THE BOILER MAKER

VOLUME XXVII

JANUARY TO DECEMBER, 1927

PUBLISHED BY

SIMMONS-BOARDMAN PUBLISHING COMPANY

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

INDEX

JANUARY TO DECEMBER, 1927

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The Boiler Maker

Volume XXVII | January, 1927 | Number 1

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

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

CONTENTS

Machine Tools in the Boiler Shop

A COMPARISON of the records of orders placed by the railroads for machine tools during the years 1925 and 1926 indicate an increasing tendency towards the improvement and modernization of shop equipment. Data compiled from reports of 97 railroads in the United States and Canada which represent 84 percent of the total route mileage account for 3,457 machine tool units ordered during 1926 which is an increase of 863 over the figures for 1925. Although an attempt has been made to segregate the boiler shop tools purchased, there are many which are of a general character and might have been ordered for the boiler shop or for some other department. For example, 296 drill presses of various types were purchased and at least a good proportion of these went into the boiler department. The same is true of grinding machines of which 346 of the double end type are listed. Fifty bolt cutters, 30 punches, 72 shears and 39 combination punches and shears were also added to equipment for the boiler and other shops.

Under the head of "flue shop machinery" are listed 16 flue welders and 11 miscellaneous machines; 17 flangers and 14 forming rolls are specifically mentioned as installed in boiler shops. Fifteen riveters were ordered, 100 blowers, 86 furnaces, 82 air compressors, 158 electric welders, 50 overhead cranes, 211 air, electric and chain hoists and a great variety of miscellaneous equipment orders were placed.

With few exceptions the 1926 orders for all of these items were greater than for corresponding machines during the preceding year. From present indications this modernization of shop equipment will continue in even greater volume during the present year.

Locomotive Inspection Report

IN general the annual report of the Bureau of Locomotive Inspection covering locomotive accidents for the fiscal year 1926 indicates progress in the direction of better maintenance. Locomotive accidents decreased 16.8 percent as compared with the records of the previous year. This decrease was accompanied by 13.6 percent fewer in the number of persons injured and by a marked decrease in the number of locomotives found defective by the federal inspectors of the bureau.

This constitutes the favorable side of the situation for as the Chief Inspector states "While there was a substantial decrease in the total number of accidents during the year our investigations indicate that a still greater decrease would have resulted had the requirements of the law and rules been complied with especially so with respect to defects, the repair of which are frequently considered unimportant."

The seriousness of the failures that occurred cannot be questioned for in spite of the general decrease in the number of accidents and injuries there was a 10 percent increase in fatalities over last year's report. Boiler failures were largely responsible for this showing so that the matter is one for our readers to consider seriously. In the

1925 report 274 accidents were traceable to the failure of locomotive boilers while in the present statement the number decreased to 247 which is favorable. However of all the serious locomotive accidents which took place 43 percent were caused by boiler failures and approximately 82 percent of the deaths resulting were directly traceable to this cause.

Crown sheet failures are given as the most prolific source of boiler accidents and the numerous illustrations accompanying Mr. Pack's report indicate the usual manner of these failures. It would seem that better maintenance and particularly more careful inspections in those instances where laxity has been shown would bring about a more favorable boiler shop record. One glaring example of carelessness is demonstrated in the portion of the report devoted to the description of typical failures. In this instance, one of the federal inspectors discovered 297 broken radial stays and staybolts lying in the water space around the firebox and combustion chamber of a single boiler. This inspector states that approximately the same condition was found on a number of other locomotives where the bolts were not removed from the boiler after being renewed.

The recommendations made for the betterment of service include the application of automatic firedoors, power reverse gears, power grate shakers, automatic bell ringers and, of prime importance, the fitting of water columns with water glass and gage cocks attached with an additional water glass located on the left side of the boiler back head. The application of audible low water alarms is also looked upon with favor as a means of reducing the number of fatal accidents caused by explosions.

Locomotive Boiler Developments

LOCOMOTIVE boiler developments of the past year were mainly characterized by a continuation of experiments with high pressures. Conventional flat sheet, stayed types of boilers, utilizing carbon steel in the construction of the firebox are practically limited to a pressure of 250 pounds per square inch. Another limitation is that of weight, for as the pressure is increased the shell of the boiler also must be increased in strength and thickness. The fabrication of heavy barrel sheets for pressures of 250 pounds becomes extremely difficult and is more of a machine shop operation than one for the boiler shop.

Three types of locomotives have been built, however, embodying various forms of watertube fireboxes which are susceptible to the use of considerably higher pressures. These include the locomotive known as the "Horatio Allen" of the Delaware and Hudson Railroad which was developed by John Muhlfeld (this boiler operates at a pressure of 350 pounds per square inch); the McClellon type of watertube boiler built for the New York, New Haven and Hartford Railroad (the working pressure in this boiler is about 300 pounds per square inch) and the new Baldwin locomotive No. 60,000.

The first two types mentioned are more or less familiar to our readers since they have been described from time to time quite fully in our pages. The Baldwin locomotive No. 60,000 has only recently been completed and will be described fully later. Briefly, it is a 4-10-2 type having a working pressure of 350 pounds per square inch utilizing the double expansion principle in a 3 cylinder engine. The firebox of this locomotive is of the modified Brotan watertube type having 82 square feet of grate area and a portion of the firebox set off by a fire wall to form a combustion chamber. Preliminary data from the tests carried out at the Pennsylvania Railroad test plant at Altoona, Pa., give a boiler efficiency of 52 percent at a boiler output of 85,000 pounds equivalent evaporation per hour up to 70 percent on outputs of approximately 30,000 pounds per hour.

LETTERS TO THE EDITOR

Deflection of Boiler Sheets

TO THE EDITOR:

I have been reading your suggested solution to the problem of the bulged crown of the firebox in the experimental doghouse boiler, in the October issue (page 302) and I must say that I do not agree with all that is said.

In the first place I always have understood that circular and cambered plates were self-staying and if that is the case, the cause of the crown sheet deflection cannot be due to the unstayed part of the boiler marked *X*.

The circular crown portion of the shell does not in my opinion need any stays at all, and these stays are only attached to the shell crown for convenience, their primary duty being to stay the firebox crown. I am bringing this to your notice because the circular portion of the shell would not be stayed if the firebox crown sheet was stayed by the old method of girder stays. I think that the cause of the trouble is due to weakness of the firebox crown sheet.

From our usual formula here the working pressure for a flat 7/16 inch plate stayed by riveted stays 7-inch pitch is given by

$$\text{Pressure} = \frac{C \times T^2}{S}$$

where C = constant = 110
T = plate thickness in 1/16 inch
S = area supported by stay.

$$\text{this gives pressure} = \frac{110 \times 49}{49} = 110 \text{ pounds.}$$

So that with 150 pounds per square inch, I can quite understand that the crown would bulge.

In my opinion the remedy for this trouble will be either to construct the firebox of thicker plate, reduce the pitch of the crown stays to 6 inches or camber the crown of the firebox.

In conclusion I must add that nuts and substantial washers each side of the firebox crown sheet would answer the same purpose and give 140 pounds per square inch working pressure with 7/16-inch thick plate.

London, England. P. G. TAMKIN.

Circular Flat Tank Heads

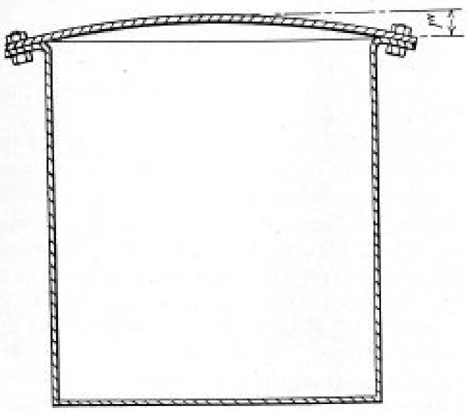
TO THE EDITOR:

With regard to the circular flat end query raised by J. G. Kirkland of York, England, in the November issue, I would point out that the rule quoted by him is one given by a well known insurance company and is quite applicable to the case in point as regards the thickness of the plate.

In my opinion, however, it is not the end plate which is at fault in this case, but the flange on the body itself. Mr. Kirkland unfortunately gives no details either of the thickness of shell plate or the construction of the flange, whether this is flanged from the shell or welded on. From the results obtained by the test, however, it would appear that the shell is made from about ⅛-inch plate and flanged outwards. My theory is, therefore, this: That what really happens when internal pressure is applied is not as shown by Mr. Kirkland's sketch, but by the sketch enclosed herewith.

The tendency would naturally be for the cover plate to assume a dished shape, and therefore the flange to which it is bolted must first be made rigid enough to withstand this stress before the thickness of the cover plate is considered.

The very fact that Mr. Kirkland states that the deflection immediately subsided on taking off the pressure, proves that it was not the plate itself which gave, or this would not have occurred. It must, therefore, have been the spring of the flange.



Sketch of tank head

There are three alternative methods of strengthening the construction; either by (1) welding a thicker flange on the body, (2) the application of a reinforcing ring about $\frac{3}{16}$ inch thick behind the flange, or (3) by using washers at both ends of the bolts. This latter may not remedy the fault, but would certainly improve matters.

Might I just be permitted to ask Mr. Kirkland what happened at the other end of the cylinder? A flat end is shown there which I presume is welded in, and I should scarcely think it would be made thicker than the cover plate. Therefore, if the theory I have put forward above is not correct, why has this end not bellied also?

Halifax, York, England. N. WIGNALL.

Permanent Deflection in Tank Head

TO THE EDITOR:

I read with some amazement the article, "Unstayed Flat Surfaces," by J. G. Kirkland in the November issue of THE BOILER MAKER. A pressure of only 10 pounds per square inch to have caused a deflection of 1 inch is unbelievable. There must have been considerable inaccuracy in Mr. Kirkland's method of gaging the deflection. Following I submit a set of calculations which, while they are not truly applicable to the condition, are, nevertheless, close enough to arrive at a reasonable approximation of the actual strain under which the head, or cover of this vessel would have been subjected in order to have reached that deflection:

From any text-book on the "Strength of Materials" we find that the unit stress, to which any elastic material is subjected, bears a certain relation to the elastic property of the material (known as its Modulus of Elasticity) and to the amount of stretch (or compression) per inch of length, called unit deformation. This relation is expressed by the formula:

$$E = \frac{s}{d}, \text{ or } s = Ed, \text{ or } d = \frac{S}{E}$$

where:

s = Unit stress in pounds per square inch.

E = Modulus of Elasticity in pounds per square inch, which for steel is invariably taken at 30,000,000.

d = Unit deformation, or the amount of deformation per inch of length.

I am attaching a sketch of the head on the vessel under discussion which for the roughest kind of calculation clearly shows that the material stretched 0.0415 inch in a length of 12 inches, whence unit deformation d in the above formula is:

$$\frac{0.0415}{12} = 0.0034583 \text{ inch.}$$

We can now solve the above formula for s, or

$s = 30{,}000{,}000 \times 0.0034583 = 103{,}749$ pounds per square inch.

This value is about twice the ultimate tensile strength of mild boiler steel, but, as I said above, the assumption for determining such a stress is not absolutely true but I'll wager it is fairly close—let's say within an error of 50 percent! Then the stress would even have been right on the ultimate strength of the material and at least 20,000 pounds per square inch over its elastic limit. Yet Mr. Kirkland states that after the pressure was removed from the cylinder the deflection disappeared!

Mr. Kirkland thinks there is something wrong with the British formula for determining the thickness of plate required for flat heads, such as he writes about, since he would like to see the American formula applied to this problem? I was not able to find anything in our greatest authority on this side, viz., the A.S.M.E. Boiler Code for rules covering unstayed flat heads, although I presume this will be covered in the section of the Code not yet officially issued, relating to the design and construction of unfired pressure vessels. I can, however, offer Mr. Kirkland two old and well known formulæ as follows:

Grashof's* formula for a flat circular plate supported at the edges and uniformly loaded:

$$f = \frac{5 \times p \times r^2}{4 \times t^2}$$

where,

f = stress in material in pounds per square inch.

r = radius of the cylinder in inches.

t = thickness of the plate in inches.

p = the pressure in pounds per square inch.

The formula can be rearranged so as to solve for t at once, thus:

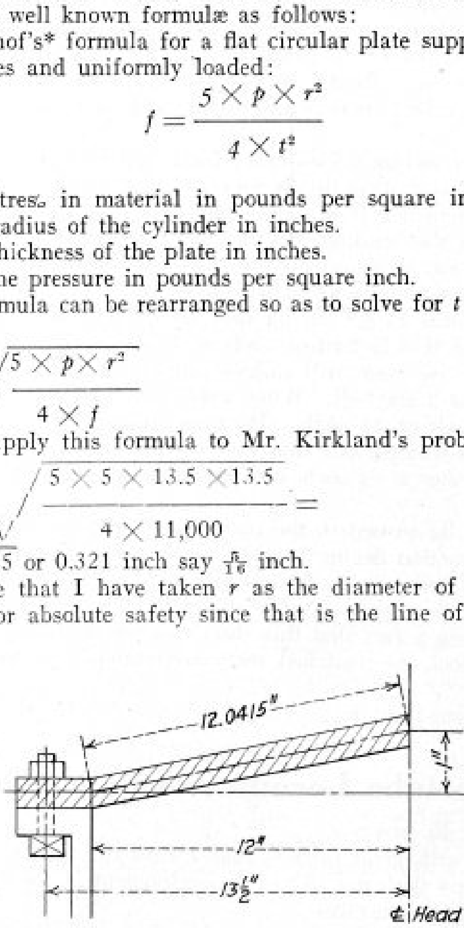
$$t = \sqrt{\frac{5 \times p \times r^2}{4 \times f}}$$

let us apply this formula to Mr. Kirkland's problem:

$$t = \sqrt{\frac{5 \times 5 \times 13.5 \times 13.5}{4 \times 11{,}000}} =$$

$\sqrt{0.1035}$ or 0.321 inch say $\frac{5}{16}$ inch.

(Note that I have taken r as the diameter of the bolt circle for absolute safety since that is the line of support



Detail of head at point of connection to tank

for the head. I have also taken f at 11,000 pounds, which for steel at 55,000 pounds per square inch ultimate is on a factor of safety of 5.)

The other formula is that of U. S. Board of Supervising Inspectors (probably of the Department of Steamboat In-

* "Theorie der Elastizität und Festigkeit," 1878, page 329, et seq.

spection Service) for unstayed flat heads *not over 20 inches in diameter:*

$$p = \frac{512\, ct^2}{3.1416\, r^2}$$

where c is 112 for plates $\frac{7}{16}$ inch and under in thickness and 120 for plates more than $\frac{7}{16}$ inch thick. All other notations are the same as in the previous formula.

In conclusion will say that I think Mr. Kirkland ought to check his measurements for the deflections he gave. The formula he used, viz. $\frac{C \times t^2}{S}$ is safe (as is any rule of the B.O.T.).

Erie, Pa. WILLIAM C. STROTT.

Experiences of an Inspector

TO THE EDITOR:

In a previous issue of THE BOILER MAKER were related the conditions under which a boiler inspector found a bird's nest full of half grown birds in the discharge pipe of a certain boiler which he had been sent to inspect. It does seem out of reason that a bird could build a nest, lay the eggs and hatch the young in such a short length of time, but nevertheless here is one that the writer thinks has the bird nest story beaten.

The writer of this letter happens to be a boiler inspector, located in one of the prominent shops of the country. The other day on coming to work in the afternoon, the shop foreman called me over and asked me what I thought of this one.

He showed me a loan order for a beading tool (all of you readers know what this is for) and told me that a man had just presented it to him and that when he in return handed the man the beading tool the man asked him if that was all that was to it and the foreman replied that it was as far as he was concerned. Then the man asked if this was all that he was to get saying that he wanted to bead several flues and that he had no tools to do the work with.

While we were still talking, in came another man and asked for a staybolt. When asked what size he wanted he replied, about ⅝ inch. He then showed us a sample of what he wanted and this was a ⅞-inch bolt. When told that it was a ⅞-inch bolt he said that was the size he wanted.

Then he turned to the two of us and remarked that he had a traction engine and that the staybolts kept on breaking and he was wondering what the trouble was remarking that they always broke down in the lower corners.

It being a fact that this shop was not operating a training, school, we switched the conversation over to another subject.

Williamsport, Pa. L. M. COVE.

Watertube Locomotive Boiler Design

TO THE EDITOR:

It is with great interest that I read the articles you are publishing with regard to the development of the watertube boiler for locomotives.

It goes without saying that this class of boiler will be a more economical steam raiser, but it is doubtful if it will be as reliable, as the usual locomotive type boiler.

The watertube type of boiler will need particular care with regard to scale and sediment in the tubes, as it is well known that should the scale become excessive, the tubes will bulge locally and rupture, due to the overheating of the metal. Unfortunately these bulges have a nasty habit of sometimes developing very quickly, particularly with a boiler that is sustaining a heavy load. A burst tube while on a journey is going to be a source of great trouble, to say nothing of the inconvenience. Of course these failures will not have the serious consequences that generally accompany a firebox failure in the firetube locomotive boiler, but I venture to say that they will be more frequent, if the tubes are not kept very clean.

This I am afraid will be one of the failings of this class of boiler, particularly if the tubes are of the curved type, as generally it cannot be seen whether these tubes are clean or otherwise.

As bulging on the tubes may be a source of trouble in this class of boiler, the question arises as to how long it will take to renew the defective tube, and also how often will the locomotive have to be laid up for examination to find these defective tubes. It will also be interesting to know from actual experience, how long it takes to wash out a boiler of this new type, as it would appear that this operation will take a surprisingly longer time than with the conventional type.

When departing from the usual practice, all these apparently small items have to be carefully watched, because it may be that these turn the scale in favor of reverting to the old style, but obviously without trial, modifications, etc., it cannot be said that watertube boilers will be a success or not in the railway world.

London, England. P. G. TAMKIN.

The Lincoln Award for the Best Paper on Arc Welding

THE A.S.M.E. has accepted the custody of $17,500 to be awarded by the Society in a world competition for the papers descriptive of the greatest improvement in the art of arc welding submitted during 1927. This fund, provided by the Lincoln Electric Company, will be bestowed in three Lincoln Arc Welding Prizes, a first award of $10,000, a second of $5,000, and a third of $2,500.

The fund was accepted at the meeting of the Council on Friday, December 10, 1926. J. F. Lincoln, vice-president of the Lincoln Electric Company, presented the matter in person, and in doing so pointed out that the prizes are offered with the sincere desire to promote the whole art of arc welding and to reduce the cost of carrying out mechanical designs and construction.

The prizes are to be administered by the Council of The American Society of Mechanical Engineers, who will invite qualified experts to assist them. Complete information can be obtained by application to the Secretary of the Society. A more extended statement of the conditions of award of the prizes is being prepared; in the meantime the following information will serve for the guidance of prospective contestants.

CONDITIONS OF AWARD OF PRIZES

1 The award to be made for the year 1927 as soon after January 1, 1928, as practicable.

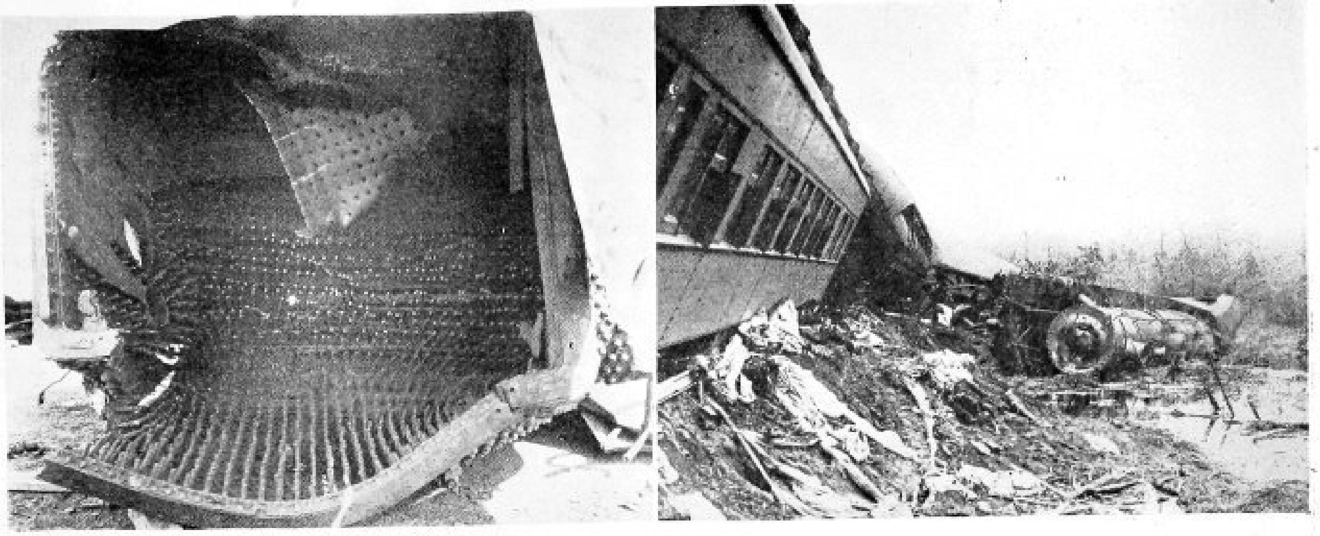
2 Any one in any country of the world may try for these prizes, but papers must be submitted in the English language.

3 The papers in competition are to be supplied in duplicate to the Council of the A.S.M.E., addressed to its Secretary, Calvin W. Rice, 29 West 39th Street, New York, before January 1, 1928. Any delay thereafter will exclude a paper from the competition.

4 To assist authors in the preparation of papers for this competition, certain conditions have been prepared that will be given out later.

5 The Council of The American Society of Mechanical Engineers may withhold any or all awards.

6 To facilitate filing and transmitting, it will be necessary that the paper be typewritten on one side of paper 8½ by 11 inches, bound at the top with covers that will protect it. The name and address of the sender should appear on the front cover, and if possible a brief statement of his qualifications should be included with the letter of transmittal.



Figs. 1 and 2—This low water boiler explosion caused the death of four persons

Annual Locomotive Inspection Report

Accidents decrease nearly seventeen percent over previous year's report—Boiler failures contribute mainly to serious disasters

By A. G. Pack*

IN compliance with section 7 of the act of February 17, 1911, as amended, the Fifteenth Annual Report of the Chief Inspector covering the work of the bureau during the fiscal year ended June 30, 1926, is respectfully submitted.

A synopsis is given, by railroads, of all accidents, showing the number of persons killed and injured due to the failure of parts and appurtenances of the locomotive and tender, including the boiler, as reported and investigated under section 8 of the locomotive inspection law, and those reported to the Bureau of Statistics under the accident report act of May, 1910, and not reported to this bureau as should have been.

The data contained herein cover all defects on all parts and appurtenances of the locomotive and tender, including the boiler, found and reported by our inspectors, arranged by railroads.

The tables show the number of accidents, the number of persons killed and number injured as a result of the failure of parts and appurtenances of the locomotive and tender, including the boiler.

Tables have been arranged so as to permit comparison with previous years as far as consistent and also show the number of locomotives inspected, the number and percentage of those inspected and found defective, the number for which written notices for repairs were issued in accordance with section 6 of the law withholding them from service because of being in violation of the law, and the total defects found and reported.

Table I—Locomotive Reports and Inspections

	1926	1925	1924	1923	1922
Number of locomotives for which reports were filed...	69,173	70,361	70,683	70,242	70,070
Number inspected...........	90,475	72,279	67,507	63,657	64,354
Number found defective.....	36,354	32,989	36,098	41,150	30,978
Percentage inspected found defective	40	46	53	65	48
Number ordered out of service	3,281	3,637	5,764	7,075	3,089
Total number of defects found	136,973	129,239	146,121	173,840	101,734

Table II—Accidents and Casualities Caused by Failure of Some Part of the Locomotive, Including Boiler or Tender

	Year ended June 30				
	1926	1925	1924	1923	1922
Number of accidents..................	574	690	1,005	1,348	622
Percent increase or decrease from previous year	16.8	31.3	25.5	[1]117	15.4
Number of persons killed............	22	20	66	72	33
Percent increase or decrease from previous year..........................	[1]10	69.7	8.3	[1]118	48.4
Number of persons injured...........	660	764	1,157	1,560	709
Percent increase or decrease from previous year..........................	13.6	33.9	25	[1]120	11.3

[1] Increase.

Table III—Accidents and Casualties Caused by Failure of Some Part or Appurtenance of the Locomotive Boiler[1]

	Year ended June 30				
	1926	1925	1924	1915	1912
Number of accidents..................	247	274	393	424	856
Number of persons killed.............	18	13	54	13	91
Number of persons injured...........	287	315	447	467	1,005

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

Investigation of Accidents

All accidents reported to this bureau, as required by the law and rules, were carefully investigated and action taken to prevent recurrences as far as possible. Copies of accident investigation reports were furnished to parties interested when requested, and otherwise used in an endeavor to bring about a decrease in the number of accidents.

A summary of all accidents and casualties to persons as compared with the previous year shows a decrease of 16.8 percent in the number of accidents, an increase of 10 percent in the number of persons killed, and a decrease of 13.6 percent in the number injured during the year. There was also a substantial decrease in the percentage of locomotives inspected by our inspectors found defective. During the year 40 percent of the locomotives inspected were found

*Chief Inspector, Bureau of Locomotive Inspection of the Interstate Commerce Commission. This article deals mainly with boiler items referred to in the report.

Fig. 3—Result of crown sheet failure on oil burning locomotive

with defects or errors in inspection that should have been corrected before being put in use as compared with 46 percent for the previous year and 53 percent for the fiscal year ended June 30, 1924.

While there was a substantial decrease in the total number of accidents during the year, our investigations indicate that a still greater decrease should have resulted had the requirements of the law and rules been complied with, especially so with respect to defects the repair of which are frequently considered unimportant.

Boiler explosions caused by crown-sheet failures continue to be the most prolific source of serious and fatal accidents with which we have to deal, 72.7 percent of the fatalities during the year being attributable to this cause. The importance of properly maintaining water level indicating appliances that will accurately register the water level in the boiler under all conditions of service, and which may be easily and accurately observed by the occupants of the locomotive cab from their usual and proper positions, cannot be overemphasized. The use of the strongest practicable firebox construction, especially within the area which may be exposed to overheating due to low water, and the application of a device that will give an audible alarm when the water level approaches the danger point, would be distinct steps forward in the reduction of accidents and casualties resulting from crown sheet failures. Further reference is made to audible low water alarms elsewhere in this report.

Table IV shows the various parts and appurtenances of the locomotive and tender which through failure have caused serious and fatal accidents which if taken advantage of and proper inspections and repairs are made in accordance with the spirit and intent of the law and rules a large portion of such accidents can be avoided.

Reduced Body Staybolts

Our investigations of reduced body staybolt breakage show that failure most frequently occurs in the reduced body at or close to the fillet joining the body of the bolt and the enlarged ends, and telltale holes which do not extend into the reduced section at least ⅝ inch cannot be depended upon to indicate broken bolts.

A great majority of broken staybolts are found by leakage through telltale holes without the aid of the hammer test. The sound and vibration when staybolts are hammer tested varies with the location of the bolts in the firebox and also with the shape of the firebox. Inspectors depend upon the telltale holes as a check of the results of the hammer test. If the telltale holes do not extend into the bolts to or beyond the usual point of breakage, they are not only useless as a safety feature but become a distinct menace to safety.

Extension of Time for Removal of Flues

One hundred and twenty-six applications were filed for extension of time for removal of flues, as provided in Rule 10. Investigation disclosed that in 12 of these cases the condition of the locomotives was such that no extension could properly be granted. Twelve were in such condition that the full extension requested could not be authorized, but an extension for a shorter period was allowed. Twenty extensions were granted after defects disclosed by investigation had been repaired; 13 applications were canceled for various reasons; 69 extensions granted for the full period requested.

Specification Cards and Alteration Reports

Under Rule 54, 1,860 specification cards and 10,378 alteration reports were filed, checked, and analyzed. These reports are necessary in order to determine whether or not the boilers represented were so constructed or repaired as to render safe and proper service and whether the stresses were within the allowed limits. Corrective measures were taken with respect to numerous discrepancies found.

Under Rule 328 of the Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam, 274 specification cards and 5 alteration reports were filed. These were carefully checked and analyzed and corrective measures taken with respect to the discrepancies found.

Prosecutions

No prosecutions for violations of the locomotive inspection law were instituted during the year.

Three cases which were pending at the beginning of the

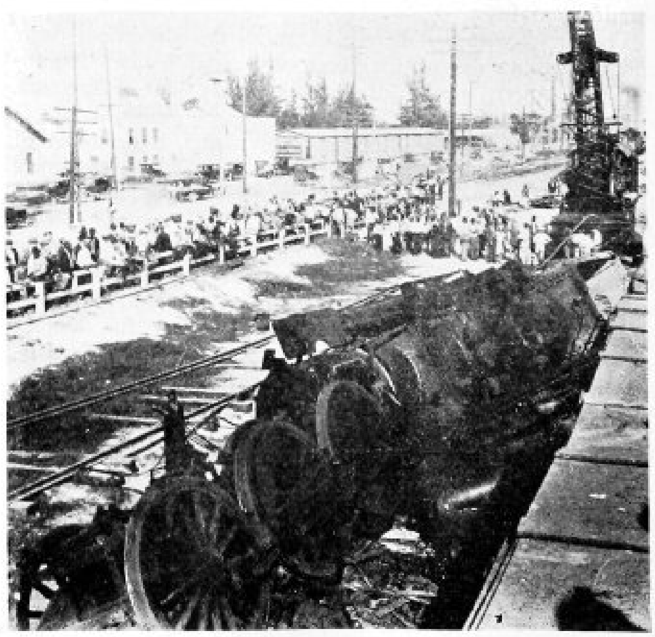


Fig. 4—Boiler in this explosion was thrown from frame

year were disposed of. Judgment was assessed against the carrier in one case, one case was compromised upon payment by the carrier of the penalties sued for, and judgment was rendered by the court in favor of the defendant in the third case.

Appeals

Three formal appeals were taken from the decisions of our inspectors during the year, two of which were dismissed. Two items were involved in one of the appeals, one of which was dismissed while the carrier was sustained in the other.

Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam

In conformity with the established practices in the formulation of rules and instructions, conferences were held with interested parties and a code of rules for inspection and testing of locomotives other than steam was formulated and agreed upon, which was approved by order of the commission dated December 14, 1925, and made effective July 1, 1926.

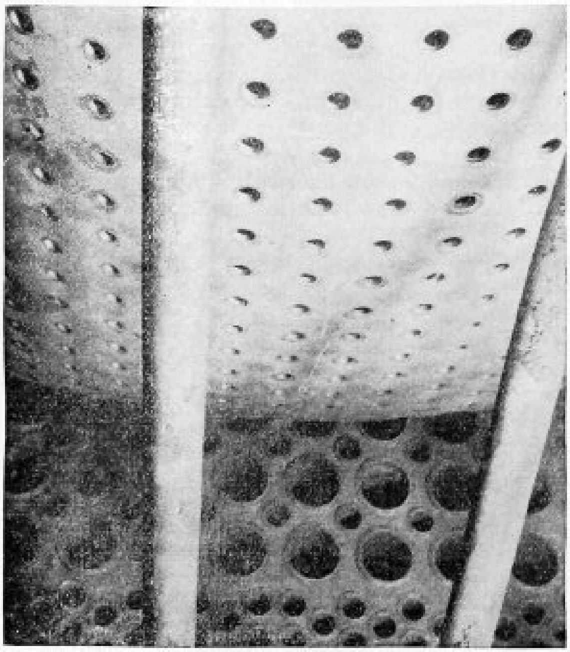


Fig. 5—Crown sheet pulled away from 456 radial stays and 13 staybolts

Recommendations for Betterment of the Service

In my former reports recommendations were made, in accordance with section 7 of the act, as amended, for the application of automatic firedoors, power reverse gears, power grate shakers, automatic bell ringers, horizontal hand holds, stirrups on cabs, and water columns with water glass and gage cocks attached with an additional water glass located on the left side or boiler back head, and reasons therefor given.

Many of the carriers are recognizing the value in the promotion of safety, efficiency, and economy of these appliances and are complying with the recommendations in many cases, while others are not, therefore the recommendations are respectfully renewed and should be made a requirement of the rules.

Low Water Alarms

Audible low water alarms are now being experimented with very successfully and are being applied by many of the carriers. The general application of a dependable low water alarm would be of inestimable value in reducing the number of serious and fatal accidents caused by explosions. It is felt that the carriers can make no greater contribution to the safety of locomotive operation than by continuing to assist in the development of these devices to the extent that they may become wholly dependable in warning the enginemen when water becomes dangerously low in the boiler.

Locomotive Boiler Explosions and Locomotive Defects

Figs. 1 and 2 show the result of a boiler explosion due to the crown sheet being overheated caused by low water, while hauling a freight train at an estimated speed of 25 miles per hour, which resulted in the death of four persons and the serious injury of three others. The line of demarcation caused by overheating was approximately 8 inches below the highest part of the crown sheet. The firebox sheets pulled away from a total of 1,373 stays and the boiler was torn from the frame and hurled 170 feet forward and 20 feet to the right of where the explosion occurred.

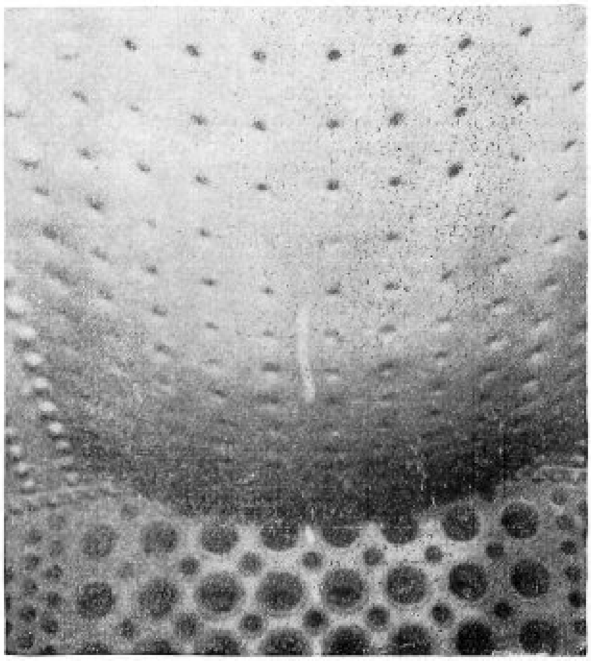


Fig. 6—Crown sheet pocketed to a depth of 11¼ inches

The explosion caused the derailment of a number of cars and the buckling of the train, blocking the adjacent main line track. Immediately after the explosion and wreck a passenger train consisting of one locomotive and nine Pullman sleeping cars, running at an estimated speed of 50 miles per hour on the adjacent track, dashed into the wreckage, causing its locomotive to be overturned, coming to rest in a reverse position. The first sleeping car was derailed and overturned, coming to rest on its side while the three following sleepers were derailed. So far as our investigation could determine the locomotive which exploded was in general good condition prior to the accident and the explosion was unquestionably caused by low water in the boiler, another indication of the ever-present weakness of human nature, possessed to a greater or less extent by all persons.

This locomotive was equipped with a water column with three gage cocks and one reflex type water glass attached to the column. The water glass so far as our investigation could determine was turned so as to afford a view from the engineer's position only. Had this locomotive been

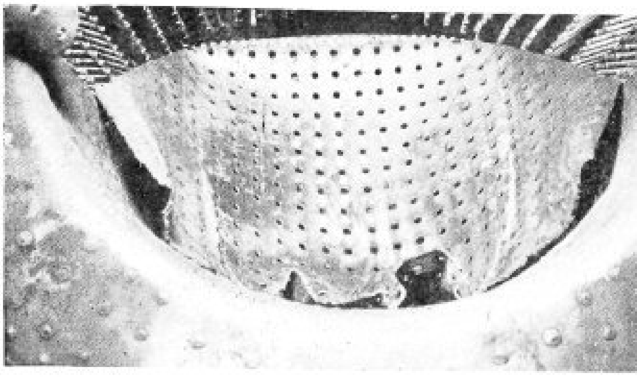


Fig. 7—Firebox sheet pulled away from 703 stays

equipped with a water glass so located, constructed, and maintained as to afford a view from the fireman's position in the cab, in addition to the view of the engineer, it is probable that the fireman or brakeman might have directed the attention of the engineer to the fact that the water was becoming low in the boiler before the disastrous explosion occurred and avoided the serious consequences which followed.

Locomotive and train operation are hazardous and exacting, therefore, every reasonable safeguard should be provided against the ever-present weakness of human nature where the loss of life and heavy property damage are at stake.

Locomotive boilers should be equipped with at least two separate and distinct water indicating appliances that will afford the widest possible clear range of vision for both the engineer and fireman if safe and economical operation are to obtain.

Figs. 3 and 4 show the result of a crown sheet failure on an oil-burning locomotive caused by overheating due to low water while it was in charge of engine watchman, which resulted in the death of a conductor while on the station platform on his way to the telegraph office and the serious injury of the watchman.

The line of demarcation caused by overheating was 10 inches below the highest part of the crown sheet. The fire box sheets pulled away from all radial stays and from 409 staybolts. The boiler was blown from the frame and landed in reverse position in front of the locomotive.

According to evidence obtained at our investigation the safety valves had been blowing for probably two hours prior to the explosion, which tends toward rapid evaporation of the water in the boiler and shows neglect or incompetency on the part of the person in charge. No contributory causes or weaknesses in the boiler were found.

Fig. 5 shows a crown sheet in firebox of riveted construction which pulled away from 456 radial stays and 13 staybolts and pocketed to a depth of 23 inches caused by overheating due to low water, no other damage being done to locomotive or train. The water at the time of the accident was 11¾ inches below the highest part of the crown sheet.

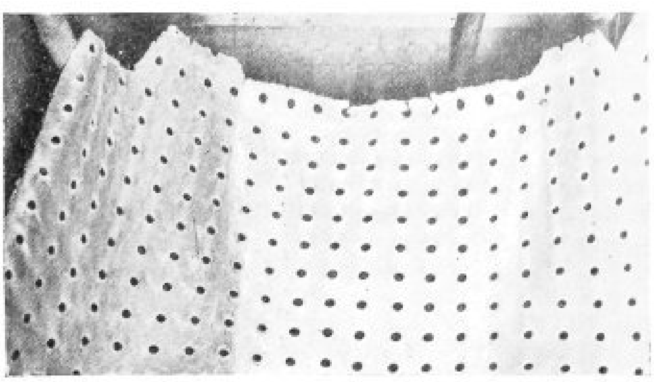


Fig. 8—Transverse seam which failed

This accident occurred while locomotive was hauling a passenger train at an estimated speed of 55 miles per hour.

Fig. 6 shows the damage to a crown sheet in firebox of riveted construction caused by overheating due to low water. The line of demarcation caused by overheating shows water to have been 5½ inches below the highest part of the crown sheet. Crown sheet pulled away from 165 radial stays and pocketed to a depth of 11¼ inches, with no other serious damage to the locomotive. The bottom water glass cock was found closed. The hand operated firedoor was blown open. The latch was loose and the notches worn so that the firedoor could be opened without operating the latch. This defective condition had been reported six times prior to the accident.

Automatic firedoors which remain closed or automatically close the moment the operator's foot is removed from the operating device have proven of great value in the protection of life and limb when firebox failures of various kinds occur.

Figs. 7, 8 and 9 show the result of a crown sheet failure primarily caused by overheating due to low water. The

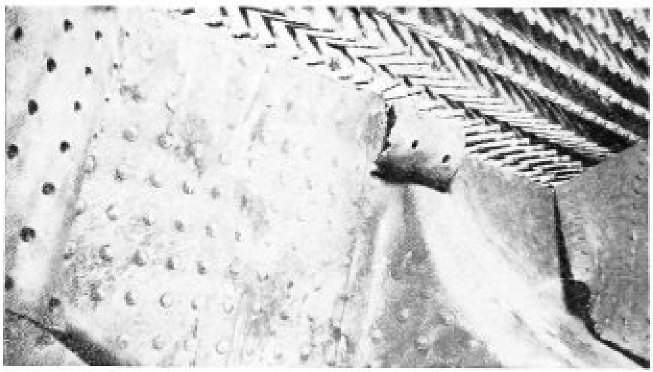


Fig. 9—Welded seam between crown and side sheets failed for entire length

firebox sheets pulled away from 591 radial stays and 112 staybolts, or a total of 703 stays, while locomotive was standing near telegraph office just after coming to a stop.

The force of the explosion raised the rear end of the locomotive and front end of tender off the rails and they came down with sufficient force to break the front cast-steel tender truck bolster, badly bend the trailer truck frame, and bend track rail downward about 4 inches. It seems apparent that had this boiler not been securely anchored to the frame it might have been thrown for a considerable distance.

Fig. 7 shows the fusion welded transverse seam between the combustion chamber and crown sheet, where the original rupture apparently took place, and the riveted seam at front end of crown sheet left intact, with combustion chamber crown sheet folded down practically against flue sheet.

Fig. 8 shows the transverse seam which failed. The weld was not uniform in strength, as evidenced by the fact that a large portion of it failed while other portions did not.

Fig. 9 shows how welded seam between the crown sheet and side sheet failed for its entire length with a portion of throat sheet ear and where its seams failed. A total of 237 inches of welded seams failed in this firebox at the time of this accident.

Fig. 10 is a view of a water glass after having been

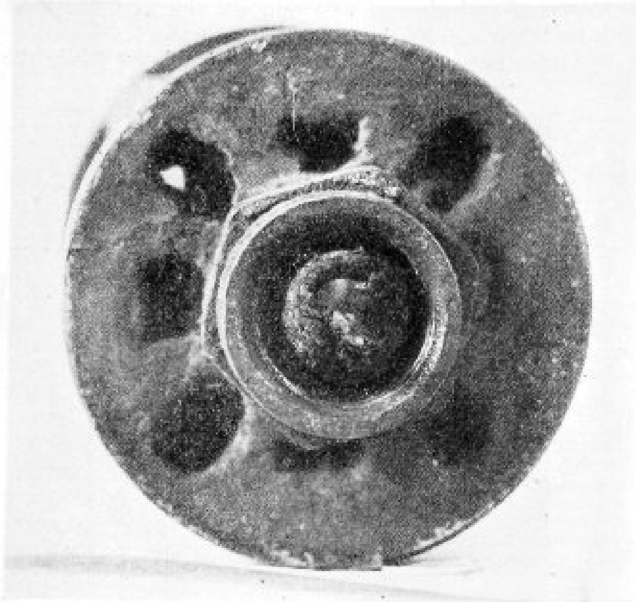


Fig. 10—End of water glass practically closed by gasket

removed from the bottom cock, showing the end of the glass practically closed by the gasket being squeezed over the end. The glass was too short when applied.

Fig. 11 shows the top riser of the same water glass filled with rubber gasket, due to the glass being broken and too short when applied, and the riser after being cleaned.

Defective and improper water glasses are strong contributory causes to overheated crown sheets and much damage to property and serious injury and loss of life to persons. Extreme care should be exercised in seeing that water indicating and feedwater appliances are maintained in good condition at all times.

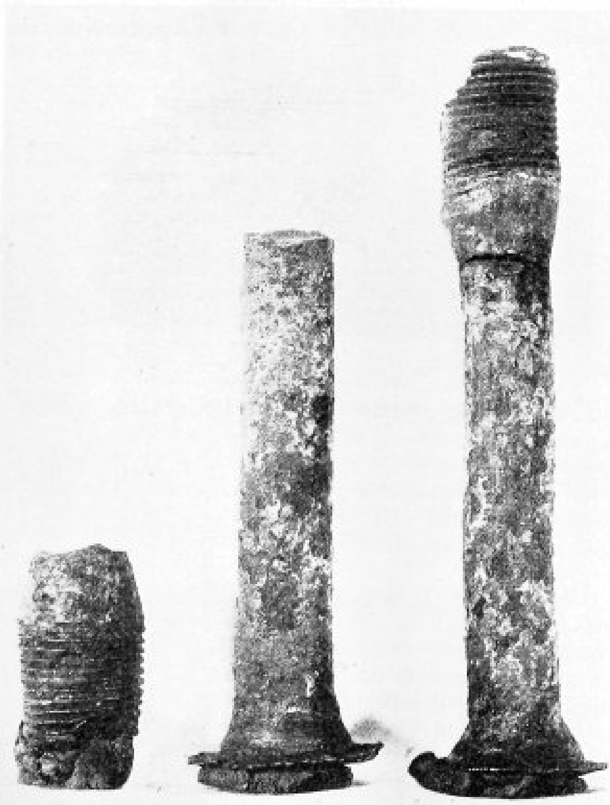


Fig. 12—Broken, reduced body staybolt

Fig. 12 shows a broken reduced body staybolt which blew out of inside firebox sheet, fatally scalding a boiler maker while making repairs to the grates.

This accident was not reported to the chief inspector as required by law, but was incidentally brought to the attention of our inspector a few days later and after the locomotive had been returned to service. At the time of our investigation of this accident a number of staybolts were found broken and fractured at the root of the fillet and beyond the telltale hole, one of which is also shown in this plate.

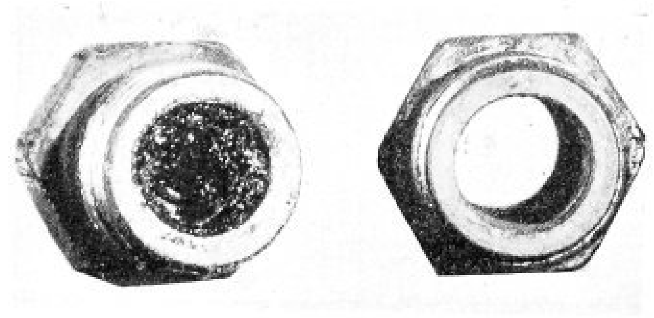


Fig. 11—Top riser of same water glass filled with rubber gasket

Fig. 13. shows the ends of the broken staybolt which caused the accident. Telltale holes are applied for the purpose of indicating broken or fractured bolts. Our experience has demonstrated that where reduced body bolts have less cross sectional area than at the root of the thread they almost invariably break in the smaller section and beyond the telltale holes; therefore, the purpose of the telltale holes is defeated unless they extend far enough into the reduced body section to serve the purpose for which they are applied.

Especial attention is directed to Fig. 12 which shows the condition of the firebox ends of these bolts caused by being redriven many times on account of leakage.

Rule 26 requires that:

> All staybolts shorter than 8 inches, except flexible bolts, shall have telltale holes three-sixteenths inch in diameter and not less than 1¼ inches deep in the outer end. These holes must be kept open at all times.

Fig. 13—Ends of broken staybolt which caused accident

Reduced body staybolts with less cross sectional area in the reduced portion than at the root of the threads will not be accepted as meeting the requirements of this rule unless the telltale holes are extended into the smaller section far enough to serve the purpose for which telltale holes are applied.

Fig. 14 shows a large number of broken radial stays left lying on the firebox crown sheet after renewals had been made.

Fig. 15 shows 297 broken radial stays and staybolts

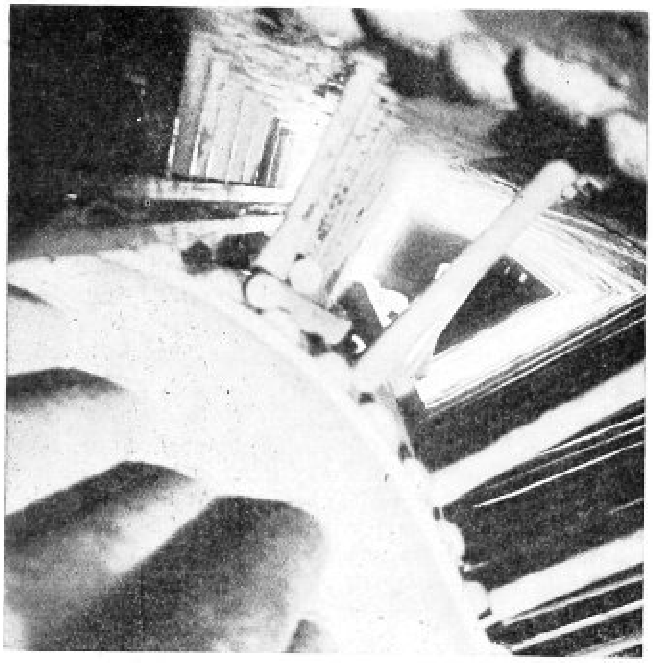


Fig. 14—Large number of broken staybolts left on crown sheet

found in the water space around the firebox and combustion chamber of the boiler shown in Fig. 14. This approximate condition was found on a number of other locomotives, it being apparent that broken radial stays and staybolts were not being removed from the boilers after being renewed.

Fig. 16 shows an arch tube which blew out of inside throat sheet while boiler was under pressure of 180 pounds, due to being cut too short when applied to be either belled

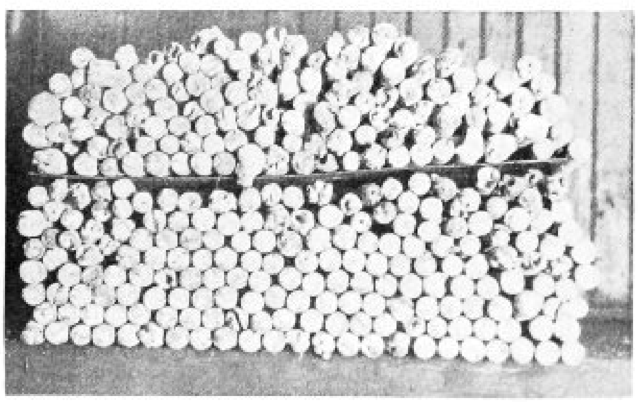


Fig. 15—Radial stays and bolts found in water space around firebox

or beaded to secure it in place. The copper ferrule had been beaded over in the water space when the tube was applied to give the appearance of a properly beaded arch tube. The tube did not enter the throat sheet at right angles, one side extending into the flue sheet only three-sixteenths of an inch, while the opposite side extended flush with the water side of the sheet.

Fig. 17 shows a superheater flue which burst while the

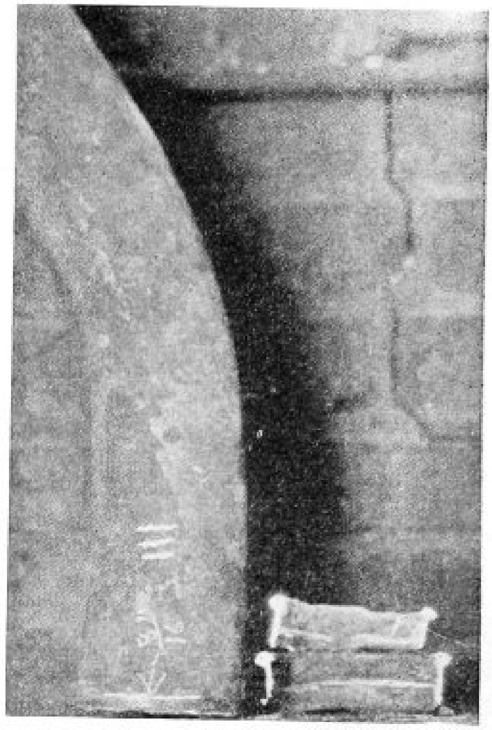


Fig. 16—Arch tube which blew out of throat sheet

train was running at an estimated speed of 20 miles per hour, resulting in serious injury to the engineer who was compelled to leave the cab, on account of the escaping steam and boiling water, before he could apply the brakes. After being scalded he made his way to the front of the loco-

Fig. 17—Superheater flues sometimes cause trouble

motive and opened the angle cock, bringing the train to a stop about 1 mile from point of accident. The flue was reduced from its original thickness of $\frac{3}{16}$ inch to 1/32 inch where it ruptured.

On November 1, 1926, the Air Reduction Company, Inc., acquired through a long term lease from the Commercial Acetylene Supply Company, Inc., the plants and business of that company on the Pacific coast. The two acetylene manufacturing plants thus taken over, located respectively at Berkeley and Los Angeles, California, enable the Air Reduction Sales Company to render the same complete service to industry in that territory that it renders elsewhere throughout the country. This nation-wide service is now accomplished through the agency of 54 plants and 177 warehouses.

The Making of Boiler Plate

Open hearth process most commonly used in this country for manufacturing boiler steel

By J. A. Shannon

DURING the past summer the writer had the opportunity of visiting the Worth Steel Company plate mill at Claymont, Delaware. Since then in conversation with men who daily engage in the fabrication of boilers it was apparent how little is known about the material they handle. It is to these men who have not been able to see a mill, this bit of information is given.

Strange as it may seem, a plate is started on its journey in the engineering department of the firm building the boiler; that is when an order for a boiler is received the draftsman or clerk who sometimes handles such matters makes a bill of material required for the job; given a final OK it is forwarded by the purchasing department to the plate mill.

Making of an Ingot

The first operation at the mill is the making of the ingot. This is done by either the Bessemer process, the acid open hearth, or the basic open hearth method. As the open hearth is the most extensively used in this country a brief description will probably be sufficient.

The smallest practicable size of an open hearth furnace is about 15 tons with some as small as five tons capacity, but as these sizes are very expensive to operate they are not good practice. This maximum practicable size is 75 to 100 tons which gives a much better opportunity for complete combustion as the gases escape through the ports and downtakes. This also lengthens the life of the ports and promotes fuel economy.

The open hearth furnace is heated by burning within it gas and air each of which has been highly preheated before it enters the combustion chamber. Below the furnace are four regenerative chambers filled with a checkerwork of brick around which the gas and air may pass. Before the furnace is started these bricks are heated up by means of wood fires. The gas enters the furnace through the inner regenerative chamber on one side and the air enters through on the outer one on the same side. They meet and unite passing through the furnace and then passing to the chimney through the two regenerative chambers at the opposite end. In this way the brick work in the outgoing chambers is heated still hotter by the waste heat of the furnace. The current of gas, air and products of combustion is changed every twenty minutes whereby all four regenerators are always kept hot. The gas and air enter the furnace in a highly preheated condition and thus give a greater temperature of combustion, while the products of combustion go out to the chimney at a relatively low heat and so fuel is saved.

Life of an Open Hearth Furnace

The life of an open hearth furnace means the number of heats that it can make continuously without stopping for any more extensive repairs than can be made in the usual week end shut down, that is without allowing it to cool down. If a basic furnace makes 350 heats which means about 18 to 24 weeks' work it is considered good. An acid furnace lasts about 1,000 heats. In an open hearth furnace the lining suffers the greatest wear at the side of the bath where the bath is thin, because the oxidation of the metal is the greatest at this point.

The charge for acid open hearth steel consists of pig iron and ore, or pig iron and scrap having a low phosphorous content and is melted in a furnace with an acid or siliceous lining. The process consists in removing the impurities in the pig iron to a great extent by means of an oxidizing flame brought about by the union of producer gas with preheated air.

The charge for basic open hearth steel consists of either melted or solid pig iron or a mixture of pig ircn and low carbon scrap and is heated in a furnace similar to the acid furnace. The lining in this case is of dolomite, lime magnesite or other basic material. Ore may or may not be used. Acid open hearth steel may be distinguished from basic open hearth steel by its being normally higher in silicon and usually in phosphorous, but lower in manganese.

All boiler codes such as the A.S.M.E. code and the Massachusetts boiler laws in their specifications for steel boiler plates give the chemical composition to which all plates are made. In ordering plate it is customary to specify whether for A.S.M.E. or Massachusetts. The reason for this is that Massachusetts is more stringent on stamping the heat numbers. These heat numbers will be explained further on. Massachusetts allows maximum tensile strength of 63,000 pounds per square inch. A.S.M.E. allows 65,000 pounds per square inch.

The duration of the heat is from six to twelve hours. When the charge is entirely melted and at intervals thereafter the melter takes a spoon ladle full of metal and pours it into an iron mold. As soon as this is set hard it is cooled in water and from the appearance of its fracture the melter can estimate very closely the amount of phosphorous and carbon it contains. A laboratory analysis is made for the phosphorous and usually for carbon as well, these determinations being made in twenty minutes or less.

Drawing the Iron

If the laboratory analysis is satisfactory in all chemical composition, the steel is run into ingot molds. These molds are made of cast iron about 2½ inches in thickness and the ingots in these molds average from 2 to 10 tons. Before receiving the iron the molds are heated so hot that the palm of the hand will not bear the heat on the outside, and they are washed inside with a thin clay wash which prevents the liquid metal sticking to the cast iron.

Stripping the Mold

As soon as they can be run into the stripping house, the ingots are solidified sufficiently on the outside for the mold to be removed, leaving the ingot standing on the car ready to be drawn to the rolling mill.

While still hot the ingots are put in soaking pits heated by regenerative gas and air. The ingots must be kept in these soaking pits long enough to be entirely solid in the interior. About 55 minutes is required for a three ton ingot.

Rolling the Plates

The ingot is first cogged down in the slabbing mill producing a long flat piece of metal. It is then cut up into slabs of the desired size such that each one will make one or more plates. The slabs are then transferred to the heating furnace, heated to about 2,370 degrees F. and rolled in what is called a three high plate mill. Some mills have a pair of vertical rolls to keep the edges straight. During the rolling a shovel full of salt is thrown upon the surface of the plate, which carries in between the rolls some of the water which is always trickling over them to keep them cool. As soon as this water is pressed against the hot plate it is converted into steam causing a rapid series of explosions which blow the scale off the upper surface of the plate and give it a smoother finish. These explosions during the rolling sound like a machine gun firing.

A person must see this to appreciate how interesting it is to see a mass of metal worked up to a plate. As the process continues the operator tests the thickness of the plate with a gage made especially for this work, and when it is of the desired thickness it is passed to the straightening rolls and then to the cooling table.

From the cooling table it goes to the layout men who mark off the sizes of plates required. They also stamp the heat of steel to which it was manufactured as well as placing other distinguishing marks. The plate is still hot enough to compel these men to wear extra wooden soles on their shoes. From here it goes to the shears, one shear handling large plates which requires a large gang of men, others going to smaller shears for straps and heads. When all this is done the plate is ready for shipment.

An analysis of each plate is made by the manufacturer showing the chemical composition, tensile strength in pounds per square inch, yield point minimum pounds per square inch, the minimum percent elongation in 8 inches. This mill test report is furnished each purchaser and each plate is stamped to correspond with the mill test report.

This in a small way covers the making of a boiler plate. For any person desiring to know more fully about the subject I would recommend H. M. Howe's book "The Metallurgy of Steel" or the like which may be found in any library.

Fall Meeting of the American Welding Society

THE sixth fall meeting of the American Welding Society was held at Buffalo, N. Y., November 16 to 19, 1926. In conjunction with the meeting, the second International Welding and Cutting Exposition was held in the Broadway Auditorium. The first exposition of welding and cutting equipment occurred at the meeting last year which was held at the Massachusetts Institute of Technology, Boston, Mass. Without doubt the exposition which was a special feature this year of the meeting will be held regularly at future meetings of the society. All of the principal processes of welding were shown and many automatic machines were exhibited in operation.

Although the exposition was opened on Tuesday, November 16, the meeting proper began on Wednesday with a paper entitled "Welding of Locomotive Parts" by M. G. Jersten, master welder of the Northern Pacific Railway Company at St. Paul, Minn. The second paper read during the morning session was entitled "Organization of Welding on the Railroad," by F. H. Williams, assistant test engineer of the Canadian National Railways. In the afternoon A. M. Candy, general engineer of the Westinghouse Electric and Manufacturing Company, discussed the subject "Comparative Tests on Arc and Riveted Structural Brace." H. H. Moss of the Linde Air Products Company followed Mr. Candy on the program with a paper entitled "Tests on Welded Roof Trusses."

On Thursday the subject of welding science in the engineering curriculum of the universities was discussed by a number of professors who are particularly interested in welding in this connection. In the afternoon a report was presented by Mr. Edwards of the American Bridge Company, chairman of the Structural Steel Welding Committee. A meeting of the Welding Wire Specifications Committee with C. A. McCune of the American Chain Company presiding and a meeting of the American Bureau of Welding followed. During the meeting of this bureau H. L. Whittemore of the Bureau of Standards described a special machine which has been developed for testing welds. This was followed by discussion of the standardization of terms for structural welding, the heat treatment of deposited metal and the carbon arc welding of tanks. C. W. Obert, secretary of the Boiler Code Committee of the American Society of Mechanical Engineers, addressed the bureau in connection with the work of this committee.

The subject of Welding in a Gaseous Atmosphere was the opening feature of the Friday morning session. The subject was discussed by P. P. Alexander and R. A. Weinman, both of the General Electric Company, Schenectady, N. Y. In this paper were described the experiments carried out by the General Electric Company in welding with atomic hydrogen. Mr. Weinman described this new method of welding, which is still in the experimental stage, illustrating his talk with lantern slides. Hydrogen is changed into atomic hydrogen by passing it through an electric arc.

The annual fall banquet was held at the Statler Hotel on Thursday evening. The meeting of the board of directors was held, at the Hotel Statler, Friday morning, and at noon the president's luncheon conference with all the vice presidents and section representatives was held at the Buffalo Athletic Club. On Friday afternoon an inspection trip was conducted to Niagara Falls.

Standard Costs

The standard cost system, as a means of controlling costs in manufacturing concerns at the executive fountain head, is described in a 28-page booklet, "Standard Costs," just issued by Ernst & Ernst, accountants, New York. The booklet explains that standard costs represent a pre-determined budget of costs—a yardstick with which to measure actual costs as the latter develop in the manufacturing process. Variations that develop between standard costs and actual costs are the important elements. These variations show how the final profit will be influenced, upward or downward, and they suggest the reasons. Total actual costs cannot be determined until the manufacturing process is complete, but the elements of standard cost can be set up, and the elements of actual cost from day to day or week to week can be measured against these, so that the executive in control knows currently what he may expect when the manufacturing process is completed.

