to say nothing of the good opinion of several men toward you young devils who cut up the monkey-shines."

"Say, Mr. Hobart, I didn't think it was as bad as that; honest, I didn't. We didn't stop to think, that's all, and I surely wouldn't have done it if I had realized how it would look from the carpet end of the shop."

"No, John, I don't suppose you would, and that is where the joker always gets into trouble. He doesn't stop to think. If he would do so, half of the fool jokes would never be played, and the other half would be jokes worth having. For there are good jokes, John, jokes which pay both you and the other fellow and which make just as much fun for you as do the nasty kind which leave a sting behind them."

"How is that, Mr. Hobart? I don't understand just what you mean."

WHY TED WAS FIRED

"It's this way. Cut out the plan and figure-changing business. That's not joking—that's criminal and its what Ted got fired for. Then, the other kind of jokes—well, just stop and plan a little beforehand, same as you would with any other bit of work. Instead of nailing down the shoes, you would have had just as much fun if you had given the shoes a first-class shine. Then the foreman would have been around all the afternoon with a manhole grin all over his face and, if there had been anything good to go your way, he would have started it along. And then the changing shoes business. If you had put a five cent plug of 'chewing' in one shoe and a handfull of peanuts in the other, then the old foreman would have passed a mighty pleasant afternoon trying to think up something pleasant to spring on you cubs. As it was, he could only raise your pay and then lay you off. And, John, that hair and tobacco business! Wouldn't there have been more fun all around from a ten cent cigar stuck into the tobacco, than from the horsehair which spoiled the whole canfull? There's joke engineering, John, as well as boiler engineering, and you can make yourself liked or disliked by jokes as well as by other things. The shop joke is a mighty particular thing to monkey with. Get it headed right and it's a pleasant thing all around; but start a joke wrong, and its worse than curses or a boomerang—and both of those are said to come back hard. So look a joke over mighty close before you turn it loose in the shop or it sure will come back on you instead of on the other fellow."

"I reckon I had better do that, Mr. Hobart, for I don't like the way these jokes turned out—not a little bit. But since I came back from my 'vacation' I have been having no end of trouble with some plates which had to be straightened and taken out of wind. Some kind of a crank ordered them for some jimcrack he is making up, and he specified the plates to be 'straight and out of wind.' They are ⅜ inch thick, and I sure have had some job getting them to suit him. He has turned down more than half of them, and I have 'em all to do over again. I don't seem to get the knack of straightening a plate, for the more I hammer it the crookeder it gets."

Straightening a Plate

"John, the only man who can straighten a plate well is a sawmaker or a man who has learned plate straightening according to sawmakers' methods. There are two things to be considered in straightening a plate—two different operations to be considered and gone through with—that of bending the plate and of stretching it. Unless a plate has been swaged or kinked, the first method is all that is necessary—just plain bending of the plate until it has been made straight. But if it has been hammered and parts of it stretched or swaged, then the second method must be used and the problem becomes far from simple, as is the case when attempts have been made to straighten plates by hammering them on an anvil or on a floor plate."

"What difference does it make whether they are hammered on the ground or on a floor plate?"

"It makes a whole lot of difference. Just try it out with a bit of tin or thin sheet iron. It works just the same as with the thick plates and you can see and understand better and quicker with the thin stuff. Just pick up a bit of No. 18 or No. 20 sheet iron and try to straighten it. Put the sheet on a board and you can hammer it flat with little trouble. If you use a wooden mallet or strike with a hammer on a bit of wood placed against the iron, there is no trouble at all in making the sheet straight. But place that bit of metal on something solid and hit it with a hammer a few times, and you never can make it straight, hit it where or as often as you may. Just as soon as you hit the sheet a single solid blow with the hammer you have stretched a spot in the metal which can never be taken out by bending in any or every direction. It can never be made flat again except by stretching the rest of the sheet or by stretching a section across the width or length of the sheet as wide as was stretched by the hamwork, but it can be done with a three-pound hammer.

"Oh, say! A blow from a hammer won't stretch a ⅜-inch plate, Mr. Hobart."

"But it will, John. You can stretch a bit of ⅜-inch, or even thicker plate, with blows from a hand hammer until the plate bags as though it had been cut from an old boiler. It will require a whole lot of hard hammering work, but it can be done with a three-pound hammer."

"There are just two kinds of bends, John. One is simply a fold in the plate and may extend across a corner or from one side to the other. Or there may be several of these bends in the plate, some in one direction, some in another and some on one side of the sheet and some on the contrary side. All bends made that way are simple folds and may be removed one at a time with a wooden maul or by springing the plate in a bending machine; but when there is a kink in the plate something different must be done, for this 'kink' is simply a slight bag or pocket in the plate and all the hammering and roll bending you can do with wooden mauls or steel rolls will not take the kink out."

"How can I get these kinks out, Mr. Hobart? That seems to be the kind I am up against in these sheets. The more I hammer the worse they get, and I'm up against it for fair."

"That's where the saw-hammerer's skill must be brought into use, John. About the best way of getting on to that business is to take a bit of thin straight sheet iron, place it fair on something solid and hit it a single blow with a round-faced hammer. From this you will find that the blow stretches the plate just where it hits and nowhere else, but the increase of area at that point caused the plate to buckle sidewise to make room for the extra area, and the stretched portion in pulling away caused the adjacent metal to stretch a little, though less. The sidewise effect seems to run off in a series of circular effects, much the same as when a pebble is dropped into still water and the circles run off into space, showing lessening effects as they travel."

"Yes, but how do you get a plate straight when it has a pocket or bulge? I never was able to take out one of these kinks."

Taking Out the Kinks

"Straighten out all the simple bends as best you can and learn to distinguish between bends and kinks. Get all the bends out in one direction, then tackle those on the other side of the plate, until finally there is nothing left but one or more kinks. Next proceed to stretch the rest of the plate as much as the kinked spot is strained, thereby relieving the stress which holds the plate dishing or bowl-shaped.

"To show the effect of a single hammer blow on a thin sheet, or many blows in the same place on a thick sheet or plate, take the thin strip of sheet iron, place it fair on heavy metal as directed elsewhere and hit it hard and you will have a plate kinked the same as shown before. Now, to straighten this plate again, you must proceed to stretch the rest of it until the stresses at the kink have been relieved.

"Just strike a series of blows, running them right across the plate or in a direction which judgment and experience tell will be best and quickest to relieve the stresses which hold the plate concave. A row of blows at one place may be all that is necessary. If so, all well and good. If not, your judgment must tell you how and where to place other blows, and you must keep it up until you have relieved all the strain in the plate; then it will lie flat and straight. But be sure to keep one thing in mind: Never hit a stretched plate where the kink is. To unkink a kink you must kink all the rest of the plate. That's 'hitting a hog on the nose' to make him go ahead."

"Well, I should say so. Now, I've been hitting the kink all the time, I reckon, and that must be the reason why I didn't get anywhere. But what is to be done, Mr. Hobart, when there are two or three of these 'kinks' in a plate, and perhaps close to each other?"

"Then, John, is where you need lots of know-how and experience. You must start taking the kinks out one at a time and keep at it until you get them all out, then the plate will lie straight and fair. But, John, the one great secret of plate straightening is: never hit a blow until you have calculated what the effect of that blow will be. If you have not had enough experience to tell beforehand just what the effect of a hammer blow will be when delivered in a certain manner, then get a piece of metal, make the conditions as near alike as possible, and experiment until you have determined what the effects of the blows will be under the conditions you have to deal with."

"Reckon it's up to me to do a whole lot of experimenting in that line before I can hammer those plates flat."

"Go to it, John. While you are testing out hammer blows you won't have need of working off any superfluous energy by way of the joke route, and it will be so much the better for the shop, and you, too."

"I'm just going to the bottom of that hammering business, Mr. Hobart, just you see if I don't. But tell me, please, before you go home, where does 'geometry' come in? That's a mighty fine heading—'John, Geometry and the Joke,' but I haven't found any geometry yet."

"Haven't you, John? Well, guess you will before you get done figuring the effect of hammer blows in a plate; and as for geometry in this story, well, that's where my little joke comes in. See?"

Welding Tubes in Back Flue Sheets of Locomotive Boilers*

With the general introduction of the fire tube type of locomotive superheater and its special flues of large diameter, there is a practice developing almost universally of welding these tubes into the back flue sheet. The uniformly satisfactory results lead one to question whether such a practice should not be as satisfactory for the small fire tubes of the boiler. For any part of the country where the water is of the quality known as "good"—that is, where there is no accumulation of scale on the flues or deposit of mud or sludge in the boiler—there is no doubt but that the welding of all of the flues into the flue sheet would be entirely successful, if tried. Most of us, however, are not blessed with such ideal conditions. The water we are using is generally heavily charged with incrusting solids and has large amounts of mud in it, which form deposits on the flues and at the usually most inaccessible points of the boiler. At the same time we are laying out our flue sheets with the flues staggered the same as we did years ago, with the fond idea that it is the most efficient plan for permitting the generated steam to rise through the water with the least amount of resistance. Should we not, on the other hand, lay out these flues with the principal thought in mind as to how the boiler washer could get at each flue and get the scales down and out without forming a bank? Such a situation existed in connection with some stationary pumping boilers of the vertical type. The flues were spaced to put the largest possible number in the boiler. Invariably the central flues and the center of the bottom flue sheet would burn out in a very short time, due to a heavy accumulation of scale which could not be reached through any of the washout holes by a stream of water or by the hooks. A new layout of flues was tried in which there was a clear way for the washout nozzle from each washout plug hole to the center of the boiler; the flues were laid out so that a right-angled nozzle would throw a stream between each row of flues to the shell of the boiler. As a result the boilers stayed in regular service almost indefinitely, the flue sheets and flues were cleaned and pumpers' steam troubles almost ceased.

With the information given us in a fully authoritative manner that the flue heating surface is of secondary importance to the firebox heating surface, should we not take more thoughtfully in consideration the matter of facility in washing out when laying out our flues? And can we not in locomotive practice get the results our stationary boiler friend so easily obtained?

DISCUSSION

Mr. J. F. Devoy: Mr. Dunham in his paper says that it appears the welding in of all our flues will be possibly the proper way. I say now that is not the thing to do at all, and I do not believe the welding of flues is going to be the proper thing, and for the following reasons: The present trouble for condemning flues in superheater engines in the territory through which we operate is the pitting of the flues, due perhaps to the construction or the material entering into the flue, and also the water that we have to use in part of the territory through which we run. That is the principal trouble with our flues. If the flues are welded in the flue sheet and a large amount of money spent in doing that and they become pitted, there has been just that amount of money wasted; therefore, the welding in of the flues in the firebox, in my opinion, is not going to solve the proposition. The question of water used and the material in the flues must first be taken into consideration before it is decided to weld tubes in the boiler, and I feel positive that this is correct.

Mr. A. N. Lucas (C., M. & St. P. Ry.): The writer of this paper, of course, intended to convey the idea of good practice in roundhouse work, which refers mostly to machine work. Boiler work in good condition undoubtedly wears the machinery out, and we do not have much boiler work to do at the first shopping. The next shopping they want to know if the boiler is not in condition, and only in for tire change. They don't let us get at the boiler at all, but rush the work in the roundhouse, and eventually the boiler maker gets a black eye for not having his boiler work up in first-class condition.

We have not welded in any superheater flues as yet. We have found in our good water territory that our flue trouble is not very great and we are getting very good service from superheater flues, although in some of our factory engines we found that the manufacturer had drilled a flue hole for superheater flues larger than we believed that they should. In taking out some of these flues we found a hole, say 4⅝ or 4¾ inches in diameter, and putting in a light copper shim, it took considerable expanding to put the flue out where it belonged. We found, also, that they did not remove the burr from the flue holes and that the copper rim was cut off inside of the flue sheet. We put in a double or heavier shim and got good results. We are welding up our superheat flues on a Hartz flue welder, swedging flue down to fit copper shim, the same as in ordinary practice. We drill a hole 4½ inches in diameter, put in the shim and swedge the flue down. By doing so the 4½-inch expander took care of the flue; but when you have these large holes a 4½-inch expander will not do. Where we expand to any extent we use an extra section. We do not use a roller in a firebox at all.

We found that the big flues in our consolidation engines gave out much sooner than the smaller flues did, and after 14, 16 to 18 months we have changed some of the larger flues. The bead gave out. I believe we would get much better service if we were to use the heavier shim and a little wider shim. The joint with a narrow shim is just the width of the shim. With a heavier shim the joint is the width of your copper, especially if your copper is heavy enough to make the joint inside of the sheet when cooling down, and therefore should not let go as readily as with a narrow or light shim. Just another word in regard to the welding. Since January 1 we have welded up flat spots in 18 engines at a cost of about $8 per engine. In each case where we welded flat spots we welded the spot up in about half an hour, and the average cost of the 18 engines was about $8 per engine. We have not had one come back on us. We have also about 20 door rings welded. We have been welding all our door rings onto a back head, putting our door sheet in and welding right on to the back head. We have had some of those in service a year and a half and they are giving good re-

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* From a paper on "Present Day Running Repairs," by W. E. Dunham, Supervisor M. P. & M., C. & N. W. Ry., read before the Western Railway Club, Chicago, Ill., April, 1914.

sults. We have welded in half side sheets. When we first started in we were welding up bolsters where they crack at each end at a cost of $18.80. We weld them up now with oxyacetylene apparatus for $2. Welding up the side arm on a Westinghouse draft rigging, I think, at first cost about $9; we are welding those at $2 or $2.50.

Mr. T. F. Powers (C. & N. W. Ry.): I am sorry Mr. Devoy does not agree with the Northwestern in regard to welding superheater flues. We think it is the thing to do, and are welding them just as fast as we can, and at the present time have a night force on in order to hurry the work along. We are welding the superheater flues in our Mikado engines at a cost of about $4, and I think it is economy to do this. Mr. Lucas brought out a point here a little while ago that the flue holes on some of his engines had become enlarged. Undoubtedly his flues have been leaking and he has had to expand them a lot. Now, by welding the superheater flues he will overcome the enlarging of flue holes. We have some engines we welded up last June, and at the time of welding them the superheater flues were over two years in service. These engines are running now and we have not had to touch the superheater flues on them since they were welded. In regard to washing boilers in roundhouse, I think some years ago some of the railroads went crazy on tube heating surface. We have found on certain classes of engines that we could take out 40 flues on the bottom, plug up the flue holes with stay rods and there was no difference in the steaming of the engine. These bottom flues used to be leaking and always plugged up. Cutting them out has overcome the leaking and it is much easier to wash the boiler. We are spreading our flues as much as we can, so as to have wide space for the mud to fall and make them easier to clean.

Mr. Devoy: I did not say I was opposed to welding tubes. I said, when the question of welding tubes came up, that the question of the material in the tubes and the quality of the water used must be taken seriously into consideration. I want now to say that I am seriously in doubt as to whether with the federal requirements of removing tubes once in every three years we are justified in welding tubes. I do not know that, and I do not think any man does, because we have not asked them that question, so that I qualified my remarks and I made them just as clear as it was possible for me to do so, and I still believe, and I think Mr. Lucas agrees with me, that our present method will get just as long life out of the tubes as would the welding, judged from the experience of other roads which I have carefully watched.

Mr. Powers: If you can save expanding your flues once a month it would pay to weld them. You can weld them for $4 a set and it will cost you $2 to expand them every month.

Mr. Pratt: You mean for labor?

Mr. Powers: Labor only. While the cost of the electricity is very little, it is not as expensive as acetylene.

Mr. T. H. Curtis (Mech. Eng., Committee on Smoke Prevention, etc., Chicago Assn. of Commerce): In regard the number of flues, that has always been a great problem to engineers of boiler construction who are thinkers, to know what to do about the number of flues. In the days when I was in the locomotive works a party ordered as many flues put in as it was possible to put in the boiler. The mechanical engineer of the works said to me, "It takes something besides flues to make steam," and I think that is true. I have had the same experience as the other gentleman here, of taking some 30 or 40 flues out of the locomotive and having a better steaming locomotive and one that gave us less trouble than it did with so many flues. But I am not prepared to say where and how to locate the flues. However, I would always leave plenty of room for an abundance of water and for a place for the water to circulate, and I think there should be an ample opportunity for the steam that is in the water to be liberated on its surface.