Some of the advantages of the standard cost system, are set forth in this booklet.

The Columbia Chuck & Tool Company, 840 Marquette Building, Chicago, Ill., has taken over the business of Christopher Murphy & Company for the sale of O'Neill rapid tube cutters and repair parts and for square grip staybolt chucks and threading chucks.

Thomas F. Powers has recently been appointed assistant chief of motive power and machinery of the Illinois Central Railroad. Mr. Powers was president of the Master Boiler Makers' Association during the past year.

International Acetylene Association Holds Twenty-Seventh Annual Convention*

THE first session of the twenty-seventh convention of the International Acetylene Association was held in the Florentine Room of the Congress Hotel, Chicago, Ill., at 11 A.M., Wednesday, November 10, 1926. An address of welcome was delivered by W. H. Cameron, managing director of the National Safety Council. Following the response to Mr. Cameron's address by W. D. Flannery, vice president of the K-G Welding Company, R. A. Sosson, president of the association, delivered his annual address. Reports of the secretary-treasurer and chairman of the Legislative Committee as well as of the Auditing Committee were presented to the meeting. This session concluded with a discussion of acetylene by Dr. Gerald Wendt, director of industrial research of the Pennsylvania State College, State College, Pa.

As is well known in the industry, many years ago Prof. George Gilbert Pond, who was professor of chemistry at the Pennsylvania State College, wrote a bulletin upon calcium carbide and acetylene which did more than any other publication at the time to place before the public the real facts concerning the scientific side of carbide and acetylene in language which could be understood by non-technical men. A good many thousands of these bulletins were issued and they became available to anyone, who was interested in the subject and are today well known to almost everyone in the industry. Dr. Wendt has carried on the work of investigation in connection with carbide and acetylene originally started by Professor Pond who died a number of years ago. In his research Dr. Wendt is developing many new uses for acetylene and calcium carbide. He stated that acetylene is the only link between inorganic and organic substances and that it is in the unique position that perhaps the human race may some day be dependent upon some product of it for food. Products developed from calcium carbide are now utilized to enrich the soil so that it may produce food supplies. As the demand for food becomes greater because of the diminishing fertility of the soil and a greater population there is a possibility that even this step may be eliminated and synthetic food produced directly from acetylene.

The first subject of the afternoon session was the discussion of generator construction rules with representatives of the Underwriters' Laboratories. For convenience the convention was made a meeting of the Oxy-Acetylene Committee of the association of which C. A. McCune of the American Chain Company is chairman. Mr. McCune and W. A. Slack, president of the Torchweld Equipment Company presided at this meeting. At the same time a meeting of the House Lighting Committee took place and later on in the afternoon a special meeting of the board of directors was held. The discussion in connection with generator construction rules dealt principally with revised rules which the Underwriters' Laboratories have formulated to cover stationary acetylene generators. Rules for portable generators are under consideration and will be presented to the industry at a later date.

The second day of the convention began with an address entitled "Use of Welding on Naval Vessels" by Commander H. E. Rossell of the Construction Corps, United States Navy, who is located at Philadelphia. L. E. Everett of the Nugent Steel Castings Company followed Commander Rossell on the program with a paper describing welding in the steel foundry. The final paper of the session was read by H. L. Whittemore of the Bureau of Standards, Washington, D. C., on "Testing of Welds." This paper particularly described the testing of welds and a simple means for determining the strength of welded specimens by the use of an impact test produced by a heavy pendulum swinging in a given arc.

The afternoon meeting was opened by the reading of the paper "A Few Factors to be Considered for Accelerated Progress of the Gas Welding Industry," by Dr. A. Krebs of the General Welding and Equipment Company, Boston, Mass. Following Dr. Krebs' paper was one presented by S. W. Miller, entitled "The Most Important Thing in Welding."

On Friday morning W. C. Swift of the American Brass Company, Bridgeport, Conn., addressed the association on "Some Applications of Bronze Welding." E. E. Thum of the Linde Air Products Company was next with an interesting address entitled "Heat Treatment by the Oxy-acetylene Flame." He dealt, among other things, with the metallurgy of steels and the reason why the torch can be so successfully used for heat treatment and hardening. The last subject of the morning session was a report by J. I. Banash, consulting engineer for the association.

The first subject of the afternoon session was a report of the Marine Lighting Committees by D. C. Duncan of the Carbic Manufacturing Company, Duluth, Minn. A report of the House Lighting Committee by J. A. Johnson of the Johnson Acetylene Gas Company, Crawfordsville, Ind., and of the Membership Committee by W. A. Slack of the Torchweld Equipment Company, followed. The feature of the afternoon session was an address by G. E. Hareke of the Air Reduction Sales Company entitled "How the Moving Picture is Educating the Public and the User." Mr. Hareke described his many interesting experiences in presenting the welding process to audiences aggregating many thousands of people. He gave a remarkably interesting and spectacular demonstration of liquid air as he has conducted it so many times in the past before these audiences. A two-reel exhibition of moving pictures was given to demonstrate welding and cutting in connection with railroad repairs. L. F. Hagglund of the Underwater Metal Cutting Corporation, New York city, presented an interesting paper upon the use of the electric arc and oxygen for underwater cutting. After Mr. Hagglund's paper was completed, an announcement was made of the award of the Morehead medal which is presented each year to the individual contributing most in development and knowledge to the industry. This year the medal was awarded to Augustine Davis formerly of the Davis-Bournonville Company. A medal was also presented to Edmund Fouché, Paris, France.

Officers elected for the ensuing year were W. A. Slack of the Torchweld Equipment Company, Chicago, president; D. C. Duncan of the Carbic Manufacturing Company, Duluth, Minn., vice president; A. Cressy Morrison was re-elected secretary and treasurer and the following new directors were elected: C. A. McCune of the American Chain Company and R. A. Sosson of the Air Reduction Sales Company.

The annual banquet was held at the Congress Hotel with W. S. Noyes, past president of the association, acting as toastmaster. The speakers of the occasion included R. A. Sosson, Dr. Gerald Wendt, A. Cressy Morrison, Dana Pierce and H. L. Whittemore.

* THE BOILER MAKER is indebted to the *Acetylene Journal* for the report of this convention.

Revisions and Addenda to Boiler Construction Cod

It is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision in the rules in its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later on in the proper place in the code.

During the past two years the Boiler Code Committee has received and acted upon a number of suggested revisions which have been approved for publication as addenda to the code. These are published below, with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticisms and comment thereon from any one interested therein. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

After 30 days have elapsed following this publication, which will afford full opportunity for such criticism and comment upon the revisions as approved by the committee, it is the intention of the committee to present the modified rules as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code. Upon approval by the council, the revisions will be published in the form of addenda data sheets, distinctly colored pink, and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

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

Revisions and Addenda

PAR. S-97. REVISE LAST SENTENCE OF SECTION *a* TO READ:

For IRON AND steel tubes over 2½ inches in diameter and up to 3¾ inches, inclusive, the width of the flange shall be ⅜ inch and for tubes over 3¾ inches the width of the flange shall be 10 percent of the outside diameter.

PAR. S-99. REVISE REQUIREMENT FOR CHARCOAL-IRON TUBES IN THIS PARAGRAPH TO READ:

Charcoal-iron tubes: No. 10 B.W.G. or lighter, to a height of 1⅛ inches; if heavier than No. 10 B.W.G., to a height of 1½-1¾ inches. Slight surface checks shall not be a cause for rejection.

PAR. S-101. REVISE FOOTNOTE REFERRED TO, TO READ:

[1] A solution of 10 PERCENT HYDROCHLORIC ACID (SP. GR. 1.19), 30 PERCENT SULPHURIC ACID (SP. GR. 1.84), AND 60 PERCENT WATER; OF 25 PERCENT NITRIC ACID (SP. GR. 1.42) AND 75 PERCENT WATER, [two parts water, one part HCl (sp. gr. 1.20), and one part H_2SO_4 (sp. gr. 1.84)] is recommended for the etch test.

SPECIFICATIONS FOR STEEL PIPE. REVISE TITLE TO READ: Specifications for WELDED AND SEAMLESS Steel Pipe.

PAR. S-110. REVISE TO READ:

S-110. *Material Covered.* These specifications cover "standard," [and] "extra strong" AND "DOUBLE EXTRA STRONG" welded and seamless steel pipe [but not "double extra strong" pipe]. Pipe ordered under these specifications are intended for bending, flanging and other special purposes.

PAR. S-113. REVISE TO READ:

S-113. *Tension Tests.* The material shall conform to the following minimum requirements as to tensile properties:

	Welded		Seamless	
	Bessemer	Open-hearth	Open-hearth Low CARBON	OPEN-HEARTH MEDIUM CARBON
Tensile strength, lb. per sq. in..	50,000	45,000	48,000	62,000
Yield point, lb. per sq. in......	30,000	25,000	26,500	35,000
Elongation in 8 in., percent....	18	20	18	...
ELONGATION IN 2 IN., PER CENT..	...	...	40	25

PAR. S-115. INSERT NEW SECTION *c* TO READ:

c THE FLATTENING TEST WILL NOT BE REQUIRED ON DOUBLE EXTRA STRONG PIPE.

TABLE S-4. ADD TWO COLUMNS OF REQUIREMENTS FOR DOUBLE EXTRA STRONG PIPE TO READ:

"DOUBLE EXTRA STRONG" PIPE

Butt-weld	Lap-weld and Seamless
....	....
....	....
....	....
700	....
700	....
700	....
2200	....
2200	3000
2200	3000
2200	3000
2200	3000
....	2500
....	2500
....	2000
....	2000
....	2000
....	2000
....	2000
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....

PAR. S-116. REVISE TO READ:

S-116. *Bend Tests.* For pipe 2 inches or under in diameter, a sufficient length of pipe shall stand being bent cold through 90 degrees around a cylindrical mandrel the diameter of which is 12 times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld. THIS TEST WILL NOT BE REQUIRED ON DOUBLE EXTRA STRONG PIPE OVER 1¼ INCHES IN DIAMETER.

PAR. S-121. REVISE TO READ:

S-121. *Permissible Variations.* The weight of the pipe shall not vary more than 5 percent FOR STANDARD AND EXTRA STRONG PIPE NOR MORE THAN 10 PERCENT FOR DOUBLE EXTRA STRONG PIPE from that specified in Table S-5.

PAR. S-122. REVISE SECTION *b* TO READ:

b Extra strong AND DOUBLE EXTRA STRONG pipe shall be in random lengths of 12 to 22 feet. Five percent may be in lengths of 6 to 12 feet.

TABLE S-5. ADD TWO COLUMNS OF REQUIREMENTS FOR DOUBLE EXTRA STRONG PIPE TO READ:

"DOUBLE EXTRA STRONG" PIPE

Thickness, in.	Weight of pipe per linear foot, plain ends, lb.
....	....
....	....
....	....
0.294	1.71
0.308	2.44
0.358	3.66
0.382	5.21
0.400	6.41
0.436	9.03
0.552	13.70
0.600	18.583
0.636	22.85
0.674	27.54
0.710	32.53
0.750	38.55
0.864	53.16
0.875	63.08
0.875	72.42
....	....
....	....
....	....

PAR. S-124. REVISE SECTION *b* TO READ:

b Extra strong welded pipe and standard and extra strong seamless pipe AND ALL DOUBLE EXTRA STRONG PIPE shall be furnished with plain ends.

PAR. S-127. REVISE TO READ:

S-127. *Material Covered.* These specifications cover "standard," [and] "extra strong" AND "DOUBLE EXTRA STRONG" welded wrought-iron pipe [but not "double extra strong" pipe].

TABLE S-6. ADD TWO COLUMNS FOR REQUIREMENTS FOR DOUBLE EXTRA STRONG PIPE TO READ:

"DOUBLE EXTRA STRONG" PIPE

Thickness, in.	Weight of pipe per linear foot, plain ends, lb.
....	....
....	....
....	....
0.294	1.71
0.308	2.44
0.358	3.66
0.382	5.21
0.400	6.41
0.436	9.03
0.552	13.70
0.600	18.583
0.636	22.85
0.674	27.54
0.710	32.53
0.750	38.55
0.864	53.16
0.875	63.08
0.875	72.42
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....

PAR. S-193. OMIT COLUMN REFERRING TO INSIDE DIAMETER, AND ADD TWO COLUMNS COVERING REQUIREMENTS FOR EXTRA STRONG PIPE TO READ:

EXTRA STRONG PIPE

Thickness, inch	Nominal weight, pound per foot of length
0.109	0.371
0.123	0.624
0.127	0.847
0.149	1.25
0.157	1.71
0.182	2.51
0.194	3.46
0.203	4.19
0.221	5.79
0.280	8.84
0.304	11.82
0.321	14.37
0.341	17.25
0.375	21.10
0.375	23.67
0.437	52.93
0.500	43.34
0.500	49.42
0.500	55.56
0.500	62.40

PAR. S-209. OMIT COLUMN REFERRING TO INSIDE DIAMETER, AND ADD TWO COLUMNS COVERING REQUIREMENTS FOR EXTRA STRONG PIPE, TO READ:

EXTRA STRONG PIPE

Thickness, inch	Nominal weight, pound per foot of length
0.100	0.353
0.123	0.593
0.127	0.805
0.149	1.19
0.157	1.62
0.182	2.39
0.194	3.30
0.203	3.99
0.221	5.51
0.280	8.41
0.304	11.24
0.321	13.67
0.341	16.41
0.375	20.07
0.375	22.52
0.437	31.32
0.500	41.23
0.500	47.02
0.500	52.81
0.500	59.32

SPECIFICATIONS FOR CARBON-STEEL CASTINGS FOR VALVES, FLANGES AND FITTINGS FOR HIGH-TEMPERATURE SERVICE.

THE FOLLOWING NEW A.S.T.M. SPECIFICATION (A-95-26T) IS TO BE INCLUDED:

1 Material Covered. These specifications cover carbon-steel castings for valves, flanges and fittings for high-temperature service (Note 1).

2 Process. The steel shall be made by one or more of the following processes: open-hearth, electric-furnace, converter, or crucible.

3 Heat Treatment. *a* All castings shall receive a heat treatment proper to the design and chemical composition of the castings.

b Heat treatment, unless otherwise specified by the purchaser, may consist of annealing, or of normalizing, or of normalizing followed by annealing, or of normalizing followed by a draw-back to a temperature below the critical range. No castings which have been quenched in any liquid medium shall be offered under these specifications.

c Annealing. The procedure for annealing shall consist in allowing the castings to cool, after pouring, to a temperature below the critical range. They shall then be uniformly reheated to the proper temperature to refine the grain and allowed to cool uniformly in the furnace.

d Normalizing. The procedure for normalizing shall consist in allowing the castings to cool, after pouring, to a temperature below the critical range. They shall then be reheated to the proper temperature to refine the grain and allowed to cool in still air.

4 Chemical Composition. *a* The castings shall conform to the following requirements as to chemical composition, except that the following limitations for carbon, manganese and silicon are intended to show desired composition and are not to be used for rejection:

Carbon	0.15–0.40 percent
Manganese	not under 0.50 percent
Silicon	not under 0.20 percent
Phosphorus	not over 0.05 percent
Sulphur	not over 0.05 percent

b Manufacturers submitting proposals to furnish material under these specifications shall specify, with their proposals, the limits of carbon, manganese and silicon which they will accept as a basis for rejection.

5 Ladle Analyses. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of the elements specified in Section 4. This analysis shall be made from drillings taken at least ¼ inch beneath the surface of a test ingot obtained during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements specified in Section 4.

6 Check Analyses. Analyses may be made by the purchaser from the broken tension-test specimen or from a casting representing each melt. The chemical composition thus determined shall conform to the requirements specified in Section 4. Samples for analysis shall be taken not less than ¼ inch beneath the surface, except in the case of castings which are too thin, and shall be taken in such a manner as not to impair the usefulness of the casting.

7 Tension Tests. *a* The castings shall conform to the following minimum requirements as to tensile properties:

Tensile strength, pound per square inch	70,000
Yield point, pound per square inch	36,000
Elongation in 2 inches, percent	22
Reduction of area, percent	30

b The yield point shall be determined by the drop of the beam of the testing machine at a crosshead speed not to exceed ⅛ inch per minute. The tensile strength shall be determined at a speed not to exceed 1½ inches per minute.

8 Bend Test. *a* Bend tests shall be required for castings only when so specified in the order.

b When a bend test is specified, the test specimens shall stand being bent cold through an angle of 90 degrees around a pin 1 inch in diameter, without cracking on the outside of the bent portion.

9 Test Specimens. a Tension-test specimens, and, when a bend test is specified, bend-test specimens, shall be taken from test bars cast attached to the castings where practicable. If the design of the castings is such that test bars should not be attached to the castings, the test bars shall be cast attached to special blocks, a sufficient number of which shall be provided for each lot of castings. Test bars from which tension- and bend-test specimens are to be taken shall remain attached to the castings or blocks they represent through heat treatment and until presented for inspection. Test bars shall be provided in sufficient numbers to furnish the tests required in Section 10.

b If satisfactory to the manufacturer and inspector, tension-test specimens may be cut from heat-treated castings instead of from test bars.

c Tension-test specimens shall conform to the dimensions shown. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial.

d Bend-test specimens shall be machined to 1 by ½ inch in section with the corners rounded to a radius of not over $\frac{1}{16}$ inch.

10 Number of Tests. a One tension test and, when specified, one bend test shall be made from each melt in each heat-treatment charge and, when specified, from each casting weighing 500 pounds or over.

b If any test specimen shows defective machining or develops flaws, it may be discarded; in which case another specimen from the same lot shall be substituted.

c If the percentage of elongation of any tension-test specimen is less than that specified in Par. 7 *a*, and any part of the fracture is more than ¾ inch from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

11 Retests. If the results of the physical tests for any lot do not conform to the requirements specified, such lot may be re-treated, but not more than twice. Retests shall be made as specified in Pars. 7 and 8.

12 Workmanship. The castings shall conform substantially to the shapes and sizes indicated by the patterns and drawings submitted by the purchaser.

13 Finish. a The castings shall be free from injurious defects.

Welding. b Defects which do not impair the strength of the castings may be welded by an approved process. The defects shall be cleaned out to solid metal, before welding, and when so required by the inspector, shall be submitted to him in this condition for his approval. All castings shall be heat-treated after welding in accordance with the requirements in Par. 3.

14 Inspection. a The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications.

b If, in the case of important castings for special purposes, surface inspection in the green state is required, this shall be so specified in the order.

c All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

15 Rejection. a Unless otherwise specified, any rejection based on tests made in accordance with Par. 6 shall be reported within five working days from the receipt of samples.

b Castings which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected and the manufacturer shall be notified.

16 Rehearing. Samples tested in accordance with Par. 6, which represent rejected castings, shall be preserved for two weeks from the date of transmission of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

Explanatory Notes

Note 1—This contemplates temperatures up to 750 deg. Fahr. (400 deg. Cent.); or at the discretion of the designing engineer higher temperatures with appropriate pressures may be used. Reference may be made to the dimensional standards for pressures and temperatures formulated by the Sectional Committee on Standardization of Pipe Flanges and Fittings, under the sponsorship of the Heating and Piping Contractors National Association, Manufacturers Standardization Society of the Valve and Fittings Industry, and The American Society of Mechanical Engineers, and organized under the procedure of the American Engineering Standards Committee.

Specifications for Carbon-Steel and Alloy-Steel Forgings

THE FOLLOWING NEW A.S.T.M. SPECIFICATION (A18-21) IS TO BE MADE AN ADDENDA TO THE CODE.

1 Material Covered. a These specifications cover the various classes of carbon-steel and alloy-steel forgings now commonly used and not covered by other existing specifications of the American Society for Testing Materials.

b The purposes for which these classes are frequently used are as follows:

Class A, for forgings which may be welded or casehardened;

Class B, for mild-steel forgings for structural purposes, for minor ship fittings, etc.;

Class C, for mild-steel forgings for structural purposes, for ships, etc.;

Classes D, E, F, G, H and *I*, for various machinery forgings, choice depending upon design and upon the stresses and services to be imposed.

Classes K, L and *M*, for various machinery forgings, choice depending upon design and upon the stresses and services to be imposed, and upon the character of machining operations to be done.

2 Process. The steel shall be made by either or both the following processes: open-hearth or electric furnace.

3 Discard. A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

4 Prolongation for Tests. The manufacturer and the purchaser shall agree upon forgings on which a prolongation for test purposes shall be provided.

5 Boring. If boring is specified, the diameter of the hole shall be at least 20 percent of the maximum outside diameter or thickness of the forging, exclusive of collars and flanges.

6 Heat Treatment. Heat treatment, if required, shall consist of either annealing or quenching and tempering, as specified.

a The procedure to be followed in annealing shall consist in allowing the objects, immediately after forging, to cool to a temperature below the critical range, under suitable conditions to prevent injury by too rapid cooling. They shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as an "annealing charge"), and allowed to cool uniformly.

b The procedure to be followed in quenching and tempering shall consist in allowing the objects, immediately after forging, to cool to a temperature below the critical range, under suitable conditions to prevent injury by too rapid cooling. They shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as a "quenching charge"), and quenched in some medium under substantially uniform conditions for each quenching charge. Finally, they shall be uniformly reheated to the proper temperature for tempering or "drawing back" (a group thus reheated being known as a "tempering charge"), and allowed to cool uniformly.

7 Chemical Composition. *a* The steel shall conform to the following requirements as to chemical composition:

	Classes				
Elements considered	A	B, C, D, E, F, G	H, I	K, L	M
Manganese, percent	0.30–0.55	0.40–0.80	0.40–0.80	....	....
Phosphorus, percent:					
Acid	not over 0.05	not over 0.05	not over 0.04	not over 0.05	not over 0.04
Basic	not over 0.05	not over 0.05	not over 0.04	not over 0.04	not over 0.04
Sulphur, percent....	not over 0.05	not over 0.05	not over 0.05	not over 0.05	not over 0.05
Nickel, percent.....	....	....	not under 3.00	....	....

b The composition of alloy steel, other than phosphorus and sulphur, to be used in forgings of Classes K, L, and M, shall be agreed upon by the manufacturer and the purchaser.

8 Ladle Analyses. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese and the elements specified in Par. 7. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Par. 7.

9 Check Analyses. An analysis may be made by the purchaser from a forging representing each melt. The chemical composition thus determined shall conform to the requirements specified in Par. 7. Drillings for analysis may be taken from the forging or from a full-size prolongation of the same, at any point midway between the center and surface of solid forgings, and at any point midway between the inner and outer surfaces of the wall of bored forgings; or turnings may be taken from a test specimen.

10 Tension Tests. *a* The forgings shall conform to the requirements as to tensile properties specified in Table I, II, and III.

b The classification by size of the forging shall be determined by the specified diameter or thickness which governs the size of the prolongation from which the test specimen is taken.

c The yield point shall be determined by the drop of the beam of the testing machine.

d The elastic limit called for by these specifications shall be determined by an extensometer reading to 0.0002 inch. The extensometer shall be attached to the specimen at the gage marks and not to the shoulders of the specimen nor to any part of the testing machine. When the specimen is in place and the extensometer attached, the testing machine shall be operated so as to increase the load on the specimen at a uniform rate. The observer shall watch the elongation of the specimen as shown by the extensometer and shall note, for this determination, the load at which the rate of elongation shows a sudden increase. The extensometer shall then be removed from the specimen, and the test continued to determine the tensil strength.

e Tests of forgings shall be made only after final treatment.

11 Tension-Test Specimens. *a.* Tension-test specimens shall be taken from a full-size prolongation of any forging. For forgings with large ends or collars the prolongation may be of the same cross-section as that of the forging back of the large end or collar. Specimens may be taken from the forging itself with a hollow drill, if approved by the purchaser.

b The axis of the specimen shall be located at any point midway between the center and surface of solid forgings, and at any point midway between the inner and outer surfaces of the wall of bored forgings, and shall be parallel to the axis of the forging in the direction in which the metal is most drawn out.

c The specimens shall conform to the dimensions shown. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial.

12 Number of Tests. Unless otherwise specified by the purchaser, tests shall be made as follows:

a For untreated forgings, one tension test shall be made from each melt.

b For annealed forgings, one tension test shall be made from each annealing charge. If more than one melt is represented in an annealing charge, one tension test shall be made from each melt.

c For quenched and tempered forgings, one tension test shall be made from each tempering charge. If more than one quenching charge is represented in a tempering charge, one tension test shall be made from each quenching charge. If more than one melt is represented in a quenching charge, one tension test shall be made from each melt.

d If more than one class of forgings by size is represented in any lot, one tension test from a forging of each class by size shall be made as specified in Pars. 10 and 11.

e If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

f If the percentage of elongation of any test specimen is less than that specified in Par. 10 *a* and any part of the fracture is more than ¾ inch from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

13 Retests. If the results of the physical tests of any test lot of forgings do not conform to the requirements specified, the manufacturer may re-treat such lot one or more times and retests shall be made as specified in Par. 12.

14 Workmanship. The forgings shall conform to the sizes and shapes specified by the purchaser. When centered, 60-degree centers with clearance drilled for points shall be used.

15 Finish. The forgings shall be free from injurious defects and shall have a workmanlike finish.

16 Marking. Identification marks shall be legibly stamped on each forging and on each test specimen. The purchaser shall indicate the location of such identification marks.

17 Inspection. *a* The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the forgings ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the forgings are being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

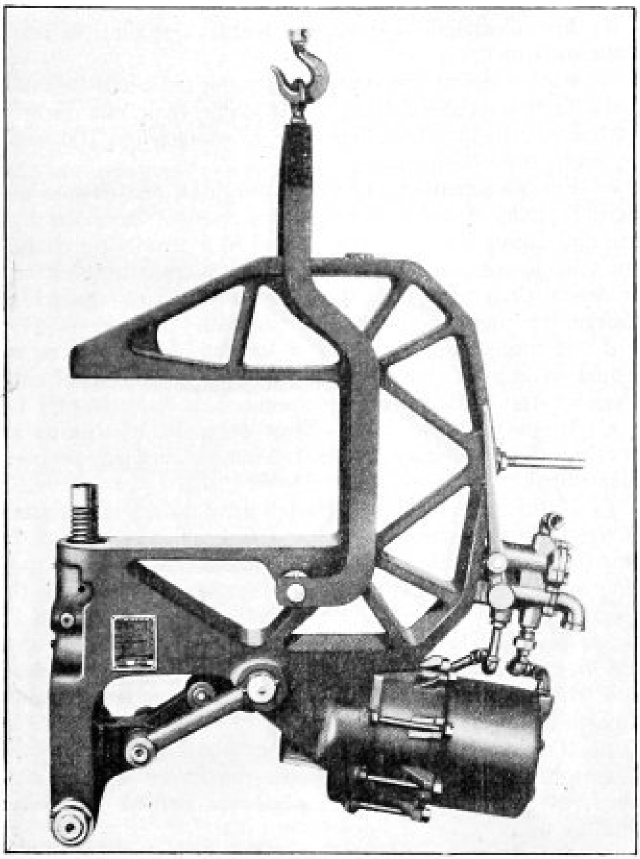
b The purchaser may make the tests to govern the acceptance or rejection of the forgings in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

c Tests and inspection shall be so conducted as not to interfere more than is necessary with the operation of the works.

Hanna Portable Compression Yoke Riveter

ONE of the features of the new Hanna portable compression yoke riveter shown in the accompanying illustration is the alloy steel truss frame construction which ensures the desired rigidity and strength with the use of a minimum of metal. This riveter has a reach of 24 inches, a gap of 15 inches, is capable of exerting a pressure of 50 tons on the rivet die at 100 pounds air pressure and weighs only 1,500 pounds.

Suspended as shown, rivets are inserted from above and headed from below making possible pinch bug (nutcracker) riveting speeds. Rivets may be placed far in advance of the riveter, enabling the "rivet-sticker" to give a portion of his time to drift pins and stitching bolts without interrupting continuous riveting. The machine may also be suspended dies vertical, cylinder up or dies horizontal, cylinder up.



Portable compression yoke riveter in the suspended position

Another feature is the method of mounting the air actuating cylinder making possible a distance of only 29 inches from the inside top surface of the live stake to the bottom of the rear cylinder head. This permits the riveter being used where work is laid down for riveting, the height of which is usually influenced by what is most desirable when reaming.

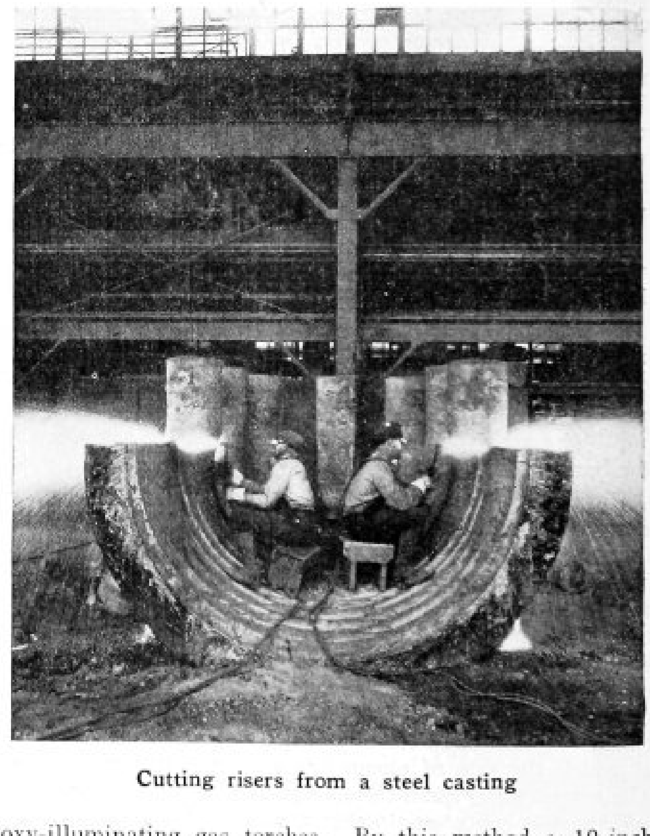
The control of the intake and exhaust air is through a Hanna combination operating valve which is a distinct unit mounted at any convenient location and may be operated by hand or foot. Two air hoses with an inner area equal to that of a one inch pipe lead from valve to cylinder. The valve combines two distinct types of valves—the balanced poppet and the balanced piston—making an air tight and free-moving valve. The most important feature of this valve is that any slight leakage at the valve will be from machine to exhaust, not from line to machine, or line to exhaust. The operating valve is designed especially to meet this service.

The pressure exerting mechanism is a combination of simple lever and toggle which combine a long die stroke with a wide range of uniform pressure. The first part of the die stroke is very rapid as the upper die approaches the work. The die or plunger speed gradually decreases until it enters the uniform pressure area of the stroke. The advantage claimed for this die stroke is, where the work is lightest the speed is greatest; as the rivet head forms, the pressure increases, reaches a maximum and maintains it for several inches of piston travel. Ordinary variations in rivet lengths and plate thicknesses are automatically taken care of by the wide range of uniform pressure.

This machine and riveters of other types are made by the Hanna Engineering Works, Chicago, Ill.

Cutting Steel with Illuminating Gas

SINCE the adoption of illuminating gas to replace acetylene, hydrogen and other fuel gases in combination with oxygen for metal cutting, the General Electric Company, Schenectady, N. Y., has found many valuable uses for this new metal cutting tool. The accompanying illustration shows two operators in the Everett plant of that company cutting risers from a steel casting with oxy-illuminating gas torches. By this method a 19-inch steel riser is cut through in 7½ minutes.



Cutting risers from a steel casting

The new method reduces gas costs, as the illuminating gas used is cheaper than either hydrogen or acetylene. The principal advantages claimed are availability; elimination of delays and handling of tanks; low cost; safety and chemical and physical properties permitting the use of the gas in a torch equipped with a superheater, thus effecting marked economies in the amount of oxygen required by the cutting jet.

Properties of Steel Filler Rods for Welding*

General significance of chemical analysis—Flux coatings—Cast iron and alloy filler rods

THERE is a growing feeling in the welding industry away from the theory that chemical analysis is the major factor in welding rod quality and towards the one that it is of no consequence within wide limits. Research indicates that neither of these tendencies represents a full statement of the facts. The matter is too complicated to permit saying that the impurities either do control or do not control, without first considering them separately, the amount of each, whether gas or electric rod is involved, and something of the welding work to be done. Some understanding of the state in which the impurities exist in filler rod must first be had before their effect on welding can be appreciated.

Impurities in Commercial Steels

The impurities commonly found in commercial steels are carbon, manganese, sulphur, phosphorous, silicon and in a surprisingly large number of steels copper is present in appreciable quantities, being left residual from the ores. It does not seem to affect welding either directly or indirectly, so it may, like all the other impurities except carbon and manganese, be disregarded. These remarks apply strictly when such quantities of these impurities are present as are regularly found in good grades of commercial steels. Carbon does not exist in steel as free carbon but as combined carbon, known as iron carbide or cementite. The same is true of the other impurities. Iron carbide is an entirely different substance from carbon, possessing different chemical and physical properties. The impurities combine among themselves and with iron in definite chemical proportions all of which has been worked out by scientists independent of the welding industry. To show what the form and percentages of these compounds are in steel, one example will be worked out. As a full explanation may be found in any good book on the metallurgy of iron and steel, no attempt will be made here to give reasons or details.

The average analysis of Weldite No. 18, which meets the American Welding Society chemical specifications E-1-B, is as follows: carbon 0.16 percent; manganese, 0.45; sulphur, 0.035; phosphorous, 0.005; silicon, 0.06; copper nil. The problem works through in round figures as follows:

0.035 sulphur forms 0.105 manganese sulphide, leaving 0.38 manganese to combine with carbon.

0.38 manganese forms 0.40 manganese carbide, leaving 0.14 carbon to combine with iron.

0.14 carbon forms 2.10 iron carbide.

0.005 phosphorus forms 0.015 iron phosphide.

0.06 silicon forms 0.18 iron silicide.

Repeating these figures in tabular form adding and subtracting the total from 100 percent gives by difference the percentage of iron existing as pure iron in this steel.

Manganese Sulphide	(Mn S)	0.105 percent
Manganese Carbide	(Mn_3C)	0.400 percent
Iron Carbide	(Fe_3C)	2.100 percent
Iron Phosphide	(Fe_3P)	0.015 percent
Iron Silicide	(FE SI)	0.180 percent
Iron, by difference	(FE)	97.200 percent

Out of the 2.8 percent not iron, 2.5 percent is carbide. As iron and manganese carbides are surprisingly similar, it would seem to make very little difference whether there is manganese present or not to combine with the carbon, because if the carbon content does not combine with the manganese it will form an equal quantity of iron carbide. More will be said of the effect of manganese on the metallic arc later. This example gives an idea of the relative importance of the various impurities so far as quantity is concerned and indicates that carbon represents about ten times all the other impurities put together.

The physical properties of the compounds formed in steel by these impurities should be understood. Both manganese and carbon tend to harden the steel, increasing its tensile strength and reducing its ductility. Sulphur makes steel brittle when heated while phosphorus causes it to be brittle when cold. Silicon has no appreciable effect over wide limits. Chemically, these impurities have a still different aspect. Manganese and silicon at welding temperatures would have a tendency to oxidize, forming a slag floating on the surface. The carbon, sulphur and phosphorus would also tend to oxidize, but their oxides being gaseous, escape. A further discussion of the effect of these impurities on the properties of filler rod requires a separate discussion for gas and electric rod.

Effect of Analysis on Gas Filler Rod

Metallurgical research independent of welding indicates that the following maximum amounts of the several impurities do not appreciably affect the quality of commercial steel; sulphur, 0.10; phosphorous, 0.05; manganese, 1.00; silicon, 0.20; copper, 0.15. Research indicates that gas welding does not inject any new phase into the matter. As practically all commercial steels fall below these limits, there seems little cause for the gas welder to be concerned with these impurities. Carbon, however, has a different significance. By a change of the relative amounts of oxygen and acetylene entering the welding flame, the amount of carbon in the filler rod may be increased, decreased or retained in the weld. It also seems possible to burn out the carbon by using a very large tip on thin work with a small filler rod. The metal is heated substantially above the melting point in this case and carbon boiling may result which will cause blow holes in the finished weld. The hardening effect of carbon, of course, applies to gas welds as well as any other form of iron-carbon alloy. There seems to be no good reason for the gas welder using rods of extremely low carbon and manganese contents. Carbon, 0.10 percent and under, manganese, 0.30 to 0.50 percent, would make a mild steel gas filler rod which should serve every purpose of mild steel welding.

Effect of Analysis on Electric Filler Rod

The temperatures of the arc are generally much higher than the oxy-acetylene flame and furthermore the heat is continuous rather than intermittent and under the operator's control. It is, therefore, natural to expect differences in the working qualities of rods of the same composition when they are used as electrodes rather than when they are made use of as gas rods.

There are so many inherent difficulties in the way of a scientific study of metallic arc electrodes that it was necessary to stop research for nearly a year and a half during which time an instrument was developed for the testing and research purposes called an Arcometer. This seems des-

*The first article on this subject appeared on page 259 of the September issue.

tinued to become the standard means of testing electrodes.

Suffice it to say: That the melting rate of electrodes seem to vary directly with the carbon content of the rod when run negatively, the higher the carbon the faster the flow. That the effect of a few points difference in carbon content has a marked effect in the low range of carbon and the same few points has little effect in the high range. That below 0.07 a variation in carbon has little or no effect nor are there indications that it has much of any effect over 1.10. When the electrode is run positively the carbon content does not seem to have any effect on melting rate over the entire range. No satisfactory theory has yet been developed for this behavior of electrodes when run positively unless it be that there is a definite time interval required after a molten drop has left the rod for the heat to work back and melt the next drop.

The fact that carbon oxidizes to a gas, probably carbon monoxide, at arc temperatures leads strongly to the theory that it is this gas which is responsible for the melting rate. The more of this gas formed the more chance of blowing the molten drops off the end of the rod and allowing the arc heat to get at the rod again to melt another drop. Occluded gas in an electrode increases its melting rate, no doubt, for the same reason.

Sulphur oxidizes probably to sulphur dioxide, but its effect on the melting rate of even extremely low carbon rods seems to be nil, or at least so small that the action of the carbon masks it. This seems logical because the atomic weight of sulphur is 32 while carbon is 12. Oxygen being 16, it therefore would take 1½ times as much sulphur to form the same amount of sulphur dioxide as it does of carbon to form carbon dioxide. Researches on the equilibrium of gas in blast furnace indicate that at arc temperatures carbon dioxide does not exist but rather carbon monoxide. If this be true it would take about 2⅓ times as much sulphur to form the same volume of gas as carbon forms. The flame from the arc is more pronounced with high carbon rods and it is reasonable to suppose this is largely carbon monoxide burning to the dioxide.

There is no question that carbon content has a definite effect on the rate of flow of electrodes and there is much evidence that none of the other impurities as ordinarily found in commercial steels have any appreciable effect on the properties of electric filler rod except manganese.

There are indications that manganese influences the ratio of heat developed at the positive and negative poles of the arc. As the manganese content of the filler rod increases a larger percentage of the heat is developed on the positive side, which is usually the work. This causes the rod to melt slower and increases the penetration. An increase of manganese seems to tend to make the arc less stable. These remarks apply to a bare rod. Some flux coatings tend to prevent both the carbon and manganese from burning out and they give an electrode with relatively high carbon and manganese the same characteristics as a bare rod containing but little of these elements. The retention of manganese by flux coated rods may be one cause for the increased arc stability of such rods.

Anything such as occluded gas or gas-forming materials, such as carbon, will indirectly affect the penetration. Penetration is necessarily, the product of the amount of heat developed in the work per unit of time multiplied by the time such heat is applied. The faster any given electrode flows, the less time it can be held in one spot, and consequently the less penetration. There also seems to be a definite connection between the carbon content and the maximum arc length at normal working current density. The lower the carbon, the longer this maximum arc length. It follows that less manual skill is required to hold an arc with a low than a high carbon electrode, other conditions being equal.

FLUX COATINGS

The subject of arc stability leads to flux coatings. This is probably the most fertile field for advancement in the art of metallic arc welding. The flux coatings most generally used in connection with the popular brands of these electrodes now on the market are composed of silicon dioxide and calcium carbonate adhered to the rod with silicate of soda. Tensile tests not only on flux coated Weldite but also on several other brands of flux coated rods, show plainly that the weld metal from such rods has a substantially higher yield point than from bare rods. Bright bare rods in turn give weld metal with a higher yield point than black soft annealed rods.

CAST IRON FILLER ROD

There is not much to comment on the subject of cast iron rod. It is not pickled as are steel rods so is not subject to the effect of hydrogen. Molding sand left on the surface is, of course, undesirable. The use of cast iron for filler rod is becoming less each year and therefore research on this subject is not looked for.

ALLOY STEEL FILLER ROD

The whole subject of alloy steels is so new to industry that it must be approached cautiously from the standpoint of welding. It is evident, however, that alloy steels for both gas and electric filler rod together with flux coatings for electrodes offer the greatest opportunity for advancement in filler rod design. A nickel content of about 3½ percent adds somewhat to the hardness and much to the toughness of weld metal. Manganese over 12 percent has been successfully used to add both toughness and hardness of a substantial nature. Heat treatment is generally required on manganese steel welds and so the self-hardening chromium alloys are becoming increasingly popular. Welds made with them possess a toughness and resistance to abrasion such as has not hitherto been attained with any other type rod.

Trade Publications

ACETYLENE GENERATORS. — Airco-Davis-Bournonville acetylene pressure type generators are described in a pamphlet now being sent out by the Air Reduction Sales Company, New York. These generators are designed for the oxy-acetylene welding or cutting processes to provide acetylene under required pressure for efficient pipe line distribution in large and small plants. All generators are operated up to a maximum of 15 pounds pressure and are manufactured in sizes having an output capacity of from 50 to 300 cubic feet of acetylene per hour in normal operation.

BOILER WATER CIRCULATOR.—The "Compulsoree" which is a self-operating water circulator for land and marine boilers, is described in a catalogue issued by Cutbill, King & Company, Ltd., London, England. This circulator is a valveless, self-operating hydrostatic pump designed and arranged to lift cold water from the lowest part of the boiler to the working water level every few seconds.

WELDING AND CUTTING EQUIPMENT.—The Smith Welding Equipment Corporation, Minneapolis, Minn., has issued a complete catalogue of oxy-acetylene welding and cutting equipment including tanks, torches, generators, trucks, pre-heating torches, valves, regulators and the like.

CALENDAR.—The National Tube Company, Pittsburgh, Pa., is distributing a decorative calendar for 1927, the feature of which is a reproduction of a painting showing one operation in the manufacture of tubing.

CALENDAR.—The 1927 calendar of the Flannery Bolt Company, Pittsburgh, Pa., features various type bolts produced by the company.

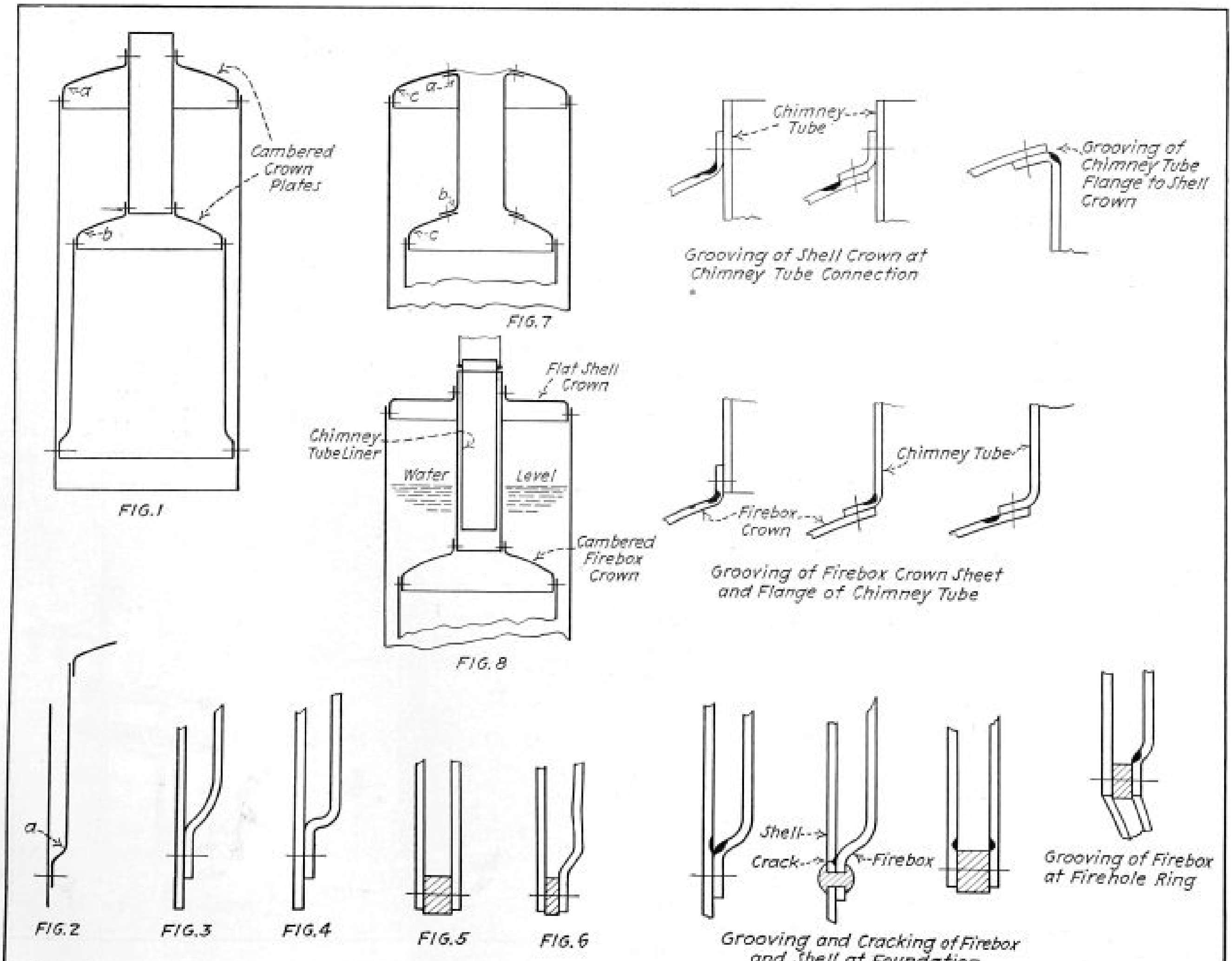
A Study of the Stresses Which Occur in Vertical Cross Tube Boilers

By A. Wrench

WHILE there are many types of vertical boilers now in use for small steam plants the vertical cross tube boiler notwithstanding its low evaporative efficiency is still very popular. The reason for its popularity is perhaps its simplicity, cheap construction and low upkeep costs. When this type of boiler is being designed due regard is taken of the stresses which occur under steam pressure; also the design is improved at parts where the makers have, during their experience, found defects to occur. On examination of the design of vertical cross tube boilers made by various makers it will be found that details differ even when the boilers are of the same size and for a similar working pressure. For example, one boiler may have the firebox and shell crown plates cambered while another may have a flat shell crown plate and a cambered firebox crown plate. Another maker may prefer to stay the two crown plates. Whenever one finds a variation in design, of the description referred to, it will almost invariably be found that it is due either to it being an old standing practice to adopt that particular method of construction or the design is due to experience of some defect that has been brought to the notice of the firm. The tensile, shearing and compressive strengths of the plates and rivets used are, of course, known and makers can arrange their plate thicknesses to suit the stresses due to steam pressure allowing a suitable factor of safety. The stresses other than those due to steam pressure are not always considered, and are only allowed for where the maker's experience has shown that defects occur from some other cause.

Expansion Stresses

The stresses due to expansion in vertical cross tube boilers are greatest when the fire is first started and before steam is generated. The firebox and chimney tube become heated before the shell plates and therefore a movement of the former takes place while the shell remains rigid. The expansion of that part of the chimney tube which is above the water level will be considerable. Assuming that the firebox is rigidly secured to the shell at the foundation,



Demonstration of vertical boiler stresses say, by a block ring as Fig. 5, the movement of the firebox may be upward. The chimney tube will transmit this movement to the shell crown plate and the flange of this plate at *a* Fig 1, will be subjected to a stress tending to open it. The expansion of the chimney tube will also tend to stress this part. The flange of the firebox crown plate at *b* Fig. 1 will be stressed in a different manner from that of the shell crown plate flange, the tendency being to close it. If the shell crown plate is flat, the stresses in the flanges will be less, owing to the greater flexibility afforded by the flat plate. It will be seen that during the period under review the chimney tube will be in compression due to resistance of the crown plates. If the chimney tube is weak and fairly long it will have a tendency to hog. Where the chimney tube is flanged to the crown plates as in outline Fig. 7 expansion stresses will occur at parts *a*, *b* and *c*.

Where the crown plates and chimney tube are of rigid construction, a portion of the stress of expansion will be transmitted to the foundation connection. If this connection is made by a block ring and the shell is made of plates less in thickness than the firebox, the tendency will be to bend out the shell just above the block ring. If the connection is made by flanging the firebox to meet the shell the stress of expansion will be taken up by this flange at *a* Fig. 2.

The stresses enumerated in the foregoing occur each time the fire is started which in most cases is daily. The usual practice with vertical cross tube boilers is to draw the fire each night and the boiler is usually cold next morning. Constant repetition of these expansion stresses cause defects to occur and it is, therefore, desirable that makers of these boilers should make ample allowance in the flanges to enable these parts to take up the stresses without undue fatigue. Where the crown plate is welded to the shell the stress caused by expansion tends to fracture the plate at or near to the weld. Welds at this part should be well rounded and free from "corners." Scale on the firebox plates will increase the stresses due to expansion during steam raising by retarding the flow of heat through the plates.

As steam is raised the tendency of pressure is to deflect the crown plates. The shell plates by this time have become heated and will expand a little in consequence. The expansion of the shell will somewhat relieve the stress caused by the expansion of the firebox and chimney tube at *a* Fig. 1 and will also tend to put the chimney tube under a tensile stress. Before the chimney tube acts as a stay between the two crown plates, the amount of expansion of the shell, due to heat of steam and water plus the amount of deflection of the crown plates must exceed the total amount of expansion of the firebox and chimney tube. When a flat shell crown plate is employed and also when the firebox connection at the foundation is flexible, the chimney tube will be subjected to tensile stress, but where rigid cambered crown plates are used and stiff foundation connections, the chimney tube will act as a strut.

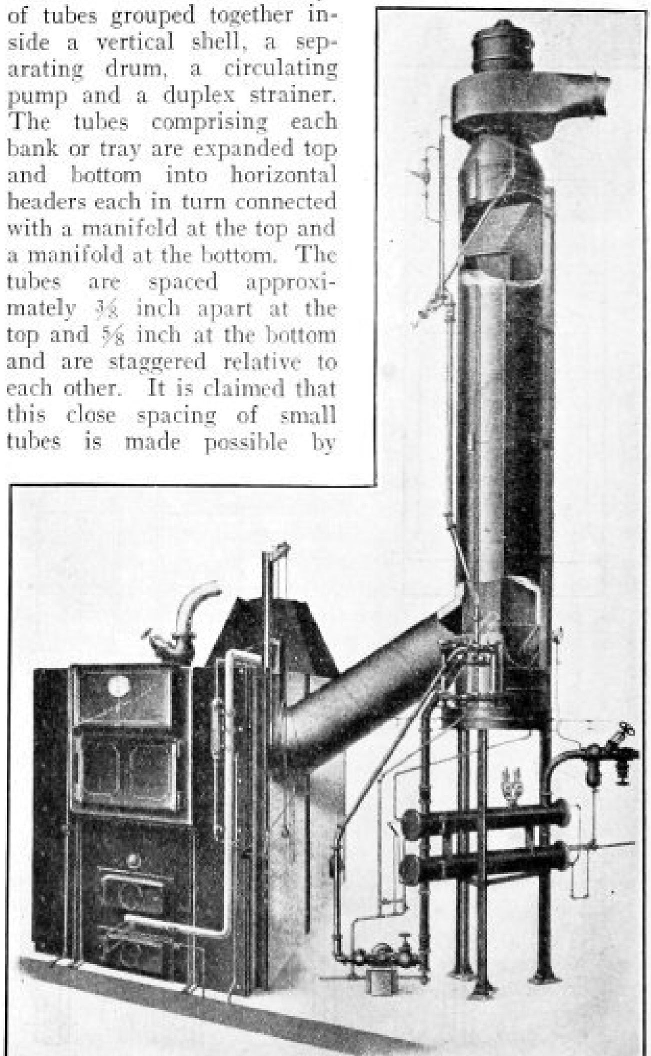
The movements of a boiler of the vertical cross tube type, under hydraulic test are much different from those movements which occur under working conditions or during steam raising. In all cases the chimney tube is under a tensile stress during hydraulic test. Where the chimney tube is flanged to meet the crown plates as in Fig. 7, the tendency of the hydraulic pressure will be to open the flanges. Under working conditions and also when steam is being raised the tendency may be for these flanges to close.

The defects caused by expansion stresses can be reduced by careful design based on working conditions. Flanges should be of large radii and the foundation flange be as in Fig. 3, and not as in Fig. 4. A liner in the chimney tube will reduce the tendency of the part which passes through the steam space to overheating. A flat shell crown plate and a cambered firebox crown plate secured by longitudinal stays with allowance for expansion are desirable.

The unnumbered sketches show some of the defects met with, the development of which are assisted by mechanical action due to expansion.

The La Mont Steam Generator

AT the recent Power Show, held in New York, the La Mont Corporation of New York city had on exhibition a steam generator which embodies several new principles, the outstanding feature of which is the method adopted of allowing a film of water to flow through the watertubes and during the process part of this water is turned into steam. The process is carried through by injecting a small but sufficient amount of water into the top of a long ⅝-inch tube in such a manner that the water forms a film on the interior of the tube. In passing down the tube only part of the water is turned into steam, the remaining water together with the steam formed pass from the lower end of the tube into a manifold or header and thence to a separating tank where the steam is liberated and discharged to the main steam header. The water is circulated by a pump so that it is positive at all times and does not depend on the natural circulation caused by convection currents. The boiler itself consists essentially of a number of banks or trays of tubes grouped together inside a vertical shell, a separating drum, a circulating pump and a duplex strainer. The tubes comprising each bank or tray are expanded top and bottom into horizontal headers each in turn connected with a manifold at the top and a manifold at the bottom. The tubes are spaced approximately ⅜ inch apart at the top and ⅝ inch at the bottom and are staggered relative to each other. It is claimed that this close spacing of small tubes is made possible by



La Mont steam generator connected with first pass of horizontal boiler utilizing the film evaporation principle. The straight upflow of the gases serves to give a high gas velocity and results in effective heat transfer and a minimum draft loss at the same time.

As the water strikes the sides of the tube it tends to form a film on the interior. Because of the small size of the tube violent ebullition takes place and, owing to the forced circulation assisted by gravity the steam bubbles are continually washed off the tube surface thus resulting in high heat transfer and insuring a continuous wet surface. The steam which is generated in the tubes together with the unevaporated water are discharged at the lower end of the tubes to a separating drum where the steam is liberated. The unevaporated water mixes with the fresh feedwater and a large portion of the carbonates and sulphates are precipitated in the process and removed by blowing down. It is claimed that, owing to the high temperature of the water entering the tubes and the washing action of the outstanding film the tubes are practically non-scaling. The heating surface is encased in a round 1/4 inch steel casing provided with a door opening sufficiently large to make the entire heating surface visible and removable. The design has been carried out to meet accepted standards in such details as the expanding of tubes into the headers, the use of seamless drawn tubing for all parts subjected to heat and pressure as well as pipe and fittings.

Defective Construction of a Vertical Boiler

By E. N. Treat

WHILE employed as a boiler inspector with an insurance company, I was sent upon a trip which was supposed to last about six weeks in good weather and longer as the weather became colder, as snows usually blocked the roads leading to the locations of the boilers to be examined. The boilers to be inspected on this trip were in many cases miles from a city or even a village and were located at times in the woods, quarries, field, creameries, mines, tanneries, summer estates and such places, that make traveling hard during the winter months. As this was now December and near Christmas, I wanted to clean up the trip and get back to headquarters before the snow became deep.

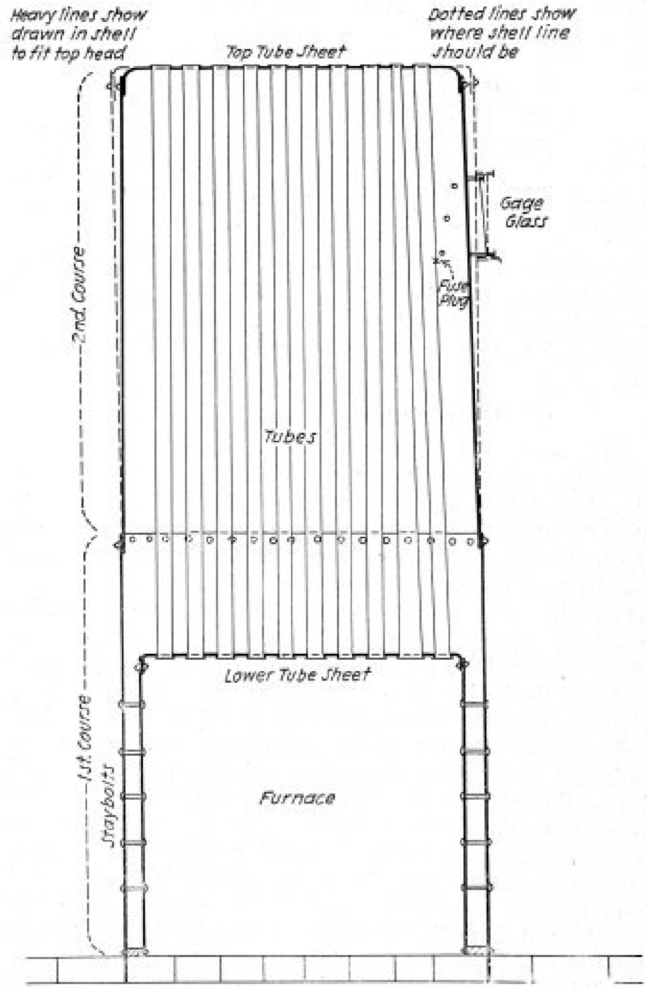
Only a few stops remained to be made; one was an external examination of a vertical tubular boiler located in a creamery, and until I visited the place I thought this examination would not take long, as the creamery was located near the railroad station. With fair train service I could make the next train out which left an hour later than my arrival and which would be fifteen minutes late, but I could see the creamery from the railroad station and the lights shone through the windows indicating that some one was still there, and that probably the boiler would be still in service for the day.

Coming into the boiler room I met the boiler attendant, introduced myself and handed him my card. It is with many engineers a grievous offence not to leave a card with your name and the name of your company upon it, as it appears that there is a tendency to collect traveling men's cards and to post them conspicuously near the boiler or engine. This over, I informed the attendant that I wished him to try the safety valve by hand, there not being sufficient steam near the blowing off point to raise the valve under steam pressure, also blow the test cocks, draw the water from the gage glass and open the blow sufficiently to prove that the blow-off valve was clear of mud or obstruction. The safety valve was tried and worked very well, the blow-off valve opened sufficiently to admit a trial and I opened the firebox door and found everything so far as could be seen there in good order. Closing the fire door and glancing up where the gage glass should be I noticed that the fixtures were there but no glass, nor were there any test cocks on the boiler.

State Boiler Laws Lacking

I requested the attendant to draw the fire at once, stating unless this was done I would telegraph my company to cancel the insurance at once, as we did not carry insurance upon any boiler where no try cocks nor water glass were used. I knew that we could not force the owner to carry insurance, or force test cocks or a glass water gage to be put on, as in this state there was no steam boiler law to back us up in our recommendations, as an owner could run his boiler in any way he saw fit. He could buy old discarded boilers in any other state having boiler laws and set the boiler up and run it without the trouble of making repairs as ordered by the state or insurance inspectors in that state which had boiler laws.

The boiler attendant informed me that the boiler had been operating for the past three months without test cocks or water glass and that while it was usual to have these fixtures upon a boiler, and handy, too, he had not found time to put in the three new test cocks and a water glass could not be put in as they simply broke at the turning of steam into the glass. Stepping to a drawer he got a new glass and a small wrench and placing the stepladder where the glass could be fitted, he invited me to try my skill. I threw off my overcoat determined to put that



Section through vertical boiler in which top course was tapered

glass in and walking over to a pail of hot water I put the glass in the water to warm up and expand. While waiting I picked out the old packing from the gland nuts and made sure the threads were in good shape. Taking the glass from the water and entering it in place, I proceeded to screw down a little on one gland which worked correctly; the other top gland didn't catch the thread readily and by forcing the packing I caught the threads, but as I did this, the glass broke short up to the top gland and I had not even turned the steam into it.

Top Shell Course Cone Shaped

Evidently something was not in line, although the gage glass fittings were screwed directly into the boiler shell. Securing a straight edge from one corner of the room I placed it along the boiler and to my amazement the top row of rivets at the top head was one inch or more from the straight edge, this amount decreasing toward the bottom of the boiler. At the girth seam rivets the straight edge was in line with rivets at bottom of the boiler but stood off at the top head seam rivets. Trying the straight edge all around the boiler, it was found that this was the case all through. From the first course girth seam rivets up, the top or second course was cone shape, evidently the top head was smaller than it should be and the top of the second course had been drawn to fit the smaller head. This was a new condition to me, the tubes were closer together in the top head than in the lower sheet, everything was tight and to all appearance the boiler was a normally constructed one.