Mr. Pratt: Mr. Powers answered the remark with regard to the removal of flues within a year on account of pitting and through poor material or some other defect, any flue that requires its removal within a year. If we can keep flues tight in the locomotive boilers and are so unfortunate as to have to take that flue out in 12 months, I believe that the pressure that is brought to bear upon us in operating railroads with 100 percent perfect service would warrant us in keeping that flue tight for 12 months. Our experience is better than that, and I do not have to look back very many years on the Northwestern Road when we had to take all the flues out of our boilers in Iowa in six months, eight months, or at most within a year's time, on account of scale due to the water, and scale accumulated in the boiler due to inadequate washout facilities. We are running through the same State and using the same water to-day, and we have freight locomotives, consolidation locomotives, with three or four times the power of years ago; these consolidation locomotives have made upwards of 100,000 miles and their large superheater flues are still in them; the engines have not yet been in for general repairs, nor are apt to go in for general repairs with less than approximately 100,000 miles. We have Pacific type locomotives running through that same water district that have made over 200,000 miles having the same large superheater flues in them and that have not received general repairs. They are now in turn receiving general repairs on a mileage running all the way from 175,000 to 220,000 miles. That is brought about by our improving conditions and practices of twenty years ago. We put in treating plants that helped the water, we improved the spacing of our flues, in some we left part of the flues out instead of crowding them in clear up against the flange of the flue sheet; we spaced them wider; we put in extensive hot water washout plants; we do better flue work; we do not use the roller; we do not use a hammer without any tool in the other hand; we do not use a pin; we maintain standard contour of flue tools. There are lots of things that you gentlemen all know about that we ought not to use and we have to be careful at some of our outside roundhouses that those things do not go on to-day. I was very much interested in the Pennsylvania Railroad tests between long and short flues and long and short superheater elements that were made about a year ago, which showed that there was such a thing as having too long a flue and too long a superheater element. I believe that it will be encouraging to those interested in boilers to see that the Pennsylvania has gone back to 19-foot instead of 21-foot flues, and they are now testing out engines with them with the expectation that they will show better results than the 21-foot flue and they will have a good many troubles in boiler maintenance.

LARGE STEEL WATER TANK.—A 2,500,000-gallon steel water tank, 100 feet in diameter and 44 feet 3 inches high, is being built by the Massachusetts Metropolitan Water Board, in West Roxbury, to act as a reservoir for the Southern Extra High Service. The work of erecting the steel is being done by Walsh's Holyoke Steam Boiler Works, Holyoke, Mass.

Computation of Safe Working Pressure for Boiler Shells, Tanks, Etc.

Many young engineers and boiler makers do not understand the method of figuring the thickness of a boiler shell or tank to withstand a certain safe working pressure. Most of those who are able to make such calculations do so by formula and are not acquainted with the fundamental theory upon which the formula is based. The following few words will make clear the derivation of the formula and its use in the solution of practical, everyday problems.

Let Fig. 1 represent a cross-section of a boiler shell or tank, etc., in which there is a pressure $= p$ in pounds per square inch as would be shown by a pressure gage. The pressure always acts in lines perpendicular to the circumference, as shown by the various arrows, p, p, etc., so that on every square inch of the shell there is an outward pressure $= p$ pounds. By the use of higher mathematics it can be shown that the sum of all the forces acting on each square inch of the shell, Fig. 1, is exactly equal to the pressure p acting at right angles on each square inch of a plane passing through the center of the cylinder, as shown in Fig. 2.

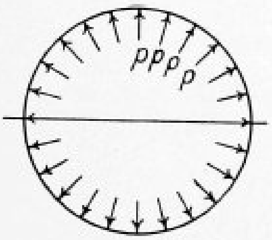

FIG. 1

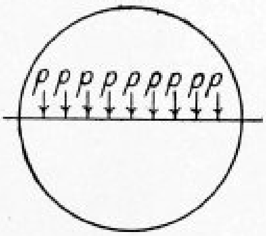

FIG. 2

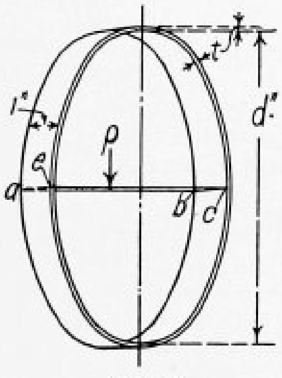

FIG. 3

To make this statement clearer let Fig. 3 represent a section of a seamless cylinder or shell 1 inch long, having a diameter $= d$ inches and under a pressure $= p$ pounds per square inch. The letters a, b, c, e represent a plane passing through the center of the cylinder and its area is equal to the diameter d of the cylinder multiplied by 1 inch $= d \times 1$, and the total pressure which tends to burst the cylinder $= p \times d \times 1 = pd$. This pressure, or, more correctly speaking, this load must be held by the resistance of the steel in the shell along the lines ae and bc, which is determined by the thickness and tensile strength per square inch.

Let t = thickness of the steel.
s = tensile strength per square inch.

As we are considering a shell or cylinder 1 inch long, as per Fig. 3, the area in square inches of the steel along the lines ae and $bc = t \times 1$ inch, and as the strength of the steel per square inch $= s$ pounds, the total tensile strength of the shell along both of the lines ae and $bc = 2\,t\,s$.

The bursting pressure within the shell must be exactly equal to the total strength of the shell, hence

$$p \times d = 2\,t\,s, \text{ or } p = \frac{2\,t\,s}{d}. \qquad (1)$$

This is the fundamental formula for the strength of thin cylindrical shells under an internal pressure, and from it are derived all the rules and formulæ for ascertaining the safe working pressure of boilers and tanks.

As an illustration of the use of this formula, let the diameter of the cylinder, in Fig. 3, be 30 inches (i. e., $d = 30$), thickness of shell $t = \frac{1}{4}$ inch, the tensile strength $s = 50{,}000$ pounds per square inch, and it is desired to know the required internal pressure to rupture the shell plates.

By inserting the values t, s and d in formula (1), this equation becomes

$$p = \frac{2 \times \frac{1}{4} \times 50{,}000}{30} = \frac{2 \times 1 \times 50{,}000}{4 \times 30} = 833 \text{ pounds per square inch.}$$

DERIVATION OF FORMULA FOR SAFE WORKING PRESSURE

The cylindrical shell shown in Fig. 3 was assumed to be without a joint (seamless), and formula (1) derived under this assumption does not take into consideration any reduction in the strength of the shell due to the presence of a riveted joint. The strength of a joint is expressed as a certain percent of the strength of the plate; thus a double-riveted lap joint may be 70 percent as strong as the plates which are joined together, in which case the efficiency of the joint would be 70 percent. A steel plate 1 inch thick and 12 inches wide, having a tensile strength of 60,000 pounds per square inch, would have a total strength of $12 \times 60{,}000 = 720{,}000$ pounds. If two such plates were joined together by a riveted lap joint of 70 percent efficiency the tensile strength of the joint would be 70 percent of 720,000 = 504,000 pounds. From this illustration it is easily seen why the efficiency or the strength of the joint is a factor which determines the strength of a riveted cylindrical shell.

Let e represent the efficiency of the joint, then $e \times s =$ the real strength of the plate at its weakest point and formula (1) may be written

$$pd = 2\,t\,e\,s \text{ and } p = \frac{2\,t\,e\,s}{d}, \qquad (2)$$

$$\text{or } t = \frac{pd}{2\,e\,s}. \qquad (3)$$

Example.—Find the thickness of a boiler shell plate for a bursting pressure of 500 pounds per square inch.

Inside diameter of boiler = 60 inches.
Efficiency of joint = 80 percent.
Tensile strength = 60,000 pounds per square inch.

From formula (3)

$$t = \frac{pd}{2\,e\,s} = \frac{500 \times 60}{2 \times .80 \times 60{,}000} = .3125 = 5/16 \text{ inch} = \text{thickness of plate.}$$

Thus far we have dealt with the bursting pressure, and of course, for obvious reasons, the safe working pressure must be very much less than the bursting pressure—the ratio or proportion between the two is known as the factor of safety. In boiler work the safe working pressure is usually taken as 1/5 of the bursting pressure as determined by formula (2).

Let W = safe working pressure.
f = factor of safety.

Then

$\frac{p}{f} = W$, or $p = W f$, and formula 2 and 3 may be written

$$\text{Safe working pressure} = \frac{2 t e s}{f d} \qquad (4)$$

$$\text{Thickness of plate} = t = \frac{W f d}{2 e s} \qquad (5)$$

Fig. 4 is a chart showing graphically the relation between the bursting pressure, the diameter of tank or boiler and the thickness of the shell. The computations for the chart were made from formula (1). From this chart it is an easy matter to find the safe working pressure of any cylinder of the diameter given on the chart, for any factor of safety, efficiency of joint or tensile strength of plate.

To do this, first find the bursting pressure as if the shell were without a joint. Divide the bursting pressure by the factor of safety and multiply the result by the efficiency of the joint. For example, assume that it is desired to find the safe working pressure of a boiler 60 inches diameter, ⅜-inch shell plates, 80 percent efficiency of joint and 60,000 pounds tensile strength. From the chart the bursting pressure for a 60-inch diameter cylinder of shell made of ⅜-inch plates = 750 pounds. This, divided by the factor of safety 5, gives 150 pounds, which multiplied by the efficiency of joint .70 = 105 pounds, the safe working pressure. If the tensile strength of the plate were only 50,000 pounds, then the safe working pressure would be

$$105 \times \frac{50{,}000}{60{,}000} = 87 \text{ pounds per square inch.}$$

For ordinary tank work and in cases where the exact tensile strength of plates is not known, it is often assumed = 50,000 pounds per square inch. Also the longitudinal seam of double riveted shells may be assumed to have an efficiency = .70. Under these conditions the safe working pressure will be with a factor of safety = 5.

$$W = \frac{2 t \times .70 \times 50{,}000}{5 d} = \frac{14{,}000\, t}{d}.$$

G. W. K.

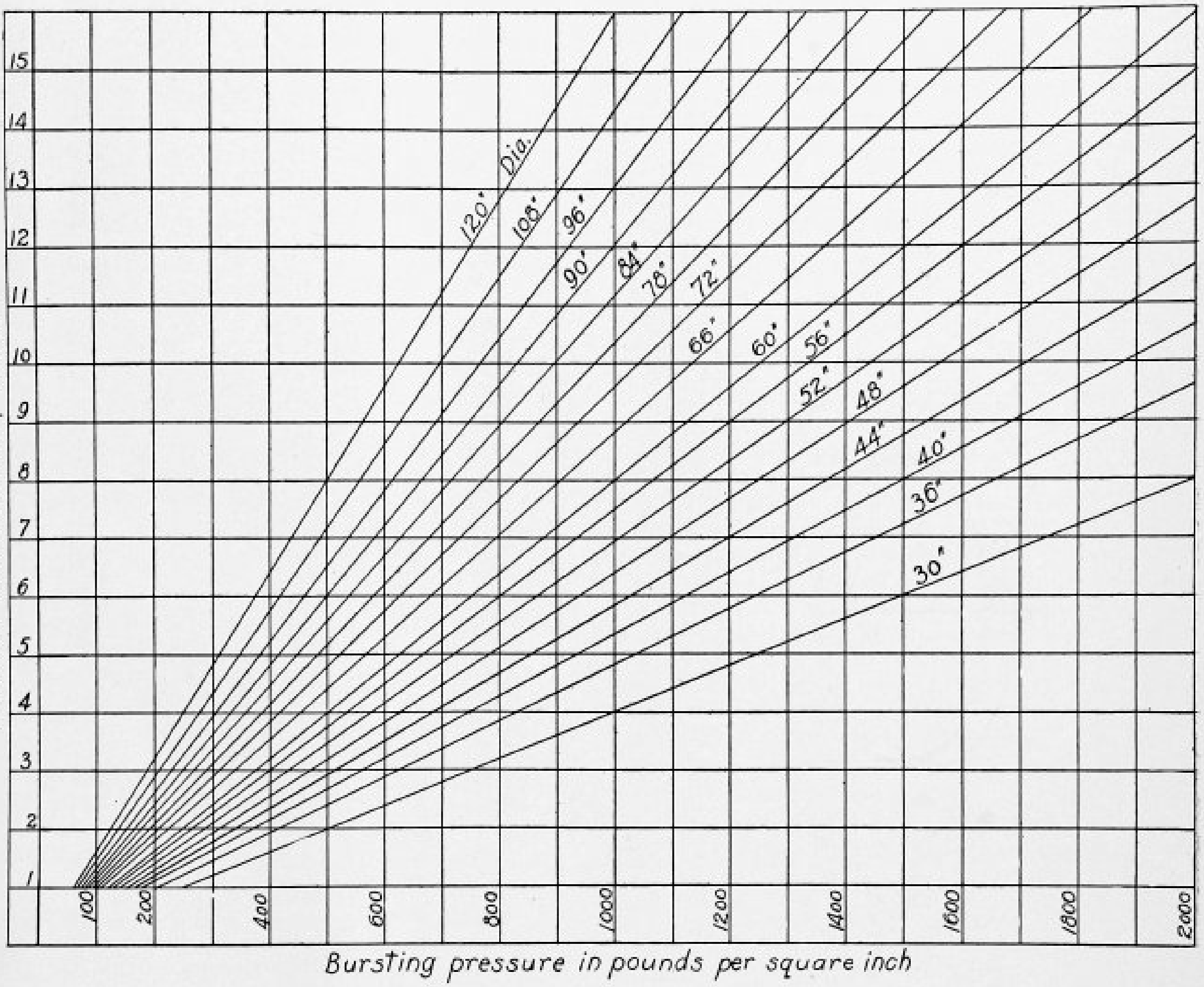

Chart Showing Bursting Pressure of Cylindrical Shells, With Tensile Strength of Steel 60,000 Pounds per Square Inch

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DISCUSSION OF STEAM BOILERS.—At a meeting held at the La Salle Hotel, Chicago, on November 20 by Chicago members of the American Society of Mechanical Engineers, a paper was read by W. H. Winslow, president of the Winslow High-Pressure Boiler Company, on "A New High-Pressure Steam Safety Boiler." Another paper was read by Joseph W. Hayes, combustion engineer, on "Boiler Furnace Efficiency." Other papers presented at this meeting included one on "Boiler Efficiency Meters and European Boiler Practice," by W. A. Blonck, consulting engineer, and one on "Mechanical Filters," by Walter H. Green, chief engineer, International Filter Company."

Layout of a Ship Ventilator Cowl

Development of Patterns for Sections of a Ship Ventilator Showing Method of Obtaining Cross Seams

BY L. L. LANE

Since the principal proportions of the ventilator may be shown in its side elevation, that view is the first to be drawn. Construct the right angle 1_1-2_1-3_1, Fig. 1, and produce its sides indefinitely upwards and towards the left. In this case it is assumed that the amount of overhang will equal the diameter of the bottom. Accordingly, the distance equal to the diameter of the lower end is measured off on the horizontal line from the point 2_1 and point 1 is located as shown in Fig. 1. Another distance is then laid off on the same line equal to 2_1-1 in order to locate the point 1_1. From these points, 1_1, and 1, projectors are carried to the plan and the outline of the circle is then drawn in the latter view, as shown.

The projector from 1_1 may be carried upwards for a short distance, and, taking point 1 as the lower position of the miter line, the regular line of intersection for a six-piece round elbow may be drawn in the usual way. Next, the distance 2_1-*W* is measured off on the vertical line of the right angle and is made equal in length to one-quarter of the diameter. In the side elevation the point *W* represents the lower extremity of the elliptical end of the ventilator, while the point 3_1 represents the upper extremity, the distance *W*-3_1 being equal to three times the diameter of the lower opening.

In order to define points on the upper outline of the ventilator, the dividers are now set to the distance *W*-3_1 and with points 7 and 3_1, respectively, as centers intersecting arcs are described locating the point *O*, Fig. 1. With point *O* as a center and with the same radius the dotted arc 7-3_1 is then drawn. The arc 7-3_1 is next divided into five equal parts and chords are drawn between the points thus located.

The points on the lower outline of the ventilator are spaced in a similar manner on an arc described from the point *O* as a center and with a radius *O*-1. The method of locating the point *O* on line 1_1-2_1 is clearly shown in Fig. 1. Intersecting arcs are first drawn from the points 1 and *W* as centers with a radius slightly longer than one-half of the perpendicular distance between 1 and *W*. Point *O* is then located at the intersection of the bisector with line 1_1-2_1. As in the case of the upper outline of the ventilator, chords are drawn between the points located on the outline of the arc.