Opening a drain valve the steam was released from the boiler and the gage fixtures were taken out of the shell. How to overcome this was the question. A short nipple and a coupling would be too long for the distance the shell was drawn, and the glass with its connections was desired as close to the boiler as possible without undue piping between the gage fixture and boiler. A bushing as used in pipe work of course wouldn't take the gage fixture, it being reduced. After some time considering what should be done, we decided to thread a pipe and cut it off short, then cut a pipe coupling off with a hack saw, screw the gage fitting tightly into the coupling and then screw the short threaded pipe into the coupling. These were all brass and worked easily, although the first threaded pipe we cut was loose and had to be discarded and a tight threaded pipe cut.

Gage Glass Problem Solved

When this was finished and both gage fixtures fitted, a new glass was put in and the gland nuts screwed down; the glass did not crack. New test cocks were put into the shell in place of the pipe plugs, and as we finished filling the boiler sufficiently full to start the fire in the morning, I inquired of the boiler attendant, "How did you ever tell where the water was in the boiler? You say this boiler has been operated some time without test cocks or gage glass." "Well," said the attendant, "there were no test cocks on the boiler when it was shipped to us, but the gage glass fixtures were wrapped in burlap and in a wooden box, and after we had set up the boiler we were short the test cocks. I broke glass after glass trying to put one in and during the time I was trying to put in a glass I found that by opening the top gage glass fixture I would get steam or water from it and also the same from the lower fixture. I used these two fixtures for my test cocks. If steam issued from the bottom fixture I put on the injector and when water issued from the top fixture I shut it off; in this way and by close attention the boiler was operated. There is a fusible plug in one tube and I removed that and scraped the filling before we put the boiler up."

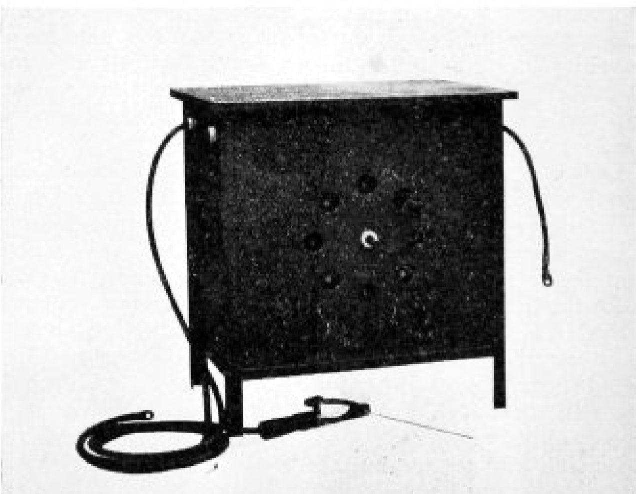
"Where did the boiler come from; who built it; and how old is it?" I asked. "It came from a second hand man in—, and he said it was only five years old. He couldn't give any information as to who built it as he had only recently gone into the second hand business and the man from whom he had purchased the business, and then dead, had given the present owner a written statement that no boiler in his yard was over five years old. There is no state number of any state that has a boiler inspection law on it, but there is stamping on one plate of 60,000 and over that is the word "steel" very faintly stamped.

It was eleven o'clock, hours ago my train had left, it was several minutes late the attendant stated. "I guess I'll go home now," he said, "as I must be back by 4 A.M. and need some sleep." "Go ahead," I said, "can I sleep here tonight?" "Help yourself," was the reply. After he had left I measured up the boiler, it was a new risk, my cards from the home office told me insurance was binding, I figured up the different parts. It was evidently good for the pressure under which it was insured, and I did not know of any reason why a vertical tubular boiler, cone shaped, could not be built and be safe as well as the ordinary one diameter boiler.

Upon my arrival at the home office, I was called upon to furnish description of the boiler with a rough sketch. "I would like to know who built it," remarked the Chief Inspector. "And why he built it that way," I added.

Air Cooled Arc Welder

THE New Monarch Machine and Stamping Company, Des Moines, Ia., has perfected an air cooled alternating current welding machine designed to weld steel and cast iron and built for both light and heavy duty. This machine was invented after a number of years of experiment by Ralph and Earle Brummett of Des Moines. The machine is entirely self-cooling and it is claimed that it cannot be overheated by constant operation. A special feature of this welder is the economy of operation, the cost being only about 15 cents an hour. The Monarch welder is made in a 1½-kilowatt size operating on 110- and 220-volt power circuits and having an adjustable amperage of 20 to 170. Because of this adjustable feature, the welder, which is primarily a heavy duty machine, is also adapted to lighter types of work since the amperage may be increased or diminished at the operator's will. It was built primarily to fill the needs of quantity production in iron and steel manufacturing.



New Monarch air cooled arc welding machine

An Unusual Boiler Explosion*

THE following is an account of a very unusual form of boiler explosion, in which a tube drew out of its header and was found to have been shortened in the process. No attempt was made at the official inquiry to explain the cause of this shortening, but C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association, has investigated the matter and puts forward a theory in his memorandum for the past year. The essence of this theory is given below.

The boiler in question was of the Babcock type, about ten years old, and was used to supply steam at the Hale End Works, Walthamstow. It was shown at the official inquiry that many of the tubes were badly choked with deposit, and that the tube which failed was completely blocked. It consequently became overheated and drew out of its header at one end. The resultant rush of steam scalded two men so severely that they died the same day.

In drawing out of the header the tube was buckled over about half its length of 18 feet, and at the part where it was choked was swelled from its original diameter of $3\frac{15}{16}$ inches, so that the circumference, instead of being 12.781 inches, became in one place as much as 13.375 inches. Over a length of 66 inches the average increase in the circumference was 0.211 inch. After the explosion, the end of the tube was, according to the official report, $\frac{1}{4}$ inch clear of the header, which means, taking into account the length of tube inside the header, that it had shortened itself by $1\frac{1}{4}$ inches. The bending could not account for so great a reduction in length, and it is Mr. Stromeyer's aim to explain the discrepancy. He says:

"The swelling of a tube's diameter should be accompanied by a shortening of its length, and it therefore seemed to me that the drawing out of this tube might be explained as due to its swelling. The possible action is somewhat complicated. If one of a number of tubes grows hotter than the surrounding ones, it would, not taking into account the steam pressure, expand both circumferentially and longitudinally, and being limited as regards movement by the adjoining tubes, it might be staved up or buckle and if cooled down again would be shorter than the other tubes and might be drawn out of its tube hole. The withdrawal in this case might therefore be explained by severe heating and sudden cooling, but the estimated movements are far smaller than required.

"Another explanation—one that fits the present case admirably—is that the tube having become hot, its metal would become semi-plastic, and, yielding to the internal steam pressure, would increase its diameter. But when plastic materials yield they do not change their volume. Their specific gravity remains almost unchanged, so that any increase in one dimension is associated with the same decrease of the cross section. . . .

"According to the official drawing, over a length of 66 inches the average circumference is 0.211 inch greater than $12\frac{7}{16}$ inches, which is the circumference at other parts of the tubes, and therefore almost certainly the original circumference. The ratio of 0.211 inches to the circumference is 0.0170, and therefore the 66 inches should have shortened 0.0085 of this length, or 0.53 inch. A careful analysis of the measured bending of the tube as recorded on the official drawing showed that this would account for 0.94 inch.

"Adding together the shortenings due to these two causes, we have $0.53 + 0.94 = 1.47$ inches. The actual shortening, or, rather, the difference of length between the withdrawn tube and the adjoining tubes was 1 19/64 inches or 1.30 inches, so that only 0.17 inch remains unaccounted for, or, rather, this difference may readily be accounted for as being due to the pull on the tube before it suddenly slipped out of its one tube hole.

"Up to this point of time the tube would almost certainly be straight, for it must have been in a high state of tension, otherwise it could not have pulled itself out of its tube hole. But it would have to move 1 inch to clear the header hole—$\frac{5}{8}$ inch thickness of plate and $\frac{3}{8}$ inch projecting tube end. Momentarily it would behave like a stretched spring, if released at one end. That end would move double the distance the spring had been stretched, and in its temporarily shortened condition it would experience a compression stress which would be exactly equal to the tension under which it started to move.

"In the present case therefore the tube end would move $2 \times 0.53 = 1.06$ inches, and just clear its hole, provided that the tube had remained straight, but being subjected to a temporary severe compression stress, and being in a plastic condition, it would buckle; in fact, it did buckle, and due to this buckling it shortened another 0.94 inch, so that for a short instant of time the end of the tube was $0.94 + 0.06 = 1.00$ inch clear of the header, but at once it returned to within about $\frac{1}{4}$ inch, as the compression stress disappeared.

"A stretching of 0.53 inch on a tube length of 213 inches implies a tension stress of 32 tons per square inch, but this has to be reduced on account of the shortening of the adjoining tubes, and also on account of the plasticity of the material, but it would be sufficiently intense, when changed into a compression stress, to account for the buckling of the tube."

* Report published through the courtesy of *The Engineer*, London, England.

Heating Engineers Propose Boiler Rating Method

FOR some time the matter of rating low pressure heating boilers has been in a chaotic condition and has been unsatisfactory to engineers, architects, manufacturers and contractors throughout the country. The situation was noted by the United States Bureau of Mines and called to the attention of the American Society of Heating & Ventilating Engineers as a most disturbing condition in the industry. The Bureau suggested the appointment of a committee to study the situation from all angles, and urged the society strongly to take up this matter in an effort to provide a satisfactory solution of the rating question.

H. P. Gant, Chairman of the Society's Committee on Research, responded to this appeal and appointed a Technical Advisory Committee with the following personnel: Alfred S. Kellogg, consulting engineer, Boston, *Chairman;* Percy Nicholls, fuel engineer, U. S. Bureau of Mines, Pittsburgh; L. E. Seeley, Sheffield Scientific School, Yale University, New Haven, Conn., and F. C. Houghton, director of the A. S. H. V. E. Research Laboratory, Pittsburgh.

No member of this Committee is in any way connected with the trade and each has accepted the difficult job of finding a solution to the boiler rating problem with the thought of establishing a plan that would be to the best interests of the public at large. Several meetings have been held and on December 8 and 9, 1926, all day conferences were held and a working plan adopted which is now being sent out in a letter from the Committee to the boiler manufacturers of the country in order to learn whether the trade really wants to have this unsatisfactory boiler rating condition cleared up and a uniform standard of rating established, or whether the manufacturers prefer the present conditions to continue.

From the results of this survey the Committee will draft a report to be presented at the Society's annual meeting in St. Louis, January 25-28, 1927.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Stack Base

Q.—Enclosed you will find a sketch of a stack base. I used triangulation but it did not come out right. I would like to have you give me a solution of the problem and would appreciate it very much. T. M.

A.—The solution of this problem is illustrated in the accompanying drawing.

A plan and elevation are laid off to the given dimensions. Divide the profiles into equal divisions and draw in the triangulation lines *b—b*, *c—c*, *d—d*, etc. Find their true lengths as indicated in the diagram of triangles. Use for these the length of the lines in the plan and the corresponding heights in the elevation. The hypotenuse of these triangles are the true lengths. The pattern is laid off by their use as shown in the one-half pattern development. Use the arc lengths in the profiles for the stretchout.

Location of Feedwater Pipe — Scale and Mud

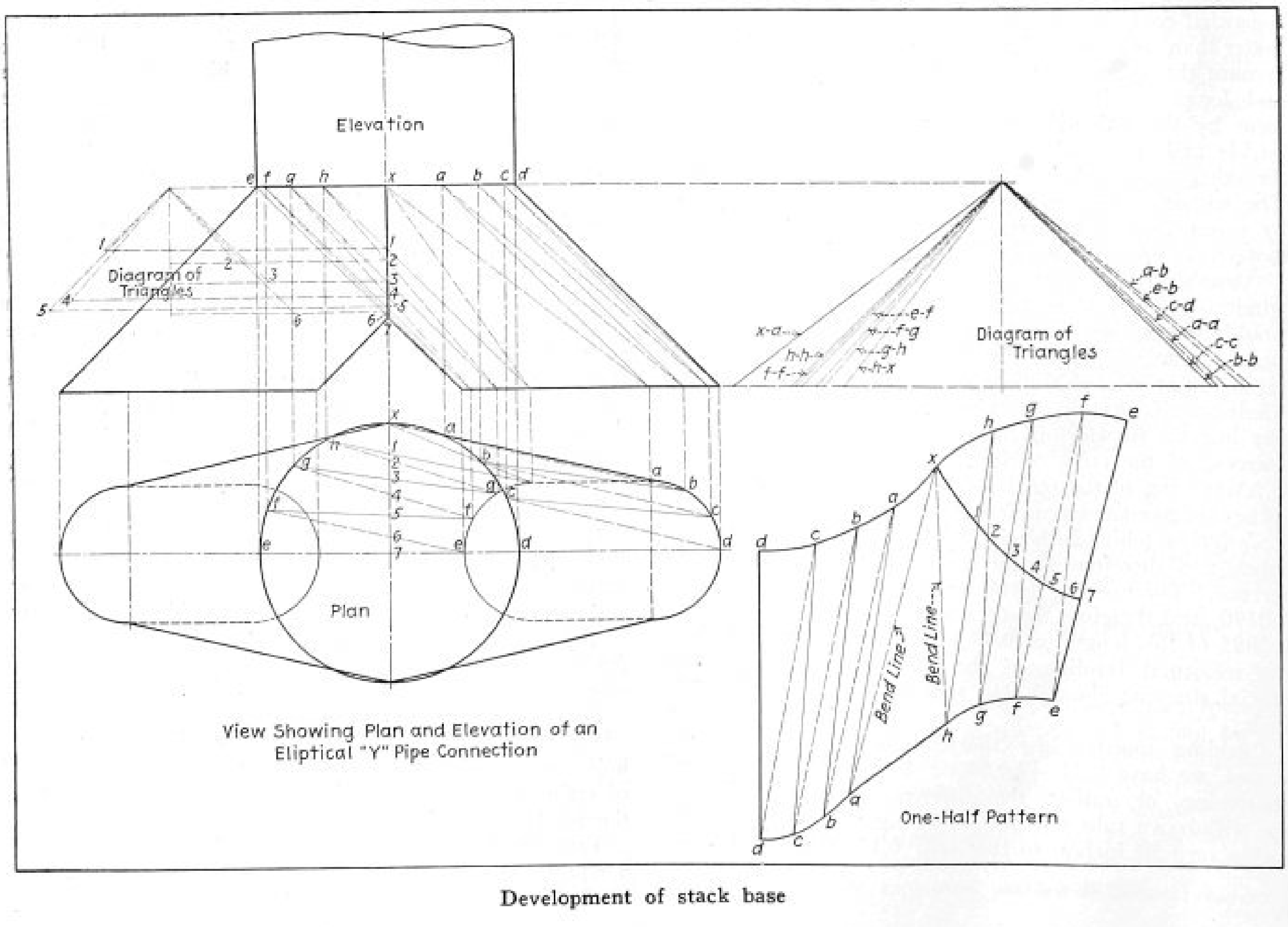
Q.—Please tell me the proper way a feed line should enter a stationary or locomotive boiler.

(2) Why is it that scale and mud always form where the feed line goes into the boiler?

(3) When a return tubular boiler is hung up how much lower should the back end be than the front? J. F. D.

A.—Feedwater should be brought into a boiler so that the water is not discharged directly against any of the heating surfaces, or close to riveted joints of the firebox or shell.

For horizontal return tubular boilers the feed pipe should be brought in from the front head and run into the boiler about three-fifths of the length of the boiler and located above the tubes in the center of the boiler.



Development of stack base

Locomotive boilers are equipped with two separate methods of feeding the water, and the feedwater should be delivered near the front tube sheet.

Mud usually collects at the low end of the boiler, and scale collects on all parts.

The end of the boiler having the blow-off attached should be about 1 inch lower than the other end so that mud and other sediment may be blown out through the blow-off and also makes it possible to drain the boiler completely.

Stand Pipe Calculations

Q.—Will you please give me some assistance in the following:

How would you determine the plate thickness and type of joint for large cylinders under a uniform external pressure, say for instance, a stand pipe 50 feet in diameter by 90 feet high? The plate thickness and type of joint could be found by the usual procedure, but how would you determine the size of any stiffeners that would be required and the spacing of same for a wind pressure of, say, 30 pounds per square foot?

Can you also give me any information on the plate thickness and type of joint for a cylinder under a concentrated external pressure? I have hunted in vain through all the handbooks available, but have yet to find any information for cylinders of large diameter.

A.—The internal pressure tending to rupture a cylindrical stand pipe, is caused by the hydrostatic head of the water. The pressure in pounds per square inch is proportional to the height of the water level above the plane or section under consideration.

A cubic foot of water weighs 62.5 pounds and if confined in a vessel will exert on each square foot of the sides and bottom in a height of 1 foot 62.5 pounds per square foot.

Let h = height of water in feet.

P = pressure in pounds per square foot.

$$\text{Then } P = \frac{h \times 62.5}{144}$$

For a height of 1 foot, called head, the pressure equals

$$\frac{1 \times 62.5}{144} = 0.433 \text{ pound per square inch.}$$

Stand pipe tanks are usually made in courses 3 to 5 feet in height, and the pressure, due to the head, above each course varies. Since the pressure exerted by the water decreases from the bottom to the top, the thickness of plate can also be decreased.

From the following formula, the thickness of plate for any section or course of the tank can be determined,

$$t = \frac{0.433\, hfd}{2\, ETS}$$

in which

t = thickness of plate, inches.
h = height of water, feet.
f = factor of safety (4 to 5).
d = inside diameter of tanks, inches.
E = efficiency of riveted joint.
TS = tensile strength of plate, pounds per square inch.
= 50,000 pounds per square inch.

In addition to the plate calculations, consideration must be given to overturning and collapsing of the structure due to the mud pressure. The mud pressure varies in different localities but for inland points it is usually figured at 30 pounds per square foot.

This force is figured the same as against a flat surface, having a width equal to the diameter of the tank and a length equal to the height. The magnitude of this force is figured from the center of the pressure, measured from the base of the tank to the center on which the pressure acts; this distance is called the lever-arm.

Thus, in this example:

$50 \times 90 \times 30 \times 540 = 72{,}900{,}000$ inch pounds.

To resist this moment of force, which tends to overturn the tank, anchor bolts are used and spaced on centers in the bolts circle of from 8 to 10 feet. Their number should not be less than 6, having a length of about one-tenth the height of the tank.

The top of empty stand pipes are subject to collapsing pressure, therefore the plate thickness should never be less than $\frac{3}{16}$ inch and reinforced by an angle ring of proper size.

Assume that the resistance of the shell at the top is negligible, and that the angle ring must carry the load. The load on the angle ring, will be assumed for a depth of 1 foot on a transverse plane through the diameter of the tank.

For a load uniformly distributed the bending moment may be found from the formula:

$$\frac{WL}{1Z}$$

in which

W = total load in pounds.
L = length of beam in inches.

The load $W = 50 \times 1 \times 30 = 1{,}500$ pounds.

$$\text{Bending moment} = \frac{1{,}500 \times 600}{12} = 75{,}000 \text{ pounds.}$$

Safe stress of material = 16,000 pounds per square inch.

Then $75{,}000 \div 16{,}000 = 4.7$ section modulus.

Structural handbooks give the properties of structural shapes. For a section modulus 4.85 an angle 5 inches by 5 inches by $1\frac{3}{16}$ inches is given.

In this example no allowance was made for the resistance of the shell plate, taking this into account the size of angle could be less.

Riveted joints are figured according to the rules given for lap or butt seams.

Boiler Patches

Q.—I have several questions which I would like to have your Questions and Answers Department explain for me. I have been a regular reader of THE BOILER MAKER for the past ten years, although I am a young boiler maker in the trade—not yet 30. I bought a book called "Laying Out for Boiler Makers" in the third edition back in 1920, which is certainly helping me in doing laying out work.

(1) *Horizontal return tubular boiler.* In figuring out whether to put a patch or drive a bag back in a boiler, as in Fig. 1, would you consider it good policy to drill a hole in the center of the bag and see how thick the plate is, and to figure out the strength of the plate using the Massachusetts Steam Boiler Code, such as

$$\frac{TS \times T \times \text{percent}}{R \times FS} = \text{allowable working pressure per square inch.}$$

As for a factor of safety using 6, do you think it would be good to go by and then decide to see if you have to put a patch on or not?

(2) In putting a patch onto a boiler as in sketch Fig. 1, for the front course, would you put the patch on the inside of the front course and calk the old plate to the new one, and for the seam the patch plate will be calked to the old plate; for a patch on the center course would it have to be an outside patch?

(3) I wrote quite a few years ago about a large patch in a horizontal return tubular boiler and received a sketch and answer, as in Fig. 2, but I did not know much on figuring the strength, etc. In looking it over, I do not quite understand it now. I can figure the tensile strength, etc.; also the safe working pressure, but that half sheet patch is beyond me. For instance, the strap is figured at approximately 89 percent and the seam about half of that, but how do you figure on a half sheet in this case on the same boiler. If the strap is approximately 89 percent, is the butt and double strap joint quadruple riveted?

In the half sheet you have one or two rows of rivets and a lap joint

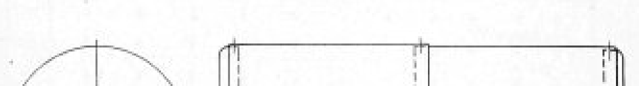


Fig. 1—Sketch of bag in horizontal boiler

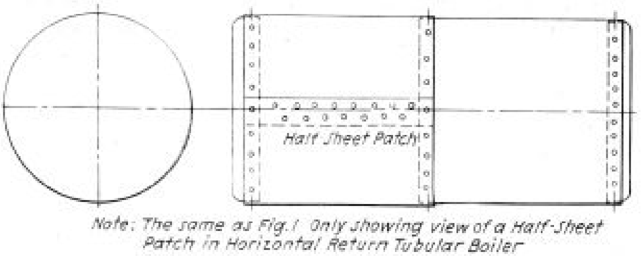


Fig. 2—Half sheet patch in horizontal boiler

with an efficiency of approximately 60 percent. If this is O.K. for a half sheet why put straps, etc., as they usually do? Will you kindly explain this matter as clearly as possible?

(4) In putting on a patch for a horizontal return tubular boiler, as in Fig. 1, to take the place of the bag, a half moon patch; would the pitch and diameter of the rivets be the same as the girth seam and should the efficiency of the patch be the same as in the seam?

(5) For an inside firebox patch in an upright boiler as in Fig. 3, should the patch come between the rows of staybolts or would the staybolt holes do and use patch bolts or rivets between the staybolts? Which would you advise as the best and should the patch bolts or rivets be the same diameter as the rivets in the seam? Also, how about a patch for the outside of the firebox; the rivets in the strap are larger than the seam, how would that affect the patch? I had an old-time boiler maker tell me to use the staybolt holes and put rivets or patch bolts between them. He said there would be too many holes the other way. I did quite a big job on a patch this way, using the staybolt holes and patch bolts between them and had a boiler inspector on the job when we tested it out and it did not leak at 175 pounds pressure. The inspector said it sure was a very good job. In looking over the third edition of my boiler book it calls for a patch between the staybolts. Kindly fix me up on this subject.—

F. B. P.

A.—Pockets or bags in a shell boiler occur from overheating. When heavy scale, grease and mud collect on the plate, the heat is not carried away fast enough to prevent the shell plate from overheating, as a result the tensile strength of the metal is reduced so that it yields to the steam pressure, in the form of a bag or pocket. Naturally in the making of such deformations the plate stretches and becomes thinner. If such a pocket is not discovered and repaired an explosion may result.

When there is any doubt as to the thickness of a boiler plate drill a hole to determine the thickness, then plug the hole with a tap bolt. It does not follow that because a plate has wasted it must be cut out.

To determine the maximum allowable working pressure on a worn boiler, follow the rules under which the boiler is operated; but it may be found by proportion. Thus, if a boiler shell 3/8 inch in thickness was originally allowed a working pressure of 125 pounds per square inch, and if the plate has been reduced in thickness to 5/16 inch, the maximum allowable pressure would equal

$$\frac{125 \times 5/16}{3/8} = 104 \text{ pounds per square inch.}$$

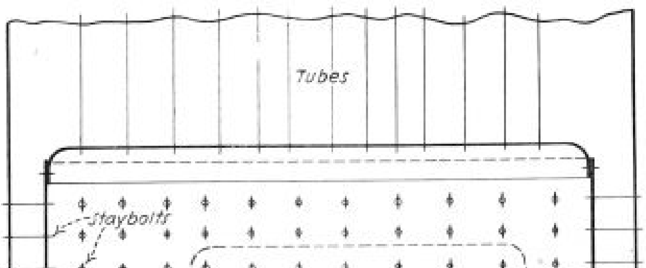
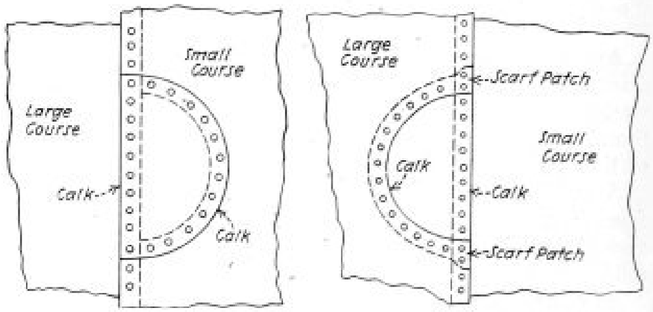


Fig. 3—Section of Manning upright boiler

If the bulge is large and deep it is advisable to remove the bag and apply a patch. To restore a bulge, the resetting should be done gradually by heating to a cherry red an area of the metal near the edge where the bag begins, then with a jack set the metal back, repeatedly reheat small areas working from the outside edge toward the center of the bag. An oxy-acetylene torch is the most convenient means for heating.

In applying patches, Figs. 4 and 5 illustrate how to apply what is commonly called a *hard patch* on the inside of the boiler shell. A hard patch is riveted to the boiler shell, and a *soft patch* is attached by the use of patch bolts. The soft patch is applied outside of the plate in cases where a hard patch cannot be applied and also in the case of temporary repairs.

The riveted joint in patches, should be single riveted if possible and should run diagonally with respect to the axis



Figs. 4 and 5—Hard and soft boiler patches

of the boiler shell, and in such arrangements if the diameter and pitch of rivets are the same as the girth seam the effective efficiency will vary according to the angle the joint makes with the girth seam.

The maximum allowable pressure on a shell, patched with a half sheet as indicated in Fig. 5 would depend on the strength of the longitudinal seam. A boiler otherwise built to carry a greater pressure would have to be operated at a reduced pressure on account of the double riveted lap joint.

The method you describe in patching the firebox shell is all right, and the method of having the patch seam come between the rows of stays is the best. The distance this patch bolt or rivet holes are from the edge of the plates, and the center to center distance between the patch bolts, or rivets, should be made the same as in a well proportioned single-riveted lap seam, having the same plate thickness.

Saving Welding Wire Ends

Q.—There has been some argument for some time past in regard to saving the ends of arc welding rods. Some companies think it is money saved by saving these ends of arc welding rods 14 inches long. I cannot understand how a 1½-inch or 2-inch that is left from a 14-inch arc welding rod can be a waste. Labor costs more than the welding material and it takes time to weld the waste end of an arc welding to the next one whether it is welded at the time the 14-inch rod is welded or picked up afterwards. I am asking that you have the Master Boiler Makers' Association investigate this and give the report in the next edition of THE BOILER MAKER or whenever you can. Thanking you in advance. D. M. McC

A.—We do not believe there is any great saving, if any, in welding the waste ends together as outlined in the question. However, since there are others who do believe in this method, the question is open to our readers for discussion.

Fred S. Doran has been appointed manager of the Cleveland Plant of Joseph T. Ryerson & Son, Inc. This new warehouse plant of the Ryerson Company was purchased from the Bourne-Fuller Company of Cleveland on January 3, 1927.

ASSOCIATIONS

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William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.

H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.

International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C. Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Avenue, Columbus, Ohio.

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First Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.

Second Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.

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Vice President—A. W. Clokey, American Arch Company, Chicago, Ill.

Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.

Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.

Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Wroks, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

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

States

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

Cities

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

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

States

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

Cities

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

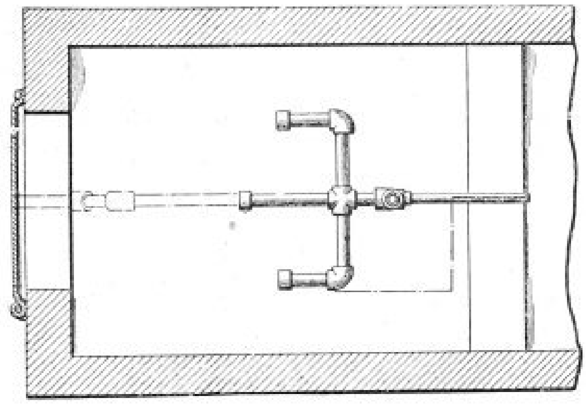
SELECTED BOILER PATENTS

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

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

1,548,360. DANIEL GOFF, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO RETTIE M. GOFF, OF PHILADELPHIA, PENNSYLVANIA. AIR FEEDER FOR FURNACES.

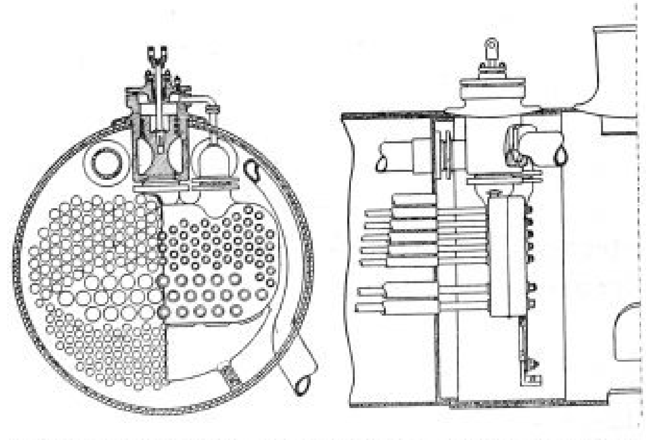
Claim 1. An a device of the character stated, an outer air supply tube, an air pre-heating tube extending into the furnace and communicating with the supply tube, a pendant tube carried by the end of the pre-heating tube,



a plurality of laterally extending air distributing tubes carried by the lower end of the pendant tube in proximity to the burning fuel, the central one of said air distributing tubes being longer and extending farther towards the front of the furnace than the other of said tubes, said tubes being closed at their free ends, and having a number of air discharge openings along the bottom sides thereof. 3 claims.

1,597,905. TEODORO LARREY AND LUIS GODARD, OF MEXICO CITY, MEXICO. STEAM SUPERHEATING SYSTEM FOR STEAM ENGINES.

Claim 1. A steam superheating system for steam engines, comprising a deflector having its interior partitioned to form a plurality of substantially-counterpart chambers disposed one in front of another, one of which is connected with a saturated steam supply; piping leading from a second chamber of the deflector for supplying superheated steam to the engine cylinders; a throttle valve in said piping for controlling the passage of the steam therethrough; and a multiplicity of tubular superheating units arranged in a plurality of distinct groups and mounted at one end in the deflector and projecting through the several chambers

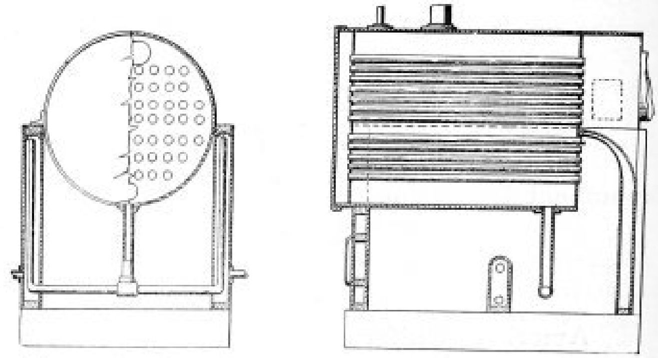


thereof, each unit being partitioned interiorly to form oppositely-extending, longitudinal inlet and outlet compartments which communicate with each other solely at the end remote from the deflector; the inlet compartments of all the tubes in one group of units having inlet ports which open directly into the first chamber of the deflector to receive saturated steam therefrom, and the outlet compartments of all the tubes of such group having outlet ports which open directly into a third chamber to discharge the then superheated steam thereinto; while the inlet compartments of all the tubes of a second group of units have inlet ports which open directly into said third chamber to receive the superheated steam therein, and the outlet compartments of all the tubes of said second group having outlet ports opening directly into the second-named chamber to discharge the superheated steam into that chamber.

Four claims.

1,601,338. FREDERIC W. BAKER, OF CLAYMONT, DELAWARE, AND JOHN R. O'NEILL, OF BALA, PENNSYLVANIA. BOILER.

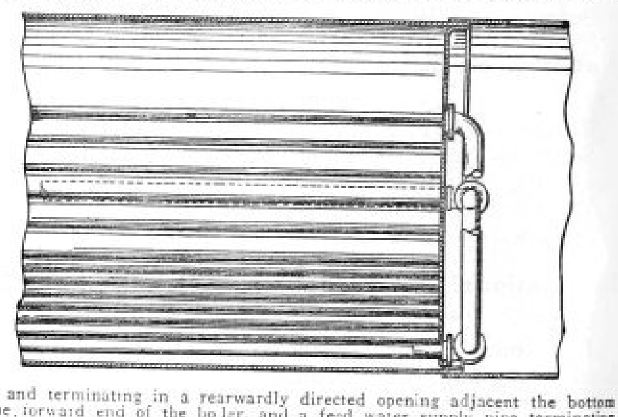
Claim.—The combination with a return tube boiler having front and rear tube plates, of a fire-box, the sides, front and rear of said fire-box being hollow water legs, said rear fire-box water leg having its upper



end inturned and engaging in edgewise engagement against said rear tube plate, vertical pipes within certain of said water legs and extending downwardly therethrough and having communication through the fire-box with the lowermost portion of the boiler. Three Claims.

1,602,232. SAMUEL J. LUPTON AND FRANCIS E. COLLINSON, OF WINNIPEG, MANITOBA, CANADA. WATER CIRCULATOR FOR BOILERS.

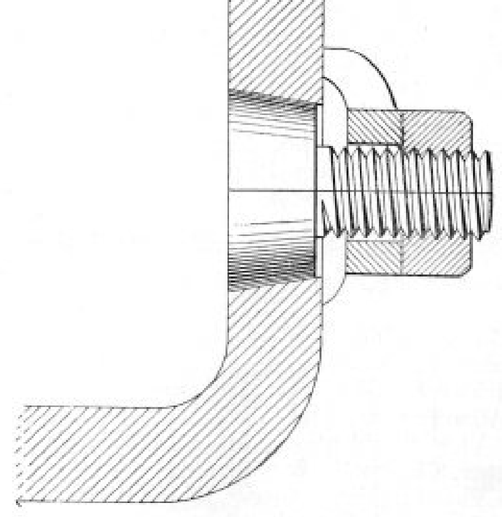
Claim.—In a locomotive, the combination with a firetube boiler; of a conduit leading from a point below and adjacent the normal boiler water



level and terminating in a rearwardly directed opening adjacent the bottom of the forward end of the boiler, and a feed water supply pipe terminating within said conduit in a discharge end directed toward the lower end of said conduit. Four Claims.

1,595,915. JAMES DENNIS O'BRIEN, OF BROOKLYN, NEW YORK. PLUG.

Claim 1. A plug for engagement within an outwardly tapering opening formed in a boiler head or the like member, comprising complementary mating sections, each consisting of a semi-frusto-conical head portion and a



threaded semi-cylindrical stem portion, said sections when mated adapted to provide a conical head tapering toward the stem and a nut adapted to engage over and lock the threaded stem portions when mated, said nut also constituting means for effecting the drawing of the head of the plug outwardly to and retaining the same in a sealing relation with respect to the opening.

Three claims.

The Boiler Maker

Volume XXVII February, 1927 Number 2

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St.
Westminster, S. W. 1.
Cable address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

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

CONTENTS

Shop Safety

ELSEWHERE in this issue appears an article "Safe Practice for Boiler and Tank Shops" which outlines methods for handling materials and operating tools that over a long period of time have been developed to safeguard the men against accidents. Inspections of various boiler shops throughout the country which are in every way representative of their type, lead to the belief that little or no thought in the majority of cases is given to this important phase of shop operation other than where the law requires certain safety measures.

Accidents happen in so many ways against which safety provisions cannot be legislated that the problem is one of education for the men rather than one susceptible to correction by state industrial department regulation. Even after all machine tools have been equipped with guards and shields and notices posted in the shop for the men to observe certain precautions, accidents will continue to happen unless the men themselves have been instructed in the safety idea. Such education should naturally begin at the top with the manager and here a policy should be formed that will ensure safe shop operation. This policy should include all the accepted machine safety devices; a hospital or first aid room if the plant is of sufficient size; adequate first aid equipment in any case; medical attention; proper sanitary arrangements and the like. From this point, it is the duty of the foreman to carry on and by example, instruction and interest in the welfare of the men to keep them informed of the dangers to be avoided and of the great penalty to themselves if carelessness is allowed to result in accidents.

Finally the safety idea should be a personal matter with every individual from the oldest to the youngest member of the shop staff; for in the final analysis the prevention of accidents depends on the care and thought with which everyone carries out his appointed task.

Meeting of the American Boiler Manufacturers' Association

AN important mid-winter meeting of the American Boiler Manufacturers' Association was held at the Hotel Cleveland, Cleveland, Ohio, on February 11. The program for the meeting included a report on the oil field boiler industry, one on steel heating boilers and a third on the Power Test Code. The address of the occasion was given by M. B. Lane of the United States Department of Commerce. The most important feature of the meeting, however, was the report of the National Trade Survey of the boiler industry in connection with which the president of the association, George M. Bach, recently sent out a letter to members of the association, an abstract of which appears below:

"At the beginning of the new year, your president feels that a brief review of last year's business is in order, and wants to take this opportunity to address the members of our Association on a subject which should be thoroughly discussed at the winter meeting, in Cleveland.

"The year of 1926 was normal or slightly better than a normal year for general business throughout the country, and the boiler industry got its share of this general business. In spite of the fact that business was at least normal, the profits in the boiler business were far below the average profits of industry as a whole, and will continue to be so until certain action is taken lending to betterment in the industry, all of which, I believe, is in the power of the industry to do legally and properly. I have in mind the survey of the industry now being conducted to give us a picture of the available capacity, and the extent to which this capacity is now working, and the general trend of the total volume of business that we may expect under present conditions in our industry. This leads up to the point of trade extension work carried on in an organized and intelligent manner. We would be repaid many times in two avenues of trade alone—first, promoting steel boilers for heating service, and second, modernization of industrial power plants, replacing obsolete boiler equipment with new boilers.

"What we need is action, and the only way to get it, in my opinion, is to have some one carry out the work and ideas that we form at our meetings as we cannot expect the committee members to do it, because it is too big a job. At the winter meeting I am going to put this up to the membership, and I would recommend having a secretary-manager who could devote all of his time and energy in promoting our cause, and thus make it possible for us to keep pace with other major industries in the development of our thoughts either in writing or orally, at our next meeting."

Boiler Statistics

THE United States Department of Commerce, Industrial Division recently presented a report including the first six months of the year 1926 outlining the status of the steel boiler manufacturing industry, exclusive of the railroad field. The department has compiled statistics of this character since 1919 and a table of the yearly comparisons is included in the report. Since these statistics are the only ones that have ever been made in the country, giving a comprehensive outline of the industry, they have become of great importance to manufacturers of boilers and allied products. Briefly, the report is as follows:

Orders were received for 8,931 steel boilers during the first half of 1926 by 58 manufacturers, comprising most of the leading concerns in the industry, while shipments by these firms for the full year 1925 totaled 13,417 boilers and, in 1924, they shipped 12,215 boilers. More boilers were shipped in 1925 than in any other year since the end of the war up to that time but, in square footage, 1920 shipments were the highest, followed by those of 1923. Of the various types of boilers reported only steel-heating stationary boilers and Scotch-marine boilers showed increases over 1924 both in number and in heating surface.

The 58 reporting firms indicated that, on the average between 1919 and 1925, 8,960 persons were employed in their boiler departments, 880 of these being in the executive, engineering or sales organizations, 7,210 in the shops and 870 in erection work. These firms used annually during that period 90,078 net tons of steel plate, 17,095 of structural shapes, 8,376 of bars, and 53,253 of tubes; they also reported 23,495 gross tons of castings.

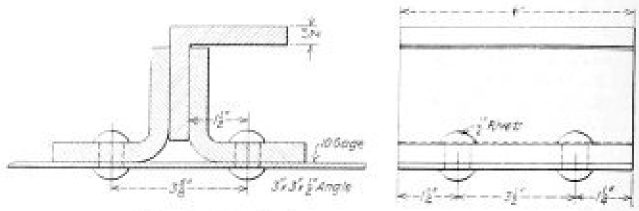
Indications are that when the final report for the year 1926 is compiled an appreciable gain in boiler construction will be shown over the number for former years. A great number of small concerns manufacturing boilers have not submitted details of their business to the Department of Commerce up to the present time and, in order that the statistics may be made complete, it is hoped that these concerns will also assist in this work in the future.

LETTERS TO THE EDITOR

Tool for Laying Out Holes on Angle Iron

TO THE EDITOR:

The attached sketch is of a small tool we find very handy for laying out holes on the legs of angle irons. As it is



Simple device for laying out holes

made of scrap material and takes very little time, the cost is practically nothing. They are used in pairs, one at each end of the bar to be held. The one shown is for ½-inch or less legs, but if heavier angles are to be used it is only necessary to increase the rivet centers which in this case is 3⅝ inches.

Oswego, N. Y. J. A. SHANNON.

Location of Feedwater Discharge in Boilers

TO THE EDITOR:

With reference to the column conducted by C. B. Lindstrom, I wish to call your attention to an error in his editorial reply to "J.F.D." as published in your issue of January, 1927.

The location for the discharge of the feedwater entering the boiler is customarily that described by Mr. Lindstrom, but unfortunately so. It would be of great benefit to boiler manufacturers, and those responsible for boiler installations, if they would consult with water treatment specialists with regard to this detail. Our work brings us in contact with boilers all over the United States, which are giving trouble on account of this faulty location of the feedwater entrance.

My answers to the questions of "J.F.D." would be as follows: In the cases of stationary boilers, of the standard horizontal firetube type the feedwater should enter through an internal pipe to a point near the end of the boiler farthest from the fire. Then should be brought down to a point near the bottom of the shell, around the tubes, next between the latter and the shell of the boiler. A tee should be used at both ends of the horizontal line with removable pipe plugs so that a cleaner can be run through the internal pipe from end to end.

In the case of watertube boilers the feedwater should enter the upper drums which are the points farthest from the fire. In the case of locomotive boilers the answer given by you is correct.

You have not given "J.F.D." an answer to his question as to why "scale and mud always form where the feed line goes into the boiler." "J.F.D." means the accumulation of soft carbonate scale, which, as he says, forms at or near the point where the feedwater meets higher temperature of the boiler, which is usually at the discharge end of the feedwater pipe.

If your plan of locating this feedwater discharge over the tubes, or flues, is followed, you aggravate the condition, because the water is discharged onto a heating surface, which quickly raises the temperature of the latter to a point above that of boiling, causing the precipitation of the carbonates of calcium and magnesium, which is usually called "mud" by the practical man, on account of its soft nature. As it progresses from this point in the circulation of the boiler, it is raised further in temperature to that corresponding with the steam pressure, the sulphates of calcium and magnesium are precipitated and the resulting formation is a hard crystalline scale, which adheres to the heating surfaces.

If, therefore, the discharge of the feedwater is directed as above described by me, the carbonates or the soft chalky scale, with free mud in the water, are precipitated where they can do the least harm, and where they can be most easily blown or washed out. But, if located as you have directed, in most of the waters of the United States the boilers would rapidly build up a solid mass of soft scale and mud between the flues where it is most difficult to wash out and where it is most harmful.

The Bird-Archer Company, Chicago, Ill.

L. F. WILSON, Vice President and General Manager.

Determining the Roundabout Length of a Boiler Patch

TO THE EDITOR:

The following notes are submitted to aid in solving boiler patch problems:

First determine length *A*. Then multiply *A* by the constant in Table 3 corresponding to the angle obtained from Table 2. This gives the vertical height of the patch, as shown at V, V_1, etc., which should be marked on the boiler shell. It must be noted that this height is measured from a point level with the center line of the highest rivet in the short roundabout seam.

Example: Patch at roundabout seam on 54-inch diameter boiler; shell and patch 5/16-inch plate; 55,000 pounds tensile strength; long seam, double riveted lap, ¼-inch rivet hole, 2⅞-inch pitch, 73.9 percent. Select pitch of rivets to be used in patch from Table 1 say 1⅞-inch and 15/16-inch holes, 56 percent. *A*—24 inches. Then $73.9 \div 56 = 1.32$ nearly. The next higher factor in Table 2 is 1.34 which corresponds to 40 degrees. By Table 3 an angle of 40 degrees gives a constant 1.192. $A \times 1.192 = 24 \times 1.192 = 28\frac{5}{8}$ inches = height V. The effective percent of the patch seam is $56 \times 1.34 = 75.24$ which is stronger than the original longitudinal seam.

Draw the diagonal lines which locate the center line of rivets in the patch. Layout all laps at 1½ times the diameter of the rivet hole used.

CAUTION

When patch rivet holes are countersunk proper allowance must be made for the metal that is removed by increasing the pitch as shown in the following table:

Plate	For 45-degree add to pitch countersink
½	¼
7/16	3/16
⅜	3/16
¾	⅛
¼	⅛

Countersink must be not deeper than ¾ thickness of plate.

TO OBTAIN THE PATCH ANGLE REQUIRED

Divide the efficiency of the longitudinal seam found on the certificate of inspection by the efficiency of the patch seam selected from Table 1. This gives the minimum factor required to maintain the strength of the shell. Take from Table 2 the angle corresponding to this factor or next higher factor which gives the required angle of the patch.

Note: Firebox steel must be used to replace firebox steel in repairing boilers.

The use of tank steel is strictly prohibited. Rivet holes for patches shall be drilled full size with patch in position or may be punched not to exceed ¼ inch less than full size for plates 7/16 inch or less in thickness and then reamed to full size with patch in place.

The welding of patches on shells or drums of boilers is strictly prohibited.

Binghamton, N. Y. C. W. CARTER, JR.

Lancashire Boiler Flues

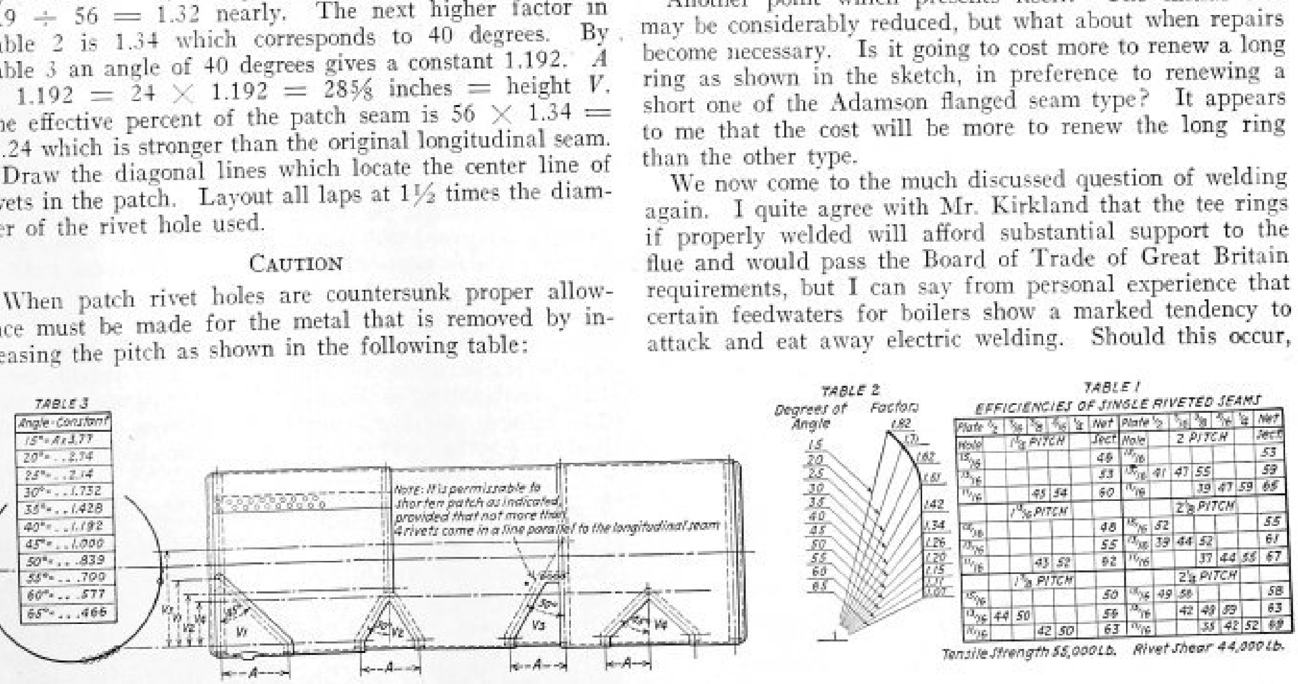
TO THE EDITOR:

In the November issue of THE BOILER MAKER there is an interesting article on the "New design of Lancashire Flues," and as I am daily in contact with boilers of all classes and design, anything which departs from the usual practice is of particular interest to me.

The writer mentions that several of the various expansion rings have bad points, such as rivet heads in the fire, etc., but does he think that two thicknesses of plate on a heating surface is good practice? I am inclined to think that one could look for trouble in the way of cracks, etc., due to overheating, where the tee hoops are shrunk on to the flue, particularly at the front end, in the grate area.

Another point which presents itself. The initial cost may be considerably reduced, but what about when repairs become necessary. Is it going to cost more to renew a long ring as shown in the sketch, in preference to renewing a short one of the Adamson flanged seam type? It appears to me that the cost will be more to renew the long ring than the other type.

We now come to the much discussed question of welding again. I quite agree with Mr. Kirkland that the tee rings if properly welded will afford substantial support to the flue and would pass the Board of Trade of Great Britain requirements, but I can say from personal experience that certain feedwaters for boilers show a marked tendency to attack and eat away electric welding. Should this occur,



Types of patches for various parts of boiler a large percentage of the support would be gone and it would be no easy job to re-weld one of these tee rings while it was in position in the boiler.

Personally I do not think the new design as suggested would give the same expansion as a combination of Adamson flanged seams and one corrugated section. I would mention that the inclusion of a corrugated section in Lancashire boiler flues is not new practice, but is practically insisted on, in conjunction with Adamson flanged seams, in all first class work supervised by the insurance companies of this country. The idea is of course to eliminate the mechanical grooving of the furnace flange attachments and front end plate flange attachments. I should like to hear what our friends have to say about this new design, for I see the writer is expecting criticism, and as he remarks, it is welcome in the interest of the trade generally.

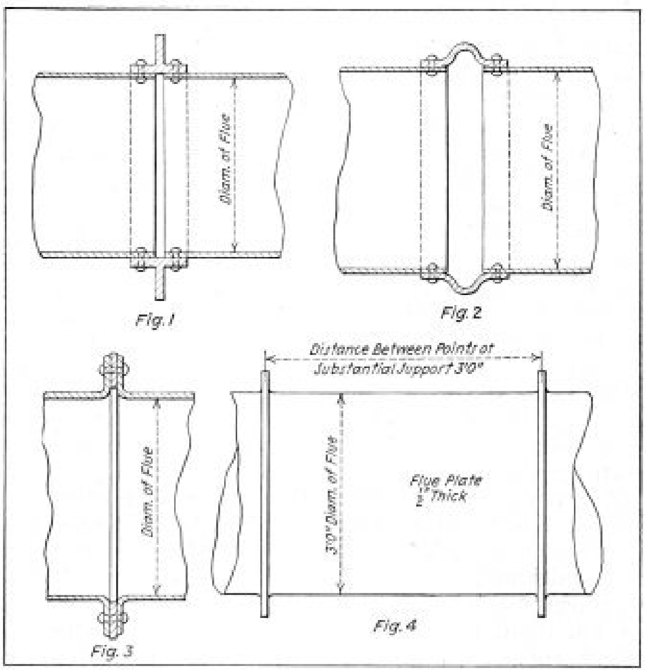
London, England. P. G. TAMKIN.

Lancashire Boiler Flues

TO THE EDITOR:

I have to thank our friend William C. Strott for his very definite criticism of the new design of Lancashire boiler flues submitted by the undersigned and published in the November issue of THE BOILER MAKER.

The design is again submitted so that he may still further study the points he raises. Mr. Strott informs us that the tee bars to be of any use whatever should be on the inside and not on the outside as shown. Makers of Lancashire boilers will be interested at his proposed revolution to the theory of structures. If Mr. Strott is familiar with



Furnace joints in Lancashire Boiler

Lancashire boilers, he will remember that tee bars were first used to connect the flue sections together, but instead of being welded together they were riveted as shown in Fig. 1. Some years later the bowling hoop was introduced to take the place of the tee bar and was a decided improvement (see Fig. 2). The next step was, I believe, the Adamson flanged seam with its very obvious improvements (Fig. 3). In each case it should be noted that the strengthening rings are on the outside, and their weight is a help rather than a detriment to the resistance they offer against collapse.

POINTS OF SUBSTANTIAL SUPPORT

This technical term does not mean that the flues have to be held up like a beam spanning a space and supported at each end. The stools referred to would be useless because the external pressure exerted on the flues is equal in all directions and collapse is just as likely to come upwards or sidewards as downwards, therefore any supports that may be necessary must be circumferential.

For the information and guidance of readers I give below a calculation for the working pressure of flues and, Fig. 4 gives the illustration of points of substantial support.

$$\text{Formula: } \frac{9{,}000 \times t}{3 \times D} \times \left(\frac{5 - L + 12}{60 \times t}\right) = WP$$

D = diameter of flue in inches.
L = length between the points of support.
t = thickness of the flue plate.
9,000 is a constant
5 is a constant
12 is a constant
60 is a constant
5 is a constant.

From this working out of this formula it will be seen that the flues shown in Fig. 4 are suitable for a working pressure of 141.644 pounds per square inch. The stools referred to hold the flues up, but do not enter into the calculation.

Batley, Yorks, England. J. G. KIRKLAND.

BOOK REVIEW

PATENTS, WHAT A BUSINESS EXECUTIVE SHOULD KNOW ABOUT PATENTS. By Roger Sherman Hoar, M.A., L.L.B., head of the patent department of Bucyrus Company, South Milwaukee, Wis. Bound in cloth, 6 inches by 8½ inches, 232 pages. Published by The Ronald Press Company, 15 East 26th street, New York.

This book, written by the author of "Hoar on Constitutional Conventions" and other works on law and engineering, contains a large number of suggestions for getting a patent through the patent office, protecting it from infringement and using legal advice to the best advantage. It outlines a policy which experience has shown will protect a company or individual from loss of patents which quite often occurs through being out-maneuvered by a competitor. The author has taken a strictly business viewpoint, which is necessary in practical commercial and financial affairs. He has undertaken to correct the many false notions generally held by those concerned with patents and has summarized a number of popular misconceptions and set forth the truth in each case.

Explanations of legal papers and forms for contracts necessary in patent practice are given with the aim of giving the reader a thorough understanding of patent tactics. Each explanation is illustrated with concrete examples. The railway executive, engineer or attorney will find this book an excellent addition to his reference library.

Edward McCabe, senior member of the firm of E. McCabe and Company, died at his home in Lawrence, Mass., February 8. He was born in Taunton, Mass., in 1844, and was actively engaged in the boiler business for fifty-five years. He was of the second generation of boiler makers in the McCabe family. He is survived by two sons, Hugh and Fred H. McCabe of the McCabe Manufacturing Company.

Safe Practice for Boiler and Tank Shops*

Simple rules for handling raw materials and boiler sheets, for operating tools and moving boilers

SAFEGUARDING the life and health of employees should be the first thought in the minds of the management of industrial plants of all kinds. In the boiler shop additional safety precaution should be taken because of the unusual hazards of this occupation. Once a shop has been provided with safety appliances and arrangements made to take care of accidents, it remains for the foreman and the men themselves to be diligent in the prevention of such accidents as may occur through carelessness in the observation of rules or from negligence in utilizing the safety means provided.

From the time the apprentice begins his training his instructors and foremen are in duty bound to outline rules and suggestions that will by repetition and example become impressed upon his mind so that his future conduct will enable him to avoid the many dangers to which he will be exposed in his calling.

Fig. 1.—Shattered goggles caused by flying metal

The foreman's job does not end with his production and cost requirements—it also includes a close supervision of his men from the safety standpoint. In this respect many foremen are lax—not through any particular fault of their own, but because of lack of training and understanding of the importance of the matter. There are an almost infinite number of ways in which a man can be injured and usually these are simple in nature. There are an equal number of ways in which these accidents may be avoided. The following simple rules and precautions for avoiding accidents in the boiler shop are the result of exhaustive study on the part of foremen and others in one of the largest boiler shops in the country and, at the same time, one in which accidents are few and far between.

Protect Your Eyes

In every well managed shop safety goggles are furnished to all employees for shop use. Before attempting to begin work, where goggles will be required and should be worn secure a pair from the foreman. When they become pitted or damaged in any way exchange them for a new pair for damaged goggles are little more protection than no goggles at all. Goggles should be worn on the following work:

(1) Grinding on emery wheels.
(2) All chipping work (air or hand).
(3) Calking or riveting.
(4) Using of air tools (except tap).
(5) Blowing dirt or scale with air tools.
(6) In work which brings the operator close to his fellow employees engaged on any of the above operations.

Goggles which are provided for shop use should have extra tough glass lenses which will not fly when broken. Cheap goggles are not safe for boiler and tank shop work as the glass chips are as much an eye hazard if the goggles become broken as flying particles would be if no goggles were worn. One very important point that should be observed at all times is that no one should borrow another man's goggles. It is a matter of record that safety goggles save many eyes from injury throughout the industries of the country every week so that too much emphasis cannot be placed upon wearing them whenever needed.

No matter how small a cut or scratch or bruise may be it should be given prompt attention at the shop hospital if there is one available or by the first aid department of which there should be one in every shop. This should be done to avoid blood poisoning.

Never allow a fellow workman to remove dirt from your eyes. His hands or the things used to remove the dirt may cause injury or disease which will be as bad or worse than the original trouble. The hospital attendant or his aid man is trained for this work.

Care in Fitting Up Boilers

In fitting up boiler sheets it is always important that the crane slings be kept hitched to the work with the slack taken up until the course is well secured by drift pins or bolts. Fig. 2 shows a boiler course entered into the firebox shell and poorly blocked, but with the crane sling removed before the bolts or drift pins were applied. There is a very grave danger in an incident such as this that the course may become loosened and fall causing injury to men who may have been working alongside of it. All work should be well supported and secured before sling chains are removed.

A very common practice and one which causes the loss of

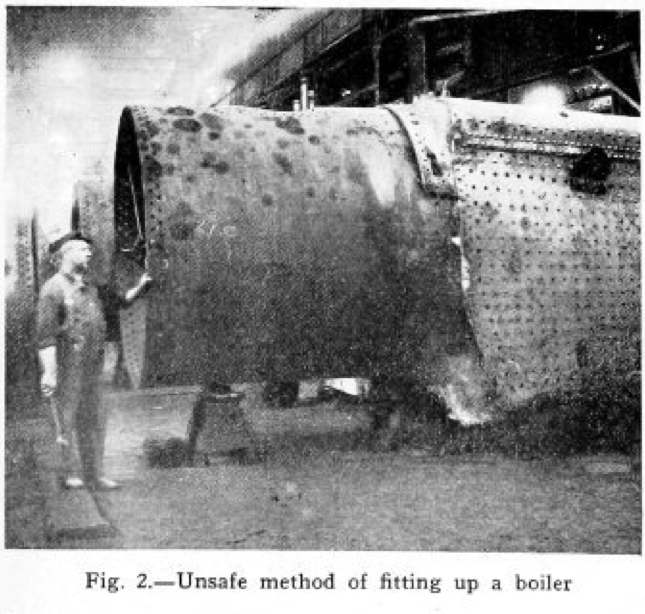


Fig. 2.—Unsafe method of fitting up a boiler

* The Boiler Maker is indebted to the American Locomotive Company for the illustration and information used in compiling these rules.