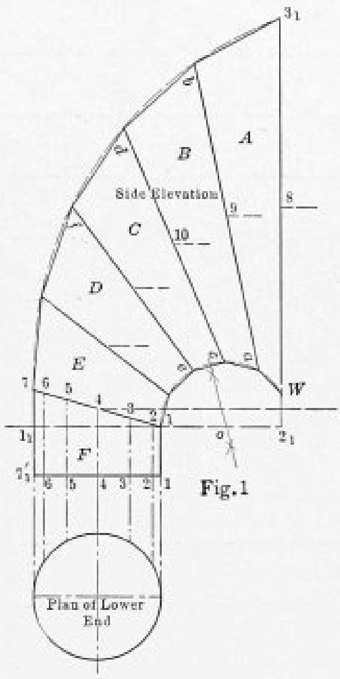

Fig. 1

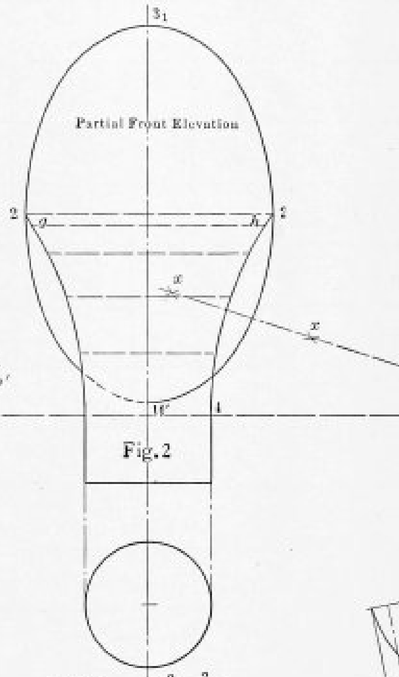

Fig. 2

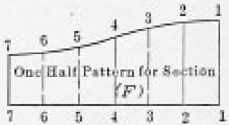

Fig. 4

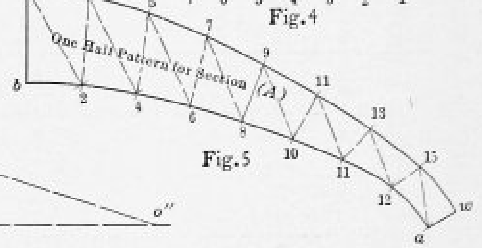

Fig. 5

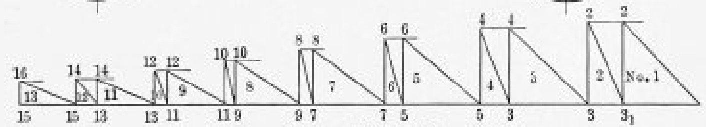

Fig. 6

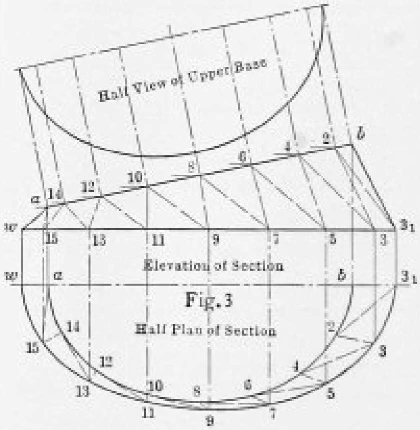

Fig. 3

Outline of Sections

Lines that establish the different sections of the ventilator may now be drawn across the side elevation between the corresponding points on each arc; that is, draw *a-b*, *c-d*, *e-f*, etc., as shown in Fig. 1. An outline of the front elevation, Fig. 2, must now be drawn in order to obtain certain necessary dimensions. In any convenient position draw the horizontal and vertical centerlines, taking care that the horizontal centerline is drawn, or rather projected, from a point midway between the points 3_1 and *W*.

Next construct the ellipse, Fig. 2, making the minor axis equal to two-thirds of the major axis; that is, 2-2 is equal to two-thirds of 3_1-*W*, Fig. 2. The circle in Fig. 2 can be drawn below the front elevation with a radius equal to that used for the plan. From the extreme right and left extensions of its horizontal diameter projectors are to be carried upwards indefinitely. These projectors are next intersected by a horizontal projector drawn from a point at the center of line 1-7 of the side elevation, as shown in Fig. 1.

The horizontal projector last drawn must be extended for the same distance beyond the right hand side of the front elevation in order to locate the center from which the arcs that form the lateral sides of the ventilator can be drawn. To determine the location of the centers, arcs are drawn at *x-x* with the dividers set to a radius slightly more than that of one-half the distance 2-4, Fig. 2. The bisectors are drawn through these arcs until they intersect the horizontal projection at the point *O″*. With *O″* as a center and a radius equal to *O″-2*, the arc 2-4 is drawn. This construction is shown only on the right hand side of the front elevation, Fig. 2, but it can readily be seen that the same method would be employed on the left hand side. In actual practice the layer out seldom draws more than one-half of the plan, since all necessary measurements can be obtained as readily from a half view as from the full figure.

Next bisect each of the miter lines shown in the side elevation, by projecting their center points as 8, 9, 10, etc., across the surface of the front elevation. These lines will represent the minor axis in the front elevation. Thus the axes will be represented by as much of the line as is included between the arc 4-2 and the corresponding arc on the left hand side.

Patterns

The construction of the different patterns for the sections is a matter of simple triangulation development. The pattern for the lower section, however, may be laid off by the ordinary projection method, using parallel lines equally spaced around the surface.

To do this, first draw the line 7-1, Fig. 4. On this line lay off the circumference of the circle, in this case only one-half the circumference is needed, forming one-half of the pattern. Divide this into as many squal spaces as there are in the plan, in this case six, and from each one of these points draw lines perpendicular to the lines 7-1, Fig. 4. Now with distances 1-1, 2-2, 3-3, etc., laid off on the proper lines as shown in Fig. 4, the half pattern for section F is completed.

As an example of how the other sections are laid out by triangulation, take section *A*. To avoid confusion of lines in the lay-off, Fig. 1, the outline of the section is laid out at *a*, *b*, 3_1, *w*, Fig. 3. Below this view of the section and parallel with the line *w*-3_1, a horizontal line is drawn for the centerline of the plan. On this centerline as a major axis the outer ellipse of the ventilator is drawn corresponding to the outline in the front elevation, Fig. 2.

Perpendiculars to the line *a-b* are then erected at points *a* and *b* and at a convenient distance away from the elevation a centerline for the half view of the upper base of the section is drawn parallel to the line *a-b* of the elevation. Taking this as the major axis, the required ellipse of the upper base is next constructed, the length of its minor axis being taken from the front elevation of Fig. 2, where it is represented by the line *g-h*.

When the ellipse that represents the half view of the upper base of the section in Fig. 3 has been constructed, its outline is divided by spacing it into a convenient number of equal parts—in this case eight. The points are next projected to the elevation and thence to the plan where the foreshortened view of the upper base is laid out. One-half of the outline of the lower base in the plan is then divided into the same number of spaces as were used in the half outline of the upper base, and the points thus located are projected to the line *w*-3_1 of the elevation. The surface of the section is then divided into triangles by lines drawn between successive points on the two bases as 3_1-2, 2-3, 3-4, etc., and the true lengths of these lines are determined by striking triangles as shown in Fig. 6. The lengths of the bases of the triangles are obtained from Fig. 3; thus the base of triangle No. 1 equals the distance 3_1-2 taken from the half plan, and the base of triangle No. 2 equals 2-3. In this manner all of the base lines are drawn. The height of each triangle is found from its perpendicular height in the elevation. The hypotenuses of the triangles represent the true lengths of the different lines of the elevation.

Begin the layout of the pattern by drawing a straight line 3_1-*b*, Fig. 5. On this lay off the distance 3_1-*b* taken from the elevation. Now with the dividers set to the distance *b-2* and with center *b* describe an arc at 2. The hypotenuse of triangle No. 1 would be the length of 3_1-2. With a distance equal to arc *b-2* and b as a center describe the arc at 3, Fig. 5. The length of 3-2 is taken from the hypotenuse of triangle No. 2, and so on until the pattern is completed, the last distance *a-w* being taken from *a-W* of the side elevation.

Talks to Young Boiler Makers

BY W. D. FORBES

At this time of year boiler shop owners and manufacturers generally begin to weigh and count up their stock and take what they call "an inventory." Everybody means to make this year's inventory the most exact they have ever taken, and they begin doing the work with great care and exactness, usually winding up with a lot of royal guessing.

This inventory is taken with a view of seeing how much the boiler shop has made, or lost, during the last year. Now, young boiler makers, it's a very wise thing for you to take an inventory of yourselves. You have, perhaps, just begun your time or are almost out of it, or strung along between the two ends. What you should try to find out is, whether you are progressing in the direction of becoming a first-class boiler maker.

It is more than likely that you think you are not getting as good a show as you should, and that you think that you have heated rivets or handled tools or toted timber for blocking or scaffolding long enough. You may think that some other young man in the shop is being given a better chance; and this is quite possible, as in a boiler shop, as elsewhere, there are likes and dislikes, and perhaps the boss's son or the foreman's cousin is working alongside of you, and it is natural, if such is the case, that he does get an advantage. Yet when you come right down to it, the apprentice who will get ahead permanently can only do so on his merit; that is, advancement will come when the job he is holding down is done better than by any other of his associates.

Small Jobs That Must Be Done Well

Blocking a boiler, so that it won't roll or tip over, may not appear to have anything to do with the boiler maker's trade; yet it has, and I have seen serious accidents occur from improper or careless blocking. Putting up a staging is a matter of importance also. Life may be lost by inattention to proper strength, and time may be lost by having the work done so that the work cannot be got at handily.

There are numerous things that you have been given to do which you have done more or less well. If you have been heating rivets, to have them at just the right heat is the point you have to aim at. If you have read The Boiler Maker, as I hope you have, you will have noticed that to know how to heat rivets was worth $10 to somebody; or, more properly, how best to heat rivets was worth that money. You have driven a few rivets, quite possibly, and have been very proud of it. You have calked a seam, perhaps; but have you got on to the fact that in driving a rivet you can pound the life out of it, and when calking a seam that you can destroy the metal by hammering away at it too long?

Do You Understand the Reason for This?

You have noticed that the horizontal seams in a boiler are more heavily riveted than the vertical ones. The reason for this is asked again and again by young boiler makers. Have you caught on to the real reason for this? or have you the same idea that a young friend had who told me he did not believe a horizontal seam needed more rivets than a vertical one, as he was sure that if he stood a boiler on its head the vertical seams would not be any weaker or any stronger than when the boiler was lying down?

If you are just starting your time you may have tried your hand at a little chipping—perhaps, I should say, you have tried your knuckles. I can remember that I did. The chipping looked so easy for big Bob Morgan, who worked beside me, that I felt I could do just about as well. I can remember how I held onto that chisel, grabbed the hammer about half-way up the handle, and with my eye on the head of the chisel hit it a "swat," with the result that I made a dent in the edge of the plate—and nothing more except that, as I had stuck my tongue out one side of my mouth to help guide the chisel, I bit it rather badly. It was pretty discouraging for me, and so is lots of boiler work when you first begin.

The boiler maker apprentice is pretty sure to think that his trade is the meanest and hardest there is to learn, and he wishes he had gone at some other; but that is just what every other apprentice in every other trade under the sun thinks. The question for you, young boiler makers and apprentices, to settle is, whether you are making the most of whatever advantages come your way; whether you are really learning not only how to do things, but why you do them.

Taking Advantage of Opportunity

Now, right here, are you using The Boiler Maker to your best advantage? Do you really grasp the idea that the editor and all his associates and all the writers for the magazine are at your service? Do you realize that they stand ready to make clear anything that perplexes you, if you will only let them know what the trouble is? You may feel timid about writing because you do not spell very well, perhaps, or because you do not write very clearly. Don't let either of these things trouble you at all. All that you want to look to is to explain your troubles; and when you get your answer, if it does not make things clear, come back again. It is very often the case that an explanation given to two men will be understood by one and not by the other; not because one is more stupid, but that the explanation suits the style of mental thought of one and not the other.

If you are going to a night school you are doing a very wise thing, but just going to school and doing the work of the class room is only part of the value of your schooling. You have to read and talk over with your shopmates and think of the subject of your lessons, and, above all, in the class room to understand every step of the work. It is fatal, if you do not understand a thing, to let it slide with the hope that a little later the step will be made clear to you. Learning is like laying bricks, you must bed down each step good and firm before you can lay another course. This is particularly true in mathematics. Any good teacher is more than glad to have a pupil come to him to make clear a point, as the teacher learns as much as the pupil.

Learning Laying Out

In laying out boiler work you have probably had very little chance during the last year to try your hand. You can readily see, if you think a moment, that a mistake in laying out is pretty sure to spoil a plate which costs money; and it may also seriously delay a boiler job, as the plate may be the only one of proper size in stock, consequently such great risks can not be run by the foreman. But because you cannot lay the work out on actual steel plates, there is no reason why you should not lay it out at home on a common piece of brown paper, using the kitchen table for a drawing board. Most men who lay out work in a boiler shop are pretty well equipped with brains, and so are willing to give a young fellow a chance at the blue prints. If the work of laying out can be accurately done on a piece of paper and shown to a layer out, he will generally point out errors or tell you if you are right.

Many of the layout jobs in The Boiler Maker are hard to understand, even for the experienced layer out, and the very best way to see if you do understand them is to lay them out on a reduced scale on paper and roll them up to see how they come out. Doing this is very interesting work. Just try it with the next laying out job that appears in these pages.

In conclusion, do not let people talk you into believing that you have made an unwise selection in learning the boiler maker's trade, or that it requires more muscle than brains. There is more mental ability required in laying out an elbow than is required in any operation that I know of in the pattern maker's, moulder's or machinist's trade, and the responsibility in boiler work is far greater than in that of the three trades named put together.

Lantern Slides for Lectures.—Messrs. Edward Bennis & Co., Ltd., London, England, inform us that they have a number of lantern slides dealing with the development of mechanical stoking, elevating and conveying apparatus, which they will be pleased to loan to any responsible engineer for lecture purposes. A list of the slides and particulars of their subject matter can be obtained on request. Applications for the loan of slides should be made well in advance of the lecture date and should be addressed to the Publicity Dept., 28, Victoria street, London, S. W.

Safety in Crane Work*

Cranes have become an essential part of the equipment of almost every modern factory and mill yard, because of their adaptability, in one form or other, for hoisting and transporting for short distances almost every kind of raw material or finished product. The monorail hoist is a recent addition to the various types of traveling cranes, and is being installed in many manufacturing plants because of its extended range of operation. The use of cranes is necessarily attended by danger, and it is the opinion of several European inspectors that cranes cause more accidents than any other one type of machinery. Most of these accidents are avoidable, however, if proper precautions are taken.

In a thoroughly modern shop an inquiry to an operator of a crane is unusual. The crane manufacturer or the shop manager is usually willing to see that every needful thing, of a substantial nature, is provided for the safety of the craneman. A substantial crane cab or cage, containing well-guarded control apparatus, is part of the modern traveling crane. Iron or steel stairways with hand-rails and toe-boards afford safe passage for the craneman from the ground to the cage, and from the cage to the upper deck of the crane. All gears and movable parts of the trolley are supposed to be guarded, safety handles have been designed for the hoisting hooks, and careful inspection aids in keeping the slings and other accessories in proper working condition.

There is nothing of a mechanical nature, however, that will cope with the uncertainties of the human equation in a shop. The workman who does not understand the risks he assumes, or who has a penchant for taking a chance, or who is careless or indifferent, should never be allowed to engage in crane work. Such a man will take a short cut under a load that is being raised or lowered, or he will pass through a narrow space between the load and the wall, when by taking a few extra steps he could easily go by on the wide and safe side, or he will do other equally unwise and unsafe things. The remedy for such conditions lies in education and discipline; and the adoption of special rules and regulations for the craneman and his crew, and of general rules for all other employees in the shop or yard, constitutes the first step in this direction. The foreman of the shop or yard where cranes are in use should make sure by individual examination and inquiry that every employee knows the rules and understands what they mean, and he should be held responsible for the strict observance of them at all times and under all conditions.

A ladder or stairway should be provided at one end of the crane runway in every instance, to give access to the crane cab; and when two cranes are operated on the same runway, ladders or stairways should be installed at both ends. The cranemen should always use these ladders or stairways when going to the crane cages or leaving them. All gears on the trolley and other parts of the crane should be guarded, and no one should be allowed on top of the crane while it is in motion. When repairs are necessary, run the crane to the end of the shop, if possible, and always see that the power switches are locked in the open position before work is started. If other cranes are in use upon the same runway, so that it is not possible to run the damaged crane to the end of the building, see that the safety bumpers are placed at each end of it, to prevent the others from running into it while the repair work is going on.

The bottom of the trolley should have a sheet-metal pan fastened beneath it, to catch any parts that may work loose, and prevent them from falling upon employees on the floor below. Guards should be provided in front of the truck wheels, to remove any obstructions that may be upon the crane tracks, and to prevent injury to persons who may be working upon the tracks. The platform on the top of the crane should be of steel, equipped with a railing, and also with a side board to prevent tools from falling. All electrical wiring for cranes should be enclosed in conduits, and it is particularly important that limit switches be provided, in all cases, for both the main and auxiliary hoists. Keep all tools, oil-cans and waste in a closed metal box, securely fastened to the crane or to the runway at some convenient point.

Woodwork should not be used around a crane, because it is likely to become oil-soaked, and it is then exceedingly combustible. If it should take fire the craneman would have to run the crane to the stairway in order to escape, and the motion would increase the fire and add to the craneman's danger. If he tries to leave the crane in any other way than by the regular ladder or stairway, he will be exposed to hazards of other kinds, and these will be accentuated by his haste.

The craneman should always sound the warning bell before raising or lowering a load, or before starting the crane; and he should never move a load in any direction until a signal has been given by the proper person. The crane crew usually know when a movement is about to take place, and are out of harm's way; but some of them may fail to hear or see the signal when it is given. The sounding of the bell gives definite warning to the worker to get clear, and it also warns the other employees in the shop who are not immediately concerned with the movements of the crane, but who are likely to pass into the danger zone without noticing the crane, unless the bell is sounded.

The craneman should never permit any person to ride on the load nor on the slings or hooks, and he should be held responsible for the enforcement of this rule. See that all employees are instructed with regard to this point, and that they know that the craneman has full authority to order them off. If they refuse to leave, the craneman should decline to start the crane, and it should be made clear to him that he will be sustained in this action by his employers. Some cranemen, rather than cause trouble between their fellow workmen and those in authority, will disregard the rule and start the crane; but they should remember that they are equally liable to discipline in such cases, and that they share the responsibility for any accident that may occur. It is not kindness to a man to cover up his errors by exposing him to peril of life and limb.

The crane operator should never allow slings, chains, cables or hooks to drag along the floor of the shop, and he should never start the crane carriage until the slings, chains or hooks are entirely clear of the floor or ground. Even in the short distance that the crane might travel before the chains leave the floor, the slings or hooks may become caught on some obstruction and cause an accident.

If the floor of the shop is well filled with workmen, it is advisable to have a man precede the crane and its load by ten or fifteen yards, and give warning to all employees to stand aside till the crane has passed. This is especially desirable when handling truck loads of material, or loads of any other kind which may slip out of the slings from vibration or any other cause.

A craneman should never try to straighten a load by swinging it against a car, building, wall or supporting column. If, after raising the load, he notices that it does not ride straight, he should sound the warning bell and

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* From *The Travelers Standard.*

lower the load and let the hookers readjust the slings. Swinging the load against a car or building often subjects the cables or chains to sudden jerks that may increase the stress upon them three or four fold, and cause them to give way. Naturally this greatly increases the likelihood of accidents. The men on the floor cannot read the craneman's mind, and therefore cannot know that he intends to swing the load. They may pass between the load and a car or post without any intimation of danger until it is too late to escape except by lying down; and to lie under a load while it is swung against a post to be straightened appears to us to be about as safe and pleasant as lying in the middle of a railway track and waiting for a string of freight cars to go by.

When a heavy load is to be handled, the craneman should first raise it a few inches to find out whether or not it is well balanced, and to make sure that no undue stress is thrown upon any part of the slings. This procedure will also permit him to test the braking apparatus. If anything is wrong with the brakes or with the adjustment of the slings, the load should be lowered at once, and no attempt should be made to move it until it has received the necessary repairs or adjustments. Caution in this respect is especially important when molten metal is to be handled, even in small quantities.

The craneman in charge of a *magnet crane* should use extreme care in its operation. With this type of crane the load is held, not by slings or chains, but by the intangible force of magnetism; and the complete shutting off of the electric current, or any marked decrease in its strength, will let the load drop immediately and without the least warning, with serious results to any person beneath. Whenever it is possible to do so, arrange to make the current supply for a magnet crane entirely independent of all other power or lighting circuits, in order to avoid interruptions of the supply that might otherwise be caused by trouble in other parts of the circuit. Magnet cranes should not be used inside of buildings, nor in any location where they will pass over workmen below.

Cranes of any kind, and particularly magnet cranes, should never be stopped over a passageway unless men are stationed at each end of the passageway to warn employees. All employees should be instructed with respect to the principle underlying the action of the magnet crane, so that they will realize the special danger of standing or passing beneath the load. Even if the magnet has no load, but has the power on, a man passing close under it may be exposed to danger if he is carrying steel or iron on his back or shoulders. If the metal comes near enough the magnet will draw it up, and the action is so quick and unexpected that the man may also be lifted before he has time to release his hold. In any such case the first and most natural impulse of the craneman is to shut off the current; but if he does so, he immediately destroys the attractive influence of the magnet, and the steel or iron that it has seized falls back again upon the workman, very likely with serious consequences.

When a magnet crane is exposed to the weather, make sure that the electrical conductors are in first-class condition at all times. Conductor losses or leakages during damp or rainy weather often weaken the holding power of the magnet. In the winter months ice is likely to form on the power rail or the trolley wire, and when the brush on the power rail or the wheel of the trolley reaches the icy section, the contact becomes broken or imperfect, and the load usually drops. It is therefore highly important to keep the conductors free from ice at all times.

The majority of what may be termed "minor injuries" among crane workers occur in connection with hooking up or unhooking the loads. It is not at all uncommon for workmen, after applying the hooks to a load, to hold them in place with their hands until the slack of the hoisting cable is taken up and the hooks take a good grip. The point of contact and the angle which a hook makes with the load usually change somewhat the instant the weight is lifted, and unless the workman anticipates these changes his fingers or hand are quite likely to be caught, and perhaps crushed or cut off. In many of our industrial plants safety handles are attached to all hooks used in crane work. We strongly favor the use of such handles, because they enable the workmen to hold the hooks in place with safety until the load bears on them. In shops where safety handles are not provided, the workmen should use notched pieces of wood of convenient size. By pressing the notched section against the hook, the latter can be held in place without danger of crushing the hands or fingers, and the men are also free from danger in case the load suddenly slips or twists around, or in case a part of the hoisting apparatus breaks.

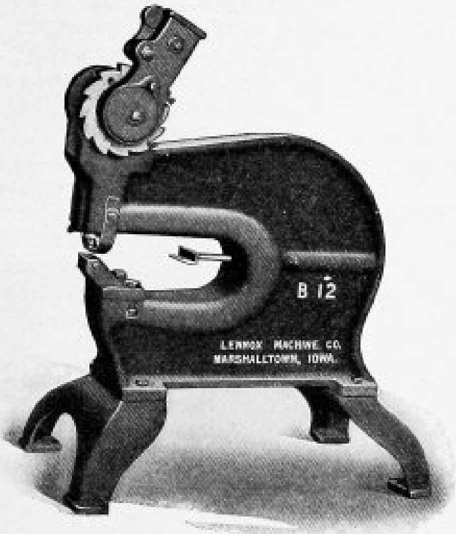
The hookers and the craneman should work together, to see that both the crane and the crane trolley are directly over the center of the load to be handled. If either one is off center, the load will swing when it is raised, and will be likely to injure anyone in its path. When the hooks or slings are in place and the slack is taken up, the workmen should immediately stand back several feet from the load.

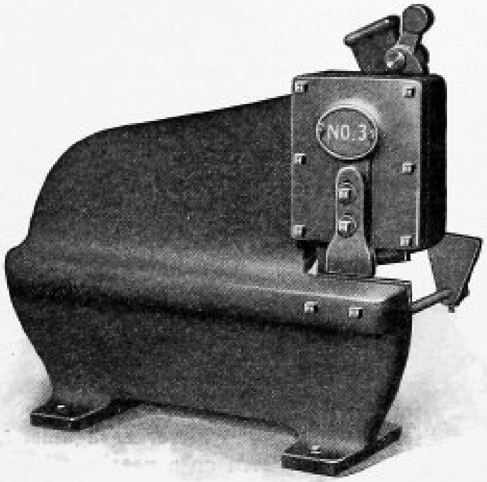
The hookers should never, under any circumstances, stand inside a car into which material, approximately as long as the car, is to be lowered, or from which material of similar length is to be raised. The margin of space at the sides or ends of the car is then small when compared with the uncertain length of the swing of the load, and the craneman (particularly if the cab is at one end of the crane and the material to be lowered into the car at the other end) may easily make a mistake of a few inches in manipulating the load. As the load is lowered it may bear for a fraction of a second upon the side or end of the car, until its own weight pulls it away with a swinging, jerky motion. A miscalculation of the position of the exact center of the load, with respect to the center of the trolley, will also cause the load to swing when it is raised. Under either of these conditions the men in the car have little or no chance to escape injury. In fact, the safety zone in a car is so limited that it is better for the workmen to remain outside, even though the material handled is only *half* the length of the car.

The man who will stay in a car when a large load is being handled, has his counterpart in the man who will continually go into a narrow space between a load and a neighboring wall or post. It is often necessary to place a load twelve or eighteen inches from a wall, but it is not necessary for a workman to get into this space while the load is being raised or lowered. The load will probably come to rest without any mishap, but the workman has no guarantee to that effect. The cables may twist and swing a corner of the load around, crushing the man in the narrow space; or a block of wood or some other unnoticed object may be lying on the floor just where the load is to be placed, and when the load is lowered this obstacle may cause it to tip far enough to kill or seriously injure the workman on the narrow side.

The sheave or block to which the hook is secured should be effectively enclosed, to prevent the hands of workmen from being drawn into it when slackening off the cables. So far as possible, the hooker should avoid trying to loosen a cable by pulling it down on the *inrunning* side of the block. His fingers may be caught between the sheave

Small Punches and Shears



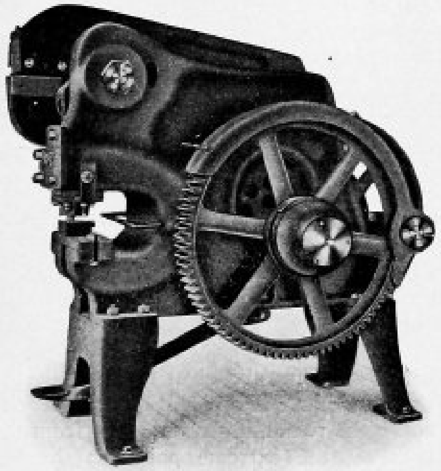


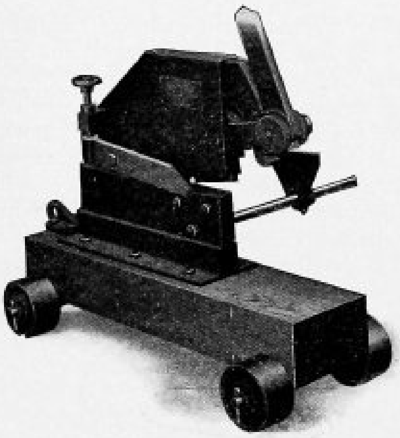
Hand Lever Splitting Shears

WE build Hand Lever Shears to handle plates from ⅛ to ½ inch in thickness. The frames are offset so that sheets of any width may be split. The leverage is so arranged that these machines can be easily handled by one operator.

Hand Lever Punch

THESE Punches are built in capacities ranging from ¼ through ¼ inch to 1 inch through ¾ inch, or their equivalents. The throats vary in depth from 4 to 18 inches. Each machine is furnished with a stripping attachment, an improved adjustable throat gauge, a hand lever, a punch and die.





Universal Steel Frame Hand-Lever Shear

THIS shear is built of forged steel plates planed to size, then pinned and riveted together. This makes it much stronger and lighter than the cast iron type. It is especially suited for heavy outside work, where portable machines are necessary. The machines are mounted on trucks, but can be furnished with or without as desired.

The machine will split plates up to ⅜ inch, will shear flat bars, 1 inch rounds and ¾ inch squares. Weight without truck 350, with truck 450.

Power Combined Punches and Shears

THESE Power Combined Punches and Shears are built with punching capacity up to 1 inch hole through ¾ inch material, shearing up to 1 x 8 inches flats, 2¼ inches rounds, and 4 x 4 x ½ inches angles. The frame is built in one piece, making a much more rigid machine than if built in parts and bolted together.

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and the chain or cable, and be cut off or badly crushed. It is far safer to grasp the *outrunning* side, and pull up and away from the sheaves or pulleys.

The crane crew and all other employees in the vicinity should keep well away while the chains or cables are being withdrawn from under a load, because they may catch and tip the load over. In such an event the action is sometimes so quick that the men have little opportunity to get out of the way. Sometimes a chain will catch on the load, but not firmly enough to tip it over, and as the steady pull of the crane overcomes the hold of the chain the latter will fly out suddenly and with great force. We have frequently seen chains jerked from under loads, in this way, with sufficient force to cause instant death if one of the links should strike a man on the head.

Another prolific cause of accidents consists in men working on the crane runways without taking sufficient precautions for their own safety. When a man is obliged to work on a runway, he should first of all notify the craneman, but he should not depend on this warning as his sole protection against being run down by the crane. The craneman may forget the workman, or he may misjudge the speed or distance, and so run the crane against him. A warning flag should be placed on a nearby column in plain sight of the craneman, and buffers should also be clamped to the crane rails a few yards from the point where the work is being done. If the craneman then forgets the man on the runway, and also fails to note the warning flag, his attention will be forcibly directed to the matter when his crane strikes the buffers. If no buffers are supplied, the workman should have a stout rope safely fastened in a convenient place, so that he may easily slip down to the ground in case of danger.

In plants having machine-shop galleries located beside crane runways it is important to screen off the runways from the galleries for their entire length.

The foregoing are some of the most common and important causes of accidents in crane use, and they can all be avoided, as we have tried to show, by the exercise of proper care. The installation of safety devices will help greatly in this direction, but educational and disciplinary measures are even more important, because many of the workmen know about the various hazards that we have mentioned, and yet fail to observe the safety rules that would prevent the consequent injuries or reduce them to a minimum.

Duplicating a Back Flue Sheet for a Modern Type Boiler

BY W. E. O'CONNOR

Figs. 1 and 2 illustrate a plan that is used at the Hornell (N. Y.) shops of the Erie Railroad when duplicating a back flue sheet for a boiler commonly known as the Atlantic or Pacific type. In a modern boiler shop the layer out is generally equipped with the necessary facilities for handling expeditiously the kind of work that usually comes his way.

Fig. 1 shows the layout for such a design in the straight sheet as it would appear when ready for flanging. The construction lines *X-Y* and *A-B* are drawn in similar positions on both the old and new sheets. From these lines the positions of all points may be obtained.

The length of the vertical height in the stretchout is found by measuring along the centerline on the surface of the old sheet from the base line to the break line over the flange at the crown with a pliable strip, and this is transferred to Fig. 1, locating point *A*. The break line over the flange is placed in and the checking of same is done when flanged by bending light bar iron templets ¼ by 1 inch fitted to either side of the old sheet reaching from a point at the top center to fixed points approaching the angular bend, point *C*, Fig. 2. Next set the templets to corresponding sides of the new sheet, Fig. 1, so that point *A*, the top center, and points *C*, *D*, the width at the section of the sheet, are cut by similar points on the templets lifted from the old sheet. The break and trimming lines may now be drawn in.

The next procedure is to locate points for the rivet holes on the leg pattern of the flange. From a sheet of light black iron, No. 18 or No. 22 gage, cut two pieces suitable to cover a fixed number of rivet holes, as shown in Fig. 2 from point *C* to point *E*. Now clamp the pieces to either side of the firebox walls and mark the rivet holes thereon, including the rivet lines at the foundation ring, as shown in Fig. 2, point *E*. Then place the templets on the corresponding sides of the flange, Fig. 2, so that the plan lines for the rivet holes on the templets coincide with the rivet holes on the face of the new sheet and lap holes *E* on the templets are cut by points *E* on the new sheet.