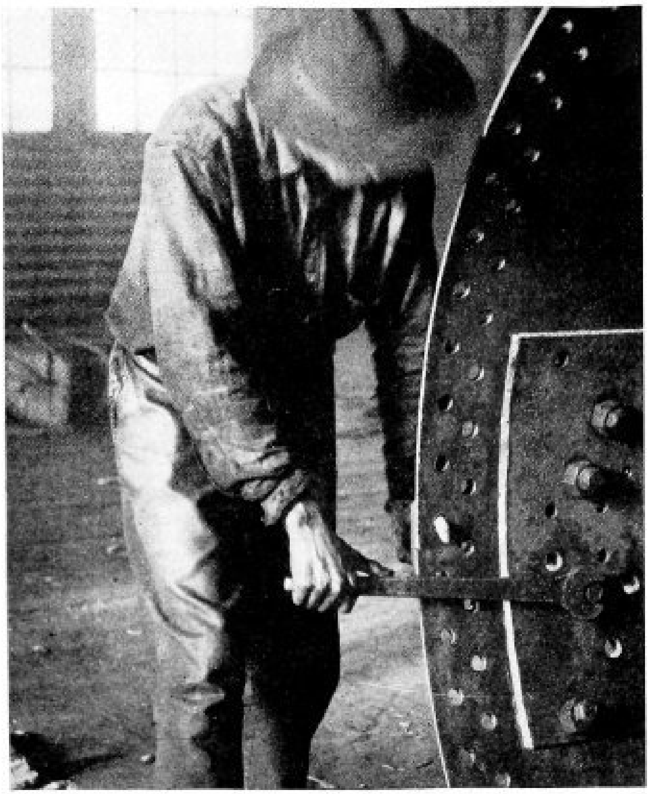


Fig. 3.—Shorn fingers result from this practice

many fingers is that of putting the fingers in rivet, bolt or pin holes to see if the surfaces are in line. If by any chance the plates should move on each other the result is a sheared finger. An example of carelessness of this kind is shown in Fig. 3. A great number of fingers have been lost in this manner due to the plates' slipping or to men moving braces or parts while they are in the process of being fastened together.

In some instances reamers or taps have been placed into a hole from the opposite side of the sheet from which a man has been working causing injury to the fingers of the man feeling in that hole in attempting to line up the plates. If you cannot see that the sheets or parts are in line the only proper method is to use a pointed drift or feeler to try out the alinement.

A common but dangerous practice is that of hitting reamers, drills, cutting tools or hardened pins with a hard hammer when trying to secure them in place. These brittle parts are apt to chip off under a blow from a hard hammer and the sharp chips fly with great force. Many eyes have been lost from this cause and many valuable tools have been needlessly damaged. A soft hammer should always be used for striking hardened tools and pins when it is necessary to hammer them at all. Care should always be taken not to injure tools by hard usage and the eyes should be protected at all times by goggles when there is danger of their being struck by flying chips.

Safety Bar on Air Motors

A safety bar should always be used to prevent the operator being thrown when using a "heavy" air machine for reaming shells and the like. The proper use of this bar is demonstrated in Fig. 4. If it is not used and the tool should stick fast in the boiler there is a constant danger that the operators will be thrown by the motor before it can be stopped. In using the safety bar, it should be placed in a nearby hole to prevent the handle of the machine turning suddenly and striking the men. This is especially important where the work being done is on the top of a boiler or on a scaffolding.

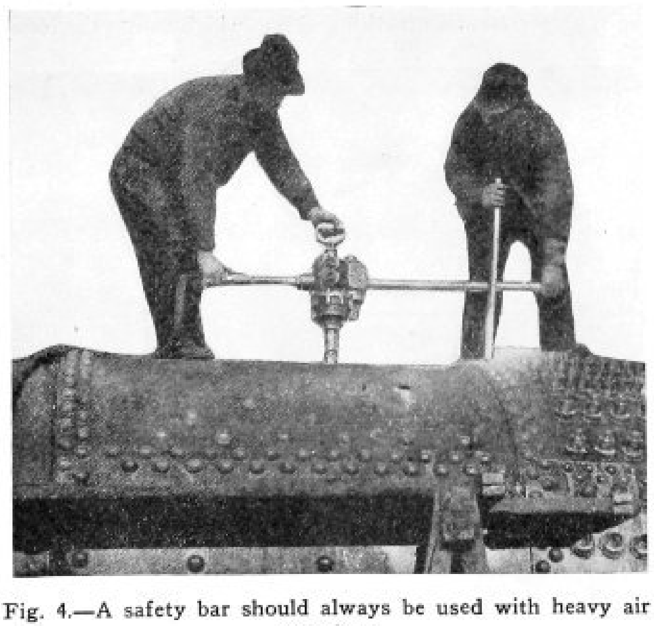


Fig. 4.—A safety bar should always be used with heavy air machines

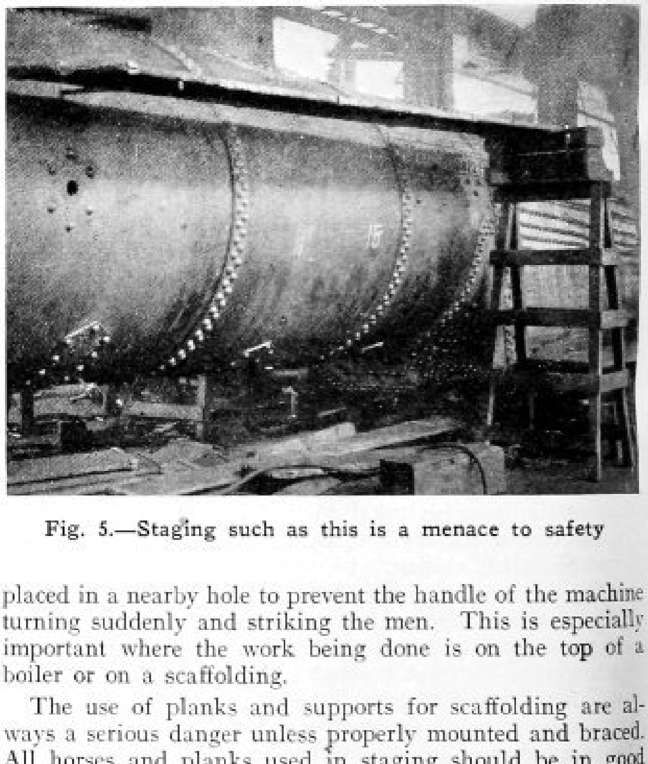


Fig. 5.—Staging such as this is a menace to safety

The use of planks and supports for scaffolding are always a serious danger unless properly mounted and braced. All horses and planks used in staging should be in good condition and the platform should be at least two planks wide. Staging, such as that shown in Fig. 5, with one end resting on a box balanced on top of a horse, is liable to cause a bad fall. Planks should rest securely on horses of a proper height. The plank should be sound and of the proper width and thickness and should be designed to support the weight safely. Never allow the ends of planks to project too far beyond the horses because they are liable to tip if anyone steps out to the end. When horses and planks need repairs they should be put out of service and at the same time reported to the foreman.

Never leave material or tools long on boilers, tanks or staging where they might fall and injure workmen below. The example given in Fig. 6, of an air motor precariously balanced on the top of the firebox with a man working directly below very aptly demonstrates the possibilities of such a situation; for the slightest jerk on the air hose or vibration in the shop is liable to cause an extremely serious injury.

Another point in connection with men carrying out operations on the top of the boiler while others are working below, is in the matter of dropping materials and tools from high points without being sure that everything is clear underneath. In Fig. 7 the situation explains itself. Remember that other men's safety as well as your own depends upon your carefulness. A moment of thoughtlessness may mean weeks of suffering.

Safe Hitching of Plates

When fitting up plates, such as tank sides, ends, tool boxes and the like, lugs should be bolted to the plates (with at least two bolts in each lug), and the chain should be looped through the lug and hooked on above. Figs. 8 and 9 indicate the correct and incorrect methods respectively for fastening chain. The practice of simply hooking into the lugs is extremely dangerous because when the plate touches the floor or some other support, the hook is liable to slip out of the hole and let the plate fall. When the sling is properly attached through the lug and the end hooked into the chain itself the rig cannot accidentally become unfastened. In connection with the lugs, be sure that they are securely bolted to the plates with bolts long enough to pass clear through the nut. The nut should be screwed up tight on the sheet.

Figs. 10, 11 and 12 show a number of standard rigs and hitches to be used in handling materials and boiler parts when assembled. In every case hitches should be carefully made to avoid any possibility of loads falling. The practice varies at different plants from the methods shown but no matter what variations are used they should conform with safety requirements. Slings, lugs and hooks

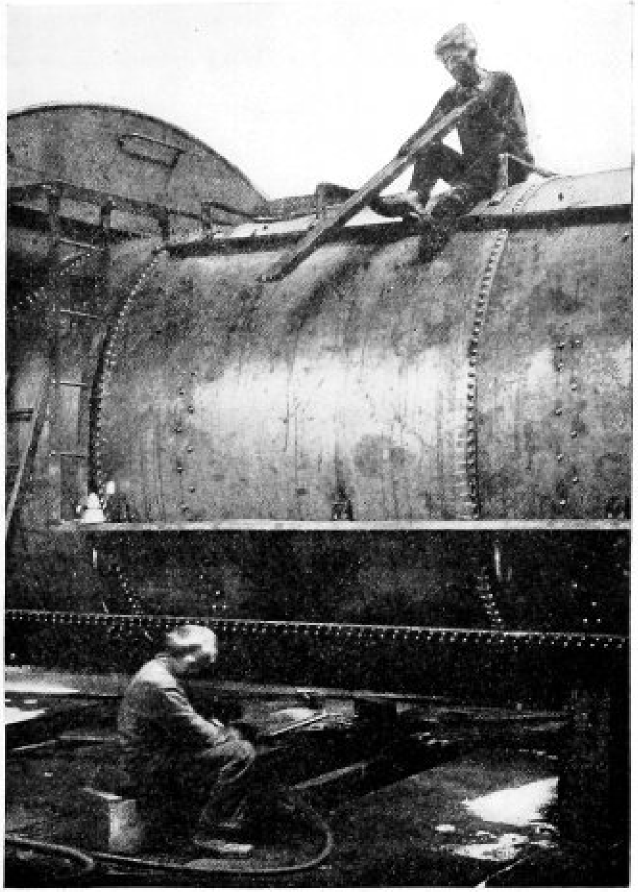


Fig. 7.—All the elements of a serious accident

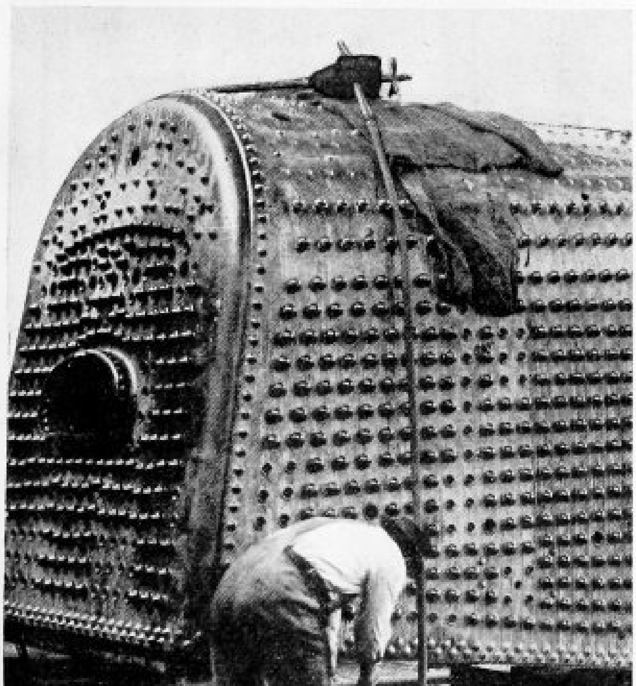


Fig. 6.—Heavy tools should never be left where they may fall on a workman

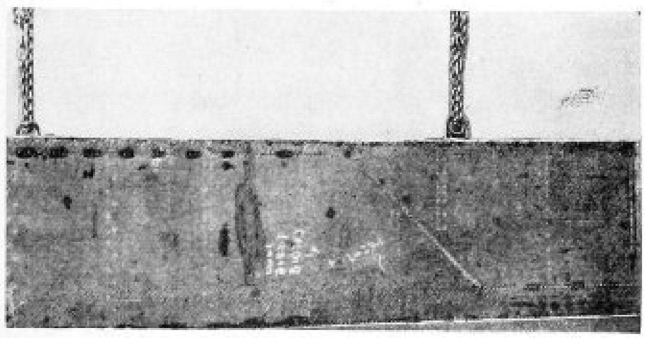


Fig. 8.—Correct method of slinging plate

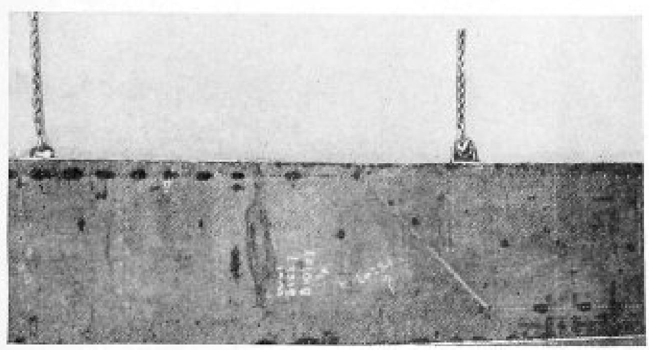


Fig. 9.—Plate should never be moved with this sling arrangement

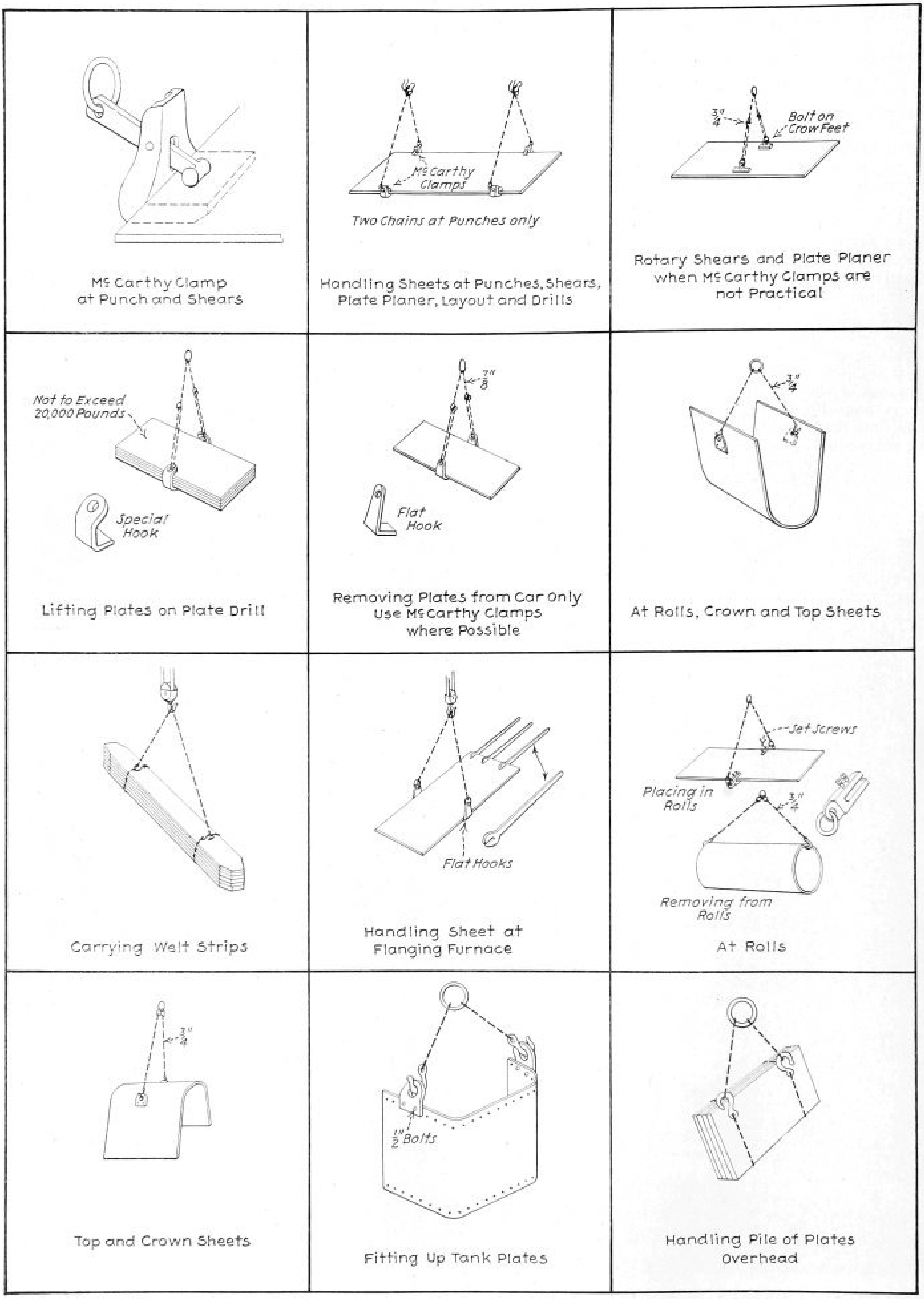


Fig. 10.—Standard types of rigs and hitches

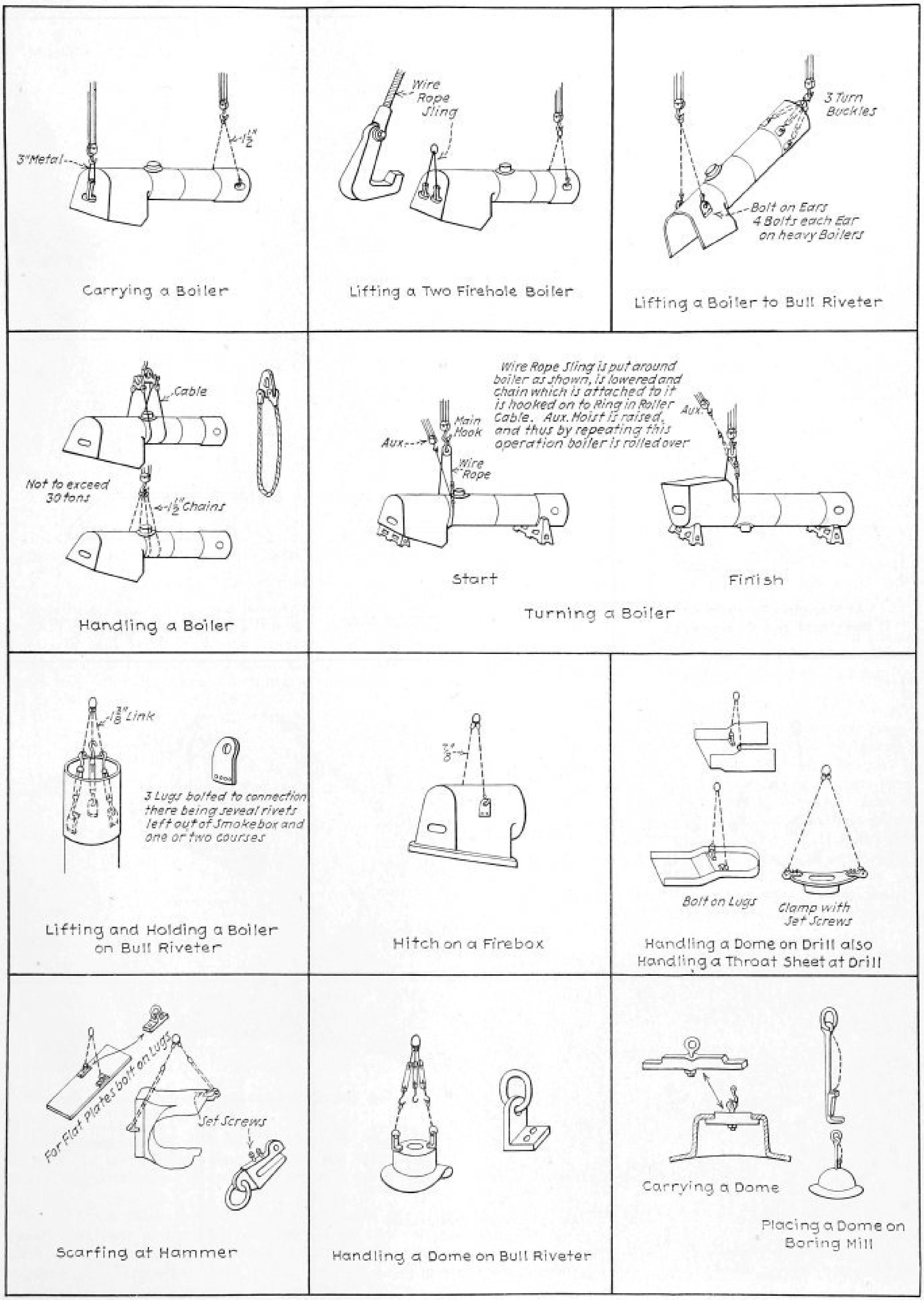


Fig. 11.—Standard types of rigs and hitches

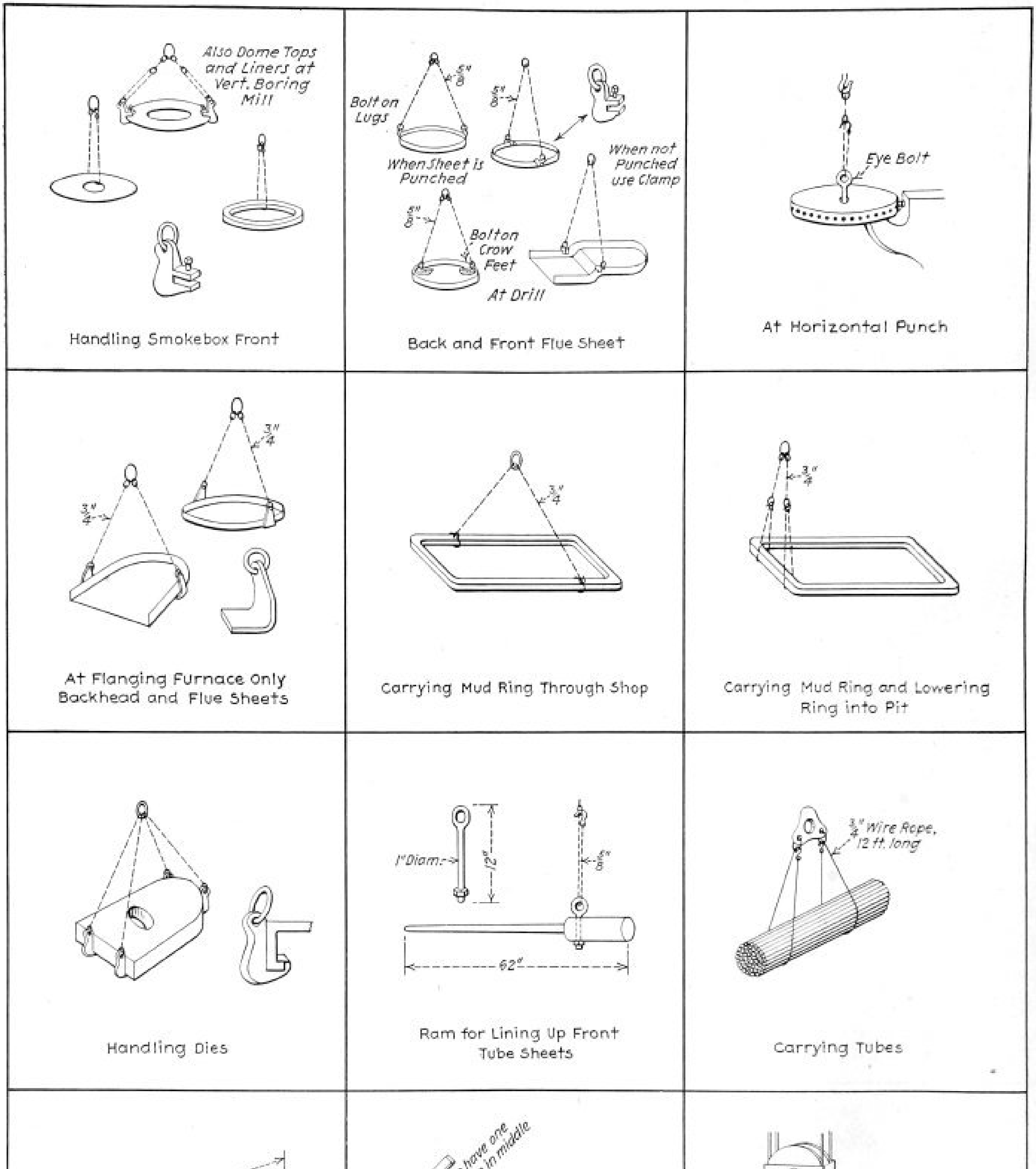


Fig. 12.—Standard types of rigs and hitches

should be maintained in good condition at all times. When pieces of handling equipment have deteriorated or are out of condition they are not safe to use and should be reported to the foreman. Do not try to make your own lifting lugs and ears by punching them from scrap pieces of plate.

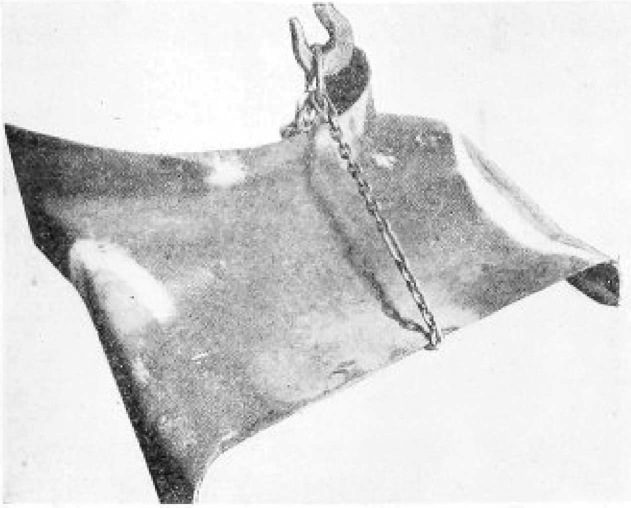


Fig. 13.—Method of slinging throat sheet

You may not get them strong enough. All equipment should be designed and furnished by the maintenance department.

Handling Throat Sheets

In placing throat sheets and moving them it is important that the sling chains be so attached that they cannot slip. The right and wrong ways for slinging throat sheets are shown in Figs. 13 and 14. A study of Fig. 14 aptly illustrates this point for there is nothing to prevent the chain

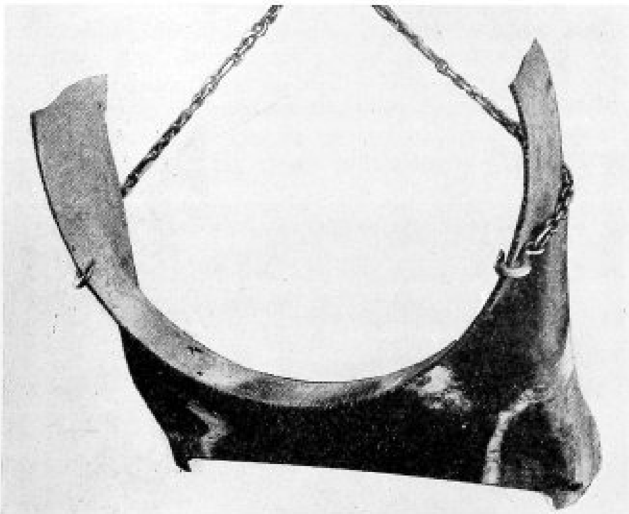


Fig. 14.—Throat sheets suspended in this way are unsafe

from slipping in this case if the sheet is joggled even slightly. In addition, the throat sheet is not well balanced and it would therefore be hard to handle in assembling it in place.

Heavy crane loads sometimes fall when being moved or placed. Everyone in the shop understands the necessity of keeping out from under loads but it is surprising how often accidents occur from this cause.

While all hoisting equipment is inspected at frequent intervals and seldom fails, there is always a chance that the

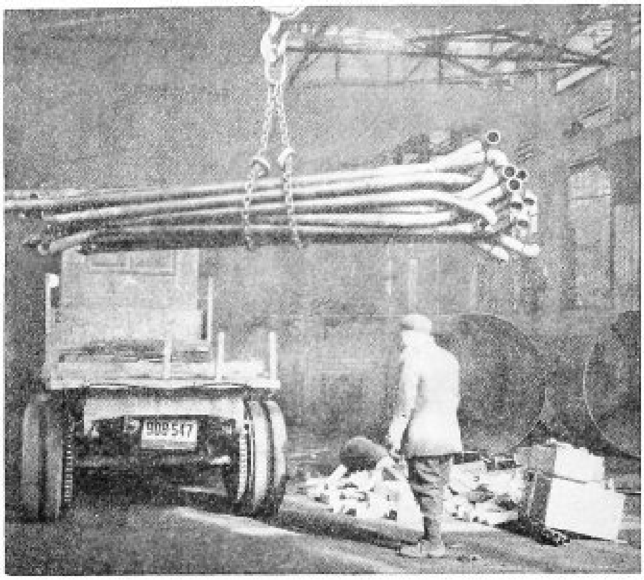


Fig. 15.—Never stand under crane loads

slings will slip or that an unexpected defect may develop allowing the load to fall. For another reason it is wise to keep well away from moving loads as there are many examples of men being caught between crane loads and piles of material, boilers or other equipment.

In moving material on rollers or blocking up or lowering such material do not reach under with your arms. If necessary to reach under for any purpose use a stick or bar as shown in Fig. 16. This is an important precaution because loads shift and hooks or slings slip. When placing blocks under a load always keep the hands on the sides of the block. Never place them on the top or the bottom.

Avoid Reaching Near Revolving Tools

Reaching for things which bring the clothes too close to revolving tools should be avoided. The result of failure to observe this precaution is shown in Fig. 17. Even if the clothes are in good condition there is danger of their catching if the operator reaches too close to the tool. Give the moving parts ample room or shut down the machine if necessary. The use of a brush or stick to adjust lubricating hose will help keep the arms at a safe distance from cutting tools.

When changing dies on riveting machines or punches keep the fingers from coming between the dies where they

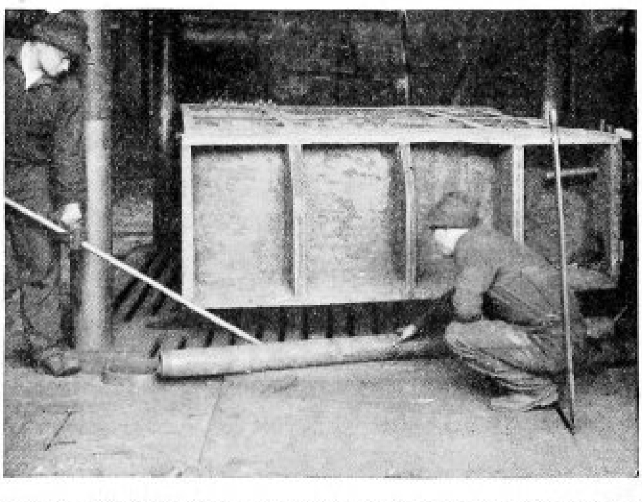


Fig. 16.—Do not reach under suspended loads to adjust rollers

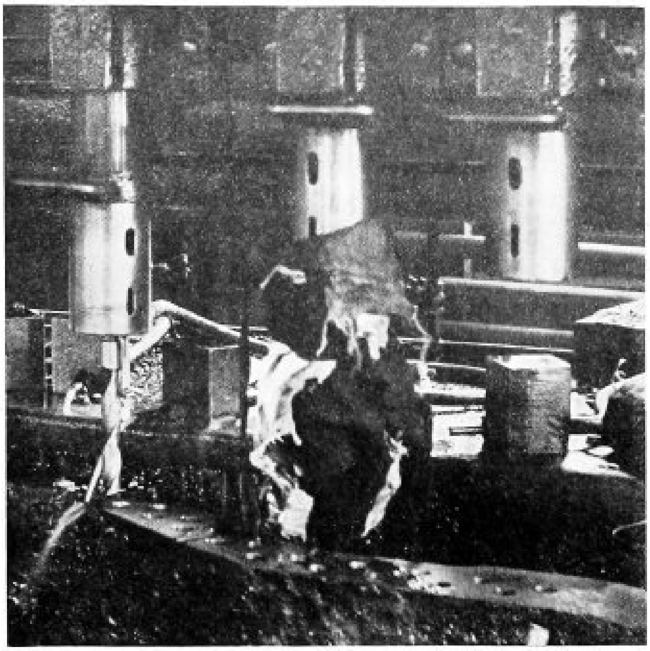


Fig. 17.—Revolving drills form an ever present hazard

might be injured if the machine is accidentally started. The right and the wrong ways of making this adjustment are shown in Fig. 18. As will be seen, the correct way is to grasp the die at the sides where they will not be injured.

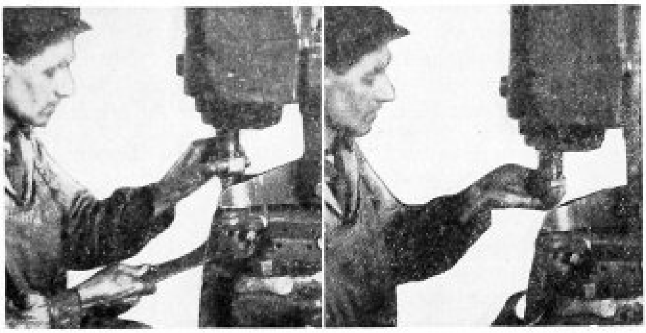


Fig. 18.—Correct way to adjust dies (left) and wrong method to use (right)

The leaking of air valves in portable machines or the hitting of the operating handle by other men has often started a machine when not expected.

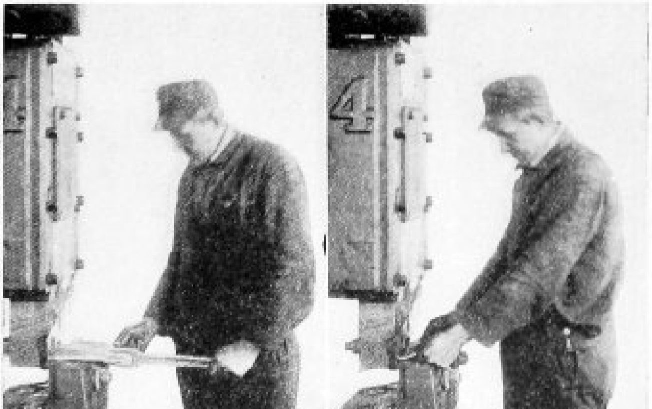


Fig. 19.—Use a wrench or tongs to hold small plates when being sheared—never hold the plate in the hands

When shearing small plates always use a wrench or pair of tongs to prevent fingers being pinched when the plate tips up. Fig. 19 indicates the correct and incorrect methods for doing this. If small plates are held by hand the fingers are brought under the shear frame; when the shear comes down the plate is tilted up at the front side and is liable to catch the fingers against the frame of the shears; many fingers have been lost in this manner. Always draw the temper of hardened tools if the shears are to be used for cutting them.

No heavy or hard material should be cut on plate shears.

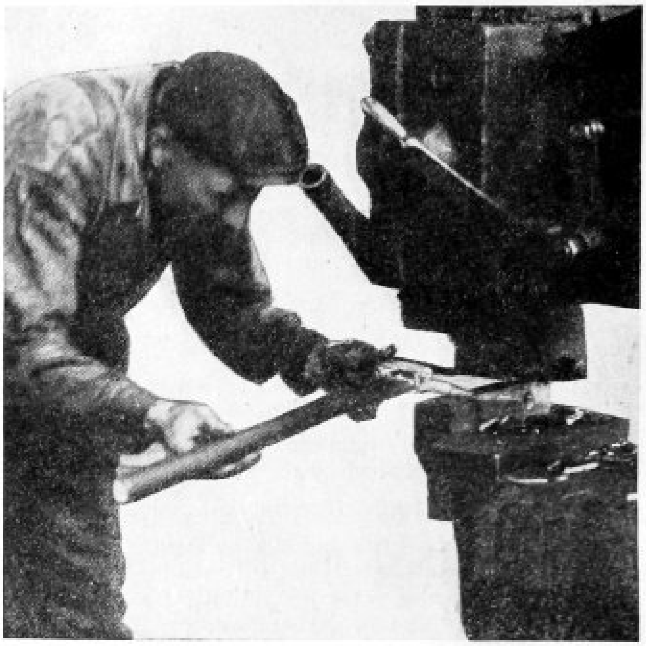


Fig. 20.—Hardened material should never be cut in the shears

These machines are not built for such work and may be broken or a broken shear plate may fly and injure the operator or other men. Plate shears are designed to cut only such plates as are commonly used in the department. Hardened or tempered pieces such as files or cutting tools should never be cut on the shears. They are very brittle

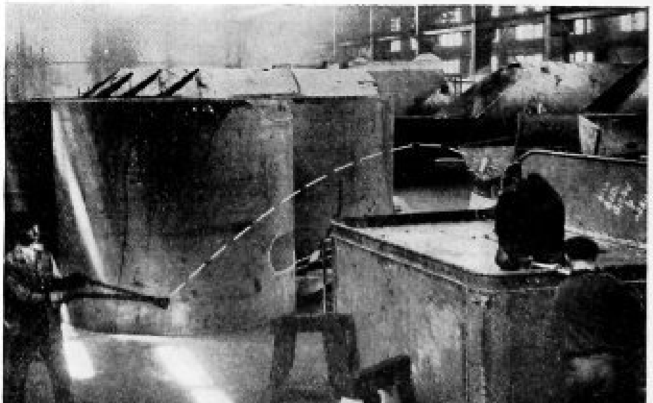


Fig. 21.—Care should be exercised in passing rivets

and will fly if cut without having the temper removed. When it is necessary to have such tools cut they should be taken to the tool room where the work can be done by experienced men. Plate shears are intended for cutting unhardened plates only.

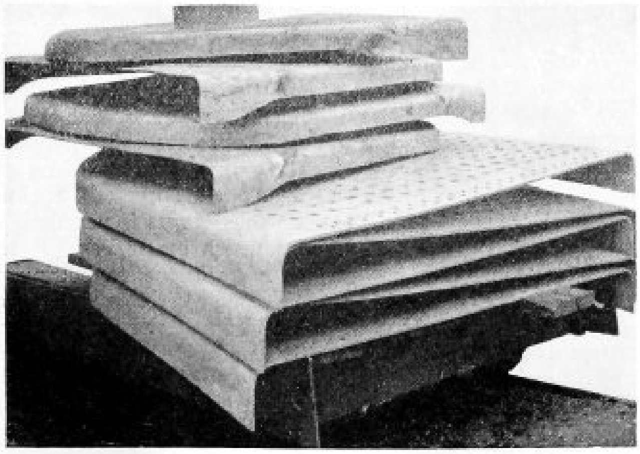


Fig. 22.—Dangerous manner of piling materials

THROWING RIVETS

Rivet boys should be cautioned to throw rivets carefully. Long throws should never be permitted and extra passers should be used when rivets must be thrown into tanks. Many men have been badly burned by carelessly thrown rivets.

Hot rivets should never be thrown into a place where the thrower cannot see where the rivets are falling. They should be passed carefully into such places and caught in metal trays or pails. Loose clothing in which hot rivets might easily be thrown should not be worn by riveters or rivet passers.

Materials should always be piled so that there will be no chance of its falling on men working or passing nearby. They certainly should never be piled as in Fig. 22 in such a manner that they might easily be toppled over. When material is piled carelessly it will sometimes fall due to the vibration of the machinery or when struck by passing crane loads it should always be secured against the possibility of falling.

Keep the floor free from unnecessary blocks, bolts, tools or other equipment. Men are liable to stumble over them or sprain an ankle when stepping on them. "Good housekeeping" does much to assist good workmanship in making the shop safe.

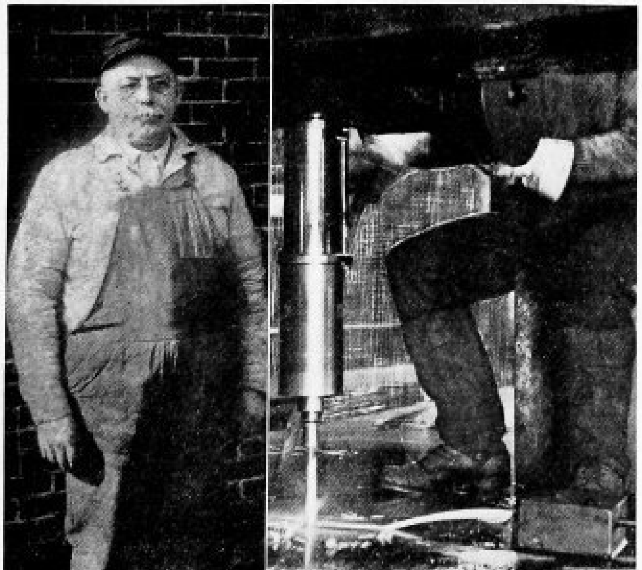


Fig. 23.—Always wear the proper clothing

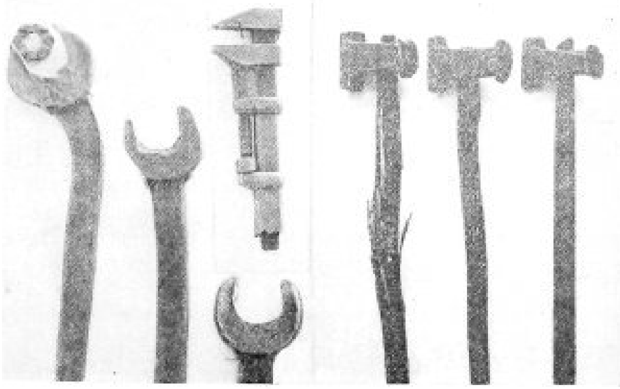


Fig. 24.—Unsafe tools

WEAR PROPER CLOTHING

Few things are more dangerous about the shop than loose or ragged jumpers, overalls, shirts or neckties. The loose ends or ragged parts catch so readily on revolving tools or projecting studs that injury is likely to occur. All plate drillers are required to wear leggings to avoid having their trousers catch on the drill or on cuttings. Every well organized company is equipped to supply such leggings to operators. Wear sound shoes; thin soles or open spots endanger the feet to injury from nails or sharp chips.

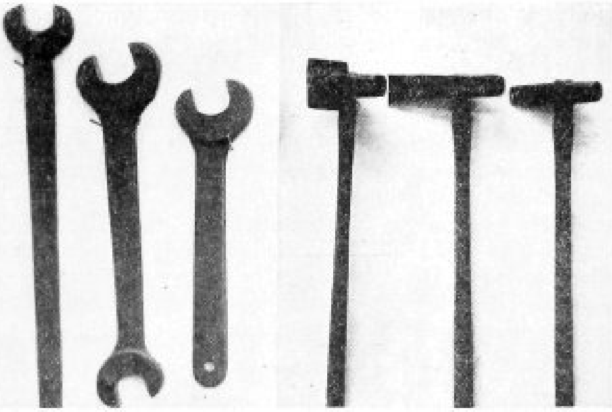


Fig. 25.—Tools should be maintained in proper condition

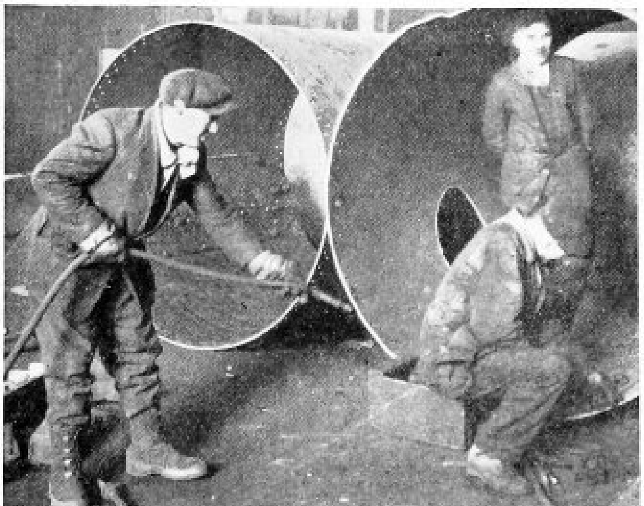


Fig. 26.—Horseplay in the shop should be absolutely forbidden

Tools with mushroomed heads or with loose or crooked handles are dangerous tools and should be turned in to the tool room for replacing. Chips will fly from mushroomed tools when used and may cause injury. A wrench with worn or sprung jaws is sure to slip sooner or later.

The foregoing suggestions should serve simply as a guide to the adoption of safe practices in the shop and may be varied to suit special conditions. Where many men are employed, however, it is essential that some rules be developed and brought to the attention of the men in order to assist them in avoiding danger to themselves and to fellow workers.

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

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

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

Below are given interpretations of the Committee in Cases Nos. 432, 453, 465, 536 and 537, as formulated at the meeting of December 3, 1926, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Cases Annulled

By resolution of the Boiler Code Committee at its meeting of December 3, 1926, the following Cases and a Communication have been ordered withdrawn and cancelled:

Case No. 432 (Annulled)
Case No. 453 (Annulled)
Case No. 465 (Annulled)

Case No. 536. *Inquiry*: Is it permissible, under the requirements of the Code for Unfired Pressure Vessels, to electrically weld the calking edges of seams of tanks in place of the customary mechanical calking specified in Par. U-52?

Reply: Par. U-52 is mandatory in its requirement for mechanical calking of seams of riveted tanks, and fusion welding as a substitute therefor is obviously not permissible.

Case No. 537. *Inquiry:* Is it the intent of Par. P-322 that the requirement for taking the water connection for a water column at a point not less than 6 inches below the center line of the shell, shall apply to all types of horizontal return tubular boilers, including such boilers of portable construction with internal cylindrical furnaces, or does it apply only to the externally fired brick-set h.r.t. boilers?

Reply: The type of boiler referred to in the inquiry is of the Scotch dry-back type to which the requirement of Par. P-322 does not apply.

Case No. 530. *Inquiry:* Is it permissible under the Code, to consider that the autogenous welding of the flanges which form the firedoor opening of a vertical firetube boiler, is supported by other construction as required by Par. P-186, inasmuch as the furnace itself is self-supporting and the weld is further reinforced by virtue of the increased stiffness given to it by the surrounding flanges formed with the furnace and shell plates?

Reply: The Committee has expressed the opinion in Case No. 252, that where the furnace and exterior sheets are stayed or otherwise supported around the door-hole opening and provided that the distance from the flange to the surrounding row of stays or other supports does not exceed the permissible staybolt pitch specified in Par. P-199, such welding of the door-hole flanges is permissible. In cases of furnace construction which under Pars. P-239 and P-240 are permitted to be built without staybolting, it is the opinion of the Committee that unless there are other means provided to relieve the welding of the flanges from stress as specified in Par. P-186, such welding of the door-hole flanges is not permissible.

Case No. 534. *Inquiry:* Is it permissible under the requirements of the Code, to rivet a cast-steel ell, of dimensions complying with Table A-6, to the bottom of a shell or drum of watertube, tubular, or waste-heat boilers, for the blow-off connection, when the operating pressure is 175 pounds per square inch or over?

Reply: The Code does not prohibit the riveting of steel castings to the shell.

Case No. 535. *Inquiry:* Is it permissible, under the requirements of Par. P-216 of the Code, to consider the bounding edges of furnace openings in Scotch type boilers as the equivalent of groups of tubes in applying the extended pitch allowances adjacent to the shell?

Reply: It is the opinion of the Committee that in the application of the provisions in Par. P-216 for extension of staybolt pitch allowances, the furnaces of Scotch-type boilers if riveted to flanged openings in the head, may be considered as the equivalent of tubes in the reinforcement thereof. Attention is called, however, to the requirement in the last sentences of Par. P-216 which, under the conditions above referred to, will apply to adjacent edges of the tube and furnace to which the common tangent may be drawn.

Krupps Produce New Improved Boiler Steel

By G. P. Blackall

At a recent meeting of the Association of Boiler Manufacturers at Kassel, Germany, it was announced that the great concern of Krupps had succeeded in producing a new mild steel for the manufacture of boilers which, unlike the older boiler steels, is capable of withstanding the heavy demand made upon boilers by modern processes.

Although no details will be available for some time, it is to be gathered that Krupps have long been experimenting with the object of overcoming the difficulties and expense caused by the increase both in pressure and temperature involved in recent process improvements. They have sought a material which should provide the necessary extra strength without any increase in the thickness of the boiler plates.

Edmond P. Burke, representative of the Los Angeles Iron & Steel Company, has been appointed a representative of the Truscon Steel Company, with headquarters at San Francisco, Cal.

W. H. S. Bateman has been appointed district sales manager of the Detroit Seamless Steel Tubes Company, Detroit, Mich., in charge of the southeastern district, with headquarters at 823 Commercial Trust building, Philadelphia, Pa.

Co-ordinated Production Control

Its functions and accomplishments in the North Little Rock shops of the Missouri Pacific

THE practical application of an up-to-date schedule and shop production plan which has been "sold" to the entire supervision and forces of the Missouri Pacific 24-pit locomotive shops at Little Rock, Ark., has resulted in a marked increase in locomotive output and reduced unit costs during the past few months. A comparison of the shop output in 1924 and 1925 is shown in Table I while Table II indicates the generally heavier character of the work. There was essentially no change in the number of men employed, the division between the various crafts being shown in Table III.

In compiling the record of schedule or shopping days in Table IV Sundays and holidays are not included. The report shows a reduction in shopping days during the past nine months of 10½ days per locomotive. During July, 1925, the monthly progress report revealed 155 delay days charged against the erecting floor; the February, 1926, report showed this condition reduced to 8½ delay days. The average number of engines turned out per month in 1924 was 13 3/10; in 1925, 14 5/10; to date, 16. The scheduling system has been extended to the passenger and freight car department.

Any new system is an innovation for only a short time. As it continues, if practical and clearly understood by all, it speeds up and runs more freely like a locomotive properly "broken in." The requisites of the successful scheduling and production control plan as installed at the North Little Rock shops of the Missouri Pacific are:

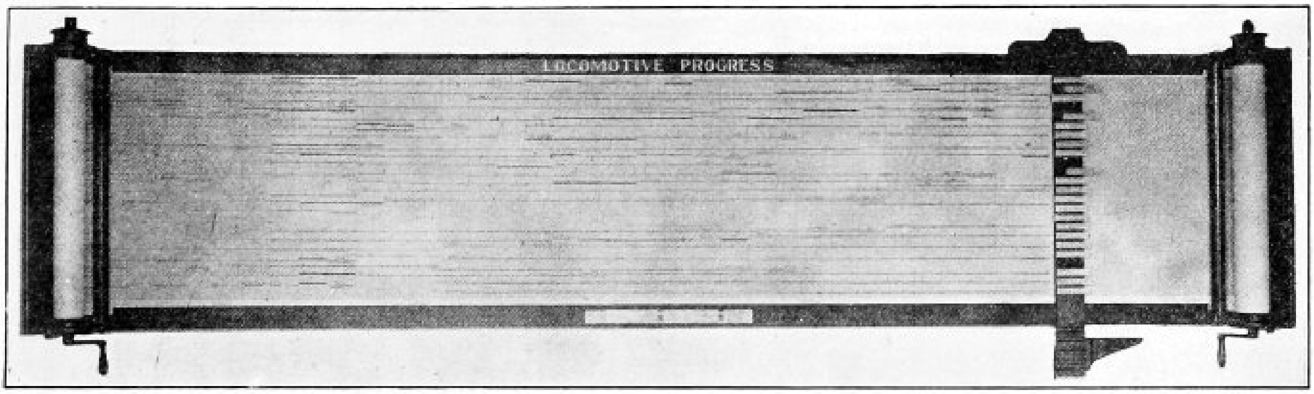
A—Adequate advice regarding repairs needed in advance of the dates of shopping of engines.
B—A properly co-ordinated method of routing work from stripping to erecting.
C—Hearty co-operation of officers and workmen.
D—Full co-operation of the purchasing and stores department.

A proper scheduling and routing method is comparable with the recording gages of a power plant, furnishing prompt information of delays, congestion or lowered production in time to correct the trouble without loss of output. Through a properly organized scheduling and routing plan, the officers are constantly in control of the shops. They have immediate information, in detail, of all the factors which enable them to make prompt and correct decisions.

Co-operation of Shop Foremen Must Be Secured

Since the co-operation of the supervisory officers is absolutely necessary, they must be convinced that the principles of the plan are right, that their authority is not invaded and that they themselves are really running the plans in their individual shops.

The success of the functioning of the production department in the North Little Rock shops is directly attributed to the complete co-operation constantly evident between everyone concerned. Some of the practical advantages of the method of co-ordinated production control used at Little Rock are as follows:



Locomotive progress chart visualizing conditions of material, sequence of operation and causes of delay. The T-square shows engine numbers, date in shop, class of repairs and completion date

Table I—Comparative shop output of locomotives, 1924-25

	Output for 1924	Output for 1925
Class 1 repairs	8	25
Class 2 repairs	4	50
Class 3 repairs	112	98
Total	160	173

Table II—Generally heavier work was handled in 1925

	1924		1925
New boilers	6		19
New fireboxes	35		42
New cylinders	34	pairs	36
New cylinders	21	single	11
New valve gear	8		11
Superheaters	5		5
Syphons	14		68
Tank frames	41		37
Tank cisterns	14		16
Flue sheets	42		33
Reverse gear	16		20
Oil burners	6		17
Steel cabs	4		25

1—The history of each locomotive is charted and its performance carefully recorded. The value of this is inestimable.

2—Repairs are planned in advance, thus preventing delays in procurement of and shortage of material inasmuch as early advice to the stores department before shopping of either engines or cars indicate the major items needed.

3—It encourages supervisory forces to think in dollars and cents, as well as in units of output.

4—By means of an efficient stores system and stores

Form 7076 5M—11-25

MISSOURI PACIFIC RAILROAD COMPANY
Mechanical Department

MATERIAL MOVE ORDER

Date ______ Engine No. ______ Group No. ______
From ______ Shops To ______ Shops

QUANTITY	DESCRIPTION OF MATERIAL

Material received by ______ Foreman ______ Dept.

Immediately upon completion of this work, return this order to Production Department.

This form filled out and placed on hook at "material move" foreman's desk assures movement of finished material to its destination within 15 min.

accounting and operating system it reduces inventories to a minimum and prevents the building up of obsolete stock.

5—The setting of time for the completion of each job serves as a goal which, when fairly established, considerably expedites production.

6—The maintaining of a master chart and divisional charts shows the progress made on every locomotive repair job each day and serves to show where there is failure to meet schedule.

7—The daily follow-up uncovers delays at once and makes possible immediate corrective measures.

8—Delays in the re-assembling of equipment are prevented. Work that should be done is not sidetracked.

9—Proper routing prepares the way for operations as completed by the previous group of workmen. The time lost between jobs is reduced to a minimum and material and parts necessary for repairs are on hand in proper sequence.

Table III—Average force of mechanics in locomotive department, 1925

Machinists	211
Boilermakers	66
Blacksmiths	29
Pipe fitters	31
Electricians	18
Loco. carpenters	14
Total	369

Note—Of this force of mechanics 77 were engaged exclusively on machine work for North Little Rock Round House engines and handling machine work on material for outside points.

North Little Rock, Ark., May, 12, 1926.

In shop 10-7 Engine No. 79 Scheduled 10-13

Due for service 10-31 Class repairs # 3 Pit 6

Shopping days -- 22

Front end and netting removed	10-7
Brake riggin and binders removed	10-7
Engine dewheeled	10-8
Spring riggin removed	10-8
Cab and running boards removed	10-8
Jacket and laggin removed	10-9
Motion work stripped	10-9
Pistons and crossheads removed	10-9
Stripping complete	10-10
Flues removed	10-10
Parts dispatched	10-10
Binders returned from Bkls, shop	10-14
Shoes and wedges machined	10-14
Furnace bearer machined	10-15
Guides machined	10-15
Shoes and wedges applied to frames	10-16
Driving boxes planed	10-17
Spring riggin returned from Bkls, shop	10-17
Furnace bearer applied	10-19
Shoes and wedges laid off	10-20
Brass work and boiler fixtures applied	10-21
BOILER TEST	10-22
Tank frame and trucks complete	10-22
Spring riggin machined	10-22
Air pumps and reservoirs applied	10-23
Laggin applied	10-23
Brake riggin returned from Bkls, shop	10-23
Engine wheeled and trammed	10-23
Motion work delivered from link gang	10-23
Tank tested and moved to paint shop	10-23
Motion work applied	10-24
Cab and running boards applied	10-24
Jacket applied	10-24
Guides lined	10-24
Piston and crossheads applied	10-26
Steam pipes tested	10-26
Valves set	10-27
Main and side rods applied	10-28
Tank complete	10-28
Brake riggin applied	10-28
Ash pan, Grates and front end complete	10-28
Air pipes and equipment OK	10-28
Out shop, Air tested, Pops set	10-29
On trial	10-30
OK for service	10-31

PRODUCTION DEPARTMENT

Typical master sheet

Plans Started With Receipt of Work Report

The production department of the North Little Rock back shops consists of a production engineer, scheduling supervisor, material supervisor and material clerk.

The first functioning of the production department in connection with the shopping of a locomotive begins with the receipt by the mechanical department of the master mechanic's work report, outlining the class of repairs to be extended, description of the work, whether parts are to be renewed or repaired and their pattern number. This locomotive work report is compiled by the mechanical inspector while inspecting the locomotive during the course of the stripping operation, which usually requires from 12 to 24 hours with an organized stripping gang, under the supervision of a lead man.

Table IV—Scheduled and actual shopping days for a nine months' period

	Scheduled Shopping Days	Actual Shopping Days
July, 1925	41	46-1/2
August	44	44
September	43	45
October	40	44-4/5
November	34	42-1/5
December	33-7/10	41
January, 1926	30-2/10	35-5/10
February, 1926	36-6/10	38-4/10
March, 1926	32	35

Copies of the locomotive work report are forwarded to the shop superintendent, the supply department and the production department. The copy to the supply department serves as advance information regarding parts needed for repairs and is checked against its stock records. This record is maintained in the supply department through the operation of a control board, giving the "in shop" date of locomotive, the date the material will be required and the date the engine is scheduled for delivery to the transportation department. This information is maintained by a material clerk who, by means of various colored tags, keeps track of the exact condition of the material. A blue tag, for example, denotes material condition being checked, a red tag that the material is ordered and a white tag that the material has been received and delivered to the shop.

All requisitions for material originate with the gang foreman directly responsible for the repairs on a locomotive assigned to his gang. They are then forwarded to the production department which checks for correct charges and scrap credit; and are then turned over to the "material move" gang foreman, in charge of delivery of all material. A force of eight men equipped with two power trucks and necessary trailers are employed in moving material. Material move orders are picked up every 15 minutes.

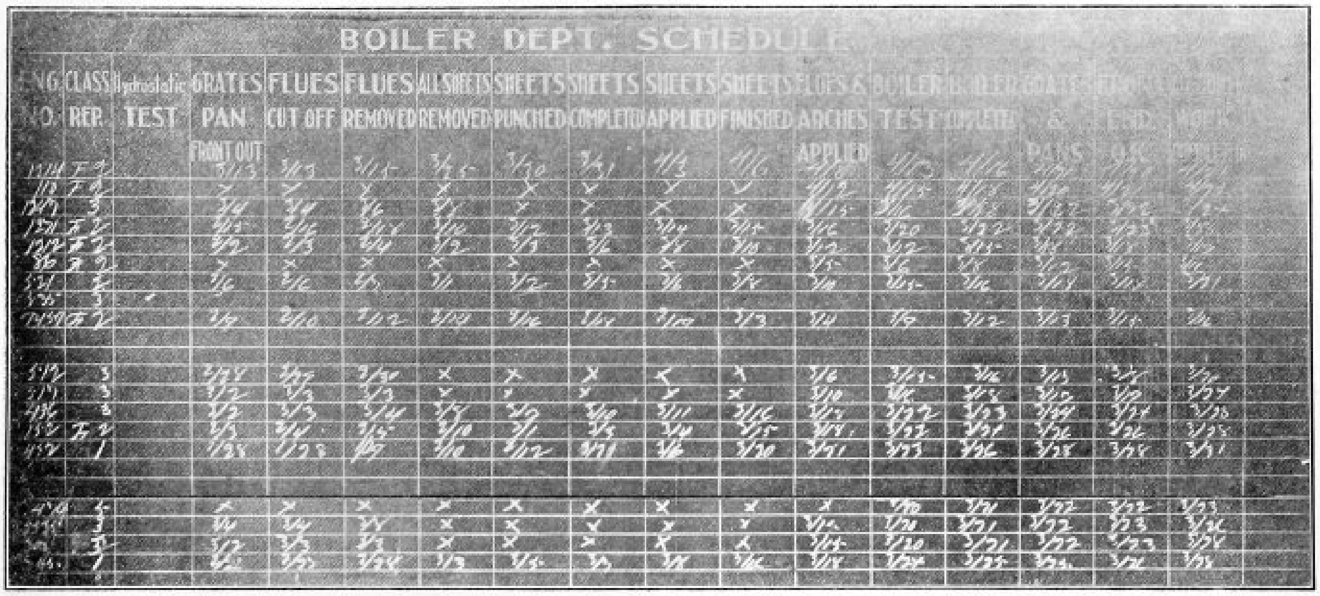
Information regarding new parts required is compiled when an engine is stripped. All parts, as removed, are delivered to the cleaning vats on schedule and, after being cleaned, are inspected to determine their fitness for use again, which determines the new material required.

Boiler Test Date the Controlling Factor

Immediately after the stripping operation is completed, the scheduling supervisor, through constant contact with the shop supervisors compiles a complete schedule for each locomotive, centering this activity around the boiler test date, the controlling factor.

The schedule contains the major operations and their completion date, which information is delivered in duplicate copies of the schedule to each supervisor concerned. The average number of schedule days on this property, embracing Classes 1, 2 and 3 repairs, is based on an average of 30 shopping days from the date the engine is delivered on the pits until it is O. K. for service.

Co-ordinated with the functioning of the schedule is the important factor of production control boards and the locomotive progress chart. Production control boards, installed in each department give the "in shop" date of the locomotive, the schedule completion date of the operation concerning individual departments, the boiler test date and the scheduled date of completion. These production control boards, maintained by foremen for their individual information visualize at all times the condition of locomotives under their charge.



Typical department schedule board showing the dates due

Schedule is Flexible and Accurate

The schedule is, however, flexible enough to take care of minor work not in the original calculations which develops during repairs. Care is taken to have all information contained upon the schedule and production boards strictly accurate so as to make possible complete cooperation between the shop supervisory forces and the production department and create confidence in the production plan.

The continued existence of hearty cooperation in the North Little Rock back shops is responsible for a 22 percent reduction in shopping time on locomotives in the past 12 months and this reduction in shopping days pertains only to Class 1, 2 and 3 repairs with practically the same force. The classification of repairs on the Missouri Pacific is as follows:

Class 1—New boiler or new back end. Flues new or reset. Tires turned or new. General repairs to machinery and tender.

Class 2—New firebox, or one or more shell courses, or roof sheet. Flues new or reset. Tires turned or new. General repairs to machinery and tender.

Class 3—Flues all new or reset (superheater flues may be excepted.) Necessary repairs to firebox and boiler. Tires turned or new. General repairs to machinery and tender.

Class 4—Flues part or full set. Light repairs to boiler or firebox. Tires turned or new. Necessary repairs to machinery and tender.

Class 5—Tires turned or new. Necessary repairs to boiler, machinery and tender, including one or more pairs of driving wheel bearings refitted.

General repairs to machinery include driving wheels removed, tires turned or changed, journals turned if necessary, and all driving boxes and rods overhauled, and bearings refitted, and other repairs necessary for a full term of service.

The suffix A after the class designation indicates accident repairs; B indicates new boiler; BE, a new back end, and F, a new firebox.

Master Progress Chart of New Design

To visualize the daily condition of locomotives and the progress of repairs, a master locomotive progress chart is maintained in the production office, in the shop superintendent's office, and in the office of the chief mechanical officer of the system. This chart is so constructed that it operates on rollers, carrying a continuous roll of drawing paper 20 inches wide and 50 yards in length, which permits the carrying of a two years' reference record of performance of locomotives, visualizing complete data, such as date in shop, scheduled date due for service, actual date of delivery to the transportation department and the shop department responsible for any delays incurred during the shopping period.

When an engine is brought into the shop, it is entered on the master chart under the date which is on the top of the chart. This entry is made in blue—denoting normal progress. In order to visualize completely any department responsible for delays, each department in the shop is given a distinctive color, and the departments are divided as follows:

Air department	light blue
Erecting floor	sepia brown
Tank shop	dark brown
Link and motion department	olive green
Engineering department	dark green
Blacksmith shop	purple
Machine shop	black
Stores department	red
Pipe department	orange
Boiler shop	yellow
Crane and trucking department	gray
Miscellaneous	pink
Superintendent's office	dark blue—interrupted line

As the engine progresses from day to day in the course of its repairs, the line is carried horizontally across the chart. Any delay occurring is charged to the department responsible, its representative color being inserted to replace the normal blue line—raised or lowered slightly from the direct horizontal to focus attention. For example, should the erecting floor fail to make the schedule date, the line is changed from blue to brown. The reason for the delay is specifically stated on the chart, affording a basis for immediate application of the remedy by the shop superintendent and general foreman.

SHORT SCHEDULES AFFORD A MARK AT WHICH TO SHOOT

One fact in proof of the success of this visualization of conditions contributing to delays is the reduction by 85 percent of delays in the erecting department alone in the past twelve months, brought about by the advance

Engine No. 79 — MISSOURI PACIFIC RAILWAY COMPANY — Date in Shop 10-7
Class Repairs 3 — Mechanical Department — Date out Shop 10-31
Shopping days 22

LOCOMOTIVE WORK REPORT

North Little Rock. Shop — Date in Production Dept

DESCRIPTION	New	Repd	Part No.
Stack		X	7140
Stack base		X	7142
Stack extension			
Front door ring	Pressed steel "16"		
Door ring liner			
Front end door			
Flag brackets	2		M-321
Peep hole (lid and base)			
Smoke arch braces			
Sand box			
Sand traps			
Dome cap			
Dome casing		(	12-X-3661
Hand rail columns	15	(	5-X-4282
Grab irons			
Headlight bracket	1		X-2352
Bell			
Bell crank			
Bell yoke			
Bell frame			
Number plate			
Hand rail tops	15	X	3663
CYLINDERS, ETC.			
Cylinders	PY 24x30x4585		
Cylinder bushing			
Cylinder bore			
Splice bolts			
Frame bolts and keys			
Heads (front)			
Heads (back)			
Casings (front)	2	X	4545
Casings (back)	1	X	4546
Cylinder jacket			
Cylinder cocks	4	X	2154
Guide yoke			
Guide yoke ends			
Guide yoke brackets			
Guide bars			
Guide blocks			
Guide cups	2		
Valve chambers			
Valve bushings			
Heads (front)			
Heads (back)			
Casings (front)			
Casings (back)			
Valve seats			
Steam chests			

DESCRIPTION	New	Repd	Part No.
Cylinders—Continued			
Steam chest covers			
Pressure plates			
Cover casing			
Steam chest casing			
Tumbling shaft			
Tumbling shaft boxes			
Counterbalance			
DRIVING GEAR			
Driving tires	Turn		
Driver retaining rings			
Trailer tires			
Trailer retaining rings			
Dr. wheel centers			
Tr. wheel centers			
Front axle	1	#	8
Back "	1	#	8
CRANK PINS			
Crank (F)	2	#	25
Crank pins (F. Int.)			
Crank pins (M)	2	#	33
Crank pins (B. Int.)			
Crank pins (B)			
Hub liners	8	#	4749
LINK AND MOTION			
Piston heads	2	X	7122
Piston Bull rings			
Packing rings	6		
Piston rods			
Piston glands			
Crossheads	2	5	489
Crosshead shoes	4	0	2475
Crosshead pins			
Valves			
Valve glands			
Valve rings and strips			
Bull rings			
Valve stems and yokes			
Valve stem guides			
Valve stem X-head			

Page 1 of a typical four-page locomotive work report

information furnished the various supervisors and their response to this condition through complete co-operation.

Schedules as compiled are made somewhat short intentionally, with the idea of setting a mark to aim at, thus keeping the various departments keyed up to a point where the production will approach, as nearly as possible, the mark set as a schedule. If this mark could be constantly maintained without intensive effort, the incentive element would be lacking. The efforts displayed by the supervisors in endeavoring to maintain schedules as nearly as possible is very commendable to the shop organization as a whole.

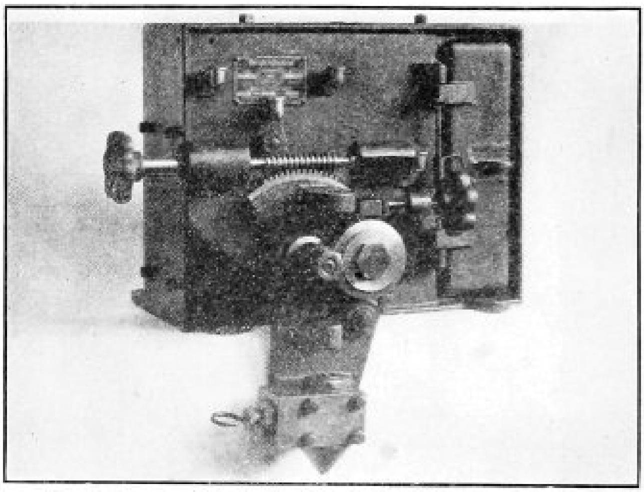
Throughout the development of this particular plan, it has been constantly explained and interpreted to all affected that the plan is of mutual benefit to every one in the shop. This viewpoint has been accepted and furnishes a big reason for the full acceptance of the plan itself. Every objection to the inauguration of the plan has been met by the facts and sound interpretations thereof. The why of the plan has been clearly explained and the shop men shown the fairness of all changes.

Westinghouse Automatic Arc Welder

THE Auto-Arc is a machine for automatically feeding a continuous welding wire, used in metallic electrode welding, to the work at any speed up to three feet per minute, which is necessary to maintain a constant arc length and a constant arc voltage. This machine, which is built by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., strikes the arc automatically and, if necessary, will exert a pull of approximately 200 pounds in order to prevent fusion of the electrode wire to the work.

This device relieves the operator of the tiresome and exacting hand labor of maintaining the arc and feeding the welding wire, and because the electrical conditions of the arc remain practically constant, it is possible to secure a better weld and to deposit metal faster than can be done by hand welding.

The arc length can be adjusted so that the arc can be



Westinghouse Auto-Arc for welding automatically

maintained at an average value of from 15 to 20 volts and will remain almost constant at any given voltage. The 1/4 horsepower feed motor and the electro-magnets do not obtain power from the arc circuit, and are therefore selected large enough to feed any size wire up to 3/8 inch.

This equipment can be used to advantage on work requiring the welding of long continuous seams, and also for some repair applications, such as building up worn crossheads, and crosshead guides and valve guides for locomotives. It is also applied in building up worn flanges for yard locomotives.

The machine is said to provide better fusion, due to the use of a higher current; ease of operation, permitting an inexperienced operator to handle it; uniformity of metal deposit, and the reduction in costs due to the ability to use wire in continuous lengths without the necessity of straightening and cutting. Other features of this equipment are dirt-proof housing and ease of accessibility to the parts.

ARTHUR C. PLETZ has been appointed sales manager of the miscellaneous machinery department of the Niles Tool Works Company division of the Niles-Bement-Pond Company, with headquarters at Hamilton, Ohio. Mr. Pletz for the last 12 years was secretary and general manager of the Morris Machine Tool Company.

Method of Laying Out a Double Elbow Connection at an Angle to Both Planes

By I. J. Haddon

DRAW the line *X-Y* or ground line; draw *A-A′* perpendicular to *X-Y;* draw the large circle *B*. This circle will represent the elevation of the large pipe that has to be met by a conical piece and *F* will represent the plane of this pipe and the circle *B* will also represent the elevation of the cone that has to meet the pipe *F*.

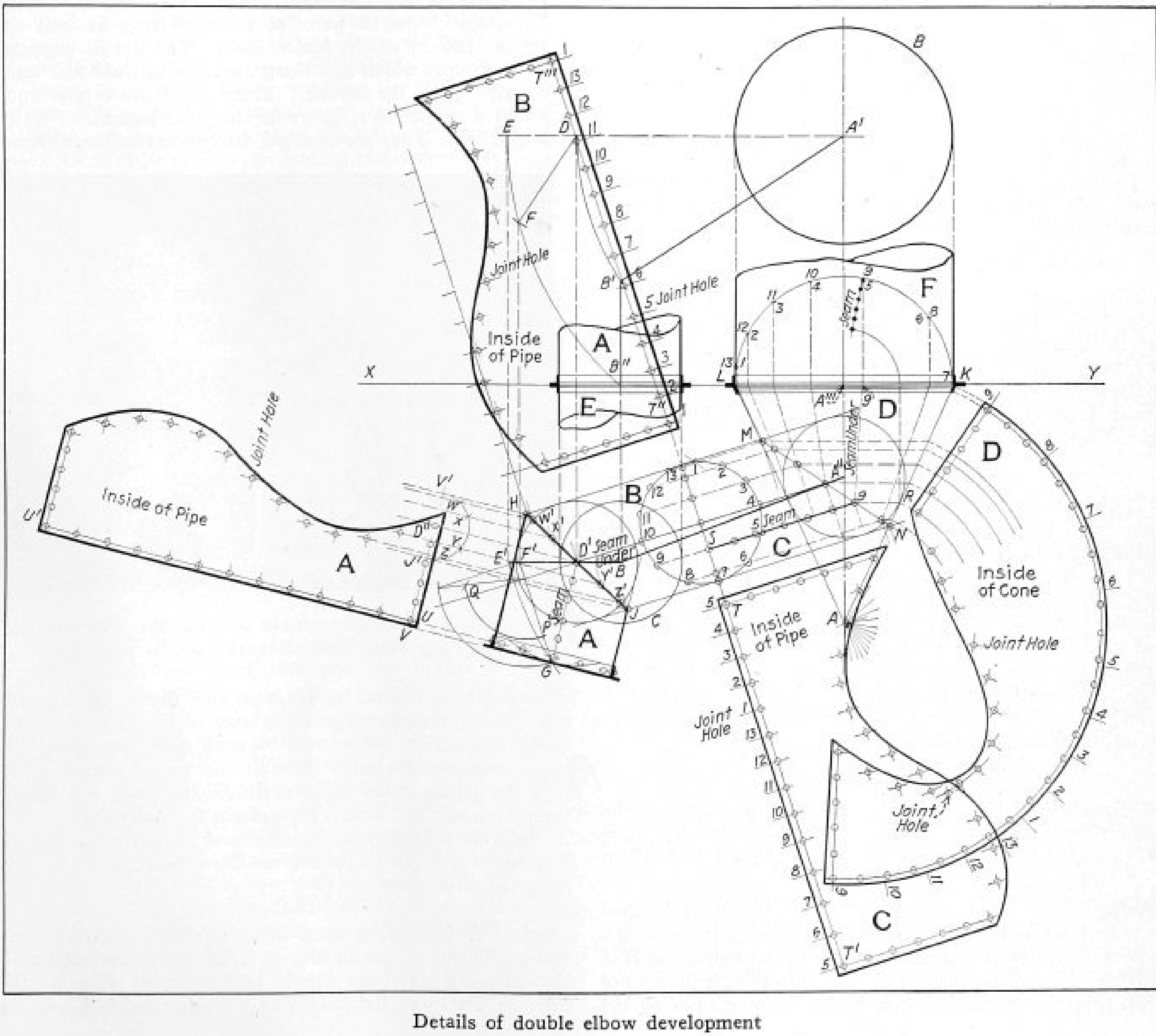
Draw the line *B-B′;* draw the lines *B′-A′* and *B-A″;* then *B′-A′* will be the elevation and *B-A″* will be the plane of the center of the two pipes *B* and *C*.

The point *A′* will be the elevation of the center line through the cone as *A″ A‴* and the point B will be the plane of the center line through the pipe *A* and *B″-B′* will be the elevation. The circle *C* will be the plane of the pipe *E* that has to be connected by the pipe *A*.

It will be seen that the true length of the center line of the pipe *A* is shown by the line *B″-B′;* also that the true length of the center line through the cone *D* is shown by the line *A″-A‴* but the center line through the pipes *B* and *C* as shown by *B-A″* in the plan and *B′-A′* in the elevation are not the true lengths as this line lies at an angle to both planes.

With center *A′* and radius *A′ B′* draw the arc *B′ D;* draw the line *A′-E* parallel to *X-Y* and cutting the arc in *D*. With center *A′* and radius *A′ B″* draw the arc *B″ E*. With center *D* and radius *B″ B′* cut the arc *B″ E* in *F*. Draw *B-E′* parallel to *X-Y*. Drop the lines *D-D′*, *F-F′* and *E-E′* to the line *D′-E′;* draw the line *D′-A* to represent the true length through the centers of the pipes *B* and *C*.

The distance from *E′* to *A″* is the true distance from *B″ A′;* therefore with *A″* as center and radius *A″ E′* draw the arc *E′ G* and from *D′* as center and radius *B″ B′* cut the arc *E′ G* in *G* and join *D′ G*. With *D′* and *A″* as centers describe circles equal to the diameter of the pipe *A;* draw lines as shown parallel to *G-D′* and tangent to the circle; also draw lines parallel to *D′-A″* and tangent to the circles. These lines will cross at *H* and *J;* join *H-J*.



Details of double elbow development

Then *H-J* will be the miter line of the pipes *A* and *B* and will show their true angle in relation to each other. Draw lines from *K* and *L* tangent to the circle drawn with *A″* as center and meeting at *A;* also cutting the other lines already drawn in *M* and *N;* join *M N;* this will be the miter line of the cone *D* and the pipe *C* and will also show the true angle in relation to each other. The pipes *A, B, C* and cone *D* are now lying in the same plane. The pipes *A* and *B* have been revolved on the seam connecting *B* to *C,* equal to the distance *PQ* and has to be taken into consideration in the development of *B* and *C* so that when they are connected up they will lie at the correct angle to each other.

The connection of the pipes and cone should be such that the joints do not have to be bent, therefore the seams of the separate plates will be as shown.

Where the circle touches the side of the cone as at *R* draw a line parallel to *X-Y* and meeting *M-N* in *9;* draw *9-S;* this line will represent the seam of the pipe *C;* also draw the line *9-9* through the apex of the cone and *9;* this line will represent the seam on the cone and will be on the under side.

Now, as the pipe *B* has its seam on the under side, and opposite the seam of the pipe *A,* its joint hole connection with the pipe *C* must be such that the amount of twist given should be equal to *P Q.* Therefore with *10* on the circle as center and radius equal to *P Q* draw the arc cutting the circle in *1.* We now have the holes *1, 4, 5, 7, 9* and *10.* Divide *1, 4* into three spaces to obtain *2, 3* and drop them parallel to *H M* to obtain the points on the circle *11, 12* and *13.* Obtain *6* and *8* in a similar manner; project these points onto the miter line of the cone and pipe as shown. Through these points on the miter line of the cone draw lines from the apex to the base of the cone *L-K* and project them vertically on to the semicircle as shown in *13, 12, 11,* etc.

The points on the miter line *M-N* must also be projected to the side of the cone as shown to obtain their true lengths from the apex *A.*

To Develop the Frustrum of the Cone D

With center *A* and radius *A K* describe the arc *9, 9* and step off the distances as shown on the semicircle; along this arc in the points *8, 7, 6,* etc., draw lines from *9, 8, 7, 6,* etc., to the point *A.* Now with *A* as center and radius *A N, A R,* etc., as shown, draw arcs cutting their respective lines drawn from the outside arc to *A* as shown. These will be rivet holes, allow on lap to complete the layout.

To Develop the Pipe C

Draw the line *T-T′* in a line with the rivet holes that connect the pipe *C* to *B* as shown. Make *5, 5* equal to the circumference of the pipe *C;* step along this line from *5* to *5* the respective distances as shown on the circle as *5, 4, 3, 2, 1, 13,* etc. These points will be rivet holes for connecting to pipe *B.* Project all the points on the miter line of the cone and pipe *D* parallel to *T T′.* Drop lines from *5, 4, 3, 2,* etc., parallel to the seam *S 9* as shown and crossing those drawn from miter line. Then these new points will be the rivet holes for connecting *C* to *D;* allow on lap to complete the layout.

To Develop the Pipe A

Draw the line *U-U′* in a line with the rivet holes of the angle ring on pipe *A;* at any convenient distance draw *V-V′* parallel to *G-D′;* project *J-H* on to the line *V-V′* in *V′ J′* and the point *D′* to *D″.*

With *D″* as center and radius *D″ V′* describe the semicircle and divide it into any number of equal parts as shown in *W X Y Z;* project these points on to the miter line *H-J* in *W′ X′ Y′* and *Z′*; make *U U′* equal to the circumference of the pipe *A* and divide it into double the number of spaces that the semicircle was divided into; in this case 12 equal parts as shown; these will represent rivet holes.

Draw lines parallel to *U-U′* from the holes on the miter lines as shown; then vertical lines drawn from the rivet holes on the line *U-U′* will cross the lines drawn from the miter line and will represent rivet holes for connecting to pipe *B* as shown. Allow on the lap to complete the layout.

To Develop the Pipe B

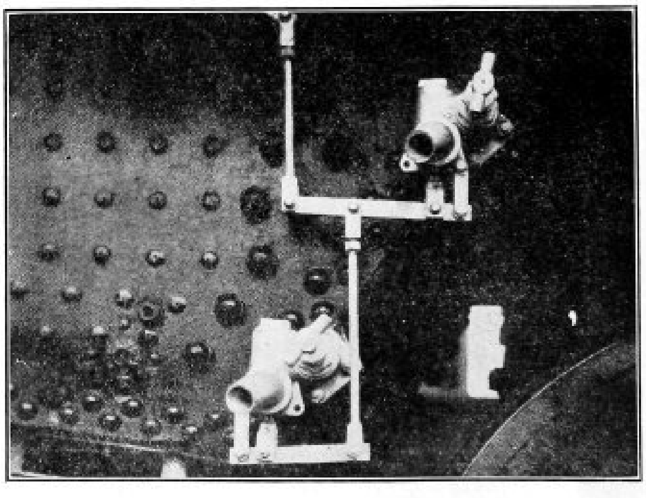
Proceed as explained for pipe *A* as regards the miter line *H-J* but for the holes along the line *T″-T‴* the separate distances from hole to hole must be taken from the circle in a similar manner to what was done for pipe *C,* commencing at *1* as shown, as it is the joint hole and will connect to a point *1* on pipe *C.* Allow on lap to complete the layout.

Note: According to the position of the pipes as shown, the cone *D* is the *only right cone* that will suit, the angle at the apex of the cone being governed by the position of the pipe *C* and its diameter.

Note: In this problem the seams are arranged so that no joint requires bending when joining up, the greatest amount of bend will be at *M N H* and *J* but none at the straight seams.

Locomotive Sludge Remover

The Bird-Archer Company, Chicago, has placed on the market a sludge remover which is designed to remove sludge from all parts of the mud ring as well as from the bottom of the boiler shell. The device consists of slotted pipes which run along the belly of the boiler and the waterlegs of the firebox. These pipes are copper and are slotted or drilled at intervals along the bottom for their entire length. They are attached directly to two large blow-off cocks, both located on the same side of the firebox and connected to the same operating lever in the cab, as shown in the illustration. When the blow-off cocks are open, the upper one draws sludge through the slotted copper pipe from the bottom of the boiler shell and the lower one draws sludge through the slotted pipes from the water legs.



Exterior view of sludge remover showing the lever rigging for operating both blow-off cocks at the same time

Since the slotted pipes are made of copper there is less tendency for scale to deposit on them and no pitting or corrosion.

John T. Carroll, general superintendent motive power and equipment of the Baltimore & Ohio, has resigned and has entered the railway supply business with office at 203 Citizens National Bank building, Baltimore, Md.

Effect of Surface Materials on Steel Welding Rods*

Discussion of the effect on working qualities of metallic and non-metallic surface materials—Gas filler rods

THERE are three materials which might appear on the surface of filler rods as ordinarily made by wire mills. These are lime, iron oxide, and copper. Lime and iron oxide are lubricants used in wire drawing when what is known as the "dry process" is employed and copper when the rod is drawn by the "wet process." If the rod is annealed as the last operation, this usually results in covering the rod with a reasonably thick layer of iron oxide called scale. This scale is black while the iron oxide used for lubricating is reddish in color. The research department has experimented with nickel, cobalt, tin, copper, and some mixtures of these. A mixture of tin and copper is quite common in wire mills. This gives the rod the appearance of brass plating and it is known as "liquor bright finish."

A great many tests covering all these surface materials applied to low carbon, high carbon, and alloy rods have been made by the research department in the laboratory and extensive observations over a period of years have also been made in numerous shops under commercial welding conditions. The results can be summarized by saying that none of the metal surfaces affect gas welding in any way while lime and iron oxide, which might be classed as non-metal surface materials, interfere in proportion to the quantity present. No differences can be noted as between filler rods coated with copper, tin, cobalt, nickel or mixtures of these either so far as flowing qualities under the torch or quality of the weld deposit is concerned. They are all equally good.

In the case of lime and iron oxide, quite the reverse appears to be true. If there is an appreciable quantity present, it interferes with smooth flow. These materials do not alloy with the steel of the filler rod but float around as bright specks on the liquid weld puddle. A certain percentage of these specks usually seem to get entangled with the weld metal just as it solidifies and become slag inclusions. These, of course, weaken the weld.

Drawing Low Carbon Rods

So far, no wire mill has succeeded in drawing low carbon rods by the dry process without leaving some lime or iron oxide or both on the surface. To entirely remove these materials, the rod must be pickled and wet drawn. So long as all the metals which might be applied in conjunction with the wet drawing process work the same for welding, it is logical to prefer copper. It is the cheapest and its color tells anyone at a glance whether or not the filler rod has been made by the wet process, and therefore, whether it is entirely free from lime and iron oxide.

Somewhat different conditions apply to high carbon and alloy rods. These are much harder than mild steel and by using care in the wire mill, so nearly all the lime and iron oxide can be scraped off in drawing as to make dry drawn, or bare rods, suitable for gas welding. While wire mills which have not made a careful study of the effect of surface materials on filler rods may draw high carbon and alloy rods just the same for both gas and electric welding, they are not serving the welder with the best rod if they do this. The gas welder should insist on the brightest, cleanest finish obtainable while the metallic arc welder wants all the lime on his rod he can get.

The gas welder should never use any filler rod which has been black annealed as the last wire mill operation. Only under very unusual conditions, is it necessary for the gas welder to use a rod which has even been annealed in process. Very occasionally it is necessary to weld in a place so small a man can barely get in and then the welder must have a rod which he can wind up much like string solder. Under such conditions, a bright annealed coppered rod is really the only one to use, and then the extra cost of such a rod is justified.

The conclusion to be drawn from these investigations is that the popular coppered finish for gas welding rod probably can not be improved upon in the low carbon grades while, in the high carbon and alloy grades, care should be exercised to see that the rod used has a perfectly clean surface so far as lime and iron oxide is concerned.

Experiment With Three Surfaces on One Electrode

The starting point in a study of the effect of surface materials is to first find out what happens when they are entirely absent. An interesting demonstration can be made in this connection by preparing an electrode as shown in Fig. 1. Select what is considered a smooth running mild steel electrode. The analysis of this is, of course, the same throughout its length. The surface materials only are varied as indicated in the figure. The flux coating may be omitted, leaving only the natural bare finish and the polished surface for the experiment. If the flux coating is included the top third of the electrode may be dipped in silicate of soda or in acetylene generator sludge and dried for this purpose.

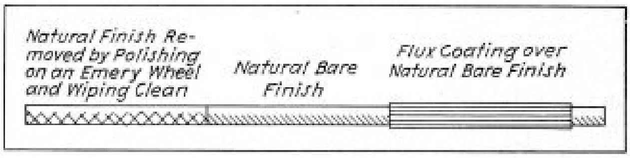


Fig. 1.—Electrode for testing

Unless the electric welding generator has unusually large ballast resistance or steadying inductance and windings, it is very easy in running this experimental electrode to tell, as the rod melts, when the change comes from one surface to another. If a bead is laid down on a plate, the surface of this bead also changes with each change of electrode surface.

When the polished surface is running, the arc is almost impossible to hold. The operating smooths out when the natural bare surface is reached and the arc becomes very steady while the flux coated portion is running. Few welders, until they have tried this experiment, realize that what they have always called "bare electrodes" are not really bare but have something on the surface which, when removed, makes an otherwise good electrode almost unmanageable.

Surface Materials on Bare Electrodes

What is really on the surface of these bare electrodes is mostly lime, often also containing rust and also a little soap or grease. These are the common wire mill lubricants. Electrodes are drawn down to size in the wire mill by passing the wire cold time after time through drawing

*Published through the courtesy of the Chicago Steel & Wire Company, Chicago, Illinois.

dies, each a little smaller than the preceding, until the finished size is reached. During this process the wire is in large coils, not being straightened and cut for electrodes until later. If the wire were not properly lubricated during drawing, it would break up into small pieces and the drawing become impossible. The more times the wire is drawn through the dies, the less lime, etc., is left on it. Slight changes in the steel, too slight to be otherwise detected, give trouble in the drawing and require changes in the dies. Every little change causes a variation in the quantity of residual lime left on the wire when it has reached finished size. Inasmuch as the working qualities of electrodes depend to such a great extent on the quantity of residual lime on their surfaces, it is easy to understand why there can be a wide variation in these working qualities. Few electrode manufacturers have in the past appreciated the importance to the welder of this residual lime and it is a wonder bare electrodes have had much of any uniformity.

The extremely skillful welder is able to compensate for much of this lack of uniformity and modern welding generators have been ingeniously designed to take care automatically of some variation in electrode properties. It seems illogical, however, to ask the welder and generator manufacturer to use their efforts to compensate for the shortcomings of the electrode producer. An attempt has been made in the right direction by offering the welding industry flux coated electrodes. The main function of these is to stabilize the arc and the benefits from increased arc stability are far greater than merely making the work easier for the welder, as will be explained later.

One general objection to flux coated electrodes is their cost. Rather than obtain the desired arc stability at an increased electrode cost through flux coating, it would seem more logical to accomplish it by improving and standardizing the surface finish of what have been called bare electrodes. Such improvement should give a uniformly stable arc permitting the highest quality work with both direct and alternating current. Flux Coating would still have its field of usefulness, a field which has been hardly touched as yet. This is the field of special work and here an increased electrode cost is fully justified.

(To be continued)

Gas Welding for Central Heating Boilers

By G. P. Blackall

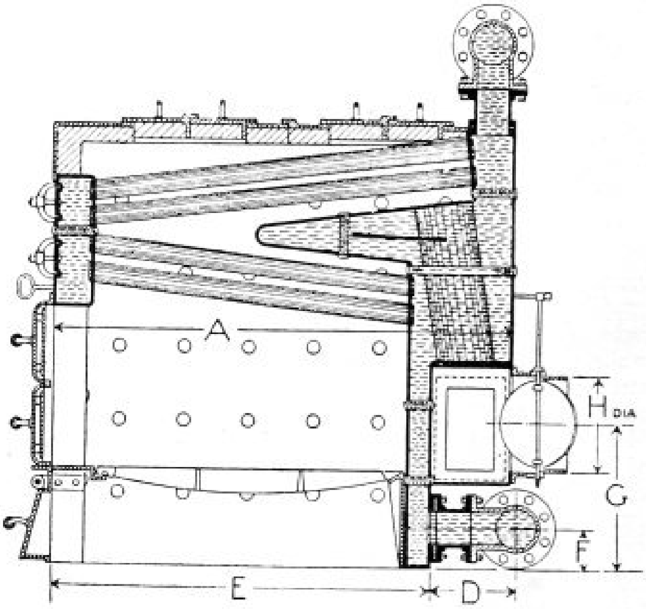
An important lecture on oxy-acetylene welding in the construction of boilers for central heating, etc., was delivered in London recently by Samuel Fox (of Hartley & Sugden, Ltd.), before the British Acetylene and Welding Association. Mr. Fox gave a number of important facts which it will be of value to summarize briefly here.

Prior to 1913 the oxy-acetylene welding process as applied to wrought welded boilers for central heating and hot water supply was little known. In 1908 some cylindrical boilers with flanged pieces welded on were displayed at the Dusseldorf Exposition in Germany. As this job had always been regarded as impossible a director of Mr. Fox's firm dispatched the foreman welder to Dusseldorf to see the miracle for himself. The foreman returned very little the wiser and could only report that the pieces certainly were welded by some secret process which he could not fathom for himself, and the Germans were not anxious to dispel his ignorance.

Later when the process came to England Mr. Fox was so struck with it that he made his firm purchase a small portable apparatus.

Although there was much talk about making boilers by oxy-acetylene welding, the prejudice against it was very strong throughout the entire trade. It was maintained that the plates were not welded together, but only stuck on the surface. Admittedly, at that time, there was much justification for this criticism.

Some of the more advanced concerns commenced in a small way to turn out boilers by the new process, but no great advance was made, chiefly owing to the unfair criticism of competitors. Certainly much of the welding was very badly done owing to the fact that workmen had not been properly trained, and there was much ignorance displayed in the preparing of the plates for the welds. Mr. Fox made his first oxy-acetylene welded boiler in 1911, and this was of a very simple design. It was made from $\frac{5}{16}$-inch



Type of gas welded boiler

plates and subjected to a pressure of 30 pounds per square inch only, as it was for a kitchen range of a type common in Scotland. In 1913 another portable gas apparatus was purchased and a few boilers were made from it and turned out very well. It was then decided with another firm to install a large generator and go out for gas welding.

At this time there was a strike of fire welders in progress and for a time the strikers laughed at the new process which was getting some of their business while they were "out." Later, however, as the gas welders were leaving work at noon, the strikers turned up in force and a pitched battle was fought. The generator was blown up and the new industry was temporarily stranded. Finally the strike ended, but at one works they never made another fire welded boiler. Such, briefly, is the history of how gas welding first got a real foothold in the boiler making industry, but once there it never went back, but continued to make steady progress, and today there is hardly a fire welder in the trade outside London.

With the war came the next leap forward. The articles then made were weapons of war, but it was necessary to carry out some wonderful welding on them in order to stand the required pressure. The first article was a plain cylinder with dished ends. This was made from ordinary mild steel of 26-30 tons tensile strength, $\frac{1}{4}$-inch body, $\frac{5}{16}$-inch ends. The flanged pieces had to be dead accurate in order to fit up to other parts of the apparatus in the trenches. When working the pressure on these cylinders was 1,300 pounds per square inch, and these were tested at the plant to 1,850 pounds per square inch. All the welding was well hammered while hot, thus adding greatly to its strength. The reason for constructing this and other articles from such light material was that they had to be carried by men to the front line trenches and a man was not allowed to carry more than a specified weight.

Another war article was a paravane head, a cone-shaped vessel with cast steel angles welded inside and at the bottom edge tubes passed through the head. The pressed parts arrived in halves and the material was steel 50-60 tons tensile, ⅛-inch thick. Riveting having proved unsatisfactory, it was decided to weld these heads. When finished the seams had to be perfectly smooth and the whole head polished bright as silver. Admiralty inspectors had to pass them and the limit of error was 2 in 1,000. Large numbers were made successfully. A system of jigs had to be used and this was Mr. Fox's first experience of welding in a jig. The two pressed parts were fixed on a solid cast cone-shaped block and as the welding proceeded it was hammered flat against the block so that a good shape was kept and the welded seam had a neat finish. The angles were electrically welded.

Quite a number of cylinders 16½ inches long and 4½ inches in diameter had to be made with ends dished and flanged and welded into the body of a solid drawn tube $\frac{1}{16}$-inch thick. An order was given for others to be made for experimental purposes and tested to an extremely high pressure. The following are the results of the tests on these cylinders carried out by the British Army:

Length of cylinders, 16½ inches. Diameter 4½ inches.
Approximate capacity: 264½ cubic inches.
Nos. 1 and 2, examined at each 50 pounds of pressure.

No. 1

250 pounds per square inch.	No change up to 650 pounds per square inch.
650 pounds per square inch.	No change.
700 pounds per square inch.	Diameter $4\frac{9}{16}$ inches.
750 pounds per square inch.	Cylinder leaked at a pin hole in bottom welding.

No. 2

250 pounds per square inch.	850 pounds per square inch. No change.
900 pounds per square inch.	Diameter $4\frac{9}{16}$ inches.
950 pounds per square inch.	No change.
1,000 pounds per square inch.	Diameter 4⅝ inches.

Nothing more happened until:—

1,150 pounds per square inch.	Length $16\frac{9}{16}$ inches.
1,250 pounds per square inch.	Bottom blew out.

Building Central Heating Boilers

Although all this has nothing to do with boilers for central heating and domestic supply, the knowledge then acquired of what could be done by oxy-acetylene welding had a great and lasting influence on the welded boiler industry. Most important of all, it proved conclusively that the weld was much stronger and more generally satisfactory than the old fire weld and finally overcame what remained of the old prejudice. This only applied, however, when skilled men did the work, as it was quickly discovered that the so-called gas welder trained during the war to light work not subject to test pressure was of no use whatever for boiler work. This type of man did the trade much harm when later he was let loose in the commercial world. But from the end of the war the oxy-acetylene process has slowly but surely superseded the fire process. Today little trouble is encountered with experts and insurance companies. They will pass for insurance a vertical steam boiler oxy-acetylene welded throughout for a working pressure of 25 pounds per square inch.

Recently there was a little trouble in Australia where welding which may be subject to steam pressure is illegal. On giving proof, however, that the English insurance companies accepted the work this trouble was removed.

In due course it became desirable to make cross tubes for steam boilers working up to 80-100 pounds per square inch by gas welding the seams and then reheating and subjecting the weld to pressure under a hydraulic rolling machine. In order to gain the permission of the Manchester Steam Users' Association, samples of 8-inch by 10-inch diameter tubes ⅜-inch thick, made in this maner, were submitted. The association at once consented to their use. A gas welded seam finished in this manner is very difficult to detect, the surface is perfectly smooth and the weld much stronger, so that it has the appearance and almost the strength of a solid drawn tube. The hydraulic machine was worked with about 10 tons in the accumulator and the reheating was done by coal gas. Since 1919 Mr. Fox's firm has welded in this manner scores of miles of straight seams in cylindrical boilers and cross tubes and has never had a failure.

It will be of interest to give some details of a common type of boiler used for large domestic supply installations, when made in the old way and the new. When constructing fire welded the plates, which were ⅜-inch mild steel of 25-30 tons tensile strength, were bent and rolled in a very similar manner to the preparation for a gas welded boiler. The firebox was the first portion to be welded and this had to be fitted with clamps in order to turn it in and out of the fire. It was lifted by a lever arrangement which was operated by three men. The part to be welded was heated on the open hearth, then turned out on to the floor and the two fire welders hammered the plates until the weld was made. On the average about two inches was welded at each heat and the lever was then brought into operation and the boiler lifted to the fire and the heating process recommenced. Five men were employed and, as the job neared its end and the weight was increased by the addition of the outer shell and crowns, another man would help to swell the crowd. In the welding of this boiler 637 man hours were worked on the fire. In 1926 three boilers of the same size were made to one order and all were made entirely with the torch, each boiler containing about 150 feet of welding. The average man hours worked on these three boilers was 204 each. Only one boiler had to go back to the welder after a hydraulic test of 120 pounds per square inch and that was for a very minor defect. They were perfect pieces of workmanship done by skilled men who had had a long training. These men earn much higher wages than fire welders and only one laborer is required to five or six welders. Such workmanship can only be done by highly skilled men.

Another item where there is a great saving in the making of such a boiler is in the fitting of the necessary castings to the boiler body. The greater accuracy and neater finish of a gas welded boiler allows the castings to be fitted in exactly the same manner as to a cast iron boiler. Probably the worst feature of a fire welded boiler was the badly fitted castings. It was hardly possible to make two boilers alike, and the result was great confusion, annoyance and expense when replacement castings had to be sent. This fault has been completely remedied in gas welded boilers.

Another type of welded boiler for central heating differs from the one just described in that it has a firebox and two flue traverses, whereas the former type has a plain firebox and cross tubes and no flues. It is entirely gas welded, and large numbers are at work under very heavy head pressures, also under steam pressure. It is a very efficient boiler and specially suitable for oil firing. The plates from which most gas welded boilers for central heating are made are ¼-inch, $\frac{5}{16}$-inch, ⅜-inch, and ½-inch thick, but Mr. Fox's firm is constantly welding plates up to 1¼ inches thick.

The test pressures vary from 50 to 300 pounds per square inch, and the designs vary considerably, also the weights which may be from 2 hundredweight to 2 tons. Under Mr. Fox's supervision a battery of five boilers was recently made which weighed two tons each and contained over 200 feet of welding each.

Before the introduction of gas welding many attempts had been made to produce a wrought boiler made in sections, but they were all failures. Large power sectional boilers are now being made in mild steel, gas welded, and are probably the most efficient heating boilers on the market. A boiler of this type must be accurate in finish and without any distortion of the flat sides, so that the sections fit accurately one to the other in order that a boiler may be extended or a section replaced at any time.

The accompanying illustration gives an idea of the intricacy of design of such a boiler, a design that could not have been attempted years ago. This section weighs 1,456 pounds, contains 84 square feet of heating surface and 130 feet of welding. Such a boiler will give a 76 percent fuel efficiency, withstand the head pressure of any modern building and can be taken to the most inaccessible boiler house in parts and erected on the site without the slightest difficulty. The building of this type of boiler is an entirely new trade that has been made possible by the gas welding process.

There are many minor details of fittings which used to be studded or riveted to welded boilers, such as the screwed flanges for connecting pipes, strengthening rings round mudholes, etc., and in this work gas welding now plays an important part. It is now quite common custom to use up scrap round bar by sawing it into disks and welding to the shell of the boiler, in place of the wrought screwed flange studded to the plate and joint made with a rubber ring. On an average there will be four such flanges on each boiler, so that a very considerable saving is made annually on this item alone. The cost of the new method is roughly one-half the old and in addition a much scunder job is turned out.

Fire welding is wasteful of space in comparison with gas welding. Not only does the fire require a lot of elbow room, but a vast amount of heavy gearing has to be kept at hand. Roughly, in the area occupied by one fire it is possible for three gas welders to work in comfort. Not only is the necessary capital outlay saved by the latter method, but depreciation and general maintenance are not added to the already too high overhead charges. One firm, by completely clearing out its old welding fires, had at its disposal a good shed which it turned into a light casting foundry which is giving a daily output of five tons of small light castings. The saving in capital outlay in this case alone is about $40,000.

It is wise to refrain from mentioning any particular type of blowpipe or plant, as there are so many that are good. Mr. Fox has experimented with every kind of blowpipe, English, German, American and French, and is now using the former, which has been selected owing to its adaptability to the various thicknesses of metal to be worked in the shop.

The welding rods are all-important if really sound welding is to be done, and here again every kind of material has been experimented with, but for some years past Mr. Fox has used nothing but a good Swedish iron that is clean and non porous. It is the duty of one man in his firm to see that all welding is absolutely clean and free from rust.

The Chicago Tube & Iron Company and Warren, Corning & Co. have been consolidated under the name of the former company. E. E. Peter remains chairman of the Chicago Tube & Iron Company. The other officers of the company will be Warren S. Corning, president; Fred Gardener, vice president and general manager; E. M. Peter, treasurer and E. S. Nathans, secretary.

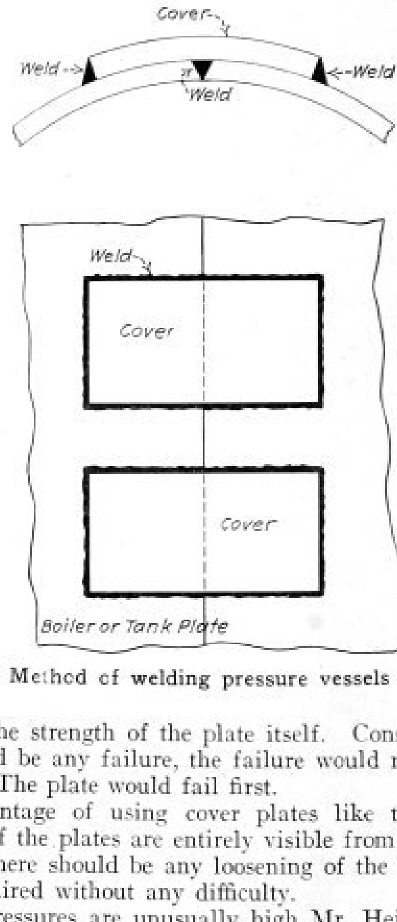
An Excellent Welded Joint

By W. F. Schaphorst

FOR several years I have been warning users and prospective users about the use of electric and gas welded pressure vessels. My contention has been that one cannot be so certain of the safety of such vessels as one can be of the riveted variety. Welding involves the personal factor.

In reply to a recent communication of mine concerning these dangers, an excellent method of welding pressure vessels is shown by R. T. Heinrici of Austria. He states that this method is employed by a prominent firm of boiler makers in Switzerland. They make important welded joints in the manner shown in the sketch herewith.

By welding cover plates outside and across the joint, as shown, the strength of the joint is made greater by 20 per-



Method of welding pressure vessels

cent than the strength of the plate itself. Consequently if there should be any failure, the failure would not occur in the joint. The plate would fail first.

An advantage of using cover plates like this is that the welds of the plates are entirely visible from the outside so that if there should be any loosening of the plates, they can be repaired without any difficulty.

Where pressures are unusually high Mr. Heinrici states that covers should be used both inside and outside of the vessel. To the writer this looks like good sensible engineering and is a step forward in the science of welding pressure vessels.

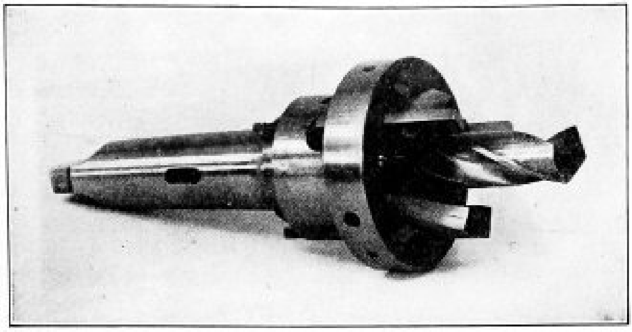
COMBINATION WELDING

A writer in England who apparently has had experience with all kinds of welding states that no system of welding is applicable universally. He writes of tests that were made by manufacturers of cylindrical pressure vessels for withstanding high pressures. He states that the best results were obtained when the longitudinal seams were welded by means of the water gas process, the branches by means of oxy-acetylene, and the flanges and ends by means of the carbon-arc process.

Of course it is impractical for everybody to be equipped with all kinds of welding apparatus, but anyway the above is instructive and I hope it may be helpful.

Trepanning Tool for Flue Sheets

THE special trepanning tool illustrated has been designed by W. L. Brubaker & Bros. Co., 50 Church street, New York, for cutting holes 3 inches in diameter and larger in flue sheets. It combines a standard drill, with a Morse taper shank, with special tools for trepanning and chamfering. The tool is made in positive sizes with



Brubaker trepanning tool for flue sheet holes 3 inches in diameter or larger

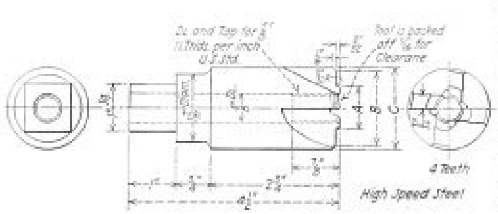
no radial adjustments. Both the trepanning and chamfering cutters may be adjusted longitudinally, however, to maintain the proper lengths after grinding. The range of adjustment permits the maximum use of the cutters, all of which are made from high speed steel to assure long life.

This tool is designed to give shorter production time and, hence, lower cost of production owing to the performing of several operations in one set-up, and accurate cutting of holes owing to the rigid support of the cutters. The tools may be quickly taken apart or assembled.

Tools for Counterboring Crown Sheet Holes

By E. A. Miller

TWO tools for counterboring holes in crown sheets are shown in the drawings. One of the tools is designed to be used with an air motor and the other to be used on a drill press. Referring to Fig. 1, the drill press tool has a standard No. 3 Morse taper shank and the socket is drilled for a No. 5 standard taper pin. The collar fits over the socket and is held by the taper pin. The end of the socket is drilled and tapped for the screw which

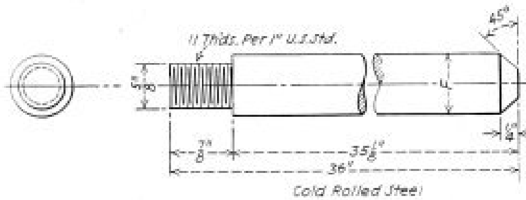


Size of Crown Bolt	A	B	C
1"	[illegible]	[illegible]	[illegible]
1 1/16"	[illegible]	[illegible]	[illegible]
1 1/8"	[illegible]	[illegible]	[illegible]
1 3/16"	[illegible]	[illegible]	[illegible]
1 1/4"	[illegible]	[illegible]	2"
1 5/16"	[illegible]	[illegible]	2"
1 3/8"	[illegible]	[illegible]	2"
1 7/16"	[illegible]	[illegible]	2"

Fig. 2.—Air motor tool for use in counterboring holes in crown sheets

holds the cutter to the socket. This cutter is of high-speed steel and is made interchangeable with the socket to suit the different sizes of crown bolts shown in the table.

The air motor tool, details of which are shown in Figs. 2 and 3, is also made with an interchangeable cutter, the

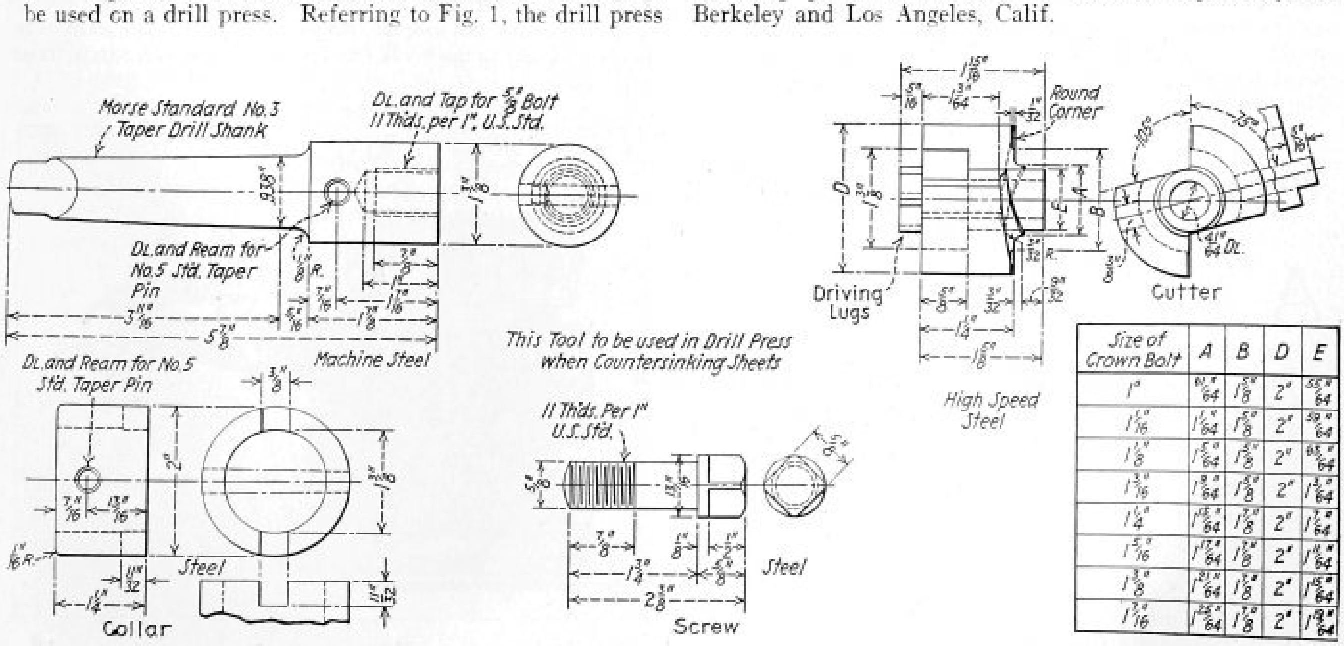


Size of Crown Bolt	F
1"	[illegible]
1 1/16"	[illegible]
1 1/8"	1"
1 3/16"	[illegible]
1 1/4"	[illegible]
1 5/16"	[illegible]
1 3/8"	[illegible]
1 7/16"	[illegible]

Fig. 3.—Pilot pin for the air motor tool

dimensions of which are shown in the table in Fig. 2. The pilot pin screws into the end of the cutter as shown. Different diameters of pilot pins (see the table, Fig. 3) are provided to suit the sizes of the holes to be counterbored.

The Air Reduction Company, Inc., has acquired, through a long term lease from the Commercial Acetylene Supply Company, Inc., the plants and business of that company on the Pacific Coast. The two acetylene manufacturing plants taken over are located, respectively, at Berkeley and Los Angeles, Calif.



Size of Crown Bolt	A	B	D	E
1"	61/64"	1 5/8"	2"	55/64"
1 1/16"	1 1/64"	1 5/8"	2"	59/64"
1 1/8"	1 5/64"	1 5/8"	2"	63/64"
1 3/16"	1 9/64"	1 5/8"	2"	1 3/64"
1 1/4"	1 13/64"	1 7/8"	2"	1 7/64"
1 5/16"	1 17/64"	1 7/8"	2"	1 11/64"
1 3/8"	1 21/64"	1 7/8"	2"	1 15/64"
1 7/16"	1 25/64"	1 7/8"	2"	1 19/64"

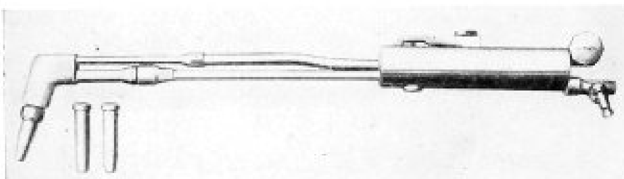
Fig. 1.—Tool used on a drill press for counterboring holes in crown sheets

Torch for Cutting Metals Using Oxy-Illuminating Gas

THE cutting of heavy plates, risers, gates, billets, etc., with ordinary 4-inch water column pressure, ounces pressure or pounds pressure using either city gas, natural gas or by-product (coke oven) gas has been made possible by the development of the Milburn oxy-illuminating gas cutting torch, type LPG.

This torch is manufactured by The Alexander Milburn Company, Baltimore, Md., which has experimented with these torches in connection with some of the largest industrial plants in the country until the final torch has been developed and perfected.

This type LPG torch can be used with by-product (coke oven) gas. It is not necessary to have the gas scrubbed; it can be used just as it comes from the coke ovens. A recent test with this particular by-product gas with a low B. T. U. content showed a speed averaging one foot per minute on three-inch plate using forty pounds oxygen pressure in conjunction with the gas at ordinary line pressure without being boosted.



Milburn illuminating gas cutting torch

The cuts showed a sharp clean edge, devoid of slag on the underside of the cut, a narrow kerf and very smooth surfaces. An important feature is the non-case hardening of the surfaces, which makes for easier machining, being able to maintain the same speeds and feeds while performing the machining operations.

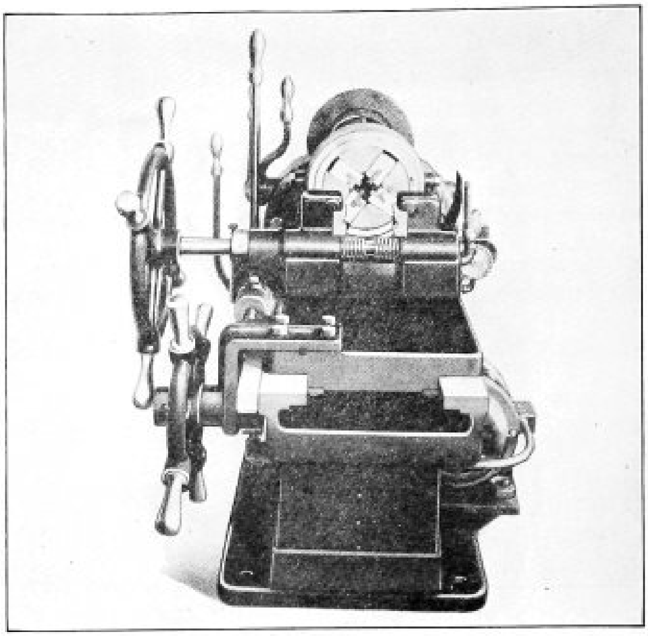
The torch is made of bronze forgings and special seamless tubing, constructed to withstand constant and severe service. It is evenly balanced and ruggedly built. The high pressure cutting oxygen is controlled by a thumb valve which remains fixed in either open or closed position. The arrangement of the gas tubes gives the torch great transverse strength.

The torch is supplied with a range of tips to accommodate all thicknesses of metal. The tips are made of solid copper, designed to rapidly preheat the gases, giving better penetration and quicker cutting.

Williams Rapiduction Bolt-Threading Machine

A BOLT-THREADING and cutting machine of the geared-head type, particularly designed for production, has just been placed on the market by the Williams Tool Corporation, Erie, Pa. The machine is compact and follows the modern trend of machine-tool design by having the motor at the base instead of above.

The machine uses large die holders to support small renewable dies of high speed steel. The large die holders do not have to be removed from the head in order to change dies. Neither is there any special head adjustment needed, except for the actual fitting of the thread that is to be cut. The size of the thread desired is taken care of by the length of the dies. To cut a different size thread, the operator can quickly change dies simply by loosening the locking screw and taking the die from the holder.

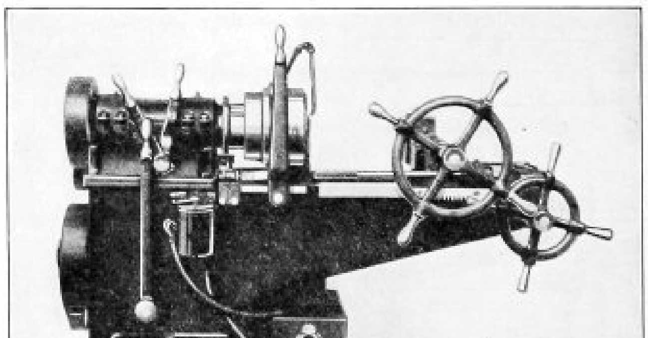


A large die holder is used to support the small renewable dies

Dies are furnished $\frac{3}{8}$ inch to $1\frac{1}{2}$ inches, inclusive, for the $1\frac{1}{2}$ inch machines and $\frac{1}{2}$ inch to 2 inches, inclusive, for the 2-inch machines. Nut taps are also furnished within the same range.

The operator has complete control of the machine from one position and can get seven different speeds by operating only two levers. To change gears, it is only necessary to ease out on the clutch which permits the placing of one or both gear shift levers. A speed plate back of the levers gives the correct position for each size of bolt. Another feature of the machine is the simplicity of the automatic die head.

The shell, which is controlled by compression springs, travels backward and forward on the die head and, in turn, opens and closes the dies. The head is adjusted by pulling the lever forward and is released by a trip rod in the carriage. The trip rod can be set to give any desired length of thread within the capacity of the machine. The dies are adjusted by releasing the cam ring from the shell. A spanner wrench, engaged in the cam ring, is moved backward or forward in order to give a larger or smaller adjustment for the size of thread to be cut. The cam ring is then locked to the shell, holding the die holders in a fixed position.



Front view of the Williams Rapiduction bolt threader

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Irregular Sheet Copper Problem

Q.—In the April issue of THE BOILER MAKER you showed a development of an irregular sheet connection sent to you by myself and the development is incorrect inasmuch as this is to be made out of 5/32-inch thick copper. As you know that copper cannot be welded after flanging or before, you can readily see that the corners cannot be split as shown. Please publish the answer in THE BOILER MAKER or send it to me as I am still confronted with this problem. Thanking you in advance. A. P.

A.—The development given for this example will answer your requirements, except that instead of bending the corners and welding same, the corners are formed by hammering the metal to shape. In that case sufficient metal is added at the corners for the "raising process." The corners can be split as shown and welded together by the *brazing process.*

Head Calculations—Drafting of a Locomotive

Q.—I would like to have some rule showing what thickness plate should be used for welded heads in pipe from 4 inches to 30 inches inclusive, so that unstayed head will have about same factor of safety that the size of pipe has which it is welded into. At about what size pipe should we start to use convex heads?

What effect would an exhaust pot leaking at joint at bottom have on the drafting of a locomotive? W. N. S. and J. L. F.

A.—Refer to P. 23, A.S.M.E. Code, for determining the thickness of pipe, and the rules dished heads P. 195, for finding the plate thickness of such heads.

The pressure that may be carried safely by an unstayed circular flat head, supported at its edges may be found from the formula:

$$P = \frac{3\,t^2\,TS}{2r^2\,FS} \qquad (1)$$

In which P = pressure in pounds per square inch.

t = thickness of plate, inches.

TS = ultimate tensile strength of the material, pounds per square inch.

r = radius of the circular plate, inches.

FS = factor of safety = 5.

By solving the formula (1) for t

$$t = r\sqrt{\frac{2\,P\,FS}{3\,TS}} \qquad (2)$$

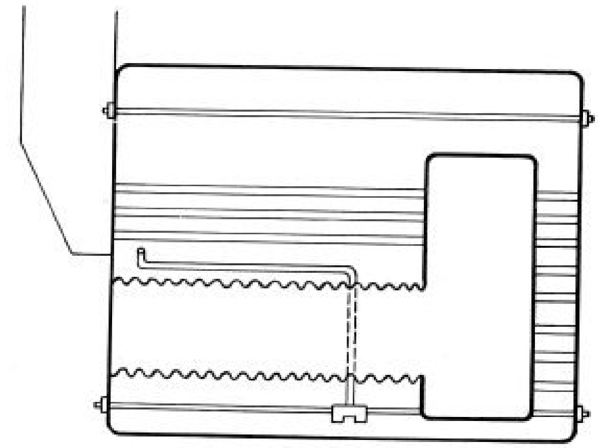
The strength of the weld may vary from 50 to 75 percent of the strength of the plate.

Insufficient vacuum in the smokebox may result from the leak referred to, and as a result the locomotive will steam badly, on account of retarded draft.

Circulating Tubes

Q.—There are two 3-furnace Scotch boilers on my ship. They were built in England in 1898. The furnaces have 3-inch tubes bent around them as I tried to picture in the sketch on the other side. Each wing furnace has one of these so-called circulating tubes and the center furnace has 2. I think the idea of the designer was that the water would circulate from the bottom of the boiler through the tube and out underneath the firetubes. These (circulating) tubes form mud pockets on top of the furnaces. Do you think they help the circulation? Would it be a good idea to take them out and give them "the deep six"? Is copper as good as black iron for shimming up tube holes on the front tube sheet of a Scotch boiler? T. L. D.

A.—The bent tubes are intended to promote circulation of the water in the dead water space under the furnaces.



Location of Circulating Tube

Their use, however, is of little value, if any, since they prove troublesome in carrying and discharging sediment above the furnace.

Copper ferrules are best for shimming up tube holes.

Boiler Calculations

Q.—In a boiler carrying 200 pounds pressure, having 15/16-inch outside diameter staybolts with 3/16-inch tell-tale hole, how far apart may the bolts be placed and have a factor of safety of 5?

(2) If a 2¼-inch boiler tube is worth 15 cents per foot, how many pits could be economically welded in a tube 19 feet 6 inches long, allowing the reclaimed tube to be worth 60 percent of the value of a new tube?