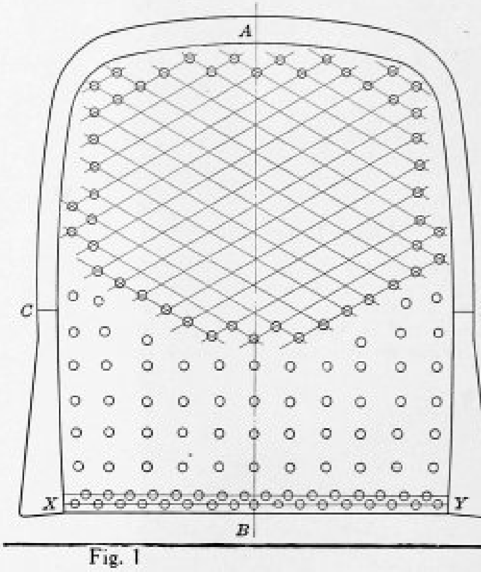

Fig. 1

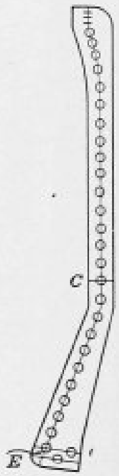

Fig. 2

To locate points for the rivet holes at the crown portion of the flange, cut two pieces of light black iron suitable to cover the remaining rivet holes from the top center to point *C*, the extreme point on the leg templet. Clamp the pieces to the flange of the old sheet on either side and mark on the templet the fixed number of rivet holes. Next set the templets on the respective sides on the flange of the new sheet in such a manner that the top center hole on the new sheet and the extreme hole, *C*, cuts point *C* on the sheet and the points for the rivet holes coincide with their respective rivet holes.

In conclusion, it is customary in practice to omit the ring holes in the corners, since these holes may be drilled in place after the corners are set up by heating with the blow torch.

OBITUARY.—Lewis Solberg, vice-president of the La Crosse Boiler Company, La Crosse, Wis., died of paralysis at his home in La Crosse on November 15, aged 69. Mr. Solberg was president of the Reliance Steam Boiler Works, which in 1905 consolidated with the M. Funk Boiler Works and incorporated under the present firm name.

Shop Practice

BY J. P. MORRISON

While the mechanical press is devoting much space to boiler inspection laws and the final report of the A. S. M. E. committee on uniform boiler specifications is expected daily, it may not be amiss to refer to a question of boiler construction having as much to do with boiler safety as have the chemical and physical properties of the material and the design of the seams.

Only a few years ago the locomotive type boiler, used either on locomotives or as a portable boiler, the marine type and vertical tubular type, were the only boilers having surfaces supported by staybolts, and in each of the types mentioned the staybolting was a simple proposition, following the practices in vogue for a generation. However, with the appearance of locomotive boilers having the crown sheet supported by radial stays, submerged vertical tubular boilers with the cone top supported from the upper part of the shell by staybolts, and watertube boilers the headers of which are formed of staybolted water legs, new problems arose which have, in part at least, not been solved satisfactorily by all the builders who manufacture those types of boilers.

Fig. 1.—Enlarged View of Inner End of Damaged Staybolt

The standard staybolt tap has a threaded section approximately 6 inches in length, and so long as the water space or distance between the outer and inner sheet does not exceed 4 or 5 inches, the threads in the outer and inner sheets are parts of a continuous thread, because the threaded portion of the staybolt tap engages the inner sheet before its full threaded part has passed through the outer sheet. However, when the length of the staybolts supporting the sheets of a locomotive firebox, cone top of a submerged vertical tubular boiler or the tube sheet and hand hole sheet of the waterleg header of a watertube boiler exceeds the length of the threaded portion of the tap, the tap, of course, leaves the outer sheet before it has started a thread in the hole in the inner sheet. Thus the tap "jumps," or its travel toward the inner sheet is faster than that due wholly to the revolution it makes, and threads started in the inner sheet seldom form a part of a continuous thread with those in the hole in the outer sheet.

This difference may be slight, or it may be one whole thread, and when the staybolt, inserted through the threaded hole in the outside sheet, reaches the inner sheet, the threads do not engage and it is necessary for the bolt to force the sheet apart until the threaded end of the bolt enters the threaded hole. The distance through which the inner or outer sheet is moved, of course, depends upon the amount the tap has "jumped" between the sheets and may be nearly one-twelfth inch, assuming the tap is standard with twelve threads to the inch.

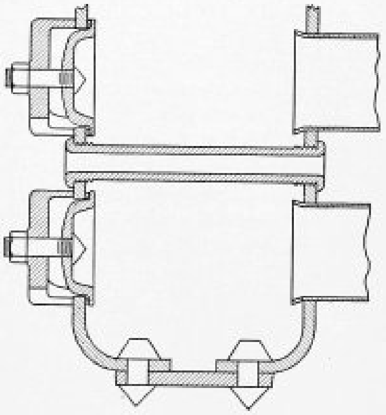

Fig. 2

The stress set up in the threads in the hole in the outer sheet depends upon the location of the bolt with respect to the curved surfaces and its proximity to the laps and flanges, as well as to the thickness of the sheet, and this stress is transferred from the threads in the outer hole to the bolt, and finally falls on the thread at the end of the bolt and the first thread in the hole in the inner sheet. Should the bolt hole be located near a flange or pass through a curved surface, it is not only possible, but probable, that the thread in the hole and the thread at the end of the bolt will be damaged before the sheet will "give" a sufficient distance to enable the threads to engage. Should the sheet be of ½-inch or thicker material, the probability of damage to the threads increases.

In many shops manufacturing watertube boilers "I" beams are used as "stiff-backs" to keep the extra sheets straight until they are staybolted. This practice, although apparently necessary, makes the sheet at each line of holes very rigid, with increased probability of damaging the threads should the bolt not enter the hole easily.

Those who have had experience in staybolt work know that the usual result of a damaged first thread on the bolt or in the hole is a "stripped" thread. The photograph, Fig. 1, shows the inner end of a staybolt, removed with eight others in like condition, from the rear water leg of a watertube boiler which had been in operation about eight years. The water leg is 10 inches deep. These bolts had given trouble from leakage almost from the time the boiler was installed. Frequent repairs were made by driving a taper pin into the end of the bolt and redriving the head, but the relief obtained in this way was only temporary.

It appears that the warping of tubes, near to which these bolts were located, as shown in Fig. 2, produced strains in the sheet, which changed its position slightly, possibly on account of the condition of the threads on the bolt and in the staybolt hole, after which the bolts would give trouble. When each tube was renewed and the surrounding bolts re-expanded, the leakage at those particular bolt ends would cease for a time, or until the new tube warped considerably. The ends of the bolts after they were removed showed quite plainly that they had been stripped when inserted, as can be seen by examining the photograph carefully, and the bolt head alone was staying the water leg.

The examination of new boilers of this and similar types in the shop during the process of construction, where the short staybolt taps have been used, revealed many staybolts which had been stripped at the inner end or at the sheet last entered. One manufacturer who adopted the use of longer taps and discontinued the practice of threading one end of a hollow staybolt and then reversing the bolt in the bolt cutter, to thread the other end, has had no trouble, although the cost of tapping the holes and cutting the bolts has increased slightly.

Much of the trouble with the staybolting of the cone top of submerged vertical tubular boilers may be attributed to the same cause, due consideration, of course, being given to the angle at which the bolt enters the sheet. On account of the slope of the cone top sheet, which gives unusual powers of resistance against collapsing stresses, the bolt may be expected to strip before it forces the sheet sufficiently to engage the threads, where the threads in both sheets are not part of a continuous thread.

Let us not overlook the question of good workmanship and good shop practice in drawing up standard specifications, the whole intent and purpose of which may be nullified by the use of poor tools and poor shop methods.

A New Inspection Method*

The whole art of boiler inspection rests upon the possibility of detecting nearly every sort of dangerous boiler defect while it is still in an incipient stage, or at least before it has progressed far enough to produce an accident. How well this ideal has been accomplished is too well known to need further corroboration; and yet, in spite of the enormous decrease in boiler casualties which has followed the general adoption of some sort of inspection, a few types of defects, like some diseases of humans, have always been difficult of diagnosis.

Probably the hidden crack which forms under the overlap of a joint has been more fruitful of destruction and less open to detection by preventive inspection than any other boiler ill. As is but too well known, such cracks form with alarming frequency in the seams of lap-seam boilers when they have passed through a sufficient length of service. The reason for this has been so often discussed that it scarcely needs more than a passing mention; namely, the breathing of a shell slightly "out of round" owing to the overlapped seam which endeavors to assume a truly circular form upon each application of internal pressure.

The extreme difficulty which has attended the detection of this trouble has been due to the fact that the crack forms under the overlap of the joint, as is shown in Fig. 1, where it cannot be seen until it has progressed far enough to render an explosion extremely probable. Add to this the further fact that, as most boilers are set, one side of the longitudinal joint is very apt to be hidden by the insulating material or the brickwork of the setting, so that only the inside is available for the intimate examination of the inspector, and one sees why the majority of lap seam accidents have escaped prevention.

It must not, of course, be concluded from what we have just said that inspectors have never been able to detect lap cracks, for of course this is far from true. Sometimes a persistent leak at a longitudinal seam has led to an investigation by the inspector. He generally applies a hydrostatic test pressure to the suspected boiler and proceeds to hammer the doubtful joint while the pressure is on. In many cases this treatment has caused a small crack to open sufficiently to indicate a serious defect and the removal of the plate has revealed the crack.

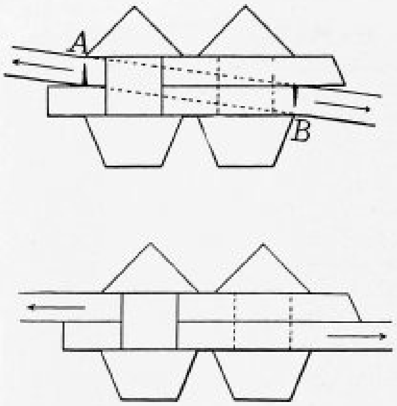

Fig. 1.—Formation of Lap Cracks

Mr. S. F. Jeter, supervising inspector of the Hartford Steam Boiler Inspection and Insurance Company, has recently patented a method for rendering the detection of seam cracks more certain. It bids fair to remove most of the uncertainty, and hence much of the danger, of ultimate violent failure from this sort of defect. His process (U. S. Patent No. 1,091,847) consists in cutting narrow grooves or slots nearly through the plate, and at right angles to the probable course of the crack, at points where cracks are liable to form, so that a crack will reach the bottom of one of these slots and either show up to the eye of the inspector or develop a leak which will give warning, while the plate still has a large part of its original thickness, and before the structure has weakened to the explosion stage. This is shown in Figs. 2 to 4. V-shaped notches may be cut in the calking edge of the overlapping plate to uncover the region in the underlying plate subject to crack formation, dependence being placed on the slots to give warning if the crack develops in the overlap. Such notches or slots will not weaken a joint appreciably or reduce the safe working pressure if they are cut at intervals of a foot or so along the longitudinal seams.

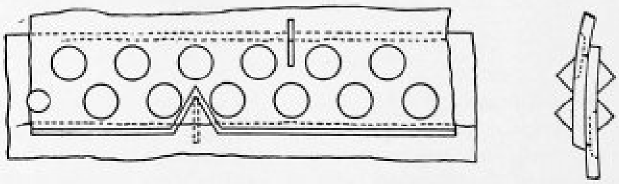

Fig. 2.—Mr. Jeter's Slots Applied to a Lap Seam

The method is strictly analogous to that adopted long

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* From *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

ago for the discovery of fractured staybolts. Here also we have a type of defect which could often be discovered through the agency of the inspector's hammer, owing to the vibrations which light hammer blows set up in a fractured bolt. So much uncertainty attached to this method, and so much skill and experience was necessary before an inspector could trust himself to order partly fractured bolts replaced, with the attendant expense and the discredit which he would receive regarding his ability if it should prove that he had marked sound bolts for renewal, that nearly as many staybolt troubles occurred in inspected as in uninspected boilers. All this has been changed in a large measure through the practice of drilling telltale holes in the ends of the bolts. The holes need not extend more than a short way through that part of the bolt in the supported sheet, as nearly all the fractures occur just inside the stayed sheet, and at the end of the bolt holding the thickest sheet, where the destructive bending is largely concentrated. Here, also, the weakening of the bolt by the hole is trivial, while a leak gives early warning of the formation of a crack.

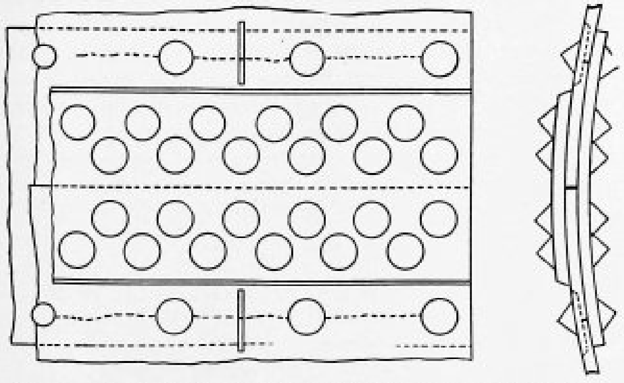

Fig. 3.—The Method Applied to a Butt Joint of the Wide Inner Strap Type

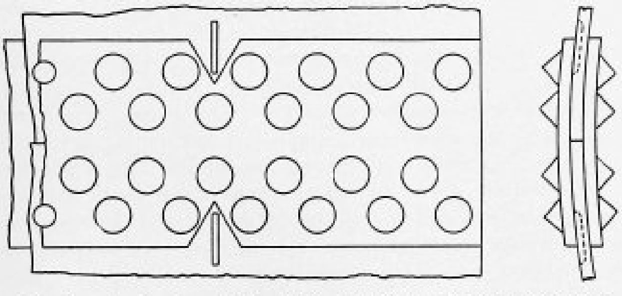

Fig. 4.—Application of the Method to Butt Joint with Straps of Equal Width

Lap seam boilers have been referred to for the most part as subject to the hidden crack. While it is true that they are more affected than these of butt and double strap construction, owing to the more nearly circular form of the latter, still cases have some to our attention where a butt-strapped boiler has developed hidden cracks of the same nature, probably because of poor forming of the ends of the plates when they were rolled up into a cylindrical form in the boiler shop. The plate ends are especially hard to get truly round; and if they are flattened, then the butt joint will suffer a breathing action from the internal pressure as well as the lap joint, and the formation of cracks may be expected to follow the breathing after a sufficient time. Anticipating the probability of an increasing number of these cracks coming to light in the future as the average age of the butt joint boilers in use increases, Mr. Jeter has adapted his system of slots and V notches to this construction, as is shown in Figs. 3 and 4, where the method is applied to the case where the inner strap is wider than the outer one, the common construction in this country, and also to the case of straps of equal width, the more common practice abroad.

Repairing a Crankshaft by Autogenous Welding

A chief engineer is frequently required to use unerring judgment in making extensive repairs in his power plant, and to make these repairs permanently durable, quickly, economically and neat appearing. The occasion which requires this ability comes unexpectedly and is usually attended by a complete shutdown of his plant. To keep himself forearmed for these emergencies it is desirable to know of the methods and success other mechanics have had in these events, and with a motive to contribute to his preparedness I call attention to the prompt results and unusual success obtained in repairing a large crankshaft by autogenous welding with an oxy-acetylene torch.

The crankshaft was 6 inches in diameter by 11 feet long, and was a member in a three-cylinder, 100-horse-electric light plant. It was broken square off through one of the arms and totally disabled the entire plant.

Just previous to the welding operation the fractured ends were placed in a glowing bed of charcoal and surrounded by brick to thoroughly preheat the portion adjacent to the fracture. This performance was not vital to the actual welding operation, but was only an economic measure to save gas. After preheating, it was perfectly alined on V blocks, and with the torch a gap was cut on opposite sides, the sloping sides of the gap forming an angle of about 75 degrees with the vertex at the point of fracture, in the center of the shaft. This cutting was done entirely with the torch, and left the sides of the gap dripping with molten metal, a condition which penetrated the material of the shaft. In fact, it would be exceedingly difficult to determine just where this molten condition actually terminated. This fluid and semi-fluid state was maintained or renewed with the torch while the gap was being welded full of molten steel from the welding rod, working from the center of the shaft outward. The weld was then finished by melting away the superfluous metal and smoothing off with the torch. The apparatus and torch used were those furnished by the Vulcan Process Company, of Minneapolis.

The complete job was welded and ready to deliver in less than twenty-four hours at a cost of about $26, as detailed below.