(3) What is the factor of safety of a boiler whose weakest part is the longitudinal slant course having ¾-inch plate 50 inches inside diameter, working pressure 225 pounds, joint efficiency 75 percent and tensile strength of plate 50,000 pounds? G. W. T.

A.—To answer the first question it is necessary to know the thickness of plate.

From the formula given in the A.S.M.E. Code, paragraph 199, the maximum allowable working pressure for stayed flat plates supported by stays symmetrically spaced shall be calculated from the formula

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

From this formula the pitch may be found by changing the formula as follows:

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

An examination of the formulas shows that for a maximum allowable working pressure on a flat surface there are two variable factors, the plate thickness and the maximum pitch of stays.

(2) This question is left open for our readers to discuss.

(3) Par. 180, A.S.M.E. Code gives the formula:

$$P = \frac{TS \times t \times E}{R \times FS}$$

in which P = maximum allowable working pressure, pounds per square inch.
TS = ultimate tensile strength of plate, pounds per square inch.
t = minimum thickness of plate, inches.
E = efficiency of longitudinal joint.
R = inside radius of the weakest course, inches.
FS = factor of safety = 5 for new constructions.

To find the factor of safety when other values are given, the formula is:

$$FS = \frac{TS \times t \times E}{P \times R}$$

Substitute the values of the example in the formula.

$$\text{Then, } FS = \frac{50{,}000 \times 3/4 \times .75}{225 \times 25} = 5.$$

Stay Problem

Q.—With reference to the A. S. M. E. Boiler Code, Part I, Section 3, L-43 which reads in part (second paragraph) "the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays." I will greatly appreciate it if you would advise me through the columns of THE BOILER MAKER just how this calculation is made. L. W. D.

A.—Refer to October issue of THE BOILER MAKER, therein we gave a complete answer to this question, showing the application of rules P. 212—*a* and *b*.

The calculation covering your question is made in accordance with P. 180 to find the allowable working pressure on the stayed surface, without allowing for the holding power of the stays, as follows:

$$\frac{TS \times t \times E}{R \times FS}$$

in which TS = tensile strength of plate in pounds per square inch = 55,000.
t = minimum thickness of plate, inches.
E = efficiency of longitudinal joint or net section of plate between stayholes.
R = inside radius of wrapper sheet, inches.
FS = factor of safety, equals 5 for new construction.

To this pressure, as found by the foregoing formula, is to be added the pressure obtained by the formula in P. 199 as follows:

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

in which: P = allowable working pressure, pounds per square inch.
T = thickness of plate in *sixteenths*.
p = maximum pitch of stays between stays, inches.
C = constant, as given in paragraph 199 for different thickness of plate and method of staying.

Tank Calculations

Q.—Enclosed find blueprint showing tank with 1½-inch by 10½-inch by 18-foot steam compartment to hold 100 pounds pressure. This tank was fabricated according to sketches shown on print. I now have an inquiry to place a steam compartment in tanks of the following dimensions to carry 100 pounds pressure of steam:

1 tank 10½ inches by 11¾ inches by 18 feet
1 tank 10½ inches by 11¾ inches by 10 feet
1 tank 10½ inches by 11¾ inches by 8 feet.

The tanks are made of ¼-inch plate.

Will a tank of ¼-inch plate made as shown and noted by pencil marks be safe? If not will you kindly submit all the information necessary to fabricate these tanks to carry the pressure required? This information is very urgent, and I will appreciate immediate attention with reply. I have been a subscriber to THE BOILER MAKER and have certainly found it a very valuable and educational periodical. I am renewing my subscription in a few days as it has been one of my points to always read THE BOILER MAKER.—J. J. M.

A.—The A.S.M.E. Code, gives the following formula on stayed flat plates, using staybolts of uniform diameter and symmetrically spaced.

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

where, P = maximum allowable working pressure, pounds per square inch.
C = 112 for stays screwed through plates not over 7/16 inch thick with ends riveted over.
T = thickness of plate in sixteenths of an inch.
p = maximum pitch between stays, measured in a straight line in the different rows; which may be horizontal, vertical or inclined, inches.

To find the value of p in the formula

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

Substitute the values given in the example, in the above formula,

$$p = \sqrt{\frac{112 \times 4^2}{100}} = 4.12 \text{ inches.}$$

The area to be supported in the smaller tank on each of the longest sides equals $10.5 \times 96 = 1{,}008$ square inches.

Total pressure on one side equals

$$1{,}008 \times 100 = 100{,}800 \text{ pounds.}$$

The given diameter of rivet is ¾ inch and the required number of rivets to carry this load equals

$$100{,}800 \div 3/4^2 \times 0.7854 \times \frac{45{,}000}{5} = 26$$

Consideration of the support due to the welded seams should not be taken into account in making the calculation for the number of rivets.

By the use of a flanged rimer sheet riveted to the outer shell, the number of stays required would be less.

With ¼-inch plate, the bearing around the countersunk rivet heads would be insufficient, therefore, the plate should be reinforced with a plate 2 or 3 inches square, around each rivet opening.

The rivets must be of sufficient length to fill the rivet holes completely and the heads at least equal to the strength of the body of the rivet.

Anson Wood Burchard, vice-chairman of the board of directors and chairman of the executive committee of the General Electric Company and chairman of the board of directors of the International General Electric Company, died on January 22 in New York City. He was also director of several utility and electrical companies.

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

States

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

Cities

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

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

States

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

Cities

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

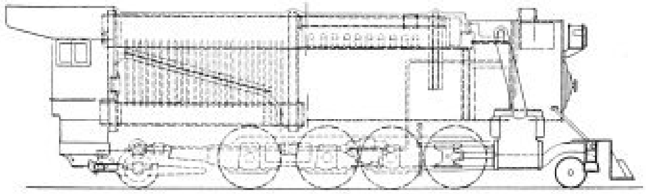
SELECTED BOILER PATENTS

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

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

1,611,770. JOHN E. MUHLFELD, OF SCARSDALE, AND VIRGINIUS Z. CARACRISTI, OF BRONXVILLE, NEW YORK. STEAMBOILER STRUCTURE.

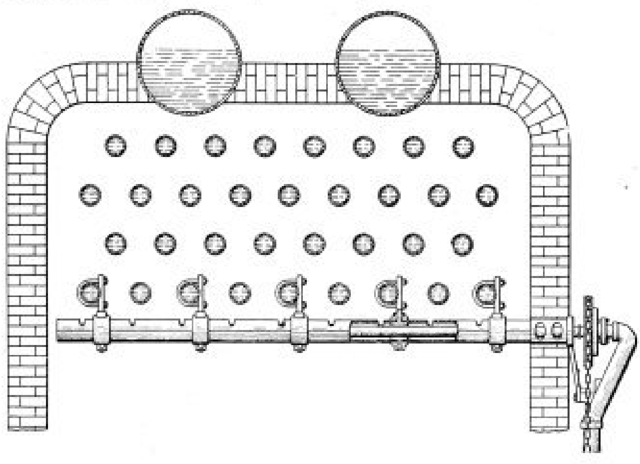
Claim 1. In a steam locomotive, a fire box and a fire tube boiler extending forwardly therefrom, upper and lower drums arranged in pairs at opposite sides of the fire box, said lower drums terminating at the



rear end of the boiler and the upper drums extending forwardly over the boiler, a front water leg connecting the forward ends of the upper drums with the boiler and affording communication therebetween, a rear water leg connecting the rear ends of the upper and lower drums with each other, and an intermediate water leg rigidly connecting the upper drums with the rear end of the boiler and with the forward ends of the lower drums. Five claims.

1,610,287. DUNCAN C. HOOKER, OF FARMINGTON, CONNECTICUT, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DIAMOND POWER SPECIALTY CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN. PROTECTION FOR SOOT BLOWERS.

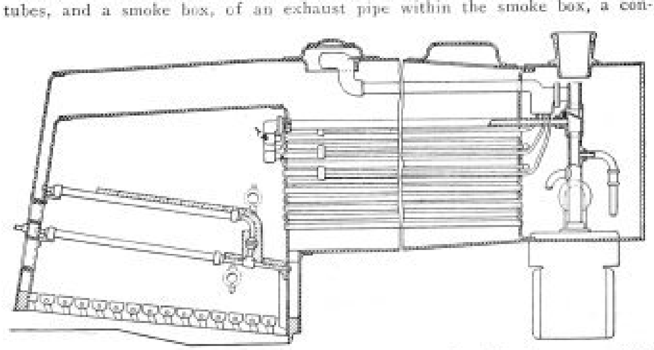
Claim 1. The combination with the water tubes of a steam boiler, of a soot blower tube, a plurality of bearings, means connecting the water



tubes and bearings for supporting the blower tube at intervals in spaced relation from said water tubes, said bearings adapted to permit rotation of the blower tube therein, and a stationary protecting case surrounding the blower tube and mounted on said bearings. Seven claims.

1,600,063. MICHAEL PEKICH, OF PITTSBURGH, PENNSYLVANIA. STEAM LOCOMOTIVE.

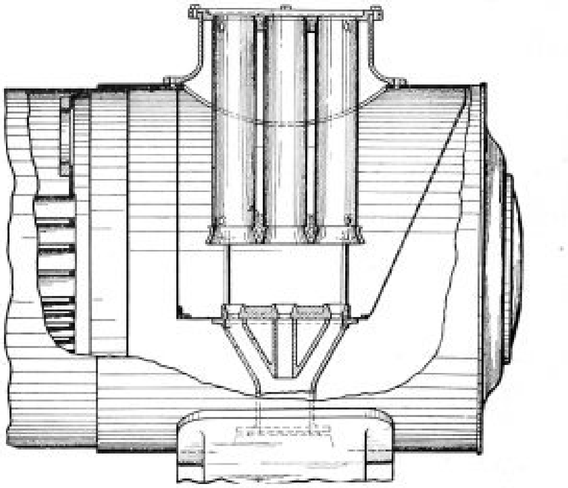
Claim.—The combination with a steam locomotive having a fire-box, fire tubes, and a smoke box, of an exhaust pipe within the smoke box, a con-



duit leading from said pipe to the front end of one of said tubes, a manifold disposed in the fire-box and connected to the rear end of said tube, and forwardly-directed nozzles on said manifold, in longitudinal alinement with certain other fire tubes. Two Claims.

1,601,004. CLEMENT F. STREET, OF GREENWICH, CONNECTICUT. LOCOMOTIVE STACK.

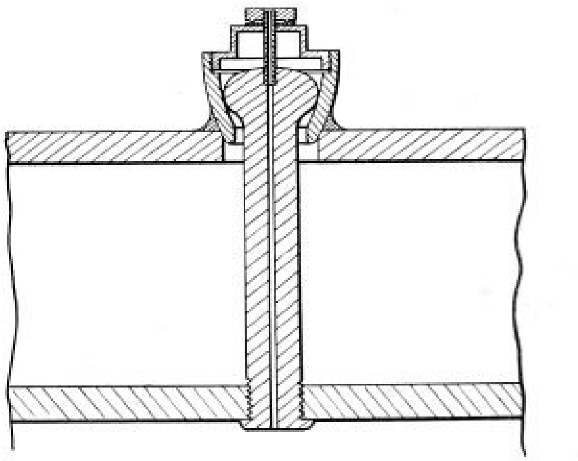
Claim.—In a multiple locomotive stack the combination of a plurality



of vertical discharge channels; and upper and lower head plates, flexibly connected to said discharge channels. Five Claims.

1,601,845. ROBERT SINCLAIR BOOTH, OF WASHINGTON, DISTRICT OF COLUMBIA. STAYBOLT.

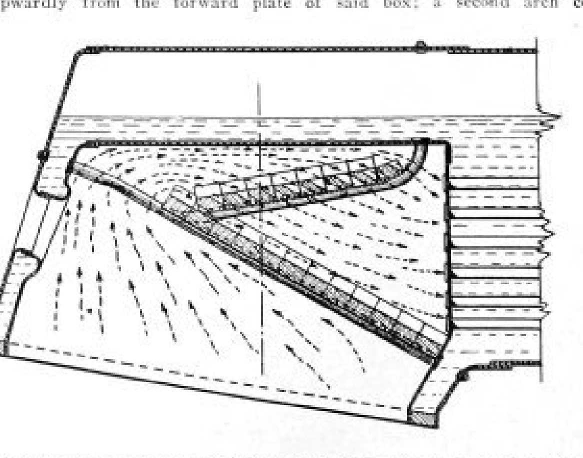
Claim.—In a flexible tell-tale, staybolt cnostruction for boilers, a tell-tale staybolt having a flexible connection with the shell of the boiler, a closure for the flexible connection so positioned relative to the staybolt as to provide



a relatively large space therebetween, and a flexible tube extending through and secured to the closure and fixed to the head of the staybolt to thereby extend the tell-tale to the exterior of said closure. Four Claims.

1,610,231. PERRY W. BARKER, OF DENVER, COLORADO, ASSIGNOR OF ONE-HALF TO EARL BALFOUR, OF DENVER, COLORADO. LOCOMOTIVE FIRE BOX.

Claim 1. In a locomotive fire box having an arch extending rearwardly and upwardly from the forward plate of said box; a second arch co-



operating with said first arch and extending forwardly and upwardly therefrom, said first arch being supported on water tubes extending from the forward to rear plates of said fire box, said second arch being supported on other water tubes extending from the crown sheet of said fire box to the rear plate thereof and passing between said first tubes. Two claims.

The Boiler Maker

Volume XVII March, 1927 Number 3

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
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Cleveland: 6007 Euclid Ave.
Mandeville, La.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.

Cable address: Urasigmec, London.

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

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CONTENTS

Survey of the Boiler Making Industry

The outstanding development in the activities of the American Boiler Manufacturers' Association, as shown by the report of the mid-winter meeting of the association published elsewhere in this issue, is the preliminary survey of the steel boiler making industry carried out by the Bureau of Census of the Department of Commerce. This movement is in line with similar projects carried out under the supervision of Secretary Hoover in many other American industries and the results indicate that it will prove one of the most useful activities, from a commercial standpoint, ever undertaken by the industry. The preliminary survey shows the annual production in numbers and square feet of heating surface of the boilers produced by 58 leading concerns manufacturing steel boilers beginning with the year 1919 and continuing up to and including the first half of the year 1926. The returns are subdivided as to types of boilers produced in the stationary and marine fields and give a truthful picture of the growth of the industry in its various branches. The members of the association who attended the mid-winter meeting were enthusiastic in their commendation of this project and voted unanimously to continue the work so that monthly reports of production may be issued by the Bureau of Census. It was strongly emphasized at the meeting that the ultimate value of these reports depends upon the completeness and accuracy with which they cover the entire industry. While the preliminary survey was incomplete in that reports from only 58 manufacturers were included, the willingness of those who fathered the project to act as missionaries in securing the cooperation of other boiler manufacturers in this work gives every assurance that in a very short time the monthly reports will cover at least 90 percent of the steel boiler making industry. When this result is achieved, each individual concern will have an accurate index not only of business conditions in his own field but also a fair approximation of the trend in other related industries.

Boiler Code Work

From time to time the American Society of Mechanical Engineers Boiler Code Committee issues notices of certain revisions, changes or additions to the Boiler Code. Such proposed changes are published in various journals which are read by practically all members of the boiler manufacturing and allied industries who are primarily interested in the subjects dealt with. Hearings are held at some time subsequent to the publication of these notices and anyone desiring to do so may present his views on the proposed changes at that time either in person or by written discussion.

Not infrequently, however, individuals who are well equipped by training and experience to assist in the solution of the problems involved and who have the most to gain or lose by the changes are lax in taking advantage of the opportunity for presenting their ideas. The result is that in several instances changes have been incorporated in the Boiler Code and put into effect by inspection departments as part of their requirements which have at the last moment been protested by individuals who previously have been given ample opportunity to present their side of the case.

In this issue of THE BOILER MAKER appears a proposed "Manufacturers' Data Report for Unfired Pressure Vessels," which has been approved as addenda to section VIII of the Code. As stated in the secretary's notice, this form has been published so that everyone interested in the matter may have ample opportunity to criticize it and to offer such suggestions as may seem necessary. Written discussions are requested which may be sent to the secretary of the Boiler Code Committee who will transfer them to the committee for consideration at the next meeting. Thirty days after the original issue of the report by the committee it is the intention to present it to the council of the society for approval as an addition to the Boiler Code.

This interval allows ample opportunity for discussion from members of the industry and the final form of the data sheet will represent the concensus of opinion as expressed in these discussions. Too great emphasis cannot be placed on the necessity of giving the matter immediate and careful attention and if comments are to be made at all they must be made in time for consideration by the committee.

Welded Pressure Vessels

APPEARING elsewhere in this issue is the first instalment of an article dealing with the design, construction and testing of a large high pressure storage tank. This tank which is now operating satisfactorily under 300 pounds per square inch pressure is an excellent demonstration of the future possibilities of fusion welding. The engineering ability and experience developed by the welding industry over a long period of time were brought to bear on the problem and a procedure was followed that indicates the road to safe welding.

Beginning with the design of the joints, every step was studied carefully and definite instructions outlined for the fabricators to observe. All the factors essential to a satisfactory result entered the work, material of good welding characteristics was used; the welding operators were tested and checked throughout on the quality of their work; the plates were properly prepared for the welders; approved technique for this type of work was carefully followed; and the completed joints were tested in every possible manner.

The article describing this procedure enters into the subject in minute detail, so that it would be possible to duplicate the construction almost exactly if necessary. It is of course doubtful that any of our readers will ever be faced with this same problem, but the instructions outlined will serve equally well when applied to practically any other job of welding on pressure vessels.

Of special interest is the method of testing the completed tank, which will also be published. During the hydrostatic test, which was started at 600 pounds per square inch and increased to 900 pounds and finally to 1,000 pounds, it was found that a point of weakness was developing around the head knuckles and the manhole. The test was continued until at the third application of pressure the manhole failed at 930 pounds per square inch. No other points of weakness developed in the tank.

A new manhole ring was then designed and installed and the hydrostatic tests repeated. No sign of weakness developed with the new ring, but to make doubly certain an air pressure of 450 pounds per square inch was imposed and the seams tested with soapy water. The tank met this test successfully and was accepted.

When such care is observed in the construction of welded vessels, there can be no doubt of its rapid advance in fields where there has been hesitation in applying it in the past.

LETTERS TO THE EDITOR

Low Water Explosions

TO THE EDITOR:

On the question and answer page of the December issue a correspondent asks several questions which are substantially the same ones that are often asked and discussed by railroad men. These are to quote "I have been told that in a boiler explosion the steam gage hand goes all the way around. What causes this and does putting the injector on (that) cause it to burst? Would it have burst if the injector had not been put on? If you have anything further along this line I would like to hear from you."

Realizing that to reply to these questions may possibly tread on controversial ground, would it be permissible to elaborate on your answers? J. F. D. is undoubtedly referring entirely to explosions due to low water although his questions may not be well put. Many people have fanciful ideas as to what happens in low water cases and many would not put an injector on if the water is low, but there appears to be no sound reason for us not knowing pretty well what the conditions are in a low water case or for not knowing that putting water in the boiler is the most efficacious remedy at hand.

Now to answer the questions specifically: In a low water case, that is where the water level is below the crown sheet, thus permitting it to become overheated, there is no reason why the steam gage hand should register an abnormal pressure. As the crown sheet become hot it loses its strength and is unable to withstand the pressure in the boiler and therefore pockets down between the crown stays. As it pockets it stretches and the thickness of the sheet is reduced until finally a rupture occurs at the bottom of the pocket. The momentum with which the sheet is pocketed probably governs the extent of the initial rupture and the size of the tear governs the extent of the explosion. The water in the boiler is the same temperature as the steam, around 390 degrees F. for average pressure, and if the pressure is reduced quickly this water immediately flashes into steam due to the latent heat it contains. The energy and momentum of this steam generated so quickly is responsible for the force of the explosion. Therefore in a low water case the pressure is not involved except that it forces the hot sheet down between the bolts, thinning it as it bulges until a rupture occurs; and except that the higher the pressure the higher the temperature of the water and therefore the more latent heat to be converted into more energy when the water flashes into steam.

Obviously when a crown sheet becomes uncovered it will become hot as the heat cannot be transmitted to the water. The extent and location of the overheating will depend upon firebox temperature, draft and length of time the sheet is uncovered. If the fire is very hot, the sheet becomes hotter each second and the time element becomes the deciding factor as to whether an explosion will occur. There are only two ways in which the overheating can be stopped—cover the sheet with water or reduce the firebox temperature by removing or extinguishing the fire. Putting both injectors to work will raise the water level slowly, some two to four inches per minute and, if the crown sheet becomes covered with water before it has pocketed sufficiently to tear, an explosion will be averted. If it is not known how low the water level is, it is of course dangerous to be around the boiler, but it is less dangerous to put both injectors on and get away from boiler, until the water level is ample, than it is to stand in a position where injury is almost certain and remove a heavy fire. Where the level is known not to be very low, both remedies can be used and quicker relief obtained.

Should an explosion occur after putting the injectors to work it is because the sheet was hot enough for the pressure to tear it and an explosion would have occurred at practically the same instant if the injectors had not been working. The addition of water to the boiler can have no detrimental effect other than causing bolts to leak and will avert an explosion if it can be added quickly enough.

With the firebox temperature some 2,000 degrees higher than the normal temperature of the crown sheet, it can readily be seen that the sheet will soon become hot enough to bend or pocket, stretch and tear. This is a matter of minutes, however, and not seconds. The water level goes down slowly and the rapid circulation around the firebox tends to splash water on the crown sheet, especially at the front and back ends, after the general level is well below the crown sheet. The front end of crown sheet is almost invariably higher at the front and this together with the splashing effect from the rapid rise of steam bubbles accounts for the fact that the general water level in low water failures may vary from 2 inches to 8 inches or even more below the highest part of the crown sheet.

Washington, D. C. JOHN MITCHELL.

Data for Estimating Boiler and Tank Work

TO THE EDITOR:

"As a reader of long standing of your valuable magazine I will esteem it a favor if you could induce some of your readers to send in articles on estimating on boiler repairs, tank work, riveted and welded. Of course the writer knows that this request concerns a firm's confidential business, but as an educational aid to us workers, old estimates properly detailed would be acceptable and profitable."

EDITOR'S NOTE:

The above request from one of our readers concerns a subject that is of extreme importance to those dealing with work of this character. If any of our other readers have such information available for publication, it will be used without in any way identifying the source of the material. We earnestly hope that those in a position to do so will render this service for the benefit of the field as a whole.

Lap Jointed Shells in Boilers

TO THE EDITOR:

I have recently come across some dangerous conditions in riveted cap seams and I am anxious to learn what devices are being used by insurance and inspection authorities to measure the movement of the plate at and adjacent to the cap joint at the longitudinal seam (say a triple riveted specimen)? It would be necessary, before a knowledge of the stresses tending to produce fracture of the plate could be obtained to know something of the *direction* in which the forces acted through the riveted parts of the joint, due to the tensile stress in the shell plate.

Having a knowledge of the movement and its amount, and knowing the direction the forces acted through, possibly the stresses producing such distortion may be estimated. I would esteem it a very great favor if your technical department could advise me as to whether the variable quantities acting in the conditions pertaining to operation under steam pressure, could be specified sufficiently to get an approximate idea of what the cap joint under review is having to bear, both as a result of its changing shape and the normal operating load at the same time? If a result sufficiently accurate could be obtained, then one might know how near to the elastic limit of the material in the shell plate the operation was being carried and thus have a chance to avoid an explosion.

Another method would be to examine the plate directly for cracks at the places under suspicion by means of an X-Ray machine, *if one exists, which could be applied to the purpose of looking directly through the boiler plate.* If you know of such an apparatus I would be thankful indeed to hear from the manufacturers something of the conditions under which their machine works; the class of work which has already been accomplished. The size, weight, operating necessities, etc., as well as the price.

I trust you will give this matter your consideration and I would be very glad to hear from you at your earliest convenience.

Vancouver, B. C. JOHN O'NEILL.

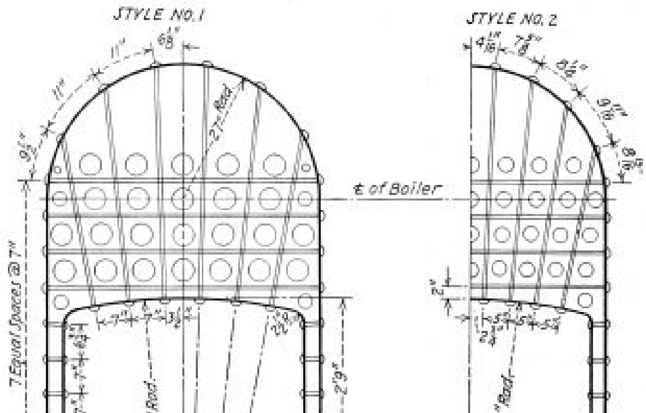
Staying Boilers

TO THE EDITOR:

I am sending you a sketch showing how the boiler may be stayed which appeared on page 302 of the October issue showing the deflection in the boiler sheets.

As the staybolts are spaced 7 inches center to center, as "E. J." puts it, and the firebox shows 4 rows, therefore the firebox cannot be more than 2 feet 9 inches high. He also shows 4 rows of through stays and the top row is above center line of the boiler.

I presume that the through stays are also 7 inches center to center, that will put the center line of the boiler 3½



Two methods of preventing deflection of boiler sheets

inches below the top row, making the radius of the boiler 27 inches; that is, one-half of 54 inches as shown on the bottom of the firebox.

Also the crown sheet, with 96-inch radius; it will shorten the side sheets, but will gain by having one 3½-inch or, by careful layout, two 2-inch boiler tubes in the top corner as shown. Care must be taken to have them as high as possible above the crown sheet, so that not to have them resting on the crown sheet as it would accumulate scale.

You will note Style No. 1; it is as near as I can make it out from "E. J.'s" description on page 302 of the October issue. Also Style No. 2; here we have 8 rows of radial stays and 36 boiler tubes 3 inches in diameter.

I would also like to suggest that the fire door should be rounded on the top.

Winnipeg, Canada. D. LENOSKI.

On the Inspection of Vertical Boilers

To the Editor:

I wish to answer the article published in the January issue of The Boiler Maker entitled "Defective Construction of a Vertical Boiler." Commenting on the statement that due to the fact that the boiler has a tapering course the boiler is freakish or defective, I beg to take issue with the writer.

A boiler may be constructed with a taper course and still come within the range of good workmanship or construction. It does not necessarily follow that, due to the tapering course, the manufacturer of the boiler built it so in order to correspond with a smaller diameter head, he may have built the course that way on purpose.

Then coming to the point of water glass, the holes would be straight in, on the shell course, no matter whether the boiler was exactly perpendicular or at an angle of 45 degrees. The cause of the water glass breaking may have been due to the fact that the water glass valves were not alike and that one projected out further than the other, causing the openings to be out of alinement. Then again, the holes may not have been tapped straight into the shell plate.

For the benefit of novices or apprentices who intend to follow up boiler inspection I would like to suggest a few hints: When intending to inspect a boiler for the first time, advise the owner or operator to have the boiler properly prepared for inspection when you arrive at the plant; then you can proceed to make a very thorough inspection. It is not necessary for you to place fittings or appurtenances in working order; in fact, by making a good fellow of yourself you will get yourself into trouble. Before making comments on the construction of boilers or fittings, thoroughly study and know that when you do speak you are correct. You may think you are right and the first thing you know someone else comes along and can convince you that you were wrong.

You cannot properly inspect a boiler by merely measuring the plates, rivet pitch, etc.; it is absolutely essential that you remove grates, handhole plates and smokebox cover on vertical tube boilers. Also examine all fittings and appliances to see that they are in proper order.

Binghamton, N. Y. INSPECTOR.

Washing Out Locomotive Boilers

To the Editor:

It may be of interest to the readers of your valuable paper to mention the washing out method I have adopted in China and I would be glad to have comments from your readers in this regard.

When a locomotive from service is due for washing out and has to be returned to the traffic department in the least possible time the method adopted is as follows:

Fill the boiler to the top gage nut by injector or feed pump then blow the boiler down. By the time the steam is out of the boiler the water then will be showing about one-third in the gage glass.

Remove a plug or door at the highest point on the boiler, refill the boiler by hose to the top gage nut; either remove a plug at the bottom of the boiler or open the blow-off cock. Then let the water flow in at the top while the water is flowing out at the bottom plug.

Continue this operation until the temperature of the water is approximately 80 degrees F.; that is, when the washout man can comfortably put his hand in the water. Then remove all the plugs and doors and give the boiler the usual washout.

C. R. Butler,
Boiler Inspector.

Pukow, Kiangsu, China.

Spacing of Staybolts

To the Editor:

On page 57 of the February issue of The Boiler Maker is given the following question: "In a boiler carrying 200 pounds pressure, having 15/16-inch outside diameter staybolts with 3/16-inch tell-tale hole, how far apart may the bolts be placed to have a factor of safety of 5?

I am giving below a solution which I hope will be of interest to you.

Insofar as the staybolt is concerned the maximum area of plate it could support would depend on the sectional area of the staybolt and its tensile strength. Paragraph p-220 (a) of the A.S.M.E. Boiler Code states, "The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay and the area occupied by the stay shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in pounds per square inch gives the load to be supported by the stay."

If $p =$ pitch of staybolts in inches.

$a = 0.4665$ square inches, area at root of thread for 15/16-inch staybolt after deducting area of 3/16-inch hole.

$S = 7{,}500$ pounds per square inch, the maximum allowable stress for staybolts (Table P-7 A.S.M.E. Code).

$P =$ Maximum allowable working pressure, pounds per square inch $= 200$.

Also $p^2 - a =$ the net area supported by one staybolt. (Par. P. 220-a).

$P(p^2 - a) =$ load on one staybolt (Par. P. 220-a).

$S \times a =$ maximum load that can be put on one staybolt.

Therefore:

$$P(p^2 - a) = S \times a$$

Solving for p we have

$$p = \sqrt{\frac{S \times a}{P} + a}$$

substituting we have

$$p = \sqrt{\frac{7{,}500 \times 0.4665}{200} + 0.4665} = 4.237 \text{ inches}$$

This is the maximum pitch for 200 pound pressure that a 15/16-inch staybolt with a 3/16-inch tell tale hole can support.

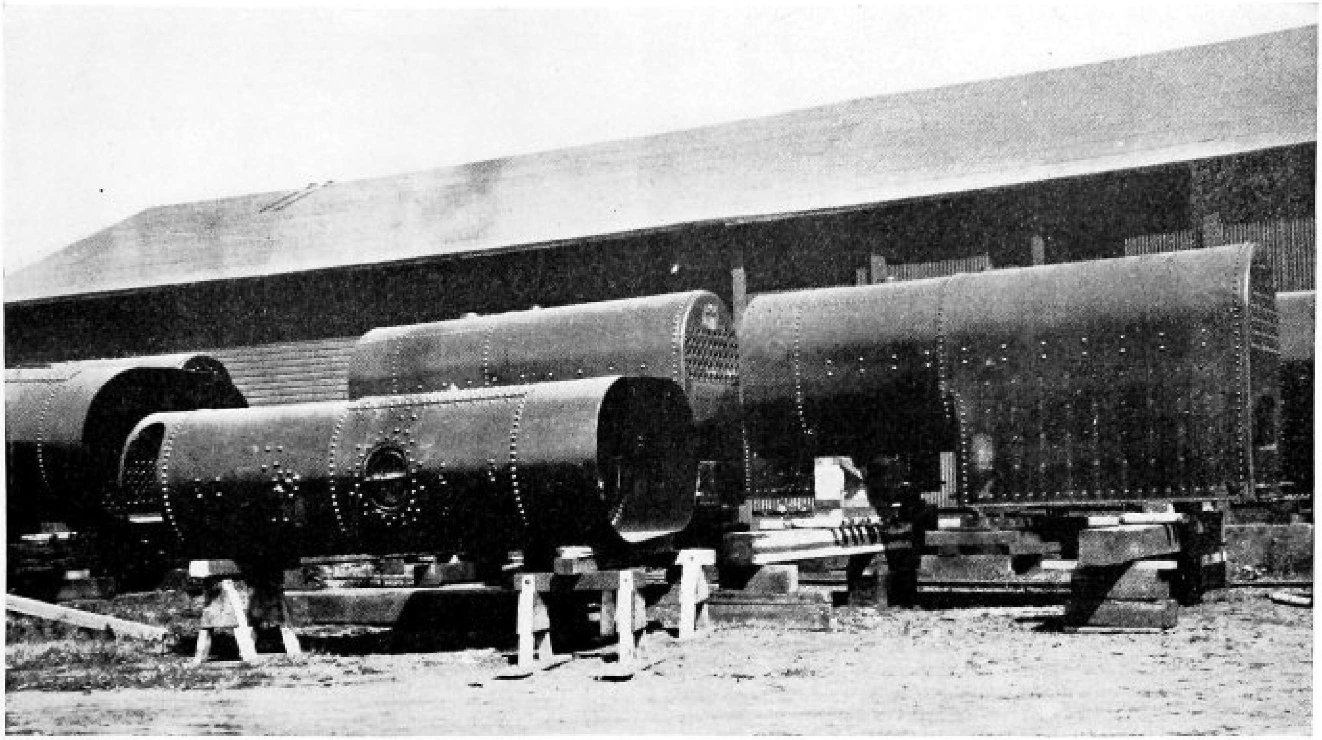
Whether the plate through which the staybolt is passed will permit of this pitch is a different story and must be checked by the formula:

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

Table P-6 of the A.S.M.E. Code gives maximum pitch for 3/8-inch plate with 200 pound pressure as 4½ inches. If the plate is 3/8 inch or over the pitch calculated above is O.K. If the plate is less, then of course, the pitch must be reduced accordingly, in which case the staybolt will not be loaded to its full strength.

The factor of safety of 5 mentioned in the problem has not been used. Par. S-82 of the A.S.M.E. Boiler Code gives the minimum tensile strength of staybolt iron as 48,000 pounds per square inch. With a factor of safety of 5 this would give a working stress of 9,600 pounds per square inch which would be contrary to maximum allowable stresses for staybolts as specified in Table P-7 of the A.S.M.E. Code.

Altoona, Pa. J. H. Yoder.



Boilers stored in the yard awaiting shipment

Boiler Shop of the Ames Iron Works

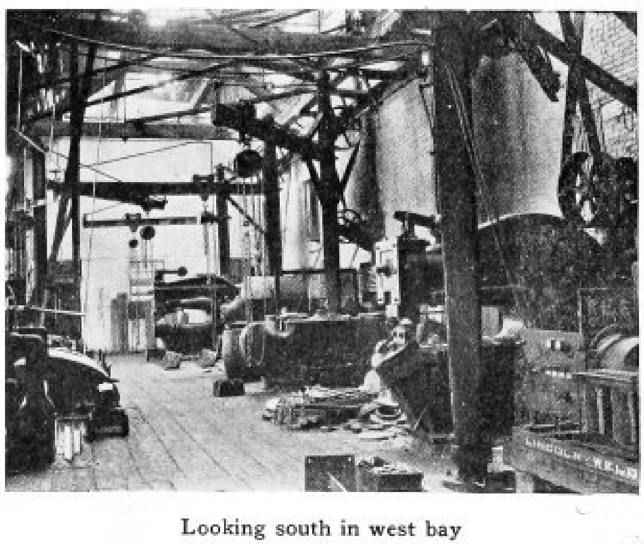
Average annual output of 2,500 tons of finished products turned out by shop force of 120 men

WITH over 75 years of experience in the building of high grade firetube boilers of various types as a background of achievement the Ames Iron Works, of Oswego, N. Y., which is now a division of the Pierce, Butler & Pierce Manufacturing Corporation, New York, is an important factor in the tubular boiler field in the East. With an average force of 120 men the annual output of the boiler shop is about 2,500 tons of finished products, 75 percent of which are boilers built for power purposes and 10 percent are welded heating boilers. About 25 percent of the output is exported to foreign countries. In the sheet iron shop of the plant, where 12 men are usually employed, the output averages 120 tons of steel products each year.

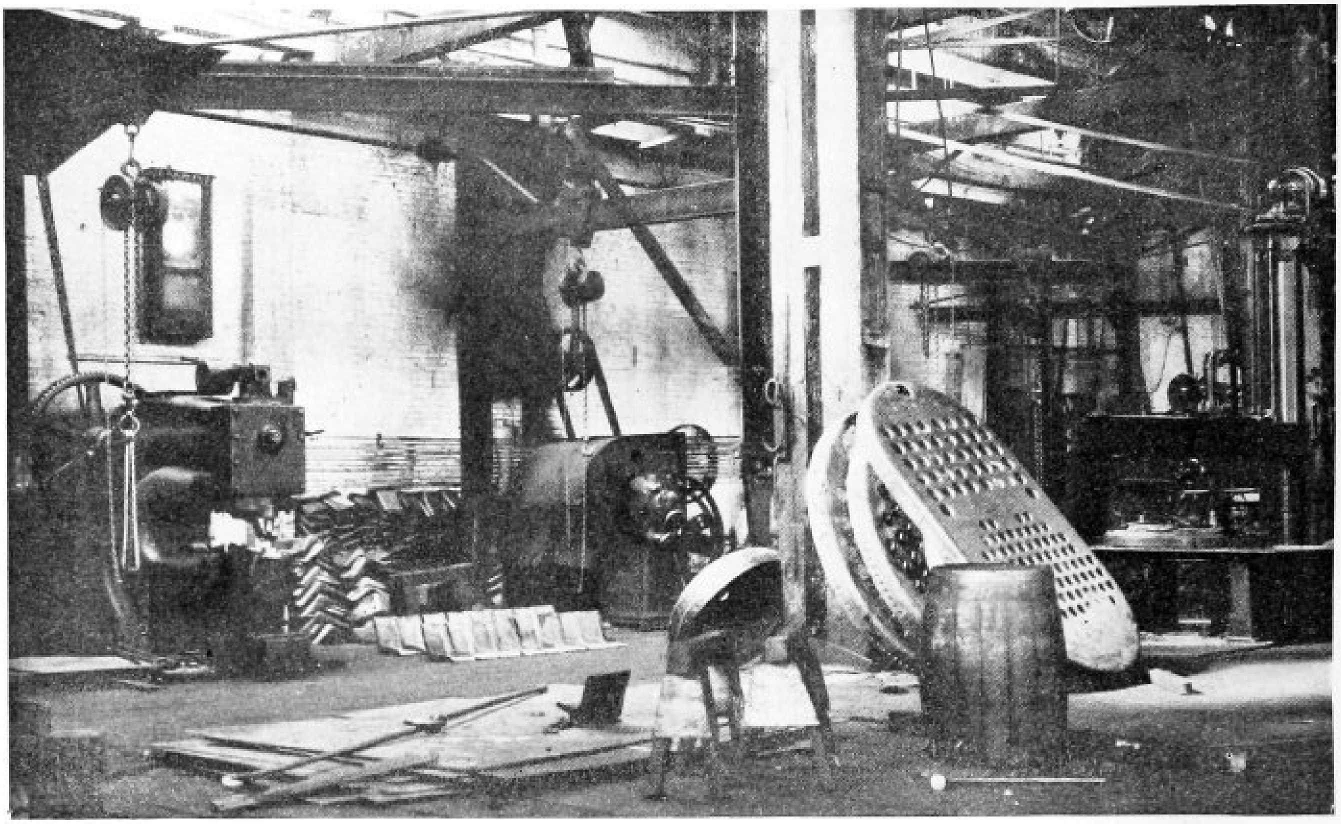
As the Ames Iron Works manufactures engines as well as boilers the boiler shop comprises about half of the entire plant and adjoins the machine shop, blacksmith shop and foundry. The flange shop is at the rear of the boiler shop and the sheet iron shop is in a separate building across the street from the boiler shop. All castings are made in the company's foundry.

The boiler shop itself is about 400 feet long by 100 feet

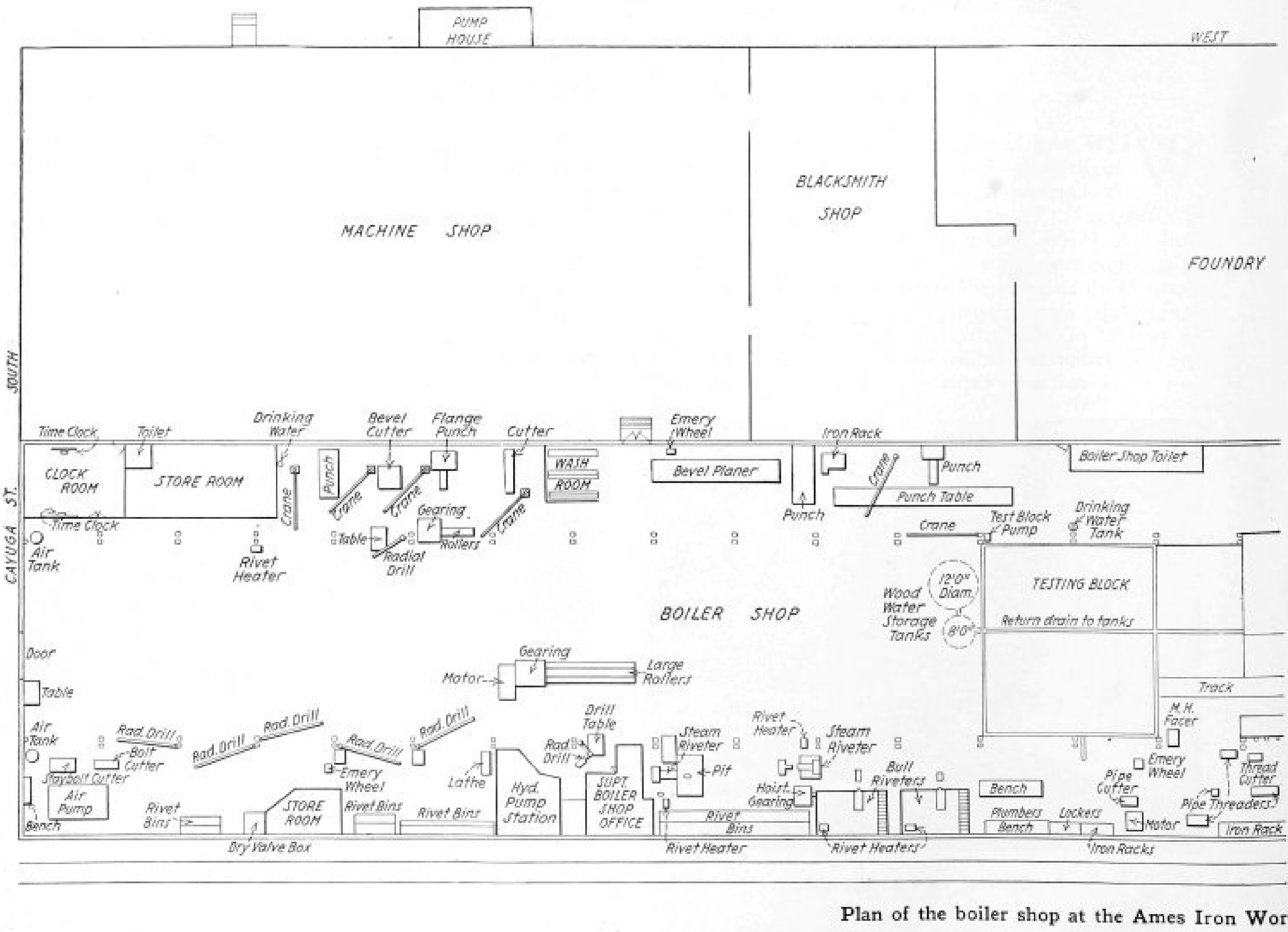
General view of the shop



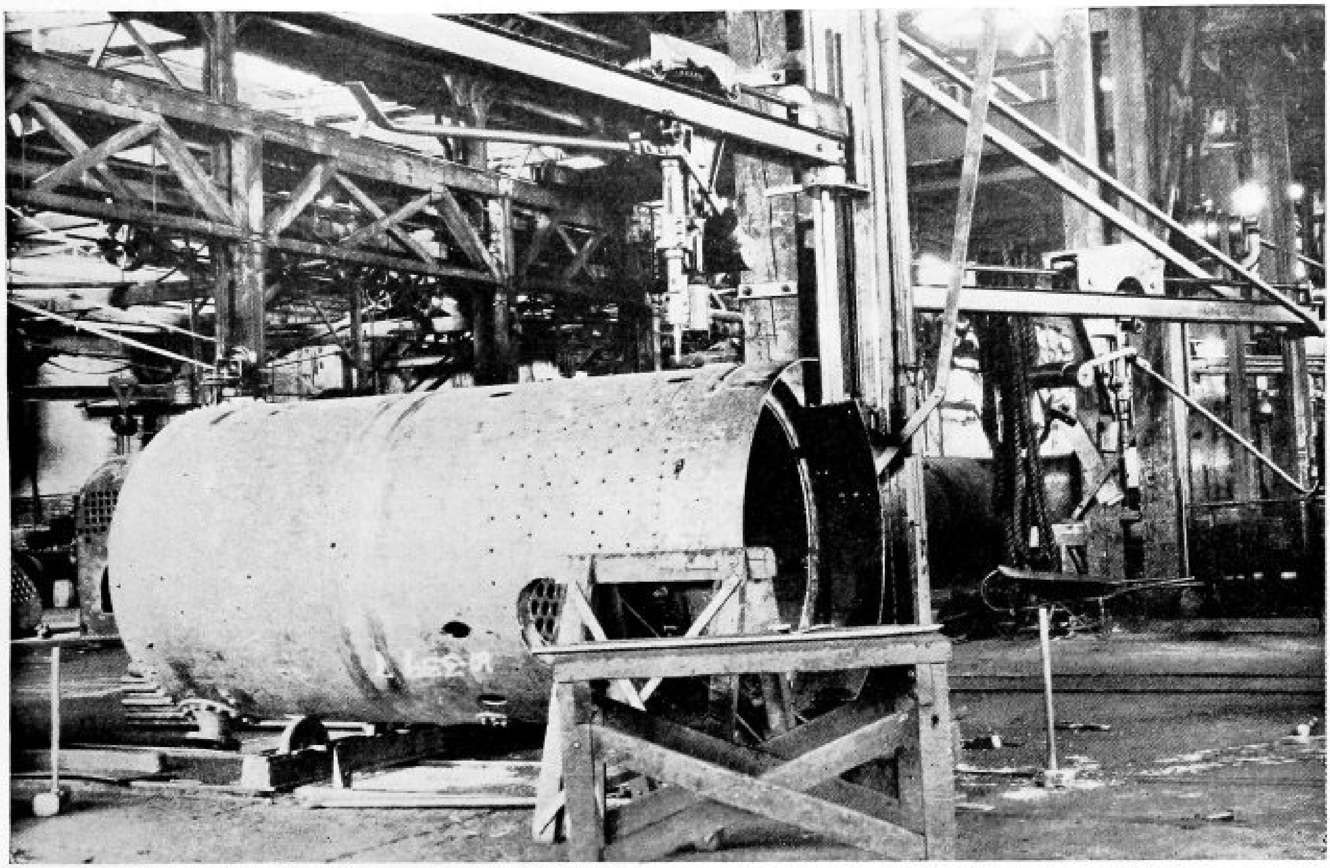
Looking south in west bay



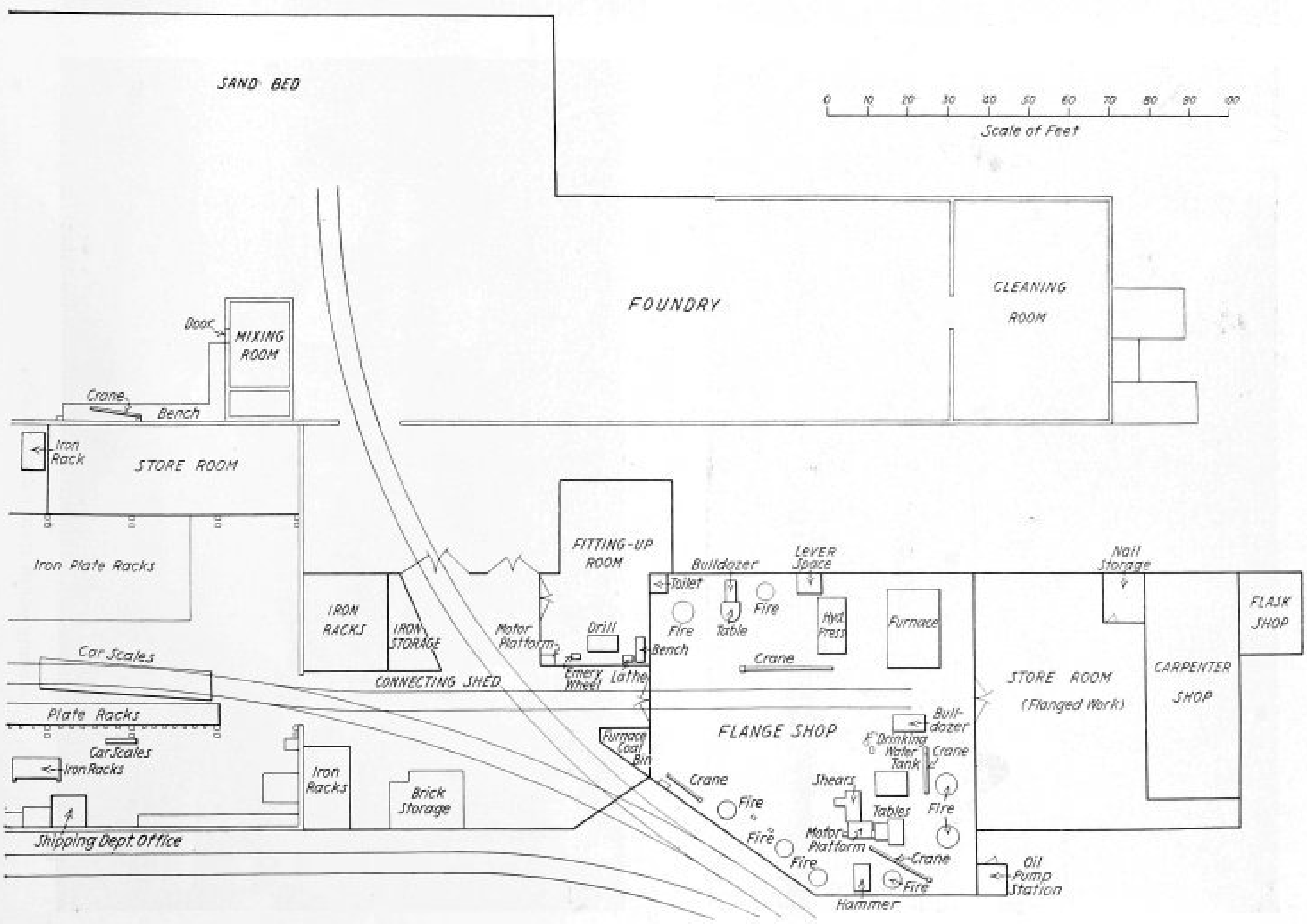
Punches and shears



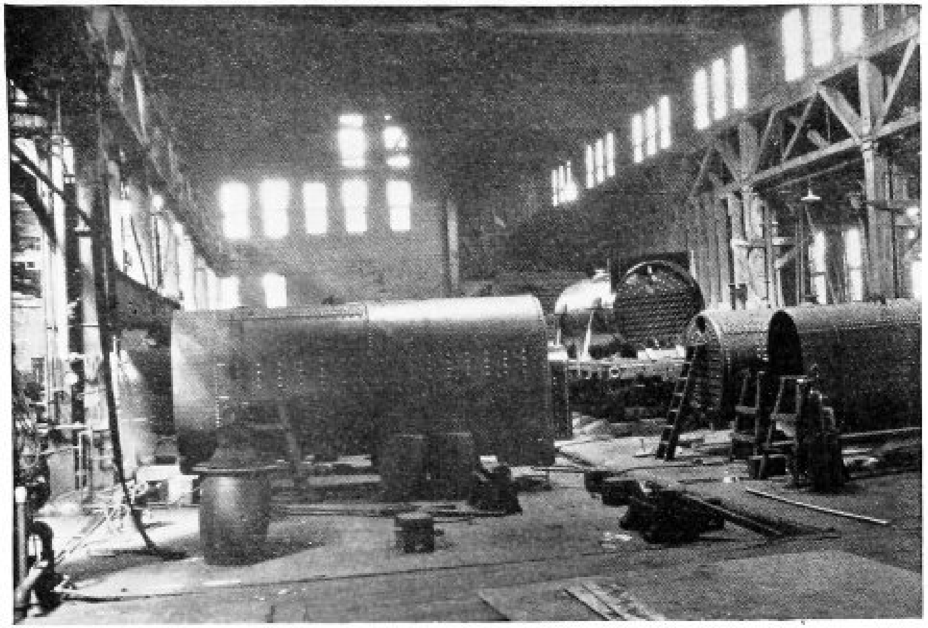
Plan of the boiler shop at the Ames Iron Works



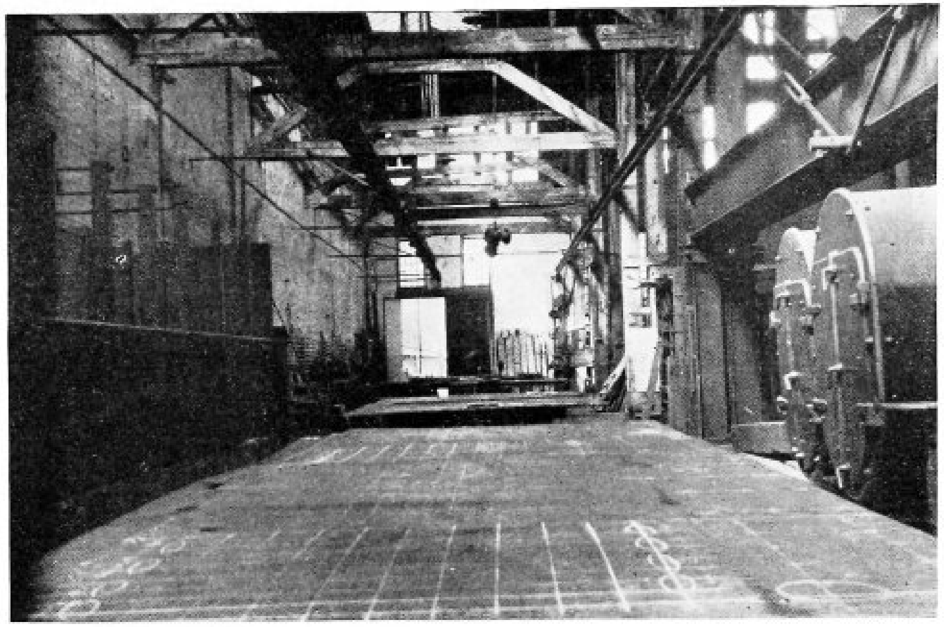
Wall type drills mounted on swinging arms



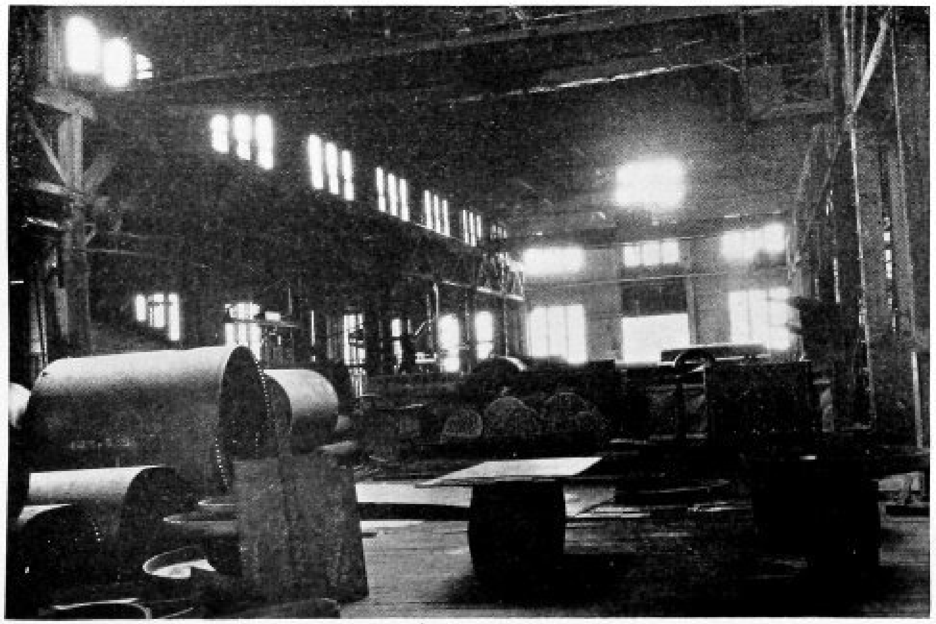
Showing the location of the machinery and other equipment



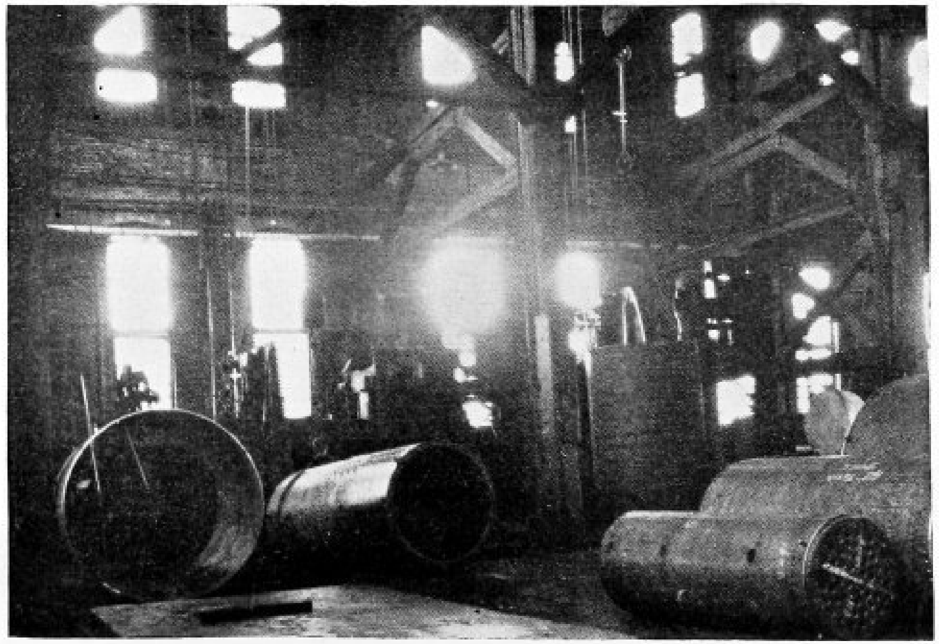
Looking north from center of shop



Laying out space



Looking south from center of shop

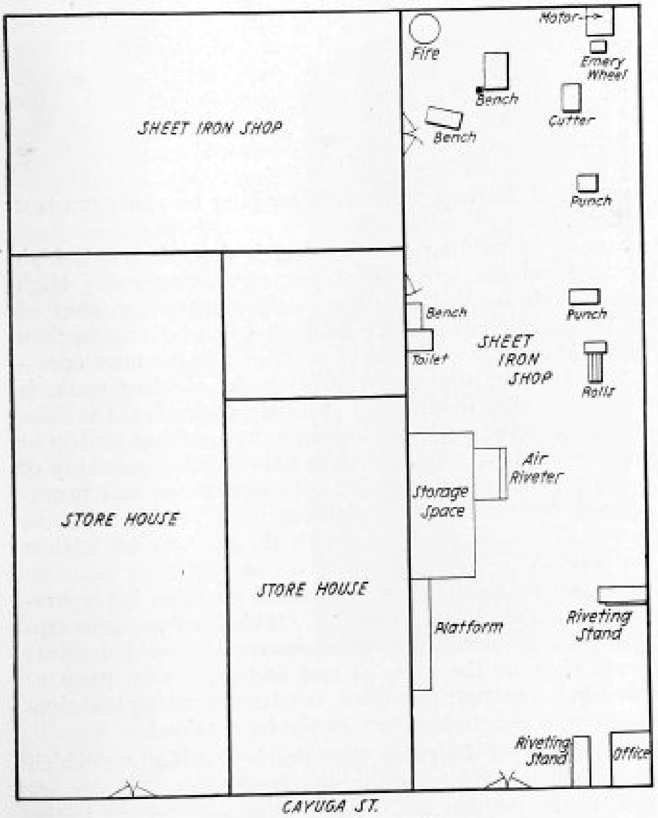


Riveting department

wide divided into three bays. The general arrangement and the location of the machinery and equipment are shown in the plan reproduced on pages 66 and 67, while the list of equipment is given on this page.

Spur tracks enter the shop at the north end where car scales weigh the shipments. Plates for flanging are stored in racks on one side of the shop and for boiler shells in racks on the other side. About 800 tons of steel are stored in the shop for fabrication.

The plates are laid out at the north end of the west bay and then go to the punch table adjoining the laying out space. Next the edges of the plates are planed on the plate planer located beyond the punch table. They are then taken across the shop to the large bending rolls after which the butt straps are bolted on and the shells are placed under



Plan of sheet iron shop

the drills at the southeast corner of the shop where the holes are drilled and reamed. The shells are then riveted at the riveting tower and transferred to the fitting up space where the staybolts and tubes are applied and the calking and welding finished.

Upon completion, the boilers are placed on the testing block at the north end of the shop where they are given a hydrostatic test and then loaded directly on the cars for shipment or taken to a storage yard back of the shop.

The material is handled in the main part of the shop by two overhead 10-ton Shaw electric cranes. At the machine tools the material is handled by either air or electric hoists operating on jib cranes.