Eight hours' welding time at 35 cents.....	$2.80
812 feet oxygen gas at 2 cents............	16.24
817 feet acetylene gas at 8 cents..........	6.54
50 pounds charcoal at 1 cent............	.50
	$26.08

After cooling, the welding was found to be perfectly homogeneous in texture, void of fire scale or oxidation, and machines freely.

This crankshaft has now been in heavy service for several months and given perfect satisfaction.

Minneapolis, Minn. C. H. Burrows.

A. S. M. E. Boiler Code

The preliminary report of the committee on uniform boiler laws and regulations of the American Society of Mechanical Engineers, which has been compiling a standard code of boiler rules to govern boiler practice throughout the country and to serve as a basis for legislation covering the construction and inspection of steam boilers, received a most thorough discussion at the annual meeting of the Society held in New York December 1-4. The final revision of this report will probably be available early next year, and it will be presented for adoption at the spring meeting of the society in Buffalo.

The introduction of this preliminary report reads as follows:

Every year there averages in the United States between 1,300 and 1,400 serious boiler accidents, of which 300 to 400 are violent explosions. These accidents kill between 400 and 500 persons, injure 700 to 800 more, and destroy more than a half million dollars' worth of property. In a single explosion, that of the R. B. Grover Shoe Company at Brockton, Mass., 58 persons were killed, 117 more were injured, $250,000 worth of property was destroyed, and an aggregate of $280,000 was claimed in the personal injury and death suits that were brought.

These disasters emphasize the necessity of constructing and installing steam vessels and their appurtenances in as nearly perfect a manner as possible; the importance of preventing carelessness in their operation; and the wisdom of having them inspected at regular intervals by disinterested experts.

At the present time ten States and nineteen municipalities have in force laws for the compulsory inspection of steam boilers in which are comprised a code of practical rules for their construction and operation; and a number of other states and municipalities either have prepared or are now preparing similar laws for enactment. The laws now in force all differ from one another in a number of material respects, and unless some relief can be obtained each new law as enacted will differ from all the others.

By reason of the differences in these laws a boiler built in one State having such a law may not be shipped into another State having such a law—not because the boiler is any less safe in one State than in another—but solely because it does not meet the requirements of construction in both States. Worse than this, a State which has no such law becomes a common dumping ground for all the old worn out and unsafe boilers that are condemned and put out of service by the States that have such laws.

On account of this lack of uniformity in these laws intolerable confusion has resulted. It is a practical impossibility for boiler manufacturers to comply with all the various rules of construction embodied in so many different State laws. This condition seriously affects virtually every manufacturing interest in the United States. It affects every purchaser of a steam boiler because it increases in an unnecessary and unwarranted manner the cost of boiler construction; it affects all manufacturers of boiler material because boiler plate and other material cannot be made to uniform specifications; and it affects the makers of boiler fittings and safety appliances because they cannot be standardized.

The urgent need, therefore, of uniform laws for the construction and safe operation of boilers is apparent.

It order to make it possible for each State in the United States to adopt identical laws, not only for the construction and operation of boilers, but for examining and licensing engineers, the American Society of Mechanical Engineers, during the presidency and at the suggestion of E. D. Meier, appointed a committee consisting of seven members as follows: A consulting engineer, former member of the Massachusetts Board of Boiler Rules, and two professors of engineering representing the steam users' interests; two boiler manufacturers representing the boiler makers' interests; a steel manufacturer representing the boiler material interests; and an insurance engineer representing the interests of the boiler insuring companies. The committee used as a basis for discussion the rules that have for several years worked so satisfactorily in practice in the States of Massachusetts and Ohio, and which were acknowledged by all interests to be the best rules then in existence. Numerous meetings of the committee were held, during which these rules were deliberated upon and then modified or added to in accordance with the best information obtainable by the committee and in accordance with the committee's best judgment. The committee then prepared a first preliminary draft of the rules for construction, some 2,000 copies or more of which were sent to professors of engineering in technical schools, superintendents of inspection departments of insurance companies, chief inspectors in charge of United States, State and municipal boiler inspection departments, prominent engineers known to be interested in the construction and operation of steam boilers, prominent manufacturers of steam boilers, and editors of prominent engineering journals. A letter was sent with each copy requesting the recipient to carefully read the preliminary report and then to give the committee the benefit of any criticisms or suggestions he had to offer. All replies were given careful consideration, and at the spring meeting of the society, held in St. Paul, on June 16 to 19, 1914, it was decided to invite all interests affected to appear at public hearings to be held in the Engineering Society's Building in New York, beginning September 15, 1914. These hearings were the means of bringing together representatives of the steel manufacturers, of the railways, of the boiler manufacturers, of the American Society for Testing Materials, of the Heating and Ventilating Engineers, of the National Association of Stationary Engineers, and of other associations and interests. These hearings developed into one of the most important movements ever undertaken for the protection of human life and property.

It is especially worthy of mention that at these hearings uniform specifications for boiler steel and other material were agreed upon; uniform specifications for boiler tubes were agreed upon; uniform rules for safety valves were agreed upon; uniform rules for firetube boilers were agreed upon; uniform rules for watertube boilers were agreed upon, and uniform rules for steam and hot water heating boilers were agreed upon.

It may be noted that the factors of safety recommended for stationary boilers are somewhat higher than those required by the Government for railway locomotive boilers. This is in no sense a criticism of the requirements of the Interstate Commerce Commission, but is based upon the judgment of the committee, that a higher factor should be used for stationary boilers—first, because not every stationary boiler is built in a modern shop under careful engineering supervision; second, because not every stationary boiler is in charge of an operator so skilled as a thoroughly experienced locomotive engineer; third, because stationary boilers are so bricked in and so constructed that their condition cannot so readily be determined; and finally because locomotive boilers are required by law to be inspected not less than once a month. For these reasons the committee is of the opinion that while a factor of safety of *four* affords ample protection for railway locomotive boilers a higher factor of safety is required for stationary boilers.

It is hoped that by the universal adoption of this proposed Code better and safer boilers will be produced, and that the saving of human life which should be brought about by the adoption of these standards will in itself more than repay all who have aided this work.

The Boiler Maker

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NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Attention is called more than once in this issue to the desirability of spacing the tubes in a fire-tube boiler in such a way that not only will the steam generated have a free passage through the water in the boiler to the steam space, but also so that the outer surfaces of the tubes can be easily and thoroughly cleaned of any deposits or accumulation of scale.

There are several ways in which the tubes can be spaced, but the best arrangement is in vertical and horizontal rows equally spaced. By staggering the holes a greater number of tubes can be placed in a given area of the tube sheet, although it becomes more difficult to get at the outer surfaces of the tubes and keep them clean. In locomotive boilers it was considered at one time highly desirable to crowd in as many flues as possible for the sake of the added heating surface gained, but later investigations have shown that one square foot of firebox heating surface is over seven times as valuable for the generation of steam as one square foot of tube heating surface, and with this truth established the overcrowding of tubes in a boiler has been given up.

It should not be forgotten that the value of tube heating surface rapidly diminishes as soon as the tubes become coated with scale, and especially when the spaces between the tubes become filled with mud and sediment. If it is impossible to reach all of the tubes and clean out the scale and deposits, either mechanically or by washing, the disastrous effects are soon apparent in the form of burned and leaky tubes and tube sheets. In the case of locomotive boilers, where "good" feed water is the exception rather than the rule, the great quantities of impurities that enter the boiler must be removed immediately in order to prolong the life of the flues and flue sheets and reduce the time that the engines are kept out of service for boiler repairs and renewals. As long as the heating surfaces of the boiler are kept perfectly clean a large share of the boiler troubles are eliminated and it is by the proper spacing of tubes that much of this can be accomplished.

While wider spacing of flues gives a better opportunity for the mud and other impurities to fall down between the flues so that they can be removed more easily, it is also beneficial for the flue sheet. With close spacing of flues and narrow bridges between the tube holes, and especially with the flues crowded up to the flange of the flue sheet, cracks are liable to develop in the flue sheet, caused by burning due to scale formation on the sheet or by the distortion of the sheet, due either to unequal expansion or contraction or to the setting of the flues.

Discussion of the preliminary report of the boiler code committee at the annual meeting of the American Society of Mechanical Engineers, held early this month in New York, was concerned chiefly with the part of the report containing the rules for the construction and installation of steam boilers. The discussion lasted through six separate sessions and each paragraph of the report was taken up in its minutest details. The report is now in its fourth printing, and it is probable that the fifth printing, containing the revisions and corrections of the previous issues, will be available early in the year 1915, although it will not be brought up for action by the society until its summer meeting in Buffalo next June Considering the fact that the next printing of this boiler code will represent five revisions of the original code which has now been before the public for over a year, it is likely that the fifth printing of the code will be adopted at once in a number of States where boiler rules are now pending, as, for instance, in Tennessee, Pennsylvania and Wisconsin, and in the States where boiler rules are already in force, such as Massachusetts and Ohio. How far the work of this committee has progressed can be seen from the fact that at the previous hearings uniform specifications for boiler steel and other materials, uniform specifications for boiler tubes, uniform rules for safety valves, uniform rules for firetube and watertube boilers, and uniform rules for steam and hot water heating boilers were agreed upon. That the boiler code finally adopted will be subject to further change and revision is of course inevitable, but it is fully expected that this standard will keep step with all new developments in steam boiler practice, and that it will be one of the most important contributions to steam engineering that has been made for many years.

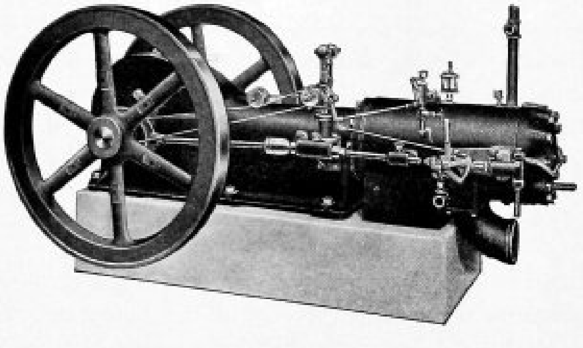
Engineering Specialties for Boiler Making

Air Compressor Driven by Heavy Oil Engine—Power Bending Machine for Light Sheet Metal

The "Giant" Low Grade Fuel Oil Engine

The "Giant" low-grade fuel oil engine is the result of several years of painstaking development in the internal combustion engine field by the Chicago Pneumatic Tool Company, Chicago, Ill. The engine has no valves, gears, carburetors, mixers, oil or air heaters, magnets, batteries, timers, switches, coils, wires or spark plugs, and, it is claimed, will operate successfully on practically any grade of liquid fuel from crude oil to gasoline.

The cylinder is of the valveless, two-cycle, low compression type, having water jackets cast integral with the cylinder. Like the cylinder, the head is made of the best close-grained cast iron obtainable, and is a single-piece casting thoroughly jacketed. The piston is of the trunk type and is provided with four self-adjusting eccentric spring rings. These rings are wider than the admission and exhaust ports, and, it is claimed, cannot catch or break, effectually securing the compression, which accounts for the efficiency of the engine. The deflector is of an improved form, developed by experiment, and tends to promote more perfect scavenging of the cylinder at each stroke. A piston rod and crosshead with guide removes from the piston the angular thrust of the connecting rod, with its tendency to wear the top and bottom of the cylinders more than the sides. With the crosshead type all bearings are accessible, and by compressing in the front end or extension of the cylinder, instead of in the crank case, better compression is secured and the compression space is greatly reduced. Lubricating oil from the crank case cannot possibly enter the combustion chamber. This better compression also has a decidedly advantageous effect on scavenging.


"Giant" Heavy Oil Engine

The method of igniting the fuel charge is positive and extremely simple, with no delicate parts involved and no sensitive adjustments necessary. A thin, circular plate is rigidly secured to the piston, and after the engine is started fuel injected against this plate, which becomes hot, is instantly gasified and ignited. By this system, it is claimed, air only is compressed by the cylinder, the fuel is injected at the proper time, and high sustained operating economies are possible.

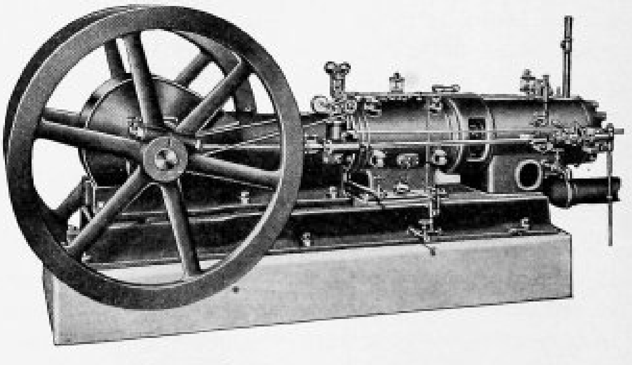
In the fuel pump, which is of simple construction, the method of regulating the stroke of the plunger is extremely efficient and meets all the requirements imposed by widely varying loads. A cam under the control of the governor rests against a collar on the plunger rod, the position of the cam determining and regulating the stroke of the pump, and consequently the quantity of fuel injected. A hand-operated lever, also acting on the plunger, is provided for stopping the engine.

The fuel nozzle, a combination ball check valve and nozzle, is made of bronze and screwed into the center of the cylinder head. It can be quickly replaced and can be cleaned without removing from the cylinder head.

The water regulator of the Giant A-O engine is nothing more than a needle valve, which is at all times under the control of the governor and automatically varies the admission of water to meet load requirements. Removable oil-tight covers in a completely enclosed frame provide ready access for inspection and adjustment.

The main bearings, of the diagonal box type, are of large proportions and are cast integral with the frame. The crank shaft is of the center crank type, of the best open hearth steel forging, and is well balanced with center balance weights. Extra large flywheels are used to facilitate starting, and are of sufficient weight to insure easy and steady operation. All of the smaller engines may be readily started by hand, but for the largest size and for smaller, when desired, a small vertical single-acting air compressor is provided, which is driven from a pulley bolted to the flywheel. This compressor delivers air to a storage receiver, suitable for 150 pounds working pressure, and a lever-operated, air-starting valve permits running the engine on air until firing of the fuel charges begins.

The engines are built in four standard strokes, 8, 10, 12 and 14 inches of 12, 18, 25 and 45 brake horsepower respectively. They are also built in duplex or twin construction in 24, 36, 50 and 90 brake horsepower respectively.

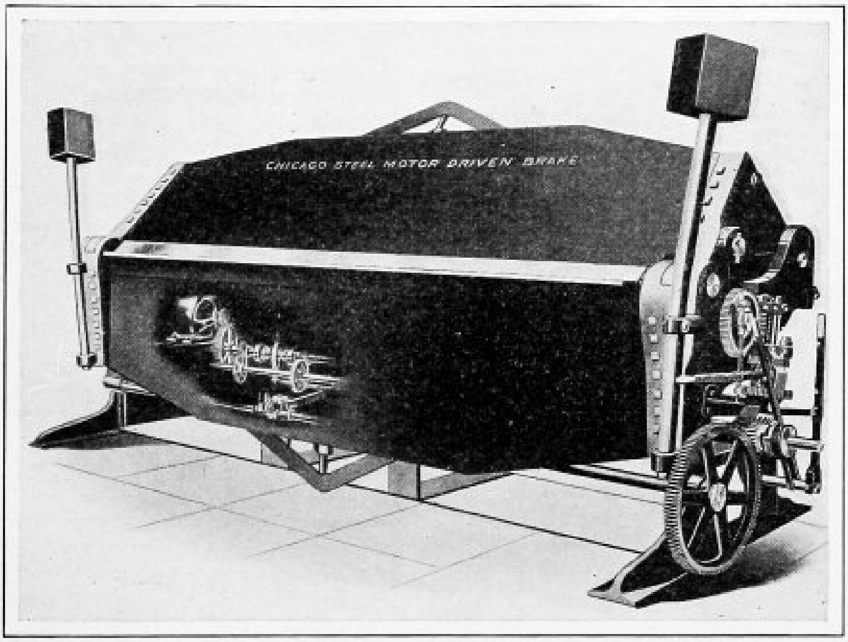

"Giant" Oil Engine Driven Compressor

In their new type N. S. O. compressors, the Chicago Pneumatic Tool Company has combined the power cylinder of the "Giant" fuel oil engines and the air ends of the type N compressors with Simplate flat disk valves. In general they are built on the well-known lines of the Chicago Pneumatic gasoline-driven compressors and are adaptable to stationary, semi-portable or portable use. Their adaptability to any fuel oils above 28 degrees Baumé, together with the inclosed construction, automatic lubrication and regulation, and freedom from the necessity of expert attendance, enable these machines to meet the requirements of many services which have formerly precluded the satisfactory employment of compressed air. These compressors are offered in four standard sizes in strokes of 8, 10, 12 and 14 inches, having capacities of from 70 to 300 feet.