A wide range of work is turned out in the shop, including horizontal return tubular boilers, upright tubular boilers, Empire return tubular portable boilers and Pierce firebox boilers with either plain or down draft furnaces. J. H. Taylor is general superintendent of the Ames Iron Works and F. A. Scott is superintendent of the boiler department. All boilers are built under the direct supervision of a resident inspector of the Hartford Steam Boiler Inspection and Insurance Company.

List of Equipment in Boiler Shop

1 Lever punch, 27-inch throat.
1 Wickes punch and shear, 48-inch throat, capacity 17-inch shear or punch 1¼-inch hole in 1-inch plate or 4½-inch hole in ⅝-inch plate.
1 Lennox rotary bevel shear.
1 Hilles & Jones punch, 8-inch throat.
1 Long & Alstatter 42-inch shear.
1 set of bending rolls, 8 inches by 7 feet 6 inches.
1 20-foot Hilles & Jones plate planer.
1 Long & Alstatter punch and shear, 61-inch throat.
1 Long & Alstatter punch and shear, 18-inch throat, with spacing table.
1 Long & Alstatter punch and shear, 16-inch throat, with spacing table.
2 15-foot arm Cleveland Punch & Shear Works radial drills.
2 Lincoln electric welding machines.
1 Landis double head staybolt cutter.
2 15-foot arm Fitchburg radial drills, with 46-inch by 72-inch table on wheels.
1 20-foot Wickes bending rolls, upper roll 20-inch diameter, lower rolls 13-inch diameter.
1 Kingsford wall type swinging arm drill.
1 Sellers 50-ton steam riveter, 126-inch gap.
1 Bement 40-ton steam riveter.
1 94-ton hydraulic accumulator.
1 75-ton R. D. Wood hydraulic riveter.
2 Jaracki pipe machines.
1 Fox Machine Company tube cutting machine.
1 Westinghouse vertical steam driven air compressor.
2 Ames Iron Works double end emery grinders.
1 Ames Iron Works manhole facing machine.
2 12-foot span wood frame riveting tower cranes.
1 100-ton W. H. Wood hydraulic riveter.
1 steel water tank, 42 inches by 8 feet 6 inches.
1 steel water tank, 30 inches by 54 inches.
1 Acme single head bolt cutter.
1 Monarch oxy-acetylene gas generating apparatus.
2 10-ton Shaw electric traveling cranes with 50-foot span and 26-foot lift.
2 Helwig staybolt clippers.
1 Gould triplex pump.
1 Gould centrifugal pump.
1 radial drill with 7-foot arm.
1 Ingersoll-Rand air compressor (16 by 10 by 14).
1 Crane pipe threading machine.
1 Cleveland radial drill.
1 2-ton Curtis overhead crane with 13-foot 5-inch span.

Flange Shop

1 550-ton W. H. Wood hydraulic flanging press.
1 W. H. Wood circular flanging machine.
1 Bradley 200-pound power hammer.
1 plate shear and bolt cutter; throat, 10 inches; stroke 1½ inches.
1 Rockwell Furnace Company fuel oil pumping outfit.
1 Ames Iron Works double end emery grinder.

Sheet Iron Shop

1 50-inch Bertsch bending rolls (diameter of rolls, 5 inches).
1 Cleveland punch or shear.
1 Ames Iron Works circular bevel shear.
1 Long & Alstatter punch.
1 Niagara hand lever alligator shear.
1 upright heating boiler 48 inches by 109 inches.
1 Marsh horizontal simplex steam pump.
1 Hardsocg 6-inch gap riveter.

Shop Accidents Reduced on A. C. L.

Competition in safety records, one of the methods for promoting diligence and enthusiasm among employees in the preservation of their own lives and limbs and those of their fellow workmen, has been a feature of the service in two shops of the Atlantic Coast Line during the past year; the plant at Emerson, employing 2,006 men and that at Waycross employing 2,176. Waycross challenged Emerson, and the results of the intensive work done by the shop superintendents and their foremen are shown in the following figures:

Emerson shop plant:	
Average employees on duty 1916	2,006
Average for previous six years	1,551
Increase in employees	455 = 29 p.c.
Average number injured per year during previous six years	106
Number injured during 1926	52
Decrease in injuries	54 = 51 p.c.
Waycross shop plant:	
Average employees on duty, 1926	2,176
Average employees, previous six years	1,693
Increase in employees	483 = 20 p.c.
Average number injured per year, during previous six years	169
Number injured during 1926	60
Decrease in injuries	109 = 64 p.c.

While Waycross shop plant showed a larger reduction in accidents over her previous record, the rate per 100 employees on duty gave to Emerson shop the lead by a small margin, and that shop was declared the winner.

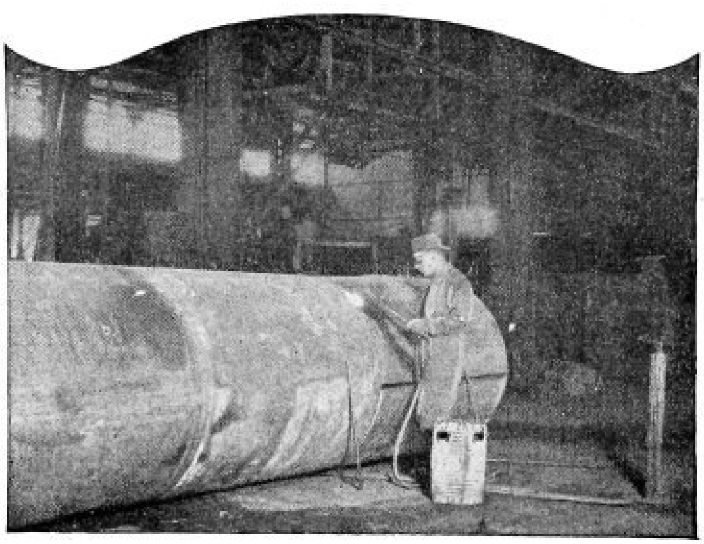


Fig. 1.—Tightness is required in storage tanks

Methods of Welding Steel Plate Work*

Habit of Study and Testing of Finished Welds Makes Proficient Operators

As a man's experience with oxy-acetylene welding increases, he will find that welding mild steel becomes one of the easiest things he has to do. Technique for this work grows almost to be instinctive and the operator will make strong, sound welds, hardly knowing exactly how he does it. Those who have had less experience with the blowpipe sometimes find that they fall just short of the results expected. It is usually found that this is the result of missing one or two of the minor essentials so necessary to a perfect job. It will pay every welder once in a while to check his methods very carefully. If he is regularly making good welds he can be sure of this fact, and can maintain high quality or even better it. On the other hand, if he is not satisfied with the welds he produces, he can discover and correct the faults that are responsible for his difficulties.

Often the comparative simplicity of mild steel welding causes the minor difficulties. The feeling develops that this is such a simple operation it just "does itself." If good welding requires anything, it is care and thorough workmanship; when either of these two factors is neglected the result is disappointing.

Two major factors are important in welding on steel plate and shapes just as in all oxy-acetylene welding: fusion and penetration.

To explain these in simple words, the term "fusion" indicates the thorough mixing of molten metal from the sides of the joint and from the welding rod. Its undesirable opposite is the melting of welding rod on relatively cool and unfused edges of the base metal. The latter is not a true weld and the joint will have little strength. To obtain thorough fusion, the operator must be certain that the base material is actually molten and flowing freely before he begins adding welding rod between the edges to be welded. He must then be careful that weld metal from the rod is also thoroughly molten as it is added. This is generally accomplished, as will be explained later, by melting the welding rod in a puddle of molten metal.

By "penetration" is indicated the careful welding of pieces to be joined the entire way to the bottom of the space between the edges, clear through to the underside. Combat the tendency to melt down the top edges and allow this metal to flow together, bridging over the lower space without working the flame down all the way to the bottom. This effect is avoided by working carefully from the bottom up and being sure that the edges are thoroughly fused every bit of the way. We shall see later how this can best be done.

Success in welding on mild steel is dependent to a high degree upon the selection of proper welding rod. High quality rods applied by experienced operators to steel of firebox quality will produce welds that will be stronger than the original plate. The main point in this for most operators or for men who are responsible for welding work, is that best quality welding rod is highly desirable; it is false economy to save a few pennies by compromising quality in the finished work. To use cheap rods of inferior quality or picked-up material not specifically formulated and manufactured for oxy-acetylene welding is to gamble with the success of the finished job—with the chances all against good work.

Another matter that is worth careful attention is preparation of the material to be welded. This involves three separate phases: first, properly designing the welded joint; second, cleaning the edges of rust and scale, dirt, paint or other foreign matter; and third, beveling or veeing the edges so thorough penetration can easily be obtained.

The matter of designing the joint is a subject on which much could be said especially on those phases of design relating to the position and type of joint with respect to the stress to which the weld will be subjected in use. It is sufficient to say here, however, that for most purposes the butt type joint, which is a joint in which the edges to be welded are brought together either in the same plane or

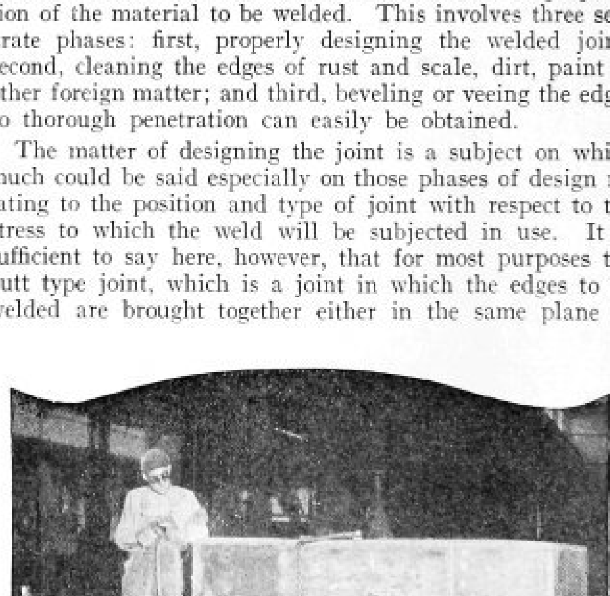


Fig. 2.—Process of welding a square tank

*Published through the courtesy of *Oxy-Acetylene Tips*.

in planes at an angle, is usually preferred over other types. Lapped joints are undesirable, especially where such a joint can be welded from one side only.

Butt joints in steel plate can be of either the single-vee or double-vee type. While some work is of such nature that it would be difficult or impossible to weld from both sides, it is usually best where maximum strength is desired to employ the double vee. This has several advantages, especially on heavy plate. The weld can be reinforced on both sides, for one thing. Less time and welding rod are required than for single-vee welding in the same thickness of metal. Single-vee welds are usually employed on metal less than 3/8 inch thick.

On metal lighter than 1/8 inch, or 11 gage, the edges are rarely beveled at all. The parts are simply brought together and welded either with or without addition of metal from the welding rod, depending upon the extent of reinforcement desired. Light gage sheet metal is often flanged slightly, the two flanged edges being put together and welded without addition of welding rod.

When welding steel plate, especially long seams, it is necessary to make provision for changes in position of the parts as welding proceeds. This is usually done by spacing the edges slightly apart at the far end of the seam, this spacing being roughly 1/4 inch to one foot of seam length. The operator's technique will have something to do with the correctness of this figure since the speed of welding and the total amount of heat thrown into the plate will affect the rapidity with which the edges draw together.

Fig. 3.—Making a practice weld

For welding on mild steel the neutral flame should be employed. This will give a maximum welding speed. An excess of oxygen tends to burn the steel.

To make a weld in 3/8-inch steel plate, melt one end of the vee, holding the blowpipe with the head inclined at an angle of about 60 degrees to the plane of the weld. This is the average welding position. If the head were tilted further the molten metal might be blown ahead of the welding zone; if it were more vertical, the preheating effect of the outer flame would not be thoroughly applied and there would be more danger of melting and blowing a hole through the bottom of the weld. The tip of the inner cone should not quite touch the molten metal.

In plate of this thickness, it is clear that the metal from both sides of the vee cannot be thoroughly fused unless the blowpipe is moved from side to side across the vee. For this reason it is necessary to develop a swinging motion when welding steel plate. When the bottom of the vee has begun to melt, move the blowpipe from one side of the vee to the other and back again, making sure that the metal on each side is thoroughly fused. At the same time the blowpipe must work forward along the line of weld.

If difficulty is experienced in acquiring the necessary swing, it may be advisable to complete this first weld at the bottom of the vee without attempting to add any welding rod. Merely move the blowpipe gradually along the line of weld, as fast as the metal becomes well melted, at the same time swinging the flame from side to side, as indicated in Fig. 4.

When welding rod is used, the weld is started just as before; that is, a small spot at one end of the vee is thoroughly melted, forming a small puddle of molten metal. While this puddle is being formed, the tip of the welding rod should be brought almost to the melting point. Before it actually begins to melt, however, the tip of the rod should be dipped below the surface of the molten puddle. Steel welding rod should always be added in this way. Never hold the tip of the rod above the surface of the molten puddle and allow it to melt drop by drop into the puddle. The reason for this is, of course, that rod melted under the surface of the puddle is completely protected from oxidation. As the rod melts, it should be moved from side to side in the puddle, the motion being just opposite to that of the blowpipe.

As the weld proceeds, the rod should be added until the surface of the joint is built up a little above the edge of the plate. This reinforcement is customary in all welding on steel plate. The small amount of oxide that forms during welding remains on the surface as a scale, and can be easily removed when cold. Any impurities that may have existed in the original steel also tend to work to the surface during the welding. In the completed joint they will consequently be located in the reinforcing portion. This can be removed, if desired, by grinding or by machining, leaving metal of highest quality and of uniform thickness with the rest of the plate.

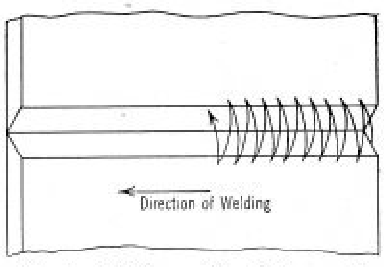


Fig. 4.—Motion of torch for welding plate

Welding is continued by a gradually advancing puddle of molten metal until the end of the vee is reached. At this point, in order to finish the work properly, it will be necessary to prevent the molten metal from running over the edge. As the end is approached, raise the blowpipe flame slightly. In this way it will be found possible to chill the molten metal slightly so it will not run like water.

Inexperienced operators will sometimes find that the welding rod, when used in the puddle, has a tendency at times to stick, and has to be melted away with the blowpipe before it can be manipulated freely again. Some instructors in welding use this as a test of proficiency, saying that an operator has really learned the methods of welding steel plate when he can go from one end of a weld to the other without having the welding rod freeze to the cooling metal. It indicates that the operator is permitting the puddle to cool or has pushed the welding rod along to a point where the base metal is not heated sufficiently.

A good way for the operator to gage his ability to make a strong weld in steel plate is to obtain pieces of scrap material, about 6 inches wide, making the weld in these just as it would be done in actual work. When the weld is finished, cut a strip 1 inch or $1\frac{1}{2}$ inches wide (which will then be 12 long) with the weld in the middle. Clamp this in a heavy vise or against an anvil, weld level with the edge, and bend it over by sledging about 4 inches above the weld. The strip should be bent so the top of the weld will be stretched; in good welding this should bend through an angle of about 90 degrees without any signs of cracking. In single-vee welds, this test will indicate the strength and ductility of the weld metal. The specimen should then be bent the other way until fracture occurs. The fracture will give a good idea of the operator's ability with regard to penetration and fusion. Where failure in penetration or lack of fusion shows up, the operator should continue his practice, taking special pains to correct these faults and any others that may occur.

Problem of Cutting the Cone

Explanation of the method of finding any required ellipse by passing a plane through the cone

By I. J. Haddon

THE problem as given by me in the October number of THE BOILER MAKER in connection with cutting a cone by planes was as follows:

Given a cone and an ellipse, to find the line on the cone representing the plane that will cut the cone, so that the true face is the ellipse required, such as, a right cone with say 30 degrees at the apex, and the size of the ellipse to be, say 6 inches by $2\frac{3}{4}$ inches.

Note: These sizes were given so that it could be drawn on an ordinary size sheet of drawing paper, but the method shown applies to *any* size ellipse and *any* cone.

In Fig. 1, AB equals the major axis of an ellipse, viz., 6 inches and CD equals the minor axis, viz., $2\frac{3}{4}$ inches; E and F are the foci of the ellipse.

To construct: Draw AB and CD at right angles to each other and crossing at G; make GA and GB each equal to 3 inches; make GC and GD each equal to $1\frac{3}{8}$ inches; then with D or C as centers, and radius BG or AG, describe the arcs crossing the line AB in E and F; then E and F are the foci of the ellipse.

In Fig. 2: Draw the lines AB, CD at right angles to each other and crossing at E; make EF and EG each equal to AG, Fig. 1; make EH equal to GD, Fig. 1. From G or F as centers and radius GF draw the arc cutting the line AB in J; join JG and JF. It will be seen that FJG is an equilateral triangle and is, therefore 60 degrees at each angle. With center J and radius JG describe the circle GFK; join KG and KF; then FKG will be an isosceles triangle and the angle at K will be 30 degrees, as was required.

Note: The angles at the centers of circles are the double of the angles at the circumference.

With center M and radius MF or MG describe the circle N. From H as center and radius $FlGl$, or radius GE, Fig. 2, cut the line CD in O and P.

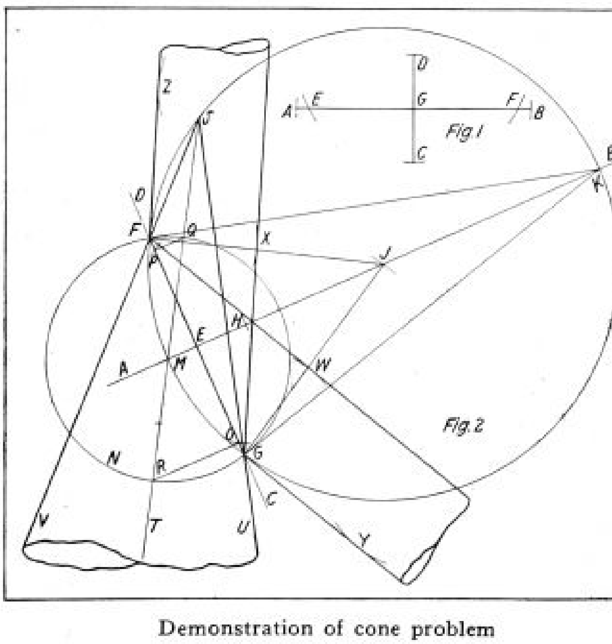
Drop the lines PQ and OR perpendicular to CD and cutting the circle N in Q and R, draw TS through the points RMQ and meeting the circle GFK in S.

Draw SU through G and SV through F, then VSU will be the cone, and FG will be the miter line required on that cone.

Note: Angles in the same segment of a circle are equal to each other; therefore the angle VSU is equal to the angle FKG and the angle at S is equal to 30 degrees as was required.

With radius CD, Fig. 1 and with G and F as centers draw the arcs as shown at W and X; draw FW produced, tangent to the arcs; draw GY and FZ parallel to FW and GX to represent a pipe cut at an angle as $YGEFW$; the same pipe turned around would lie at $ZFEGX$. Now that size pipe cut at that angle can only fit on that cone in the positions as shown.

This method may be used to demonstrate what I previously said, viz., that *any ellipse* may be cut from *any cone*.



Demonstration of cone problem

James G. Bateman, assistant manager of sales of the National Tube Company, at New York, and vice-president of the Engineers' Club, died on February 2 of pneumonia at the Engineers' Club, where he lived.

C. V. Lally has been appointed general manager of sales of Pittsburgh Steel Products Company, Pittsburgh, Pa. Richard R. Harris, who has been general manager of sales of Pittsburgh Steel Company and subsidiary companies, has resigned. Mr. Lally has been manager of the Detroit office of the National Tube Company and has been associated with that company in its sales organization for the past seventeen years.

Metallurgy of Staybolt Iron and Steel

Heat treatment and physical properties of steels that are desirable for locomotive use

By Fred Williams*

AT infrequent intervals the mechanical department of a railroad is faced with the problem of trying to determine the cause of an epidemic of broken staybolts, crown bolts, springs, or other parts. The first step generally taken when making such an investigation, is to determine that the design is correct and that the part has been properly applied. If this investigation does not reveal the trouble, then it is necessary to examine in the laboratory by means of the microscope the structure and physical properties of the materials from which the various parts are made. The photomicrographs often reveal some surprising conditions. They point particularly to the importance of proper heat treatment of anything but mild carbon steel.

The photomicrographs shown in Figs. 1 and 2 show the impregnation of slag in wrought iron. These streaks or slivers of slag are what cause the so-called "fiber" in this material. This slag is necessarily brittle and when the iron is bent, it will naturally disintegrate and allow the iron to come apart and give the appearance of a rope-like structure in the bar. Slag in iron as a virtue is very much misrepresented. Some people claim that these streaks of slag will stop progressive fracture or, at least, delay it or make a ragged fracture when the iron breaks. An appeal to reason in scanning the photographs shown in Figs. 1 and 2 cannot help but show that a progressive fracture would be caused internally and also in the surface by these slag particles and streaks. In spite of these so-called fibrous qualities of wrought iron, experience has been that staybolts made of this material will generally break off short. A comparison of the crystallographic structure shown in Fig. 2 with those shown in Figs. 3 and 4, will show that wrought iron has a crystalline structure similar to low carbon steel.

Fig. 3 shows the uniformity of structure in low carbon steel. The low carbon will give uniform structure and it does not require heat treatment. Therefore, it can be used for engine bolts in preference to wrought iron. In fact, it can be headed much more readily than wrought iron, as it will not split in heading. Neither will it become brittle under the head, which is the case in bolts manufactured from higher carbon steel when not subjected to subsequent heat treatment. Fig. 4 shows the clean character of very low carbon steel and also the similarity in the crystalline structure to the wrought iron shown in Figs. 1 and 2. A comparison of the physical properties of Figs. 1 and 2 with Figs. 3 and 4, will show their adaptability to their various purposes.

Figs. 5 and 6 show how essential it is to heat treat

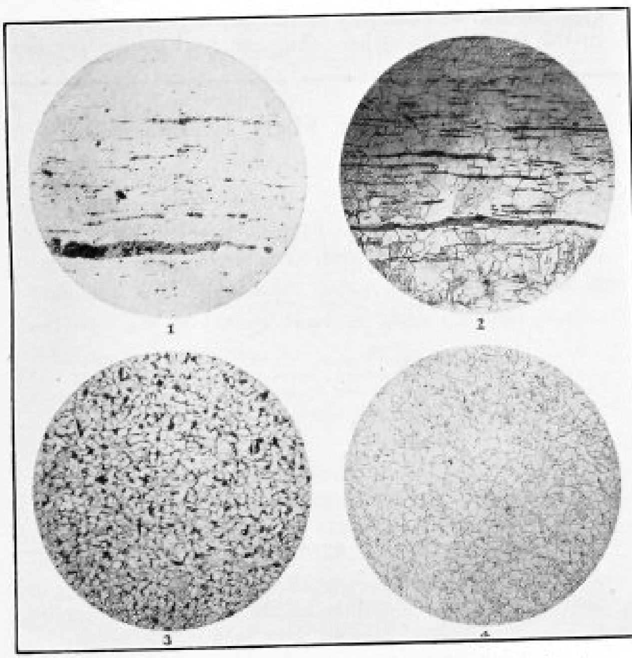


Fig. 1—Wrought iron, unetched

T. S., 47,750 lb.; Elong., 36.5%
El. L., 35,000 lb.; R. A., 57.0%
Brinell, 90; Mag., 100

Fig. 2—Wrought iron, etched

Mag. 100

Fig. 3—Low carbon steel

T. S., 63,200 lb.; Elong., 37.5%
El. L., 43,300 lb.; R. A., 69.0%
Brinell, 112; Mag., 100

Fig. 4—Very low carbon steel

T. S., 52,200 lb.; Elong., 43%
El. L., 39,650 lb.; R. A., 79%
Brinell, 99; Mag., 100

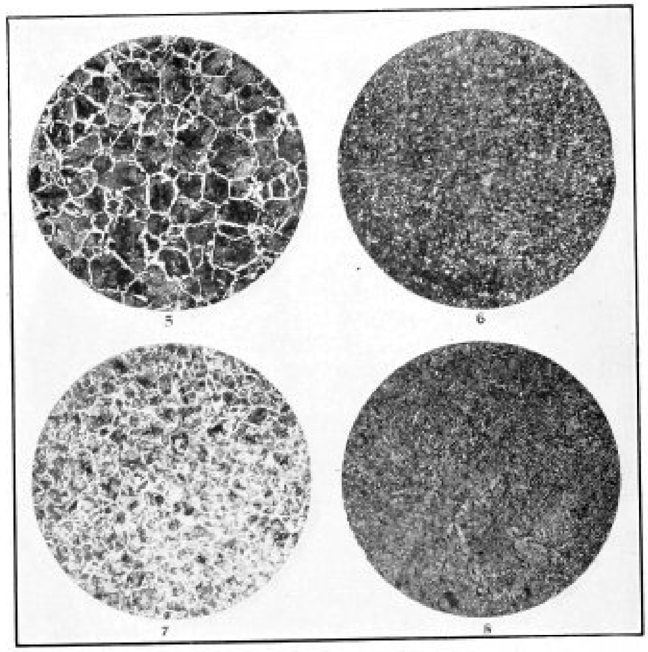


Fig. 5—Carbon steel .40, as rolled

T. S., 98,955 lb.; Elong., 24.5%
El. L., 67,250 lb.; R. A., 53.0%
Brinell, 196; Mag. 100

Fig. 6—Carbon steel .40, heat treated

T. S., 135,800 lb.; Elong., 20.0%
El. L., 103,450 lb.; R. A., 55.5%
Brinell, 311; Mag., 100
Quenched from 1,500 deg. F. in water; drawn at 800 deg. F.

Fig. 7—Carbon .30, 1.25 ni. ch., as rolled

T. S., 110,700 lb.; Elong., 22:5%
El. L., 88,810 lb.; R. A. 59.0%
Brinell, 222; Mag., 100

Fig. 8—Carbon .30, 1.25 ni. ch., heat treated

T. S., 173,300 lb.; Elong, 15.5%
El. L., 167,900 lb.; R. A., 54.5%
Brinell, 345; Mag., 100
Quenched from 1,475 deg. F. in water; drawn at 800 deg. F.

*Assistant test engineer, Canadian National, Montreal.

carbon or alloy steels after they have been subjected to the various mechanical workings. It will be noted that the structure of the roller bar, Fig. 5, contains very large crystals and that they are so interspersed that planes of weakness are set up. This necessarily makes a very poor transverse tensile strength and also leads to brittleness.

Fig. 6 shows the same bar after being subjected to the heat treatment indicated in the caption. The structure is very uniform and dense. The physical properties have been improved. The heat treatment given above is to show the maximum physical properties that can be obtained from common carbon steel for use as superheater bolts and studs.

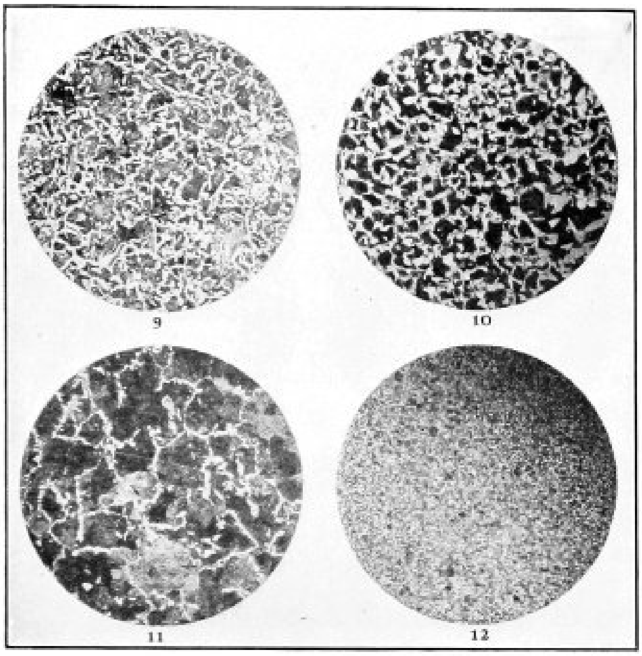


Fig. 9—Carbon steel .40, as forged

T. S., 90,300 lb.; Elong., 23.5%
El. L., 51,600 lb.; R. A., 44.0%
Brinell, 158; Mag., 100.

Fig. 10—Carbon steel .40, annealed 1,600 deg. F.

T. S., 89,300 lb.; Elong., 28%
El. L., 49,500 lb.; R. A., 50%
Brinell, 150; Mag., 100.

Fig. 11—Carbon vanadium, as forged

T. S., 118,900 lb.; Elong., 3.5%
El. L., 103,300 lb.; R. A., 10.0%
Brinell, 286; Mag., 100.

Fig. 12—Carbon vanadium, single normalized

T. S., 119,600 lb.; Elong., 18.0%
El. L., 80,950 lb.; R. A., 40.3%
Brinell, 235; Mag., 100.
Normalized at 1,600 deg. F.

The high elastic limit is obtained in order that the bolts will not stretch during installation.

Character of Alloy Steels

Figs. 7 and 8 are shown as a comparison of 30 percent carbon, 1¼ percent nickel-chrome steel with the 30 percent carbon steel shown in Figs. 5 and 6. The only difference in heat treatment of the carbon steel and those shown in Figs. 7 and 8, is a matter of 25 degrees lower temperature for the nickel steel than for the carbon, and yet the physical properties are very much better in the nickel steel than in the carbon. The elongation is not as great nor is the reduction of area, but the tensile strength is much greater. For this reason this steel is recommended for any purpose where a high tensile steel is required such as superheat bolts or similar purposes. Neither the carbon steel nor the nickel steel should be used in the unheat treated condition. This can readily be seen by the crystalline structures shown in Figs. 7 and 8.

Figs. 9 and 10 show how severe mechanical working under the hammer will change the structure of the material and how a subsequent annealing will make a very uniform material by eliminating the planes of weakness and non-uniformity shown in Fig. 9. It can be readily seen how the material is made more uniform throughout its mass by this annealing. It must be understood that these photomicrographs and test specimens are very small portions in comparison with the finished forging, and therefore, it does not necessarily imply that the physical properties shown in Fig. 9 are prevalent throughout the forging, but they vary greatly in hardness and tensile strength. There is assurance that after annealing the material it will be homogeneous throughout the mass and the physical results obtained after this annealing will be very nearly alike in different portions of the forging. The mechanical strains are also eliminated.

Carbon-vanadium forging steel will give very good results if the proper heat treatment is given the forging. Fig. 11 shows that the grain structure is large and that planes of weakness are prevalent. By thorough normalizing, the material is changed to a very homogeneous, compact or dense structure and the forging strains are relieved. Fig. 12 shows the structure from a single normalizing.

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

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

Revisions and Addenda to Boiler Construction Code

IT is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision in the rules in its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later on in the proper place in the Code.

The Boiler Code Committee has recently received and acted upon a suggested new Manufacturers' Data Report for Unfired Pressure Vessels which has been approved for publication as addenda to Section VIII of the Code. This form is published below and is submitted for criticisms and comment thereon from any one interested therein. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y.,

CERTIFICATE OF SHOP INSPECTION

Insurance Company's Serial Number............

VESSEL MADE BY....................at....................

I, the undersigned, holding a certificate of competency as an inspector of steam boilers in THE STATE OF.............. and employed by the....................of................inspected internally and externally, the vessel specified in this report on ....19 , and certify that the statements made on this report are correct, corresponding with the mill test reports of materials as furnished by the builders, and measurements made of the vessel when completed; and that this vessel is constructed in accordance with the A.S.M.E. Boiler Code Rules for the Construction of Unfired Pressure Vessels.

....

Inspector of Boilers for State or Boiler Insurance Company

MANUFACTURERS' DATA REPORT FOR UNFIRED PRESSURE VESSELS

As Required by the Provisions of the A.S.M.E. Code Rules

1. Manufactured by ....(Name and address of the Manufacturer)..
2. Manufactured for ....(Name and address of the purchaser)..
3. Type..............Unfired Pressure Vessel No.(................) (............................) (................) Year built........
(Horizontal or Vertical) (Registered No.) (Mfrs.' serial, or A.S.M.E. No.) (State and State No.)
4. Have mill test reports been checked on all the plates entering this unfired pressure vessel..
Do the chemical and physical properties of all plates meet the requirements of the Code..
5. SHELL OR DRUMS: No.........Diameter........ft........in. Length over all..........ft..........in. Height..........ft..........in.
(or width)
6. STAMPS on shell plates..Rivets, stays and braces..
(Brand and lowest tensile strength) (Iron or steel)
7. SHELL PLATES..........in. Butt straps..........in. Style of seams: Longitudinal..................................Girth..................
(Outer) (Thickness) (Thickness) (Riveted, Forge Welded, Brazed, or Fusion Welded—Type of)
8. Diameter of rivet holes..................in. Pitch of rivets................X............X..........Efficiency of joint....................%
9. GIRTH JOINTS..................Diameter rivet holes......................in. Pitch of rivets..................in. No. of courses..............
(Single or double riveted)
10. INNER SHELL..............in. Style of seams: Longitudinal..............Girth..........Length of section or course.........ft.........in.
(Thickness) (Riveted, Forge Welded, Brazed, or Fusion Welded—Type of)
11. HEADS: flat or dished..................in. Radius of dish..................in. Side to pressure..
(Thickness) (Concave or convex)
If removable, bolts used........................or method of fastening..
(Number and size) (describe or sketch)

	STAYS	No.	Size	Net area	Welded or weldless	Area to be stayed	Maximum allowable working pressure
12.	(a) F. H.						
	(b) R. H.						
	(c) Through						
	(d) Diagonal and Gusset Stays						

13. STAYBOLTS......................If hollow..
(Iron or Steel) (Size of hole)
14. Maximum pitch................X................Diameter..................in.
(Horizontal) (Vertical) (Over the threads)
15. SAFETY VALVE outlets: No.................... Size........................
16. FUSIBLE PLUG (if used): No.........................Diameter and material of filling........................Location........................
17. OUTLETS: No................Size........................Material of nozzle or reinforcement..................How attached..............
(Riveted—Welded)
18. DRAIN connection..............in. HAND HOLES OR SIGHT HOLES..
(Size) (Number, size, and location)
19. MANHOLES:.................. .... Reinforcement........................
(Number) (Size and location of each) (Riveted, Welded, etc.)
20. Method of supporting vessel..
21. Bursting pressure..lb. per sq. in. Hydrostatic test..................................lb.
22. Maximum pressure..lb. per sq. in. Unit stress ....
Remarks: ....
(Vessel to be used for air, gas, ammonia, etc.)
....
....

We certify the above data to be correct and that all details of material and construction and workmanship on this unfired pressure vessel conform to the A.S.M.E. Unfired Pressure Vessel Code. ....by........................
Date..................................19...... Signed..............(Manufacturer)

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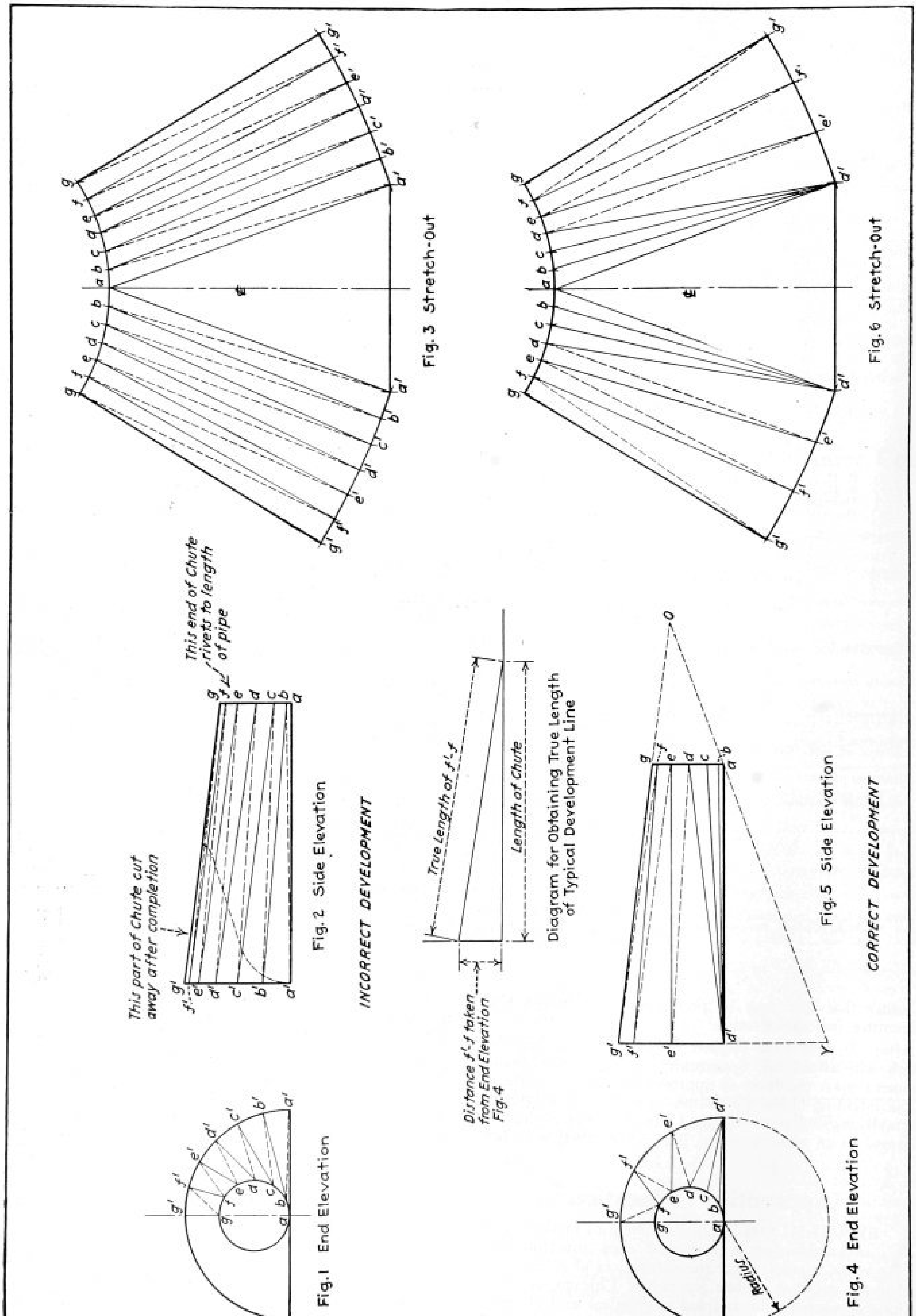
in order that they may be presented to the Boiler Code Committee for consideration.

After 30 days have elapsed following this publication, which will afford full opportunity for such criticism and comment upon the form as approved by the Committee, it is the intention of the Committee to present these addenda as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code.

Apprentice Education

A BROAD-MINDED superintendent of motive power, in combination with a wise shop superintendent, made it possible for the apprentices of a large railroad shop, within a night's journey of Chicago, to attend sessions of some of the railroad mechanical and electrical conventions in that city. Those who took advantage of this opportunity paid their own expenses, but were allowed the time lost from the shops. Each boy was asked to make a report to the shop superintendent in the form of a letter telling of the things which made a special impression upon him. The reports make interesting reading and indicate that this experience not only has a broadening effect upon the young men, but tends to stimulate their interest and study in the vocation for which they are preparing. A few other roads have followed a similar practice, but in a very limited way, in connection with the Mechanical Division conventions, and exhibits at Atlantic City. Are the railroads overlooking a real opportunity by not encouraging the younger men to attend and take advantage of meetings of this sort, as wella s railroad club meetings? Some of the foremen's or supervisors' associations have made attempts to help the more ambitious of the younger men in various ways. Is it not well worth the effort?—*Railway Mechanical Engineer.*



Details of chute development showing correct and incorrect methods

Laying Out a Chute By Triangulation

Method used to correct an error in developing a chute made from quarter-inch plate

By R. L. Phelps

A CONTRACT boiler shop with which I was connected at the time, once had occasion to make a chute of the general shape and design shown in the accompanying sketch, Figs. 1 and 2. This chute was made of 1/4 inch plate and was to be used for loading loose freight such as sulphur, which is handled in wheelbarrows. The top is cut away at the large end as indicated by the curved dotted line in Fig. 2, in order to permit the contents of a wheelbarrow to be emptied therein. This cutting line may readily be located after the stretchout is developed and will be disregarded in this discussion.

A manual on laying out which was consulted at the time contained an example of a chute similar to this one and outlined the procedure of development shown in Figs. 1, 2 and 3. The plate was laid out in this way and bent along the solid development lines with the result that a competent mechanic spent a whole day trying to bring it to the required shape and finally gave up in despair and consigned it to the scrap pile. Obviously, something was sadly wrong with this method.

Now a little study will make it apparent that this figure is a frustrum of a cone intersected longitudinally by a plane; the flat triangular bottom representing said plane. It follows that all generating lines of a conical surface must run to a common point, the vertex of the cone, and we apply this idea to our figure. The dotted construction lines in Figs. 1 and 4 are used to complete the cone *g'-O-V*, of which the chute is a part. The generating elements *g-g'*, *f-f'*, *e-e'* and *d-d'* in Fig. 5, if extended, will meet at the vertex *O* of the cone, thereby fulfilling the requirements of a conical surface. It will now be apparent that the lines *b-b'*, *c-c'*, etc., in Fig. 2, lying within the conical surface, are not straight lines but spiral curves and consequently cannot be used for bending lines. This explains the failure of the first method.

The correct procedure of development is shown in Figs. 4, 5 and 6, and, assuming that the reader is familiar with the fundamental principles of triangulation, will require no further details of explanation. The portion of the surface lying between the lines *d-d'* and *a-d'* is developed as shown and the sharp bend necessary at *d'* is produced by several bend lines converging at that point.

When laid out by the latter method and bent along the solid development lines (Fig. 4) the plate came nicely to the required shape with a minimum of trouble. Had this chute been made of light gage metal it is probable that it might have been pulled into shape in the first instance despite the wrong bend lines; as the shape and size of the stretchout in either case is approximately the same. However every boiler maker knows that steel plate a quarter of an inch thick cannot be handled like putty and when once bent is inclined to "stay put."

Effect of Surface Materials on Steel Welding Rods-II*

A study of various welding rod surfaces, their characteristics and properties for certain welding operations

WHAT is meant by a standardized surface can probably be explained in the fewest words by telling the story of the development of "green surfaced electrodes." When the research department discovered the true significance of surface materials on electrodes, the first attempt to apply the knowledge consisted in controlling the quantity of residual lime left on the wire. It was found that much could be accomplished this way. It put an extra burden on the wire drawer, however. He has his hands full when he succeeds in drawing wire economically and accurately down to size. If in addition he has to finish all sizes with a definite coating of lime remaining, it is asking too much. This is especially true because it is impossible to tell just how much lime is left by looking at the wire. The greases and soaps mixed with the lime in drawing seem to make the lime sort of transparent on the surface. For instance an electrode may not seem to have much lime on it. By dipping in water the soapy grease seems to be dissolved out and the electrode then looks as if it had a great deal of lime although, of course, none has been added. This means that the quantity of soap and grease which happens to get mixed with the lime in wire drawing varies, which in turn may result in a thin lime coating appearing like a thick one and vice versa. The true quantity of lime not the apparent quantity is what counts in welding.

Another difficulty was encountered in trying to apply the proper surface during wire drawing. No materials could be used that were not the best wire mill lubricants and this did not mean they would also be the best surfacing materials for welding. Still another difficulty lies in the fact that maximum arc stability seems to require just a slightly greater quantity of surface material than the maximum that can be applied during drawing. When all these points had been developed, it became evident that the thing to do was to apply the surface as a separate operation and of so distinctive appearance that the electrodes could not in any way become confused with what have been called bare electrodes. The commercial problem, of course, then presented itself of doing this without increasing the cost. As this is of no interest to the welder the details will be omitted.

Suffice it to say that a method was developed whereby the electrodes can be absolutely uniformly treated in mass at a low cost and enough saved by relieving the wire drawing operation of the necessity of leaving a lime coating to offset this. On account of the nature of the materials making up the green surfacing, the shade of green may vary depending on the time it takes to dry them during manufac-

*Published through the courtesy of the Chicago Steel & Wire Company, Chicago, Illinois. The first installment appeared on page 51 of the February issue.

ture. Naturally they will dry quicker on a dry day than on a damp one. This has no connection with the working qualities. Sometimes the shade of green greatly resembles Paris green, a poisonous arsenic compound. This is purely a coincidence as there are no arsenic compounds in the surface.

From the above remarks, it should be clear that the sort of surface being discussed is not a flux coating. It is simply the bare finish to which everyone is accustomed improved, standardized and made readily recognizable.

Benefits of Standardized Surface

Such a surface on electrodes is a benefit to the welder. On high carbon and alloy rods it has never been possible to leave much residual lime because the hardness of these electrodes causes practically if not quite all the lime to be scraped off each time the wire goes through the die. Thus the new surface makes these high carbon and alloy electrodes manageable without the necessity for flux coating. On the low carbon electrodes, the standardized surface gives a degree of uniformity of working which has not heretofore been obtainable with bare electrodes. For all classes of electrodes, the improvement in quality and quantity of materials over those of the familiar bare finish results in an arc so stable that the electrodes work with entire satisfaction on alternating current as well as direct.

Significance of Arc Stability

This phase of the effect of surface leads to a discussion of the general significance of arc stability from the standpoint of welding. It is self evident that the more stable the arc, the easier the welder's work. A stable arc means much more than this, however. If the arc is stable the metal must pass across in a regular stream of small particles. The result is bound to be a sounder weld with the chances that occluded slag and blowholes will not be present. It is not always possible to guess at what is below the surface of a weld from its surface appearance, so anything that makes weld metal more dependably uniform is highly desirable and a uniformly stable arc contributes in large measure toward this end. Loss of metal from sputtering is reduced with increased arc stability.

A shorter arc can be maintained when the electrode flows smoothly. The short arc reduces the time that the metal is in contact with the air while passing across from the electrode and thus seems to reduce the quantity of iron nitride and oxide in the deposit. Both of these compounds tend to make hard welds. The short arc is also a great help in overhead and vertical position welding.

Significance of Various Surfaces

The effects of arc stability are far reaching and the reason that the proper surface materials increase arc stability seems to rest largely on the fact that they must reduce the arc vapor resistance. This at least appears more logical than the assumption that surface materials refine the electrode metal. If this were the case, they would have no effect on pure iron which is already refined but they stabilize the arc here as much as on electrodes from impure iron.

When these surface materials are present in quantity as in flux coatings, the slag from such coatings which passes across and floats on top of the weld might refine the metal after it is deposited. This is unlikely, because the deposit cools almost instantly to the point where the slag and metal are no longer liquid and refining by slag contact can only take place while both slag and metal are liquid. This is the process of refining carried on in the open hearth furnace and it takes many hours to accomplish it. Flux coatings therefore seem unnecessary when their only function is to stabilize the arc.

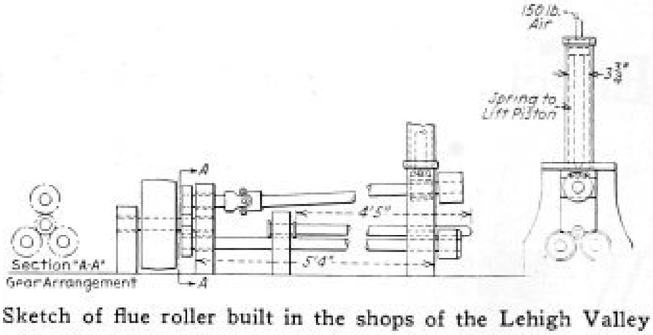
A surface such as "green surface" does this and gives all the secondary benefits that go with arc stability. When something in addition to arc stability is required, special flux coatings appear to be the only answer. For instance, it may be necessary to weld at the bottom of a deep narrow groove. The arc would jump from the side of the electrode if it were not protected by an insulating coating. Again it may be necessary to carry across some of the ingredients of the electrode which ordinarily would be burned out, in order to give the weld metal the desired physical properties. A special flux coating is about the only way to accomplish this. Extreme penetration is essential at times and again practically no penetration at all is desired. A slow flowing rod may be the best for certain work and an extremely fast flowing one must be used for other work. All of these extreme or special cases represent problems to be solved by flux coating.

Conclusions

Welders have been appreciating more and more that there are good and bad welding rods, but there has not been much information available as to what makes a rod good or bad. The surface materials certainly seem to be one very important factor governing the quality of both gas and electric filler rod. For gas rod, a clean, metallic surface seems essential, while for metallic arc welding, the presence of non-metallic materials on the surface is required. Surface materials constitute the real difference between gas and electric filler rod.

Flue Roller Used by the Lehigh Valley

THE flue roller, the construction of which is shown in the sketch, was built in the Sayre shops of the Lehigh Valley, Sayre, Pa. The rollers are 5 inches in diameter and run at 250 revolutions per minute. Pressure for the top roller is received from the shop air line through a booster pump. The top roller is raised by means of a spring under the piston.



Sketch of flue roller built in the shops of the Lehigh Valley

Trade Publications

Sludge Remover.—The details of piping and mounting of apparatus on the B.-A. sludge remover are shown in a 16-page brochure descriptive of the B.-A. Co. sludge remover and locomotive blow-off cocks which has been issued by the Bird-Archer Company, 33 Rector street, New York.

Nickel Steel.—Curves showing the average values of tensile strength, elastic limit, reduction of area, elongation and Brinell hardness at various drawing temperatures are given for the S. A. E. standard nickel and nickel-chromium steels in Bulletin No. 9 issued by the International Nickel Company, 67 Wall street, New York.

Sling Chains.—A circular and price list on the various styles of the Taylor-Mesaba sling chains has been issued by the S. G. Taylor Chain Company, 140 South Dearborn street, Chicago.

Oxy-Acetylene Welded Construction of a Large High Pressure Storage Tank*

Design of Tank—Checking of Welders—Welding Longitudinal and Girth Seams—Design of New Manhole Reinforcing Ring

By H. E. Rockefeller

THE recent completion of a large ethylene storage tank, constructed for the Carbide and Carbon Chemicals Corporation, marks another decided step in the advancement of oxy-acetylene welding in the pressure-vessel field. This tank, constructed of 1⅛-inch shell plate and 5 feet in diameter by 43 feet long, is now operating under the designed 300 pounds working pressure with complete satisfaction to the purchaser.

In the design and construction of these tanks, a definite procedure was worked out with the fabricator to insure satisfactory results. The factors involved in this procedure were: (*a*) correctly designing the joints, (*b*) selecting material of good welding quality, (*c*) determining the ability and knowledge of the welding operators, (*d*) properly preparing the plates for welding, (*e*) applying approved welding technique, and (*f*) testing the completed joints.

Since the fabricators had never welded plate as heavy as required in these tanks, it was agreed to limit the design fiber stress to 7,000 pounds per square inch so that there would be no question as to the safety of the welded joints. On this basis of design a shell thickness of ¾-inch was required, the specifications calling for tanks 7 feet in diameter and 35 feet long. The results obtained on the first three tanks, however, convinced both the fabricator and the purchaser that the original design fiber stress was too low and it was consequently increased to 8,000 pounds per square inch in designing the remainder of the tanks needed at that time.

In the early part of 1926 a demand arose for the storage of a considerable amount of gas at 300 pounds pressure. Although the tank requirements necessitated the use of heavier plate than had ever before been commercially gas welded in tank fabrication, the Carbide and Carbon Chemicals Corporation, having had such entire satisfaction in the operation of the tanks previously constructed, did not hesitate in specifying oxy-acetylene welding.

Design of Tank

The storage requirements called for a tank 5 feet in diameter by 43 feet in length. The 1⅛-inch shell thickness was based on a design fiber stress of 8,000 pounds per square inch, the same as employed in the preceding construction. In designing the heads, however, several changes were made in the layout previously used. It had been found from strain-gage measurements taken during the tests of the last tanks that the metal exceeded the yield point on the head knuckles and about the manhole opening, a standard knuckle radius of about 2½ inches and a straight flange length of 3 inches having been used. To provide a more satisfactory knuckle design, a 6-inch outside radius and a straight flange or skirt 6 inches in length were specified. (It will be noted that the minimum inside knuckle radius by the A.S.M.E. Unfired Pressure Vessel Code would be 1.8 inches. Otherwise the heads were designed in accordance with the A.S.M.E. Unfired Pressure Vessel Code, except that a design stress of 9,000 pounds per square inch was used instead of 10,000 pounds as is allowed on plate of the strength specified.

In an attempt to cut down the stresses about the manhole opening, the manhole reinforcing ring was also designed considerably stronger than specified in the Code, a 1½-inch saddle plate being used when one 1½-inch in thickness would have met the Code requirements.

It will be noted that the design of the welded joints for all longitudinal and girth seams is of the double-V butt type. The included angle of V was specified to be not less than 90 degrees and the reinforcement not less than 3/16 inch on each side of the double-V, or a total reinforcement of about 30 percent. The ultimate strength of this type of joint, when properly executed, considerably exceeds the requirement of a factor of safety of five based on the comparatively low design fiber stress used in this instance.

The fillet welds joining the manhole reinforcing ring and manhead were so designed that their shearing and tensile strengths were greater than the tensile strength of the material removed from the head. (The unit shearing and tensile strengths of the weld metal were figured conservatively at 30,000 and 40,000 pounds per square inch, respectively.) The welded connections were also designed to permit of satisfactory welding and to provide ample area of weld metal.

Another point in the design which should be noted is the location of the welded seams. It will be observed that the longitudinal seams are staggered 180 degrees. Where two longitudinal seams are used per course the seams should be staggered 90 degrees, and when three seams per course are used, the angle between adjoining welds should be 60 degrees.

Selection of Material

In order to insure the quality of the material used, firebox steel with a maximum carbon content of 0.20 percent and a minimum tensile strength of 50,000 pounds per square inch was specified. The specifications also called for the use of nickel-steel welding wire conforming to the American Welding Society specifications.

The following is a copy of the mill report on the steel used:

Size of Plate, In.	Chemical Analysis C	Mn	P	S	Physical Properties: Yield Point, Lb. Per Sq. In.	Tensile Strength, Lb. Per Sq. In.	Elongation in 8 In., Percent
1¼ × 82½ diam...	0.18	0.42	0.011	0.030	36,500	57,440 / 58,130	30.25
1⅛ × 82½ diam...	0.18	0.46	0.010	0.027	33,540	52,400 / 54,130	29.50
1⅛ × 96¾ × 198⅜	0.18	0.35	0.013	0.033	34,140	50,430 / 52,320	31.50
	0.18	0.35	0.013	0.035	30,850	52,970 / 53,480	32.50
	0.18	0.35	0.013	0.035	32,270	51,060 / 52,730	30.75
	0.18	0.35	0.013	0.033	33,650	51,160 / 53,650	29.75
	0.18	0.35	0.013	0.033	34,420	52,050 / 53,140	31.50

Check of the Welders

As a check on their ability to meet the welding specifications, each operator was required to pass a qualification test. The test including the welding together of two sec-

* Abstract of a paper presented at a joint meeting of the Metropolitan Section and Machine-shop Practice Division of the A. S. M. E. with the New York Section of the American Welding Society, New York, January 4, 1927.

tions of 1⅛-inch plate, beveled and set up in accordance with the specifications. Three standard coupons were cut from each weld specimen and pulled in a tensile testing machine. The requirement for passing this qualification test was that none of the coupons should show an ultimate strength of less than 45,000 pounds per square inch of plate section.

None of the operators engaged in the plant at which the tank was fabricated had ever welded plate above ¾ inch in thickness. With a small amount of practice under proper supervision, however, each of the welders easily passed the qualification test. The following table indicates the results of the tensile tests.

Welder	Specimen	Yield Point, Lb. Per Sq. In.	Tensile Strength, Lb. Per Sq. In.	Fracture
A	1	31,760	46,300	Edge of weld
A	2	35,000	54,400	In plate
A	3	36,200	53,300	In plate
B	1	30,600	47,600	In weld
B	2	35,420	54,200	In plate
B	3	35,400	53,500	In plate 1 in. from weld
C	1	33,000	50,700[1]	In plate
C	2	32,600	54,000	In plate 1½ in. from weld
C	3	31,200	50,200[1]	In plate 2 in. from weld
C	4	32,500	51,300	In weld

[1]Reinforcement ground off.

Preparation of the Parts for Welding

The steps taken in the fabrication of the plates preparatory to welding are noteworthy in view of their simplicity.

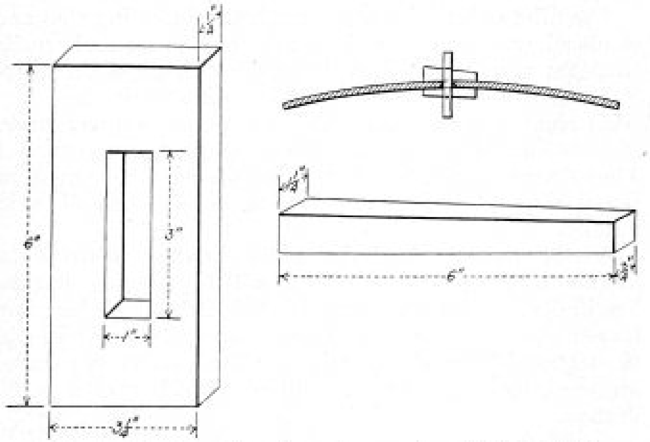


Fig. 1.—Design of wedge clamps for alining seams

The only laying out necessary was the placing of guide lines on the plate for beveling and resquaring. These operations were performed in a single set-up on the plate planer. To eliminate the flat spots on the plate ends, the edges of the plate were set to the proper curvature before being placed in the rolls. This operation was accomplished in a sectional press, the plate ends being heated before being formed. Although on the plate thicknesses previously welded the elimination of the flat spots had been accomplished by the use of jigs when lining up the girth seams, it was thought inadvisable to rely on this method of obtaining the proper curvature because of the stiffness of the heavy shell plate used in this instance.

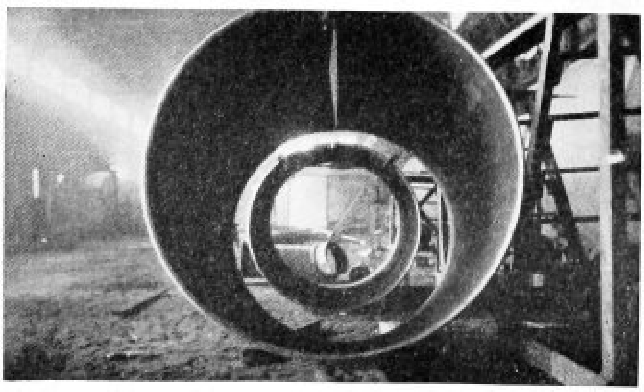


Fig. 2.—Method of spacing for tacking and welding longitudinal seams

Following the rolling operation, the abutting longitudinal seams were fastened by means of wedge clamps and then moved to the portion of the shop where the welding was to be done. The design of the wedge clamps employed is shown in Fig. 1. Prior to welding each of the longitudinal seams, one end was tack welded and the other separated the required distance to provide for contraction. For tacking, a spacing of ⅛ inch was used, and a tack weld made about 1 inch in length. When necessary a turnbuckle was employed to obtain the desired spacing. The spacing of the seam for welding was secured by inserting a wedge at the open end and spreading the plate edges about two inches at this point. This provided an allowance for contraction during the welding of ¼ inch to the foot. Fig. 2 illustrates the method of tacking and spacing. The course shown in the background is prepared for tacking, and the one in the foreground is spaced and ready for welding.

Welding Longitudinal Seams

In joining the longitudinal seams, the welding of the outer V was accomplished first, being carried on without interruption from start to completion. Three operators alternated on two seams so as to provide a 15-minute rest period after each half-hour of welding.

The method of allowing for the contraction of the seam during welding proved entirely satisfactory. After the weld had progressed a short distance, the wedge clamps were removed and the contraction of the seam controlled by the use of a wedge and a "C" clamp inserted at the open end of the seam. The manner in which the "C" clamp was

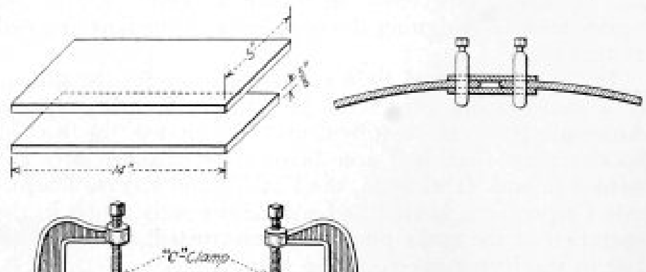


Fig. 3.—Design and method for using "C" clamp

employed is indicated in Fig. 3. The wedge was manipulated so as to maintain a spacing of about $\frac{5}{16}$ inch between the plate edges a foot ahead of the point of welding. By doing this a constant spacing of about $\frac{3}{16}$ inch was secured at the point of welding. This provided a sufficient opening to secure thorough penetration easily without slowing up the welding operation, as occurs when too wide a separation exists at the bottom of the V.

Preheating from the inside of the seam by the use of an oil torch was tried but soon discontinued. The improvised preheating arrangement, as shown in Fig. 4, was difficult to control and caused considerable discomfort to the welders. Therefore, when it was discovered that the outer V could be welded without preheating, this supplementary operation was eliminated. The course, as will be noted in Fig. 4, was tilted at an angle of about 15 degrees to facilitate the building up of the required weld reinforcement.