Improved Heavy Power Bending Brake

The Dreis & Krump Manufacturing Company, 2909 South Halsted street, Chicago, Ill., has placed on the market a motor-driven bending brake with a capacity to handle plate up to one-half inch in thickness in 16-foot lengths. The machine is driven by a 20 horsepower motor and the clamping, elevating and bending adjustments are controlled by levers actuating sets of gears and clutches.

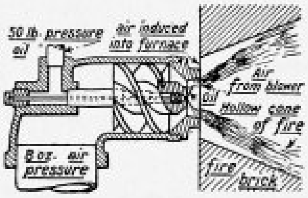
The bending leaf is actuated by a segmental rack, with cut teeth, meshing with a pinion on the lower shaft. It is claimed that by this arrangement the strength of wide steel plates is utilized, the strain in operation being delivered against their edges. The hinges and other end parts are made of steel castings, which are relied upon to prevent breakage. The angle of the bend is controlled by an automatic gage consisting of a sliding collar on the steel rack, which raises the apron. When the apron is brought up to the point at which it is desired to stop the bending, the collar comes in contact with a lever that acts directly on the pulley clutch. A portion of the upper edge of the apron is removable, which enables close reverse members to be bent. The clamping device is actuated by a miter gear from the driving shaft, the power being transmitted to a manganese bronze worm gear which is on an eccentric. The raising and lowering of the top jaw is controlled by a lever engaging a clutch at each end. An adjustment, consisting of an eccentric within the connecting link, is provided for different thicknesses of material and for sharp and rounding bends. The revolving of the eccentric increases or decreases the pressure on the sheet or plate being handled, while set and draw screws regulate the movement of the upper jaw forward or backward.



The Stilz Fuel Oil Burner

A fuel oil burner in which the pressure on the oil is utilized directly for the atomization of the oil has been developed by H. M. Stilz, 1938 North Marvine street, Philadelphia. The burner comprises an inner nozzle through which the oil is delivered under a pressure of 50 pounds per square inch. The passageway in this nozzle is terminated at the delivery end by a small orifice in which is a spiral. The oil is guided around this spiral, effecting a violently whirling jet in the orifice, causing the oil upon delivery to spread out in a cone-shaped film.

Surrounding this nozzle is a casing inclosing a large spiral through which air or steam is forced under about eight ounces pressure. The air or steam is finally delivered from a restricted discharge orifice in a whirling current which causes the air to assume the form of a hollow cone-shaped film having a backward suction at its center. This suction draws the oil film into the whirling current of air, and, being the heavier fluid, the centrifugal force throws the oil toward the outer edge of the air film. The air from the blower, therefore, it is claimed, penetrates the mechanically atomized film of oil, and the oil and air in a finely divided state are intimately mixed. By varying the shape of the bell-mouthed outer orifice any shape of flame desired can be produced from a short one of large cross section to a long one of small cross section, so that the burner can be adapted for any type of furnace.



The burners are supplied in all sizes ranging from a capacity of less than a gallon of oil per hour to 400 gallons per hour.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Rolling Boiler Tubes

Very often little boiler kinks leak out that are of great value to the manufacturers. They most frequently emanate from the man who does the work, but who seemingly does not realize the value of his idea to the boiler trade in general. A man invents the method, sees that it is useful, uses it himself, but tells nobody else about it because he thinks it of no particular value.

I was informed recently of a little kink that may be of interest to boiler makers in regard to the matter of the correct time to stop when rolling tubes into the tube sheet.

It is not uncommon to hear of tubes that are rolled so much that the roller cuts through the tube, or tubes that are rolled too thin and too weak. The man to whom I refer says that he rolls the tube gradually—not too fast—and continually feels the inside with his fingers. When the inside of the tube is smooth, of the same smoothness as that of the former tubes successfully rolled, he quits and starts work on the next tube.

I do not know of a better method than this, yet it is not as positive as we would like to know. It involves judgment, the sense of touch, but we must get along with it until a better way is discovered.

Perhaps readers of The Boiler Maker do know of a better method, if they will only tell it.

New York. N. G. Near.

How and Why I Taught Boiler Design

Just a few years ago I was busily engaged teaching the young how to design boilers. I didn't know how to design them myself, never having had any experience in a boiler shop or designing room, but that doesn't seem to make much difference in many of our colleges. All they want is "somebody to teach boiler design" in connection with a vast quantity of other teaching work, so I taught everything from mechanical lettering to boiler design and experimental engineering. We often called our courses the "Theory and Practice of ———" (whatever it might happen to be). We stopped at nothing. I had been taught by my college professor to tackle anything. "It takes nerve," he said, "to succeed," and so I believe I would have tackled a course in "The Internal Anatomy of the Atom" had I been called on to teach it. I am told that some of my pupils considered me a wise gazabo.

I am reminded right here of the young fellow—a one-time acquaintance of mine—who boasted about how he "got away with it." He graduated from college after studying mechanical engineering, and, in accordance with the wisdom of his professor, he started out to climb the ladder right from the bottom.

His idea of the bottom of the ladder was to be in charge of a large battery of boilers. He had tried shoveling coal in a college laboratory test and decided that such work was too easy and required no skill. He had a brain, had developed it in college, and insisted on using it from the start. How he did it I do not know, but he succeeded in landing a job as assistant engineer in charge of boilers at a pretty fair salary for a beginner, and he boasted, as I have already said, about how he "got away with it." He did not have to "work up" to that position at all.

However, the man who employed him made a mistake in doing so. A semi-serious boiler explosion occurred which did not kill anybody and which was quickly repaired, but investigation led directly to the fact that my friend had erred in manipulating the valves. He was ignorant of practice. So, after being duly taught that a college graduate does not necessarily know all about boilers, the employer "got away with" the ambitious young climber who would have started above the bottom of the ladder had the job been more permanent.

Our college training follows the "bluff groove" very closely. We bluff our way through college, and therefore think we can bluff our way through practice, but practice is not so easily mastered without experience. Although our theories may be perfect, it does not necessarily follow that we can practice perfectly. A man who knows all about the theory of music, for instance, perhaps cannot play at all. He may be blind, armless or legless.

So when I taught boiler design I "read up" very carefully on the subject. I had "designed" a boiler when I was a student and I possessed the title "assistant professor." Why shouldn't I know as much as there was to be known about boilers?

All that I read I remembered long enough for my lecture on the following day. I knew how to compute stresses and all that, and I had a good general idea concerning the "appearance" of a boiler. I followed a certain text-book to the letter—a book written by another professor—and thus managed to "get away with it." I have never actually designed a boiler used in practice, have never fired a boiler outside of a college, and have never worked in a boiler shop. Yet I taught boiler design because it had been taught me, and it was considered my duty to teach it in the engineering curriculum of the above college.

Thus it is that so many boiler designers get the wrong conception of design right from the start. The teacher, who is incompetent, perhaps, allows him to slide over his work. Faulty design in college goes undetected. The teacher, and therefore the student, does not know that it is possible to make a water leg too narrow, that in some cases even six inches might be too narrow. Foaming is an unthought-of factor. Judgment says, "The leg will always be full of water." That tubes can be improperly arranged is unthought of when the text-book so plainly states that "tubes must not be closer than — inches to the curvature of the tube sheet." Stays are "stuck in" almost blindly. The whole thing becomes a text-book-made boiler that "might" work and might not. Most boilers do, for a time, as long as they are water- and steam-tight.

Now, I am not making sport of text-books and professors. I am simply telling the truth about my own personal experiences, and from those experiences I draw inferences that I believe are worthy of some thought. Text-books and colleges are necessary, and instruction by even such an instructor as myself would be better than none at all, but just to tell the boiler manufacturers about college conditions I have up and confessed. Perhaps it will cause him to scrutinize the young graduate's work a little more carefully and eliminate some of the errors in design that so often creep in.

I hold that we should tell about our shortcomings and failures as well as about our strong points and successes.

New York. Ex-Professor.

Laying Out a Throat Sheet

In this article the writer will deal with the layout of a throat sheet after flanging, as that part of the layout is usually harder than the layout before flanging. It is quite a trick to put every hole in a throat sheet and put the sheet in place and have the holes come fair. The writer has been in quite a few shops where the sheet is flanged and only two or three holes put in. The sheet is then beaten and forced to place with screw jacks and drift pins and the remaining holes marked. The sheet would then be taken out again and the holes punched on the horizontal punch. This procedure certainly requires a lot of unnecessary work, and as it is a common thing to hew great stones at the quarry to fit in buildings hundreds of miles away, why should we not get out a throat sheet with all the work completed so that it can be put in at once to stay?

Looking at the side and half front views shown in Figs. 1 and 2, we will assume that the sheet has come to the laying out bench to be marked off and that the flanger has had blocks and templets to work by, so that the sheet will be a good, fair job of flanging. Before the sheet went to the flanger, the centerline was marked with three small center punch marks shown at *C C*, so that after the sheet is flanged it is an easy matter for the layer out to relocate the centerlines and check up the sheet. Then the line is drawn for the top row of mud-ring rivets by measuring 16 7/16 inches down from the flange. By using a square from the centerline the bottom row of rivets is drawn in just 1½ inches below that. It should be noted that these two lines have been marked with center punch marks to facilitate the checking up.

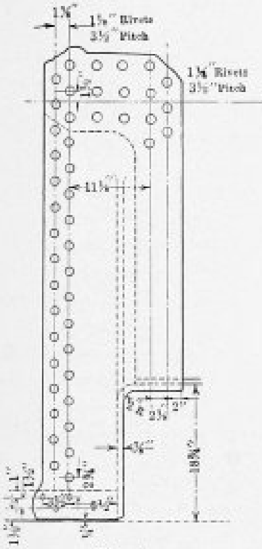


Fig 1

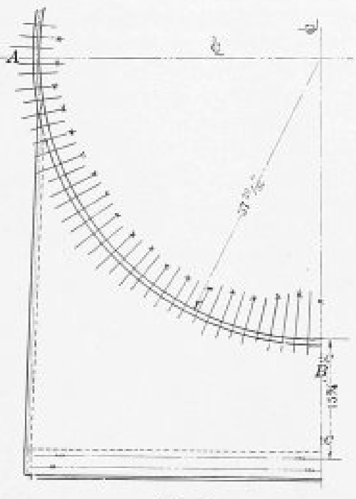


Fig. 2

The next part of the job includes a trip to the tin and jacket shop, where a piece of the thin iron that is used in bundling up the planished iron used for jackets is obtained. Referring to Fig. 1, it will be noted that the radius from the centerline to the bottom of the throat sheet is 37 29/32 + 18¾ — ¼ = 56 13/32 inches, and that the side sheet extends about 6¾ inches above the centerline. The side sheet, however, will be a little longer, as it is a slanting line, or the hypotenuse of a triangle, so it should be measured in the layout along the neutral line. It will be found to be 56¾ inches.

This distance should be laid off on a thin piece of iron, and also the two rows of 1⅛-inch rivets 1⅞ inches apart should be laid out; then measure over 11⅛ inches to the center of the first row of rivets that is to go around the girth and 2⅛ inches from that line to the centerline of the next row of rivets. As our radius is 37 29/32 inches, and the sheet ⅞ inch thick, the diameter of the girth will be 77.562 inches. This, multiplied by 3.1416, gives a circumference of 243.668 inches. Dividing this by 4 gives 60.917 or 60 59/64 inches, the distance around the girth from *A* to *B*, Fig. 2. These figures, however, are purely theoretical and the sheet will actually be slightly smaller, as it will take up some in flanging.

Returning to Fig. 3, lay off the length 50 59/64 inches. In Fig. 2 all the lines marked "*x*" are the rivets that come in the outer row and the others in the inner row, so that the bottom center rivet is in the outer row. Mark this off on the sheet, and just below the centerline a distance of ¼ inch is another hole; this will be laid off next, and then we have seventeen equal spaces between these holes. These holes can now be laid off, and also the holes in the next row, only these should be moved up half a pitch.

Having laid out all the rivet holes, cut out the opening *D* and make this opening any width you desire, although it should be wide enough so that the edge, *F*, of the pattern will not strike the root of the flange at the 2-inch radius. The edge, *E*, must be cut so as to come flush with the face of the sheet.

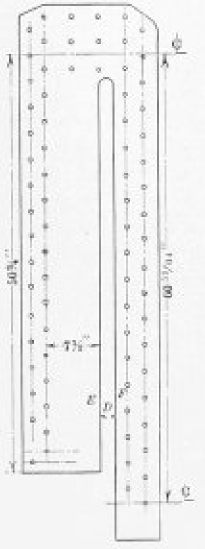


Fig. 3

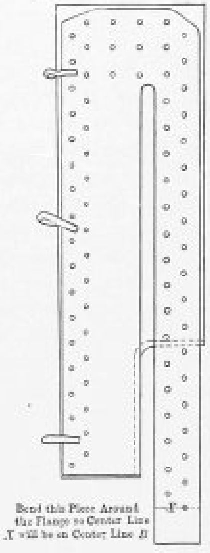


Fig. 4

Fig. 4 shows the sheet with the pattern held in place by three spring clamps, the part of the pattern that goes around the girth flange hanging free. Now bend this part around the flange so that the centerline *X* of the pattern will be on the centerline *B* of the sheet and clamp it there. This will probably be a loose fit; for, as stated above, we have made no allowance for the stretch of the material in flanging. This looseness is taken care of easily by several small wooden wedges placed so as to hold the pattern at an equal distance from the sheet. The holes are now marked off and also the outer edges of the pattern marked, as the sheet will be clipped to these marks.

The pattern is now transferred to the other side, which is marked off in the same manner. In the foregoing nothing has been said about the staybolt holes, but these could be easily laid off from the drawing. A pattern like this is especially useful when a number of any one kind of boilers are to be built. It is also applicable to old work where a throat sheet must be renewed. The pattern in this case is made directly from the old sheet.

BENT FULLER.

Safety First

While visiting the exposition held in Pittsburg recently, my attention was drawn to one booth in particular, the exhibit of one of our large local concerns wherein were shown various contrivances for the prevention of accidents at their mills, machine shops and on their railroad. To judge by the cost of such an exhibit, they must be very much in earnest and sincere in their desire to prevent accidents that may cause the loss of life or limb of men in their employ.

The simplicity of some of those accident-preventers is so striking that the writer wonders why some genius had not discovered them years ago, and avoided the loss of life that happened so often before their use. Take the railroad frog. How many feet, legs and lives have been sacrificed by persons being caught and held fast while a rapidly approaching train does the rest? Now this is a thing of the past, for by the insertion of a little block between the rails it is impossible for a man's foot to get caught in a frog; especially is this so in the immense yards of this corporation.

Passing over the guards and shields attached to trains of rolls in the mills, which make it quite safe to work around these dangerous places, we come to the machine shop, where we find a very simple affair, consisting of a frame fastened to the tool rest of a lathe. This frame holds a sheet of clear, white glass, which prevents the hot cutting from flying into the face or eyes of the operator, guarding him from serious accident. Here they have devices for throwing off belts, wheel guards for all geared wheels, and it is almost impossible to get caught now in what was formerly a source of constant accident.

Another very interesting exhibit was books of photographs of broken goggles worn by men in various capacities, the wearers escaping injury. Here it may be remarked that this company provides goggles for all men engaged in any occupation where there is the least danger of injury to the eyes. These glasses are of a fine quality, ground to suit the eyes, and can be properly adjusted to almost any eye. They cost the company $2.50 per pair. Many of the men are afraid to use them, thinking they will injure their sight; but this is a mistake and is soon overcome. From the same source I am informed that there is to-day in the United States an army of some 80,000 half-blind men. Think for one moment of this large body of men going through life with but one eye, and many of them in constant danger of losing the other, and you will agree with me that it is high time that men wear goggles or glasses of some kind to save their eyes.

And now comes the thought, how many of this large army of half-blind men are boiler makers? Look around among your friends and shopmates, and I am sure you will say with me that fifty percent is short of the mark. I for one am glad and bless the day that the law, or the good will of the employers of labor, realizes the dangers that men are exposed to and are providing means to prevent, if not diminish, accidents.

Not many years ago the writer was working on a job in the smokebox of a locomotive, and wore a pair of goggles to save his eyes. I was ridiculed for doing so, and was asked if my eyes had gone back on me. My eyes were good, but it was my duty to myself and family to take care of them. I say again that I am glad that it is now possible for a boiler maker to use glasses of some kind to protect his eyes without causing comment.

There are no mechanics engaged in the engineering trade so liable to the loss of one or both eyes as the boiler makers. Some years ago a friend and shopmate of mine was severely injured in one eye. The doctor said that the eye was like a pane of glass hit with a small stone, shattered, and when the injured eye was healed it was hard to believe that the eye was injured at all. Returning to work some time after, he again received an injury to the other eye, losing the sight completely, but, strange to say, the injury could scarcely be detected. The eye first injured was now treated and a glass fitted, and the poor fellow was able to see about three yards before him and in this condition he returned to work, ending his days doing anything that was possible for him to do.

There are other things to be guarded against in the modern boiler shop. The electric crane is almost constantly a source of danger to life and limb. The writer knows of three deaths in three different shops, and at places widely apart, which could have been prevented if proper measures had been taken. The first case was that of a man being sent to remove some pulleys near the crane runway; while busily engaged, and not thinking of danger, the crane backed down, catching the man between the craneman's cab and one of the columns. His skull was fractured and he died shortly after.

The second one was that of a pipe fitter repairing high-pressure pipes leading to the hydraulic press. The pipes were covered on the girder just below the crane track. To make the repairs he had to lean over the track, and in this position was caught and cut in two.

The third case, that of two men repairing some windows on a level with the crane track. No doubt thinking themselves safe, they paid no attention to the crane and they were caught between the truck and the wall. One man was killed outright and the other received a severe shock. Had the cranesmen been told that men were working in those dangerous places, and that they were not to move their cranes before satisfying themselves that the men were out of danger, those three fatal accidents could not have happened.

Men entrusted with the fastening of hooks and chains to boilers to be turned over or carried across the boiler shop, cannot be too careful in inspecting the chain for fractures, for many a chain has broken, dropping the boiler and causing injury to those unfortunate enough to be caught, not saying anything about the destruction to property.

I think that all cranes should be provided with bells. which the operator should ring, either by hand or electrically, and danger signals should be put in such a position that it would be impossible for the operator to move his machine without seeing them, and thus prevent accidents.

Compressed air is another source of danger, and some shops have signs posted at all air connections, warning men not to fool with them, for there have been several fatalities within the last few years in this district; and when air is compressed to 800 pounds and 900 pounds per square inch, it is a thing to be left severely alone by those not compelled to handle it.

The pneumatic riveting hammer is another dangerous tool in the hands of a careless or inexperienced workman, who may forget to release the trigger before taking the weight of his body off the hammer, with the result that the die and the piston are shot across the shop, injuring some one or other. Here I would like to say that in my experience with air hammers I find the ones with the inside trigger the safest for all purposes, for it is almost impossible to lose control of this tool, and when laid down there is no danger of kicking the trigger and firing the gun and injuring yourself or partner.

Another source of danger to the boiler maker is the oil burner very common now in our shops. Many serious accidents have happened through the careless handling of this tool. Some men seem to think that being entrusted with a tool of this kind gives them license to shoot scalding oil broadcast over the shop. One very serious accident of this kind the writer was an eyewitness to. Some repairs were being made to a tank, the oil torch being used to get the plates hot. When the plates were hot enough the burner was laid one side by the man using it, but another man picked it up, turned the valve, and sent the boiling oil all over one man, disfiguring him for life. Had the burner been left alone when laid down there would have been no accident.

The boiler maker is exposed to many dangers and anything that will lessen those dangers should be welcomed by him.

Pittsburg, Pa. Flex Ible.

Incrustation—Water Impurities

The hard scale formed by the accumulation of sediment from the feed water is called incrustation. The solid matter of the feed water is precipitated by the use of temperature or is left behind by evaporation. This solid matter, unless blown out, becomes hardened and forms a scale. It is not so much the amount as the nature of the solids that affects the quality of the feed water. Where proper care is given to blowing off the boiler, the presence of a certain amount of carbonate or chloride of soda would not be injurious, while the same amount of salts of lime would cause much trouble. The salts of lime are the most common, such as the sulphates and carbonates. Carbonate of magnesia is also common, as well as some organic impurities.

Water may be divided into two classes. That containing lime in solution is known as hard water, while soft water contains but little matter in solution. The carbonates of lime and magnesia are held in solution by an excess of carbonic acid. When water is heated and the excess of carbonic acid is driven off, most of the carbonates are precipitated in the form of whitish or grayish mud. As the temperature increases, the solubility decreases and at the boiling point it is scarcely soluble. When the carbonates are unmixed with other impurities, they may be washed out of the boiler after it has been allowed to cool. If organic matter, sulphate of lime or oil, is present, the deposits are likely to become hardened. Sulphate of lime is precipitated in the same manner as the carbonate when the temperature rises. If a little soda or soda ash is mixed with the feed water, carbonate of lime is precipitated in the form of a white powder and may be blown out. The soda should be introduced at regular intervals and the quantity required will depend upon the kind and amount in the water. The soda is dissolved in water and pumped into the boiler with the feed. An excess is likely to cause foaming and often sticks in the water glass. Sulphate of lime causes a hard crust or scale, the hardness depending upon other impurities and the temperature. If water containing lime forms a hard scale, the sulphates are present and the amount of soda to be used must be determined by trial. The deposits of carbonate of lime are soft and granular and of a grayish color.

Salammoniac is sometimes used to break up the lime compounds, but is not always desirable, as it may break up the chlorides and form free chlorine, which acts on the plates. Carbonate of magnesia is not so common as the salts of lime. When the feed water contains iron salts, the incrustation is of a reddish color. Water containing these salts is very injurious to the boiler plates. Brackish water containing chloride of magnesia is also injurious, for when heated the chloride decomposes, forming magnesia and hydrochloric acid, which rapidly corrodes the iron. The scale is usually made up of layers of varying thickness and of different degrees of hardness.

Charles Miller.

Albany, N. Y.

Personal

John W. Waters, formerly with the Kingsford Foundry & Machine Works, Oswego, N. Y., has been appointed inspector of boilers at San Juan, P. R.

Duncan B. Russell, treasurer of the James Russell Boiler Works, and also treasurer of the New England Association of Boiler Manufacturers, died Monday, November 30, at his home in Boston.

C. W. Crosier, of Baltimore, Md., has accepted his former position as superintendent and assistant manager of the Tulsa Boiler & Manufacturing Company, Tulsa, Okla. Mr. Crosier will begin his duties at Tulsa on January 1.

H. C. Hequembourg has resigned as general purchasing agent of the American Locomotive Company, New York, and until further notice the purchasing and storekeeping departments of this company will be under the jurisdiction of Mr. Leigh Best, vice-president.

Charles S. Blake, secretary of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., gave an interesting lecture on "Boilers and Boiler Explosions," illustrated with stereopticon views, at a meeting of the American Institute of Steam Boiler Inspectors in New York city on November 27.

John H. Smythe, boiler expert, has entered the service of the Lukens Iron & Steel Company, Coatesville, Pa. Mr. Smythe is well known to boiler makers throughout th country as a former president of the Master Boiler Makers' Association, and through his many years' service as foreman boiler maker for the American Locomotive Company at Paterson, N. J., and Schenectady, N. Y. In his new position he will devote his attention to the railroad work of the Lukens Company, and also to the interests of the Jacobs-Shupert firebox, manufactured by the Jacobs-Shupert United States Firebox Company, New York.

John A. Stevens, chairman of the Boiler Code Committee of the American Society of Mechanical Engineers, has had a varied career, both as a marine and stationary engineer and as a consulting engineer. He was born in Galva, Ill., in 1868, and was educated in the public scools, spending one year at the University of Michigan. After a three-years' apprenticeship in the machinist's trade, he served as engineer on a number of lake steamers, being granted an unlimited engineer's license of the highest class for ocean service when he was only twenty-seven years old. In 1893 he entered the employ of the International Navigation Company, and while in their service he became first assistant engineer of the U. S. M. S. *St. Paul*. From 1896 to 1909 Mr. Stevens was chief engineer of the Merrimack Manufacturing Company of Lowell, Mass., one of the largest cotton mills in the country, after which he took up the practice of consulting engineering. For six years Mr. Stevens represented the boiler-using interests on the Massachusetts Board of Boiler Rules.

Selected Boiler Patents

Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

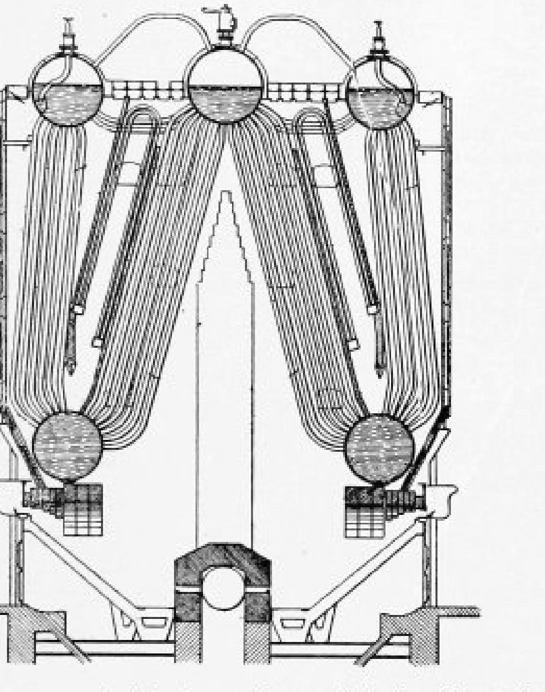
Readers wishing copies of patent papers, or any further information regarding any patent decribed, should correspond with Mr. Decker.

1,101,084. BOILER-PLUG. EUGENE J. McCARTY, OF CLINTON, MASSACHUSETTS, ASSIGNOR TO MAX MACHINE COMPANY, OF CLINTON, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

Claim 1.—The method herein described of plugging the ends of cylindrical boiler tubes consisting in inserting the plug while cold into the tube while the tube is expanded by heat and keeping the tube heated until the plug has become heated to the same temperature as the tube, the plug having a plurality of diameters, the inner one of which when cold fits the bore of the heated tube with a wedging fit and the outer end of which when cold is minutely smaller than the bore of the heated tube, whereby when it thus becomes heated to a temperature equal to that of the tube it will have become expanded sufficienty to cause it to become permanently locked in the tube and have a continuous contact with the inner face of the tube throughout its outer or peripheral surface. Three claims.

1,106,453. WATER-TUBE BOILER. DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim 1.—In combination, a steam boiler, a furnace therefor, a bridge wall having openings therein, and means for admitting air through said openings so as to make it impinge on the top of the fire adjacent the bridge wall for the purpose described. Six claims.



1,102,139. GRATE. ARCH B. COATES, OF ELLSWORTH, KANSAS, ASSIGNOR BY DIRECT AND MESNE ASSIGNMENTS, TO ECONOMY FORCED DRAFT SLACK BURNER COMPANY, OF ELLSWORTH, KANSAS.

Claim 6.—In a grate construction, the combination with supports for a grate, of a plurality of hollow grate bars positioned upon the supports, said bars being rectangular in cross section and having laterally directed spacer flanges along their lower edges to space their body portions apart, the spacer flanges of each bar bearing against the spacer flanges of adjacent bars, a packing of asbestos filling the entire space between the grate bars and resting directly on the spacer flanges, said grate bars being formed in their upper wall with draft openings, and a swinging closure for the front end of each grate bar. Six claims.

1,106,036. SUPERHEATER. ERNEST H. FOSTER, OF NEW YORK, N. Y.

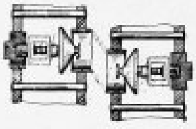
Claim 1.—The combination with a water-tube boiler having a plurality of banks of vertically extending tubes in series as regards the passage of the furnace gases, baffles between the banks for defining the path followed by the gases in passing from one bank to the next, of a superheater comprising a plurality of headers and connecting superheater tubes, supported between the tubes of the front bank and the upper portion of the baffle in the rear of the same, as set forth. Five claims.

1,106,749. WATER-CIRCULATOR FOR BOILERS. JOHN TAIT, OF DUNEDIN, NEW ZEALAND.

Claim.—A water circulator for corrugated boiler furnaces comprising a plate straddling the furnace and having portions conformably fitting in the spaces between the corrugations in said furnace, said plate being formed with parallel upturned edges; a pair of angle-irons secured to said edges; a plate connecting said angle-irons and co-operating with the same to form an open-ended pocket, said plate being provided with an opening located at the crown of the frunace; a baffle arranged over said opening for preventing the entry and settling of sediment in said pocket; and pipes connected to the ends of said pocket.

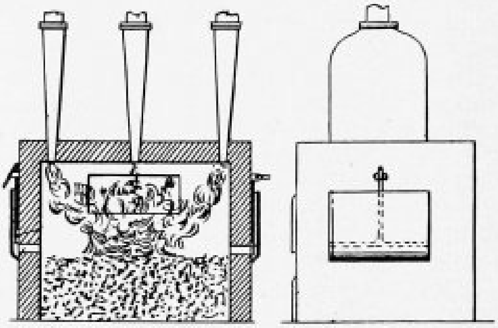
1,105,397. ARCH-TUBE SAFETY DEVICE. PAUL BOWERS, OF STARBUCK, WASHINGTON.

Claim 3.—In combination, a boiler provided with a fire-box, a tube extending across the fire-box and having its ends projecting into the boiler, and a valve closure structure for each end of the tube, each comprising a closure having a stem, an adjustable abutment nut on the stem, a guide frame adjustably mounted on the boiler and having guiding engagement with said stem, and a spring coacting with the stem and the guide frame to normally hold the valve closure away from the tube end, substantially as described. Three claims.



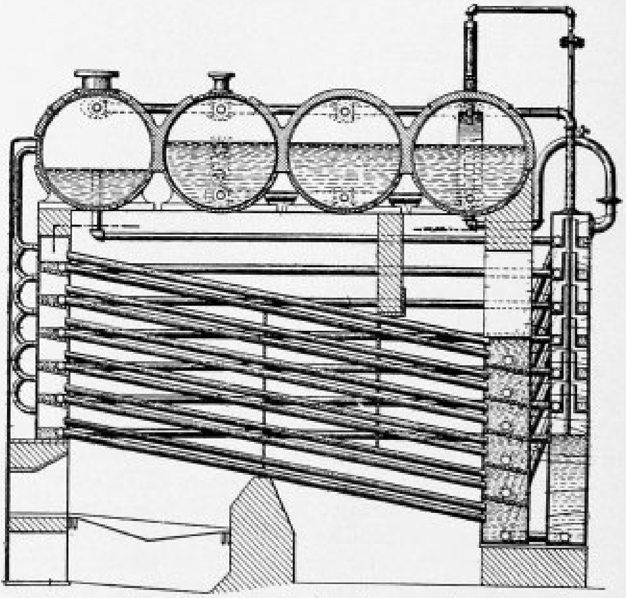
1,104,403. APPARATUS FOR UTILIZING LOW-GRADE FUELS. HENRY H. BLAKE, OF PITTSBURGH, PA., ASSIGNOR TO BLAKE CRUSHER AND PULVERIZER COMPANY, OF PITTSBURGH, PA., A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a furnace for the combustion of low-grade fuel, means for admitting pulverized higher-grade fuel downwardly into the furnace wherewith it forms a flame reverberating against the furnace bottom, means for admitting the low-grade fuel downwardly into the furnace, and means for introducing current of air laterally into said flame to force the same into contact with said low-grade fuel. Four claims.



1,109,041. STEAM GENERATOR. ALBERT A. CARY, OF NEW YORK, N. Y.

Claim 2.—In a steam generator, a plurality of banks of inclined steam generating water-tubes, front and rear headers for said banks, said tubes being substantially all inclined in the same direction, and means for admitting water to the lower end of each tube and causing the water to pass progressively downwardly through the successive banks of tubes. Fifty-six claims.



1,109,692. REFRACTORY ARCH FOR LOCOMOTIVE BOILER FURNACES.' CHARLES BREARLEY MOORE, OF EVANSTON, ILL., ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—A refractory arch brick of greater length than width, having its ends reversely inclined and having each end thereof provided with a longitudinal rib and a complementary groove parallel therewith and adapted to receive the complementary rib of a like brick, said ribs and grooves being co-extensive with said ends of the brick. Six claims.

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