After completing the seam from the outside, the inner V was chipped out to remove the oxide and excess metal which had penetrated to the inside of the seam without becoming thoroughly fused with the base metal. In welding the inner V it was found necessary to resort to preheating since the size of tip used, a No. 15 Oxweld, did not give sufficient heat to fuse the base metal with reasonable speed after the outer V weld had been made. An oil burner was used as the preheating medium, it being alined in such a way as to direct the flame on the outside of the seam about 4 inches ahead of the point of welding. A forced draft supplied from the shop compressed-air lines provided sufficient ventilation to carry off the heat radiating from the weld, making it possible to carry on the welding without interruption or inconvenience to the welders. Fig. 5 indicates the manner in which the inner V of the longitudinal seams was welded.

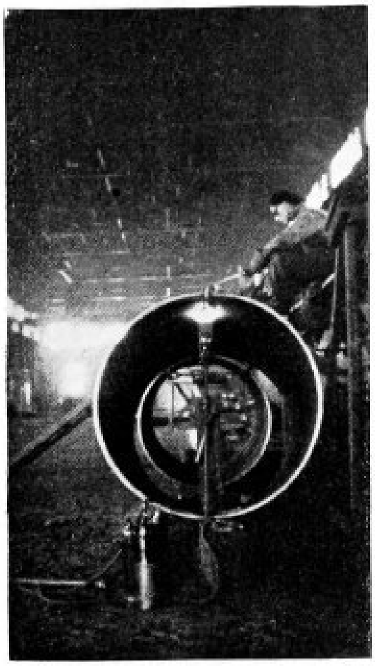


Fig. 4.—Preheating arrangement tried in preheating out V of longitudinal seams. Note how seam was tilted to facilitate building up of weld reinforcement

Reforming and Annealing

All the longitudinal seams were welded essentially in the manner indicated above. Upon completing the welding of the fifth course, they were checked for roundness and then annealed to eliminate any locked up stresses. Where necessary, the ends of the courses were heated and hammered to secure the required roundness. The annealing was accomplished by heating the entire length of the seam for a distance of about 1 foot on each side of the weld to a uniform dull red. The course was then removed from the fire, the heated section covered with dry ashes and the seam allowed to cool slowly.

These operations had not been employed on any of the tanks previously constructed as our experience had justified the decision that annealing of welded seams in general is unnecessary. In this instance, however, these precautionary measures were taken because of the heavy plate used.

Lining Up and Tacking Girth Seams

The lining up of the girth seams was accomplished by the use of the same wedge clamps previously mentioned in connection with the lining up of the longitudinal seams and illustrated in Fig. 1. The courses to be joined were first set up on rollers and the adjoining longitudinally welded seams staggered as required. The wedge clamps were then inserted at equidistant points of about 8 inches along the entire seam. A spacing of ½ inch between the abutting plate edges was employed, and the wedge clamps manipulated until the seam was within ¼ inch of true alinement at all points on its circumference.

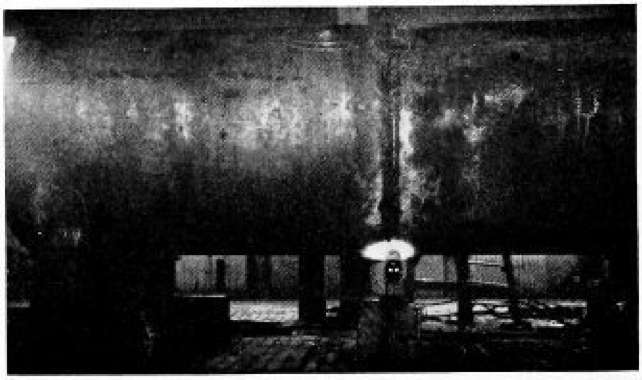


Fig. 7.—Preheating girth seam while welding inner V

It was then tack-welded at four points. Two welders working at points 180 degrees apart, one on the top welding on the outer V and the other within the shell welding on the inner V, made two tack welds simultaneously. The shell was then turned through 90 degrees and the other two tack welds made. Each tack weld was about four inches in length and without reinforcement. Fig. 6 illustrates manner in which the wedge clamps were used and the tack welds made.

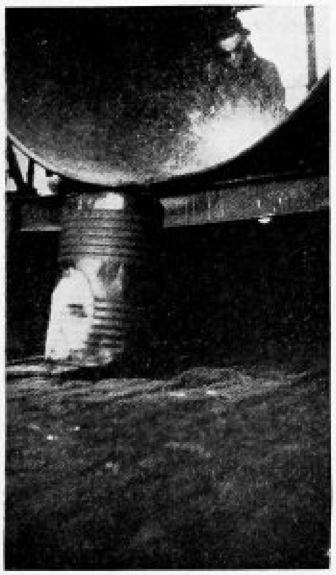


Fig. 5.—Welding inner V of longitudinal seams. Note method of preheating with oil torch

Fig. 6.—Method of securing desired spacing and alinement of girth seams. Note tack weld

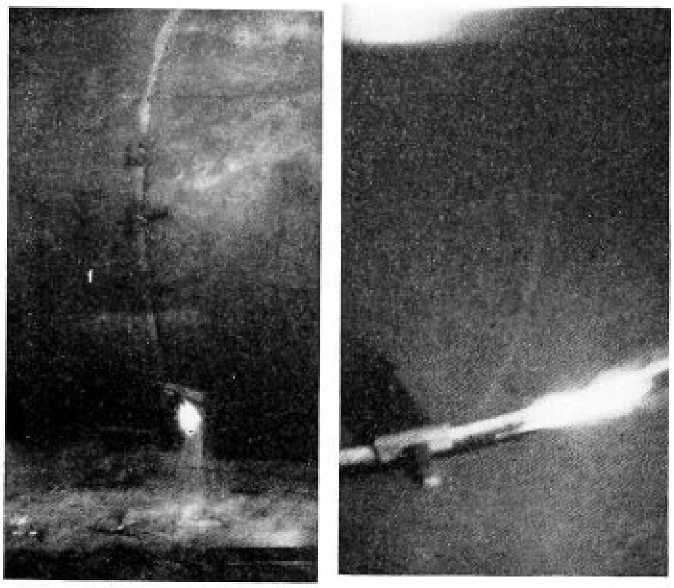
Fig. 8.—Preheating head seam while welding inner V

WELDING GIRTH SEAMS

The actual welding of the girth seams was accomplished in much the same manner as were the longitudinal seams. With the exception of one seam, the outer V was welded first without preheating and the inner V next, using the oil torch for preheating the seam from the outside. The manner in which the oil torch was used is indicated in Figs. 7 and 8.

Instead of tilting the course, as was done on the longitudinal seams to simplify the building up of the required reinforcement, the welding puddle was kept at an angle of from 10 to 15 degrees off center by turning the shell on the rollers as required. The welder, furthermore, instead of moving along the seam as it was welded, remained in one position and had the tank turned to suit his convenience.

The method of providing for contraction was also considerably different from that employed on the longitudinal seams. In the latter case, it will be recalled that the seam was spread at the open end and allowed to contract as the weld progressed. In setting up the girth seams, however, the abutting plate edges were spaced equidistantly along the entire seam and wedge clamps inserted at small intervals to retard the movement of the plate edges during welding. The four tack welds were made to prevent any undue contraction at one point and expansion at another.



Figs. 9 and 10.—Method of maintaining proper spacing of girth seams during welding of outer V. Note penetration being secured

It would appear that this method of providing for contraction by preventing it would tend to lock up the contraction stresses and thus give trouble. Since, however, a spacing of ½ inches was provided before tacking, the weld was allowed to contract in small increments and the effect of this contraction was largely prevented from being transmitted to the unwelded portion of the seam because of the wedge clamps and tack welds used. This method therefore prevented the locked-up stresses from building up in such magnitude as to give any trouble. In welding the second side of the double V, furthermore, the locked-up stresses caused by welding the first side were largely dissipated through the reheating of the welded area both by the oil torch and the oxy-acetylene blowpipe.

The application of this method was carried on in the following manner. The wedge clamps were removed for a distance of about 18 inches from the starting point of the weld. As the weld progressed, other wedge clamps were removed in such a way as to maintain a spacing of about ¼ inch, a foot ahead of the point of welding. To do this it was sometimes necessary to weld up to within about 4 inches of a wedge clamp before removing it, and the upright portion of the clamp, in this case acting as a wedge, had to be removed by cutting it out with the blowpipe. As the weld approached one of the tacks, however, the spacing between the plate edges naturally increased, and it was therefore a comparatively simple matter to control the contraction.

Following this method of procedure little difficulty was encountered in welding the six girth seams. At no point did the plate edges overlap, and for the greatest portion of the seams, the spacing between the plate edges varied from 1/16 to 3/16 inch. Figs. 9 and 10 illustrate the manner in which the wedge clamps were used to maintain the proper spacing. The thorough penetration of the seam is also made clear in these views.

(To be continued)

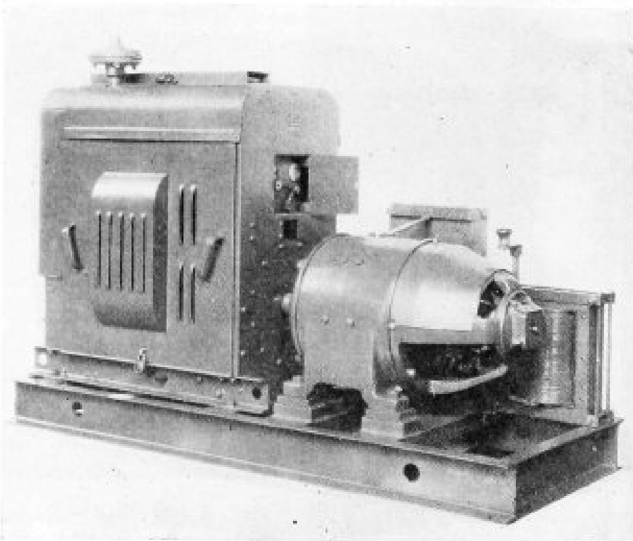
Small Sized Gas Engine Driven Welder

THE General Electric Company, Schenectady, N. Y., announces another addition to its line of welding equipment, a small engine driven welding outfit. This set incorporates the G. E. WD-11 welding generator with a continuous rating of 150 amperes and a one hour rating of 200 amperes, the welding duty range running from 50 to 250 amperes.

GENERATOR EQUIPMENT

The generator is driven by a Continental P-20, power unit rated at 18.22 horsepower S. A. E. and capable of developing 23.5 horsepower at 1,400 revolutions per minute. The generator is equipped with a control panel, rheostat and self-adjusting stabilizing reactor. The engine accessories include a strongly constructed radiator, pressure feed lubricating system with oil pressure gage and indicator, vertical tube gravity feed carburetor, air cleaner, centrifugal governor, starting crank, 10-gallon gasoline tank, tool box and sheet metal hood with sheet metal side panels which can be locked in place.

The outfit is particularly adaptable for oil field work and shop work where portability is desirable or for any application where no power supply is available for driving a motor generator type of welder.



Portable welding set

Boiler Manufacturers Hold Mid-Winter Meeting

Government survey of the industry proves successful—Reports to be issued monthly—Steel heating boiler trade shows encouraging gain

OVER 60 members and associates of the American Boiler Manufacturers' Association assembled at the Hotel Cleveland, Cleveland, O., on February 11 for the mid-winter meeting of the association. George W. Bach, vice president and general manager of the Union Iron Works, Erie, Pa., president of the association, presided at the meeting.

In reviewing the work of the association President Bach stated that its greatest accomplishment in the past has been the establishment and general adoption of the A.S.M.E. Boiler Code, which was brought about through the leadership of a former president, the late Colonel E. D. Meier, when he was president of the American Boiler Manufacturers' Association. Although this development was carried out by another organization better suited for the purpose, it was instigated largely from the membership of the American Boiler Manufacturers' Association and has had the whole hearted support of the boiler manufacturers from the start.

While in the past the activities of the American Boiler Manufacturers' Association have been devoted principally to technical matters, for the present, at least, technical matters have become of secondary importance and the commercial aspect of the industry has become of first importance. Attention is now being directed to such questions as a uniform code of practice covering specifications, guarantees, capacity, materials and workmanship, standardization in many small details and simplification of the form and character of preliminary drawings. Uniform methods and practice in such details should reduce the cost and simplify the transaction of business in the boiler field.

Topical Discussion

The first topic taken up for discussion was simplified practice covering wrought iron valves and fittings. It was pointed out by E. R. Fish, of the Heine Boiler Company, that this matter is foreign to the interests of the boiler manufacturers; others are in a better position to handle it and the boiler manufacturers can accept their findings.

President Bach called attention to a souvenir from the Kewanee Boiler Company, celebrating the 50th anniversary of the company. It was voted to appoint a committee of three to draft a letter of congratulation to the company.

Attention was directed to Bulletin No. 155 by Professor Parr issued by the University of Illinois Experiment Station, Urbana, Ill., on the "Prevention of Embrittlement in Boiler Plate" citing cases where the heads in boiler drums are becoming like glass below the water line while the material above the water line remains in its original condition.

A progress report was read from the association's representative on the joint committee with other associations which is studying the boiler feed water problem. This report reviewed the work of the committee and called for no action. President Bach stated that this work is in its infancy and urged the members to give to their representative the results of their observations on the problem.

Standard Code of Practice

Starr Barnum, of the Bigelow Company, speaking for the committee on Standard Code of Practice Regarding Boilers and Accessories referred to the fact that standard specifications had been worked up for an 18-foot horizontal return tubular boiler but that similar specifications for watertube boilers had not been accepted on account of the variety in design and construction of such boilers.

H. E. Aldrich, of the Wickes Boiler Company, stated that the work on standardizing settings and accessories is progressing satisfactorily but that the matter of standard data forms for horizontal return tubular boilers had been dropped. He urged that standards for suspensions should be carried out by the watertube boiler manufacturers. In this connection the tubular boiler manufacturers have agreed on a maximum ratio of $\frac{L}{R} = 120$ with stresses in the beams of not over 15,000 pounds per square inch and in bolt hangers of not over 10,000 pounds per square inch.

President Bach declared that the watertube people should at least agree on a standard factor of safety. As regards the tubular boilers, while it was found impossible to standardize details of construction it is proposed to standardize settings and accessories to the extent that boilers of the same size would not require special settings or connections but that there might be uniformity in the dimensions of settings and location of fittings and connections.

Oil Field Boilers

Jos. Broderick, of the Broderick Company, explained that while the manufacture of oil field boilers does not differ from that of other boilers the marketing problem is different; the demand is spasmodic, and firms that overstock with boilers during boom periods and then fail when the demand falls off and sell the surplus cheaply injure the regular firms. Changes in the size of boilers for this field have caused expensive changes in dies, machinery and other shop equipment. The field is a highly specialized one and cannot be extended to include other lines of work.

Mr. Bach uttered a warning against the tendency of manufacturers in one field attempting to take up another. It can't be done, he declared, and the manufacturer that sticks to one thing is the one who succeeds. This sentiment was concurred in by other speakers.

Steel Heating Boilers

C. E. Bronson, of the Kewanee Boiler Company, referred to the situation that exists, particularly in Massachusetts, where the requirements for low pressure steel heating boilers are just as stringent as those for high pressure power boilers, whereas the requirements for cast iron heating boilers are nothing at all except a hydrostatic test pressure. Therefore the steel heating boiler has to stand the greater expense of shop inspection, etc.

President Bach emphasized the opportunities for trade extension that lie in the steel heating boiler field as well as in the modernizing of power plants. In view of the fact that in many cases power is merely a by-product in steam using he predicted a satisfactory growth in the industrial power plant field.

The report of the committee on the A.S.M.E. Boiler Code comprised a letter from C. W. Obert, secretary of the Boiler Code Committee, calling attention to new

A.S.T.M. specifications for carbon-steel castings for valves, flanges and fittings for high pressure service and for carbon-steel and alloy-steel forgings published in the December, 1926, issue of *Mechanical Engineering* which are to be included in the addenda to the Code to be issued sometime in May of this year.

In presenting this report, President Bach took occasion to remind the members of the association of the splendid work being done in the American Society of Mechanical Engineers for the boiler making industry by Mr. Fish, Mr. Pratt and others identified with the boiler industry.

The Stoker Committee failed to report owing to the absence of the chairman, and no new business was reported by the commercial committee.

American Marine Standards

E. R. Fish reported that the A.S.M.E. Boiler Code Committee has a small committee working with the American Marine Standards Committee, the correspondence dealing chiefly with the quality of boiler plate. Progress is being made and when a decision is arrived at the results will be published.

Welding of Pressure Vessels

E. R. Fish referred briefly to the work of the joint committee of pressure vessel interests and of welding interests, stating that the American Bureau of Welding is about to conduct another more elaborate series of tests to show the reliability of welded pressure vessels. Various types of riveted and welded tanks will be tested to destruction.

President Bach called attention to the more favorable reaction that exists today with respect to welded tanks as compared with the case 4 or 5 years ago.

Dished Heads

The need was pointed out for the development of a rational formula for the better design of dished or bumped heads. This must be settled by a revision of the boiler code and a hearing on this subject is to be held by the A.S.M.E. Boiler Code Committee at 29 West 39th Street, New York, at 8 P.M. on March 17. The members voted to appoint a committee of 5 to represent the association at this meeting and all were invited to attend the meeting or to communicate to the committee any information or ideas they might have that would be useful in solving this problem.

Secretary's Report

The report of the secretary and treasurer showed that during the last 6 months two active members had joined the association but that one active and two associate members had withdrawn. The present membership, totaling 103, comprises 3 honorary, 70 active and 30 associate members.

The death of three members, Dr. J. T. Duryea, president of the Ames Iron Works, James B. Stanwood, of the Stanwood Corporation, Cincinnati, O., Mr. O'Dea of the Oil City Boiler Company, and B. N. Broido, chief engineer of the industrial department of the Superheater Company, were recorded and fitting resolutions adopted signifying the loss to the association.

Survey of the Boiler Making Industry

After luncheon, which was served in a private dining room adjoining the convention hall, President Bach explained how the executive committee which was empowered at the last annual meeting to proceed with the preliminary work of arranging for a survey of the industry had taken the matter up with the Department of Commerce in Washington and secured the cooperation of the Bureau of Census for carrying out the work. He then introduced Mr. L. Seth Schnitman, of the division of industrial statistics of the Bureau of Census, who presented the following report on steel boilers:

Steel Boilers

Orders were received for 8,931 steel boilers during the first half of 1926 by 58 manufacturers, comprising most of the leading concerns in the industry, according to a preliminary report of the Department of Commerce, while shipments by these firms for the full year 1925 totaled 13,417 boilers and, in 1924, they shipped 12,215 boilers. More boilers were shipped in 1925 than in any other year since the end of the war up to that time but, in square footage, 1920 shipments were the highest, followed by those of 1923. Of the various types of boilers reported only steel heating stationary boilers and Scotch marine boilers showed increases over 1924 both in number and in square feet of heating surface.

The 58 reporting firms indicated that, on the average between 1919 and 1925, 8,960 persons were employed in their boiler departments, 880 of these being in the executive, engineering or sales organizations, 7,210 in the shops and 870 in erection work. These firms used annually during that period 90,078 net tons of steel plate, 17,095 of structural shapes, 8,376 of bars, and 53,253 of tubes; they also reported 23,495 gross tons of castings.

The following table gives the number of reporting firms arranged in two groups: (a) According to the proportion of output shipped for export in 1925 and (b) according to the proportion of total money value of output in 1925 represented by the chief kinds of products. A few firms did not report on these items.

TABLE I—STEEL BOILERS

	Number of firms classed according to					
	Proportion of output shipped for export in 1925		Proportion of total money value of output in 1925 represented by			
Percentage groups	In number of units	In total heating surface	Boiler and boiler parts	Stacks, breechings & flues	Boiler accessories	Tanks, digesters, etc.
None	38	38	2	9	17	16
1 to 10 percent	7	9	8	24	22	13
11 to 20 percent	6	4	3	8	10	5
21 to 30 percent	2	2	4	4	3	5
31 to 40 percent	..	..	2	3	..	4
41 to 50 percent	..	..	0	4	..	1
51 to 60 percent	..	..	6	..	..	3
61 to 70 percent	..	..	4	..	..	3
71 to 80 percent	..	..	4	..	..	0
81 to 90 percent	..	..	10	..	..	2
90 to 100 percent	1	1	9	..	..	..
Total	54	54	52	52	52	52

DISCUSSION

In presenting this report Mr. Schnitman outlined briefly what the Bureau of Census has done in the collection and dissemination of industrial statistics under the Hoover administration. This work started in a modest way and covered only statistics compiled by the trades. A digest of these trade figures led to the realization that the existing statistics were not sufficient to be of much value to the industry. The industrial survey now covers 1,700 figures on industries each month and this is to be enlarged.

The steel boiler report covers 58 manufacturers. Over 200 firms were circularized at first but it was soon found that a majority of them were in the repair business. Since the report was tabulated, reports have been received from

TABLE II—STEEL BOILERS (AS REPORTED BY 58 MANUFACTURERS)

Type	Shipments 1919 No.	1919 Sq. ft.	1920 No.	1920 Sq. ft.	1921 No.	1921 Sq. ft.	1922 No.	1922 Sq. ft.	1923 No.	1923 Sq. ft.	1924 No.	1924 Sq. ft.	1925 No.	1925 Sq. ft.	Orders Received First Half, 1926 No.	First Half, 1926 Sq. ft.
Grand total	10,002	16,158,208	10,308	17,921,492	6,543	8,522,821	11,244	12,623,264	13,169	16,507,132	12,215	14,554,989	13,417	14,692,232	8,931	8,673,700
Stationary—																
Total	8,887	12,352,142	9,847	16,406,077	6,312	7,565,382	11,131	12,386,146	13,099	16,386,146	12,087	14,273,369	13,272	14,458,753	8,837	8,528,961
Watertube	1,907	7,867,701	2,564	11,100,285	888	3,684,324	1,255	6,171,654	1,678	9,552,769	1,365	8,093,504	1,380	7,417,304	759	4,078,011
Horizontal return tubular	1,692	2,060,992	1,866	2,425,091	1,221	1,515,271	1,676	1,978,501	1,698	2,027,174	1,379	1,691,430	1,243	1,625,759	521	682,211
Vertical fire tube	1,629	488,868	1,737	569,588	1,031	284,957	2,120	644,594	2,283	738,370	1,570	450,069	1,553	461,726	1,002	274,830
Locomotive (not railway)	451	207,562	529	246,140	232	120,506	374	215,361	530	269,371	417	209,824	342	154,397	210	102,980
Steel heating[1]	1,908	1,140,597	1,935	1,458,462	2,172	1,553,360	4,621	2,776,940	5,782	3,139,915	6,533	3,388,086	8,017	4,295,957	6,162	3,313,285
Oil country	1,024	507,380	703	442,333	621	363,573	923	548,895	879	575,627	535	319,412	477	386,840	23	7,430
Self-contained portable[2]	276	79,042	513	164,278	147	43,391	162	50,121	249	82,920	288	121,044	260	116,770	160	70,208
Marine—																
Total	1,115	3,806,066	461	1,515,415	231	957,439	113	237,118	70	120,986	128	281,620	145	233,479	94	135,739
Watertube	821	3,125,687	169	810,144	99	667,410	50	164,049	16	46,581	67	229,754	52	134,823	25	76,925
Pipe	33	36,914	11	11,612	9	10,683	7	8,286	12	16,338	8	7,180	11	11,909	4	872
Scotch	244	636,695	261	681,976	102	269,418	34	55,061	22	45,238	35	37,081	63	75,031	53	48,478
Two and 3 flue	17	6,770	16	10,760	17	8,670	16	6,660	14	5,770	16	6,800	15	8,170	10	7,100
Miscellaneous	...	......	4	923	4	1,258	6	3,142	6	7,059	2	805	4	3,546	2	2,364

[1]As differentiated from power boilers.
[2]Not including types listed above.

six or seven additional firms and it is believed that revised statements, to be issued later if the association desires to continue this work, will include as many as 70 boiler manufacturing concerns. He urged any present who had not contributed to the report to do so and for the members to act as missionaries among other firms so that a complete survey may be obtained.

It is believed that the present report represents a very satisfactory result and that the opportunity to make it more complete is excellent. The facts disclosed by the report show a most reassuring growth in the shipment of steel heating boilers, which is consistent with the growth of the building industry. Reports from the oil country boiler manufacturers, however, show a downward tendency generally but it must be admitted that these are incomplete.

Mr. Schnitman emphasized strongly the point that all figures submitted to the Bureau of Census for these reports are strictly confidential. Individual reports are handled only by sworn census employees and no other persons can have access to them. Mr. Schnitman pointed out that the survey should be continued and that the figures should be brought up to date periodically. Although it is up to the members of the association to say whether a monthly report should be issued or not, the Department of Commerce is ready to cooperate and to continue the survey.

President Bach went over the report item by item analyzing the figures. It was found that the size of the watertube boiler units has not increased as much as was anticipated during the past 5 years. This shows that the small unit is still in demand. The report shows that the watertube boiler manufacturers are holding their own in the volume of business and that the stationary horizontal return tubular and vertical and locomotive types follow this tendency consistently. The report of the steel heating boilers, however, is very encouraging as it shows a wonderful increase. The reports of the oil country and self-contained portable boilers do not show up as well, possibly due to the erratic nature of the business. The totals for the first half of 1926 show a good increase.

In reply to a question asked by Mr. Bach as to how the boiler business compares with other established industries, Mr. Schnitman stated that the boiler returns represented a fairly accurate index of business conditions and also a reliable forecast of future business. Taken in relation with other related industries, the boiler industry does not stand by itself, it follows the others in a consistent way. In his opinion the periodical survey will prove as valuable a medium for a guide to the industry as could be found. It represents a cross section of the industry with which the individual's business can be compared.

In a general discussion which followed it was pointed out that although the kilowatt hour output generated per year in the last 5 years had increased 100 percent, the boiler output had remained about the same. It was pointed out on the other hand that the more efficient use of steam means less horsepower required and that the efficiency of the power plants had steadily increased to the point where further increases must be very much less. As stated by Mr. Bach, you cannot base the requirements to come on the last 5 years' output; it is entirely probable that the demand will increase 100 percent. It was also pointed out that the earnings on investments in central stations have decreased in the last 5 years and that the efforts of the public utility interests are likely in future to be directed towards the soliciting of a higher rate business rather than cheap power which should improve the condition for the isolated power plant.

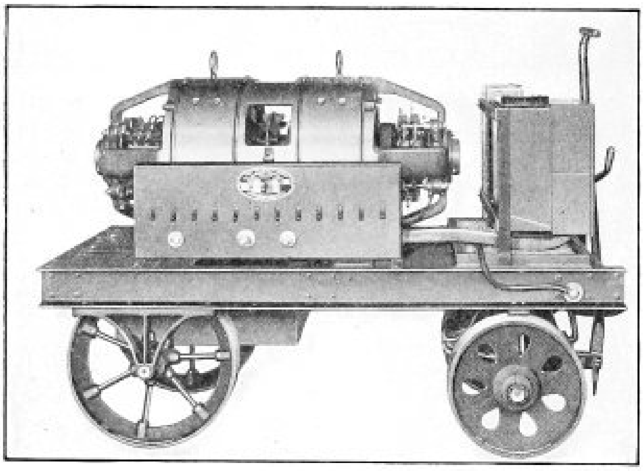
It was voted to continue the monthly reports. Those present agreed to furnish the statistics called for by the Department of Commerce and the majority seemed eager to urge other members to cooperate in this movement to improve the statistics from the industry. The general feeling toward the survey was aptly expressed by Mr. Bach in the statement that the survey is the most useful activity of the association since the A.S.M.E. Boiler Code was promulgated.

Before adjourning, the active members held a brief executive session. The time and place for holding the annual meeting were referred to the executive committee.

The Missouri Pacific is inquiring for 31 machine tools, including two two-spindle rod boring machines, one No. 5 plain milling machine, one 10-inch by 36-inch Universal grinder, one 24-inch engine lathe, one 16-inch splitting shear, one 36-inch gap spot welding machine, and one No. 1 angle iron bending roll, all of which are for use at Sedalia, Mo., one 15-ton electric traveling crane, one squaring shear, one 5-foot radial drill, one 48-inch vertical drill, one No. 5 plain milling machine, one 36-inch draw cut shaper, one 13-inch Universal punch and shear, one 42-inch engine lathe with 9 foot center, one 20-inch slotter and one Fordson tractor with boom, all of which are for use at North Little Rock, Ark., one geometric chaser grinder, one sensitive drill, one 10-inch by 36-inch Universal grinder, one 48-inch vertical drill, one Fordson tractor with boom, one 36-inch draw shaper, all of which are for use at Kansas City, Mo., one 20-inch engine lathe, one 42-inch vertical drill press and one Fordson tractor, all of which are for use at Osawatomie, Kan., one 20-inch engine lathe for use at Falls City, Neb., one double grinder and one 32-inch crank shaper for use at Omaha, Neb., one 90-inch driving wheel lathe for use at St. Louis, Mo., and one distributing valve test rack for use at Alexandria, La.

The Mann Two-Operator Electric Arc Welder

THE Mann electric arc welder, shown in the illustration, is a two-operator, 300 ampere, portable machine, manufactured by the Electric Welder Controller Company, 602 Bigelow boulevard, Pittsburgh, Pa. The machine furnishes welding current for two men, simultaneously, with no interference between the operators. The unit may also be used as a single operator set by paralleling the two welding leads. Operating in this manner, the operator will have a range of current from 10 to 350 amperes, and he can use any size of electrode from 1/32 inch to ⅜ inch. The machines driven by direct current are furnished with commutators at both ends. The machine has an emergency step for intermittent cutting at 700 amperes and will cut through and burn fitting holes in plates up to ½ inch in thickness.



The Mann two operator, 300 ampere, portable type electric arc welder

The generator will supply from 36 to 40 volts, but will give arc voltage as high as 10 volts for starting and momentarily bridging gaps. The driving motor is 15 horsepower. Ball bearings are standard on all units. The control system is by push button or toggle switch control in steps of 10 and 20 amperes. The machine is fully equipped with the necessary accessories, including all welding leads, an electrode holder with a flexible cable, a hand shield and a wire brush. A welder's locker or tool box is provided on each unit.

A Fatal Explosion of a Steel Drum

MANY a fatal accident has been caused by a gun or revolver, in the hands of a person who "didn't know it was loaded." Likewise, many a fatal or serious injury has been caused by the explosion of a supposedly empty container of some kind, which once held a volatile, inflammable liquid, or a substance containing such a liquid as an essential constituent, but which was assumed to be empty or "unloaded." In both cases many unfortunate and disastrous events have proved the danger of acting on the supposition that all the conditions were safe, instead of making a preliminary investigation to learn the actual facts, and taking appropriate precautions to avoid injury.

A recent explosion of a steel drum, under rather unusual circumstances, furnishes another proof of the danger of taking anything for granted. Some rivets were to be cut from a steel truss by means of an oxy-acetylene torch, and the truss was loaded on a truck and brought to the plant where the work was to be done. It was decided to leave the truss on the truck while removing the rivets, but in order to do so it was found necessary to provide a temporary platform to facilitate the work. A platform was therefore improvised by standing two "empty" steel drums on end and laying a plank across them.

Soon after the rivet-cutting operation had started, one of the drums exploded violently. The operator of the oxy-acetylene torch, who was standing on the platform at the time, was thrown into the air and fell to the ground, striking on his head. Flames burst out immediately after the explosion and enveloped the workman,—making it impossible to rescue him before he was burned to death.

The fact that this drum exploded proves that it was not empty, as had been supposed, but that it contained something of an explosive and inflammable nature. Upon making inquiries it was learned that it had formerly held asphaltum paint. This appears to furnish a possible explanation of the occurrence, because benzol or some other volatile and inflammable liquid is ordinarily used as a solvent in paint of this kind. Vapors of a solvent of this sort are likely to remain in a container for a long time, even after all the liquid has been drawn off; and if a flame or spark were brought near an opening in the container, these vapors are likely to ignite, and to produce an explosion if they are mixed with air in the right proportion.

There was an open bung-hole near the top of the tank that exploded, and it seems probable that fumes issuing from this opening during the rivet cutting operations were ignited by the burning oxy-acetylene torch (or by flying sparks), and that the flame flashed back into the drum with the results that have been noted.

The combination of events and conditions which resulted in this accident was unusual, and might never be reproduced in exactly the same way. With minor and inconsequent changes, however, the same thing may occur any day, in many another plant; and this accident should serve to warn every reader of the danger of using drums, cans, and other containers, without having definite knowledge of their past history and present condition. Even when (according to ordinary indications) the original contents have been entirely removed, inflammable, poisonous, or otherwise harmful fumes and vapors may remain, which will cause trouble when and if the conditions become favorable. The practical lesson is that containers which have at any time been used for explosive, inflammable, poisonous, or corrosive liquids, gases, or solid substances, should be disposed of in some safe way. When emptied they should be returned promptly to the manufacturers or supply houses from which they were obtained, or (if not returnable) they should be destroyed in some safe way. They should never be subsequently used for any purpose whatsoever,—not, at any rate, unless they have been thoroughly cleansed by somebody who knows how to do it effectively. In particular, be sure to avoid using or storing containers of volatile or inflammable materials and substances under any conditions where they will be exposed to heat or sources of ignition.—*The Travelers Standard.*

THE CHICAGO & NORTHWESTERN has ordered 12 2-8-4 type locomotives and 8 eight-wheel switching locomotives from the American Locomotive Company. The 2-8-4 type locomotives will have 27-inch by 32-inch cylinders and a total weight in working order of 395,000 pounds, and the eight-wheel switching locomotives will have 25-inch by 28-inch cylinders and a total weight in working order of 224,000 pounds.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Elbow Development

Q.—I would like to have you give me a good method to lay out an elbow of heavy plate, $\frac{5}{16}$ inch or ⅜ inch, each section of the elbow to have a large and a small end as is required in blow pipe work. I understand thoroughly how to develop an elbow and how to lay out the miter lines, but I have never been able to fathom this point.

(2) Can you give me the name and place where I can purchase a book on structural design that is as good an authority as "Laying Out for Boiler Makers" is in plate work?—P. S.

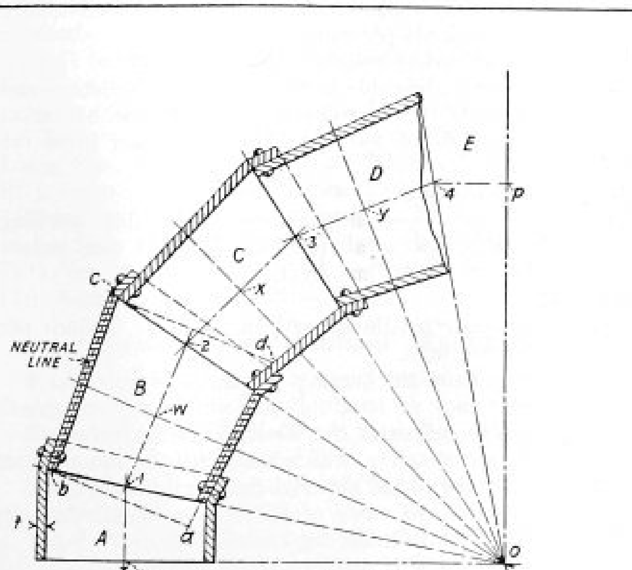
A.—The construction of one section of the elbow is given which will indicate the method of projection ordinarily applied in layouts of this kind. The plate thickness *t*, Fig. 1, is enlarged to show the tapered connections to better advantage. Lay off first the right angle *p-o-p* making the distance *o-p* equal to the depth of the elbow measured to the center of its openings. With *o* as a center draw the arc *p-p* and divide the arc into one less than the number of sections required in the elbow, thus locating the points *w-x-y*. Bisect the arc lengths *w-p* and *y-p* which locates the points 1 and 4. From point 1 set off the point 2 equal to *pw*, likewise locate the point 3. Connect *o-1*, *o-2* and *o-3* with straight lines on which lie the meters between the sections.

Consider the flow of air or gases to pass through the elbow in the direction shown by the arrow; in which case the elbow should be so installed that the gas travel is not affected by the overlapping plates at the joints. Fig. 1 shows the correct position of the joints to meet this requirement.

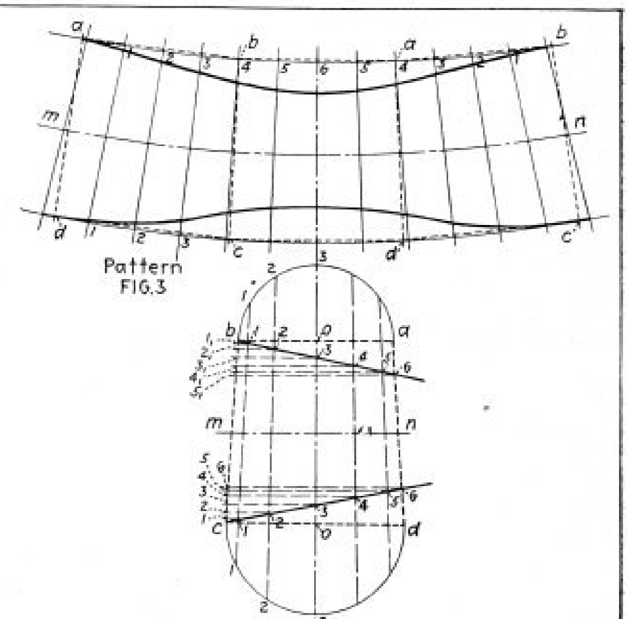
The next step in the construction is to draw the center line of each elbow section as *p-1*, which is at right angles to *o-p* and *1-2* which is at right angles to *o-w* and passes through point *w*. The axis *2-3* is perpendicular to *x-o* and passes through point *x* and *3-4* is perpendicular to *y-o*. The sections of the elbow are drawn in so that they taper, in which case the difference between the respective ends is equal to 2 plate thicknesses as indicated in Fig. 1.

From Fig. 1 the pattern layout is obtained by first constructing a frustum of a cone of which the elbow section is a part, as shown at *a-b-c-d* of section *B*, Fig. 1. This section is reproduced in Fig. 2. In cases where the taper is slight a convenient and short method of laying off a pattern for frustum of a cone is shown in Fig. 3. The pattern of the frustum is essential in this development for obtaining the elbow pattern.

In Fig. 3 reproduce three sections of the frustum *a-b-c-d*, Fig. 2, which is drawn to the neutral line of the plate thickness. Through the points *a-b-a-b* at the small end draw in the camber line and through *d-c-d-c* at the large end draw the camber for the large base. The line *m-n in* Fig. 2



Sectional Elevation of Elbow
FIG. 1



Elevation of Section B
FIG. 2

Details of layout and construction of a ninety degree elbow bisects *o-o* and the corresponding position of *m-n* is drawn in Fig. 3. In Fig. 2 semicircles are described from point *o* for the upper and lower base profiles of the frustum. They are then divided into equal parts and construction lines drawn in as shown. On the camber lines, Fig. 3, lay off the stretchout for the upper and lower bases by setting off the arc lengths *1-2*, *2-3*, etc., of the semicircles, Fig. 2. Then in Fig. 3 draw in the radial lines *1-1*, *2-2* and *3-3*, etc. Where the miter lines, Fig. 2, intersect the radial lines at *1-2-3-4*, etc., locates the points for determining the true lengths of the lines *1-1*, *2-2*, *3-3*, etc., of the elbow section.

At right angles to the line *o-o* and from points *1*, *2*, *3*, *4* and 5 draw lines to intersect the outer element of the frustum as at 1_1, 2_1, 3_1, etc. The true lengths of the development lines for the elbow pattern are then transferred from Fig. 2 to Fig. 3, taking the respective lengths from the base line *m-n*, Fig. 2, and laying them off from *m-n* of Fig. 3. The lap for the riveted joint must be allowed and the holes spaced off equally. The rivet line on the opposite end of the pattern is spaced into the same number of parts but the pitch will be less on account of the end being smaller so as to fit into the larger end of the adjoining section. This completes the more essential steps in this layout.

(2) Write the U. P. C. Book Company, Inc., 243-249 W. 39th Street, New York, N. Y.

Stack and Breeching

Q.—Please tell me what shape is a possum belly breeching? When you use one stack to connect two boilers do you make the stack larger in diameter than when using one boiler to one stack?

In the December number I noticed a ventura breeching. Why is the breeching this shape?—J. F. D.

A.—The stack or chimney should be so proportioned in area and height as to readily convey the gases and promote sufficient draft to burn the fuel. A stack proportioned for a boiler of a given size, could not be used under natural draft conditions for a two boiler installation.

The following formula based on practical experience gives the required flue area, where coal is burned.

$$A = \frac{W}{12\sqrt{h}}$$

in which

A = area of flue in square feet.

W = weight of coal in pounds.

h = height of stack in feet.

Will some of our readers furnish a sketch of a possum belly breeching?

The ventura breeching referred to is probably so designed, to make connections with the pipes *A* and *B* within a limited space. Otherwise the construction for conveying gases is poor, on account of the reduced area at the intersection of the two cones.

Lap and Dished Heads

Q.—Will you please answer for me the two following questions?

(1) Which head is stronger for air reservoirs, concave or convex?

(2) What is meant by lap? Is it from A to B or from A to C. Thanking you in advance for this information and assuring you that I always read your page with great interest. R. H. L.

A.—The distance *l* as shown in Fig. 1 is invariably referred to as the lap by boiler makers, which is measured from the center of the rivet hole to the edge of the plate. Others refer to *L* as the lap. The distance *l* or lap is usually made 1½ times the diameter of the rivet.

The heads shown in Fig. 2 are called *dished heads.*

When a head is inserted in the shell as shown at (*a*) Fig. 2 it is called *concave*, and arranged as shown in (*b*) it is called *convex*. A concave head is used only where there is no manhole opening in the vessel to permit riveting.

Dished heads are self-supporting to a certain extent, and require no bracing when made of sufficient plate thickness and of proper material. The convex head is the strongest, which varies with the radius to which it is bumped. The

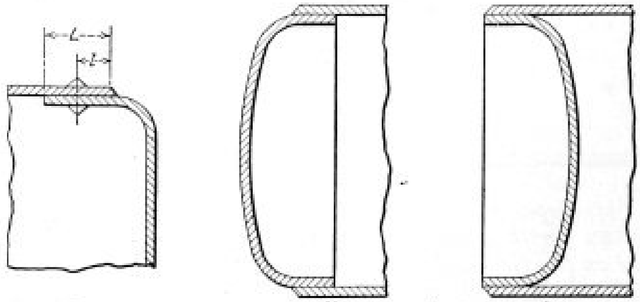


Fig. 1 (b) Fig. 2 (a)

Details of tank heads

concave head is considered to have only six-tenths the strength it would have if applied as a convex head. Refer to P. 185 of the A.S.M.E. Code.

Factor of Safety

Q.—I have been reading The Boiler Maker quite a while and am writing for information about two problems, and I would thank you very much for this information. In a boiler carrying 200 pounds pressure, having 13/16-inch outside diameter, staybolts with 3/16-inch telltale hole, how far apart may the bolts be placed and have a factor of safety of 5?

(2) What is the factor of safety of a boiler whose weakest part is the longitudinal seam course having ¾-inch plate, 50 inches inside diameter; working pressure, 225 pounds; joint efficiency, 75 percent, and tensile strength of plate 55,000 pounds? Please may I hear from you soon?—G. W. T.

A.—The rule governing staying of flat plate is given in Section III, Boilers for Locomotives, A.S.M.E. Code. There is no definite size of stay for each different thickness of plate. The strength of the stayed plate will depend on the pitch of stays and the manner in which they are fastened to the plate. The tensile strength of steel staybolt bars according to the A.S.M.E. Boiler Code shall be 60,000 pounds per square inch but the allowable stress is figured in accordance with Table P-7 of the Code. Thus for screw stays of the hollow steel type not exceeding 20 diameters in length and having heads riveted over, are allowed a safe stress of 8,000 pounds per square inch.

The factor of safety equals $60{,}000 \div 8{,}000 = 7\frac{1}{2}$.

The maximum allowable working pressure is determined from the strength of the weakest course of the boiler, as given in Par. 180 of the A.S.M.E. Code and from the formula:

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

in which,

TS = ultimate tensile strength of the plate, pounds per square inch.

t = minimum thickness of plate, inches.

E = efficiency of longitudinal joint in percentage.

R = inside radius of the weakest course, inches.

FS = factor of safety, which is the ratio of the ultimate strength of the material to the allowable stress.

By transposing, the value of FS may be found when the other values of the formula are known, thus,

$$FS = \frac{TS \times t \times E}{R \times P}$$

Substituting the values given in your example.

$$FS = \frac{55{,}000 \times 0.75 \times 0.75}{25 \times 225} = 5\frac{1}{2}.$$

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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Statistician—E. W. Farmer, Rhode Island.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.
William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.
Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.
James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.
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First Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.
Second Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.
Third Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.
Fourth Vice President—George B. Usherwood, supervisor of boilers, New York Central.
Fifth Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington and Quincy.
Secretary—Harry D. Vought, 26 Cortlandt Street, New York.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.
Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

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Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.
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States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

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

Cities

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

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

States

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

Cities

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

SELECTED BOILER PATENTS

Compiled by

DWIGHT B. GALT, Patent Attorney,

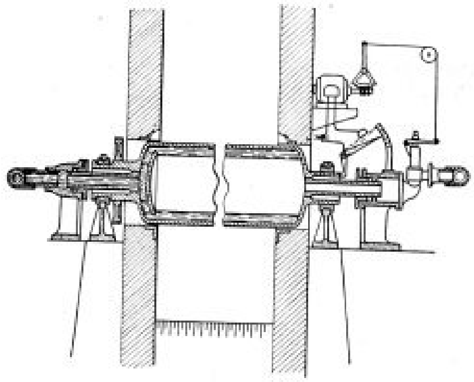
Washington Loan and Trust Building,

Washington, D. C.

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

1,611,097. JOHAN VIKTOR BLOMQUIST AND KARL FREDRIK WESSBLAD, OF STOCKHOLM, SWEDEN. APPARATUS FOR INDICATING THE ELONGATION OF TUBULAR ELEMENTS COMBINED WITH SAFETY DEVICES IN STEAM GENERATORS.

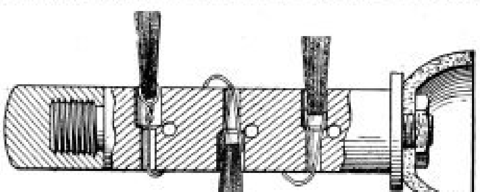
Claim 1. A rotary steam generator in which steam is generated in a plurality of tubular elements each containing a rotary layer of water, comprising, a furnace, a plurality of tubular elements mounted in the



furnace, means to produce a rotary layer of water in each element, each element having means for keeping one end of the tubular element in a fixed position to prevent it from moving axially, means for supporting the other end to permit this latter end to freely expand in an axial direction, an indicator coacting with said latter end of the tubular element, and means for transmitting the movement of axial expansion of said element to the indicator, to measure the axial expansion of the tubular element thereby. Five claims.

1,598,771. CHARLES C. GERHARDT, OF NEW YORK, N. Y. BOILER TUBE CLEANING BRUSH.

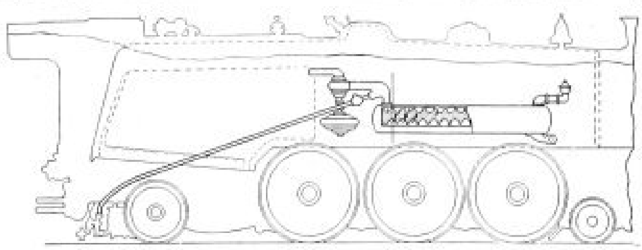
Claim—A brush for cleaning boiler tubes comprising a solid body portion of metal having a plurity of sockets bored therethrough and arranged in spiral formation, each socket comprising a portion of a larger diameter



and a portion of smaller diameter, an abutment formed at the inner end of the larger portion, a tuft of wire disposed in the larger portion of each socket and seated against said abutment, a wire for retaining said tufts in position and extending from the smaller portion of each socket round the circumference of the body portion to the smaller portion of the next socket, and means on one end of said body portion to detachably receive the brush actuating means. Four Claims.

1,611,805. LESTER P. BARLOW, OF CLEVELAND, OHIO. FEEDWATER PRECIPITATOR.

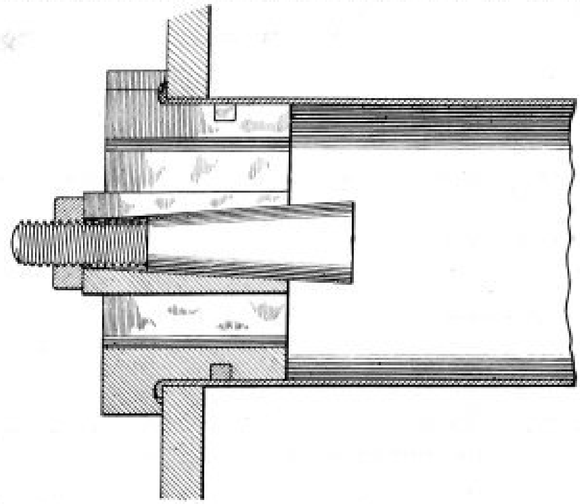
Claim 1. The method of precipitating mineral matter held in solution in feed water and separating the precipitate from the water which consists in maintaining a rapidly flowing stream of hot water of relatively large volume from one portion of the boiler to another portion thereof, supplying relatively cool feed water in relatively small volume and mixing



the same with said steam to cause mineral matter carried in solution in said feed water to be precipitated by the heat of the hot boiler water, and separating the precipitate from the water of the flowing stream by causing the flowing stream to follow a helical path about a horizontal axis at such speed as to cause the precipitate to be carried to the outside of the helical path by the momentum due to its specific gravity being greater than that of the water. Three claims.

1,613,523. JESSE L. MEGATHLIN, OF MIAMI, FLORIDA. EMERGENCY BOILER-TUBE PLUG.

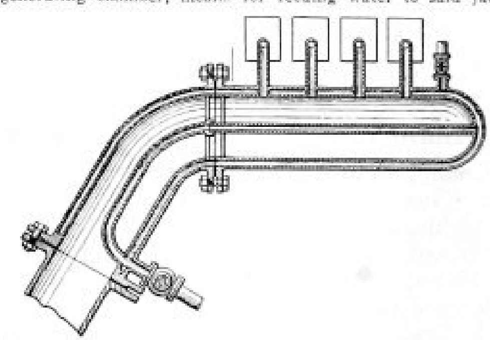
Claim.—An emergency plug for stopping a leak between the end of a tube and a sheet through which the tube extends, comprising an annular rim to fit in said tube, a hub and spokes connecting said hub and rim, with openings between the spokes through which fluid may flow through the tube, said rim having an outstanding collar at its outer end formed



with a grooved shoulder to fit over the beaded end of the tube, said rim, collar and hub being divided radially, said rim having a circumferential groove between the collar and the inner end of the rim, a circular spring in said groove, the hub having a circular hole therein tapering from the inner to the outer end of the hub, a tapered pin of circular cross-section fitted in said hole and having a screw-threaded stem at its outer end, and a nut threaded on said stem and bearing against the outer end of the hub.

1,610,810. THEOBALD H. NOLL, OF NEW YORK, N. Y. STEAM-GENERATING MEANS.

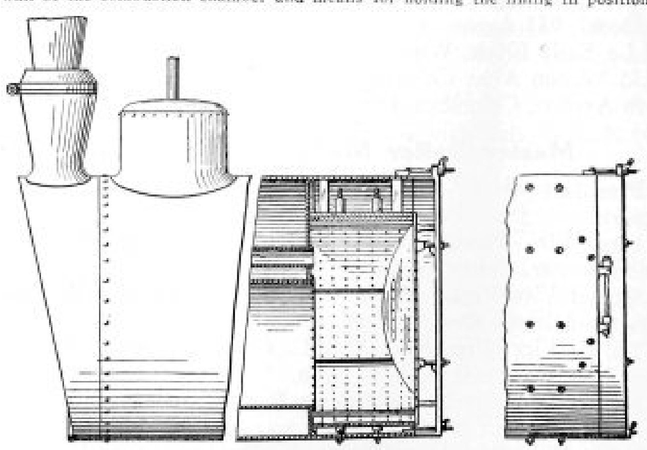
Claim 1. A manifold formed with an enclosing jacket constituting a steam-generating chamber, means for feeding water to said jacket at its



extreme inner end and extended substantially centrally therethrough, a water inlet control valve, and a steam outlet control valve for said enclosing jacket.

1,615,789. WILLIAM J. FISHER, OF YORK, PENNSYLVANIA, ASSIGNOR TO A. B. FARQUHAR CO., LTD., OF YORK, PENNSYLVANIA, A LIMITED PARTNERSHIP OF PENNSYLVANIA. BOILER.

Claim 1.—A boiler having a combustion chamber having an air cooled outside wall, a lining therefor, the lining being spaced wholly from the wall of the combustion chamber and means for holding the lining in position



in spaced relation to the combustion chamber wall, the space between the lining and wall being co-extensive with the lining, said means having very small contacting surface with the wall whereby the conduction of heat from the lining to the outer wall is minimized, the upper portion of the lining extending across the chamber adjacent the level of the lower portion of the steam space of the boiler. Three claims.

The Boiler Maker

Volume XXVII **April, 1927** **Number 4**

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
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Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.

Cable address: Urasigmec, London.

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

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CONTENTS

Master Boiler Makers' Convention

THIS issue of The Boiler Maker contains the last notice to members of the Master Boiler Makers' Association and of the Boiler Makers Supply Men's Association of the forthcoming eighteenth annual convention of the Society. This convention will be held in Chicago at the Hotel Sherman on May 3, 4, 5 and 6, and because the time available in which to make reservations is short, it behooves all those who intend to participate in the meetings to lay their plans accordingly.

To members of both associations this annual convention offers the greatest possible benefit; to the former it presents the opportunity of reviewing progress made in the construction, repair and maintenance of boilers and to the latter the facilities of a general exposition of useful and new equipment produced for the use of members of the boiler making fraternity.

Conventions during the past few years have been excellent examples both in numbers present and in interest shown of the value of this annual gathering and indications point to an even greater attendance and more general participation in the convention this year than ever before. At the time of going to press a larger number of exhibitors of equipment had signed for space in the exposition hall than were represented last year. With three weeks in which members of the Supply Men's Association who have not already reserved space to do so, the number of exhibits will be somewhat greater than the 60 odd companies who are so far listed.

One feature of the convention will be the session devoted to the discussion of the corrosion and pitting problem. The committee on this subject has prepared a comprehensive report covering it and members of the Association of Water Service Engineers have accepted invitations of the Master Boiler Makers' Association to be present for the discussion. While on the subject of papers the secretary of the Association has taken occasion to commend the members of topic committees on the promptness and thoroughness with which they have done their work this year. For the first time in many years all papers on special subjects were submitted in final form before the closing date for the publication of the program. In future years the efforts of the 1927 committees will serve as an example of committee efficiency.

The program of the convention, the layout of the exposition hall, and location and names of companies exhibiting equipment appear on pages 97 and 98 of this issue. A complete report of the convention will be published in the May issue.

Fifth Meeting of National Board

A NOTICE has been issued by the National Board of Boiler and Pressure Vessel Inspectors that the fifth annual meeting of this body will be held at Nashville, Tenn., June 14, 15 and 16. Although the meeting in general is limited to chief inspectors of state boiler departments, insurance companies, members of the boiler code committee and a few others, it is understood that all those interested in the work of promoting uniformity in the administration of the boiler code, including manufacturers of boiler and equipment and any others who have problems to discuss which come under the jurisdiction of members of this body will be welcome to attend and take part in the proceedings. A report of this meeting will appear in the July issue of the Boiler Maker.

The Weakening of Boiler Shells

At a recent meeting of the Ohio Board of Boiler Rules, attention was called to a practice that has become more or less common and one which is dangerous—that of drilling the heads and shells of boilers for the connection of water screens and water cooled walls. Steps were immediately taken to stop the practice in this state and to call to the attention of engineers in general a condition which weakens the original structure of a boiler. The extract from the minutes of this meeting of the Board of Boiler Rules in Ohio dealing with the subject follows:

"The attention of the Board was directed to the tendency on the part of builders of water screens and water cooled bridge walls to make connections to drum heads of boilers for downcomers and riser pipes. The heads of these boilers, especially those already in service, are not of the proper thickness to take care of the plate removal necessary for these openings, and in the opinion of this Board this construction creates a dangerous condition. It was unanimously ruled that this construction is not acceptable to this Board, and the Division of Boiler Inspection, is requested to send out a circular letter to boiler inspection companies, boiler manufacturers and manufacturers of water cooled walls, calling their attention to this condition."

The ruling adopted by the Board to provide for connections of this kind states that shells and heads must be increased in thickness a sufficient amount to compensate for the metal removed by making openings for the installation of water screens and water cooled walls.

So far as is known no similar action has been taken by the boiler inspection departments of other states, but the subject is one that requires attention. Undoubtedly the matter will be discussed at length at the coming meeting of the National Board and exact requirements outlined to govern installations of this character throughout all code states.

Shop Kinks

From time to time editorials have been published in The Boiler Maker on the subject of boiler shop kinks and their value to those engaged in the construction and repair of all types of boilers, tanks and miscellaneous plate work. Every practical man in the field is interested in learning of new and better ways to do his work and if he is "on the job" and is using his brains as well as his hands he has worked out labor saving devices or methods of his own.

There are mighty few up-to-date shops in these days where suggestions and ideas are not welcome and where some reward is not given for good workable methods proposed by the men. The same sort of suggestions and kinks are exactly what we wish to publish from shops all over the country. Such letters from our readers need be prepared only in rough form, for it is a simple matter to work them into shape for publication in the office. All practical shop kinks and suggestions on boiler work will be paid for at a liberal rate.

The value of interchanging ideas in this way, where the comments of members of the fraternity from all over the country will aid in solving difficulties, is hard to measure. Furthermore the proposition is not at all one sided, for there is no better way possible to work out your own problems than to get others in the same line of work interested in helping you solve them.

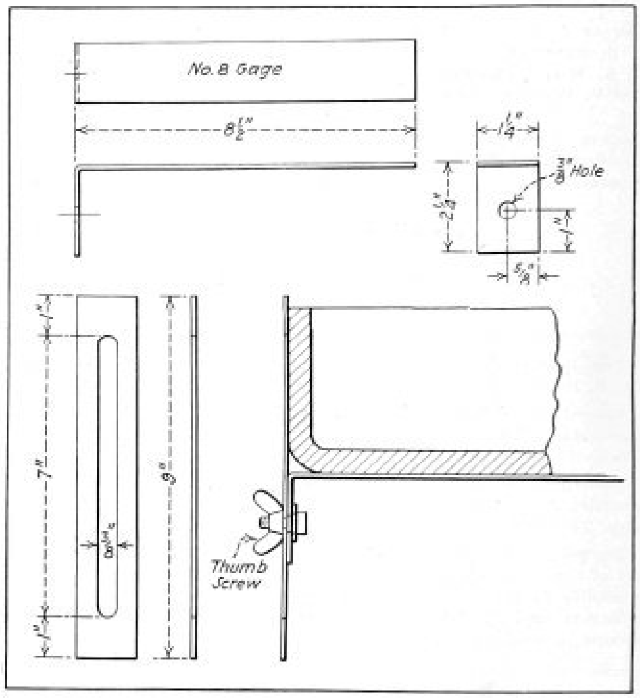
LETTERS TO THE EDITOR

Head Gage for Boiler Shop Use

To the Editor:

It is sometimes the custom when laying out girth holes on a head to mark off the gage line with a square, connecting the marks with a strip of band iron or a rule.

To eliminate many unnecessary steps, the gage, as per



Gage for use in laying out boiler heads

sketch herewith, is used in the following manner: 72-inch diameter head with 4-inch gage.

Loose thumb screw. Set horizontal strip so as to be 4 inches from the top, make screw tight, set under head and you are ready to draw the gage line.

It is a very handy tool and easy to construct as the sketch shows, although I do not think it best to make it of less than No. 8 gage; heavier iron would be O.K.

Oswego, N. Y. John A. Shannon.

Design of Dog House Boiler

To the Editor:

In reading The Boiler Maker, October, 1926 issue, I was interested in E. J.'s description and illustration therein of the trouble experienced by him with a "dog house" boiler, and in response to your general request for ideas as to the probable cause I venture to submit the following:

The wrapper plate is shown semicircular in shape and being stayed laterally at its greatest diameter is self-supporting without stays and stable throughout its entire circular length for the pressure within its capacity; that is, each lineal unit length of its curvature is subjected to equal tension by the steam pressure acting similarly in all directions, and thus preserving its circularity.

The disturbing element is introduced, however, when the furnace crown is supported by means of six rows of vertical stays attached to the wrapper plate crown. Because of the tension in the vertical stays, produced by the load on the furnace crown, the wrapper plate no longer acts independently to preserve its former equal tension throughout its circular section, which now becomes unstable and assumes a different shape to satisfy the new conditions.

Sections of the wrapper plate bulged outward under the action of the internal pressure until a stabilizing tension developed in the crown as a whole. In the process that section of the crown between the outer rows of stays was deflected downwards, rendered possible by the fact that the two crowns within the outer rows of stays are in equilibrium and susceptible to movement by the unbalanced force created by the bulging of the crown plate sections marked *x* on the illustration.

The sagging of the balanced section of the crown tended of course to lessen the tension in the stays, but the consequent sagging under its load of the furnace crown maintained the tension.

It will be noted that the outside rows of stays are attached to the furnace crown adjacent to the flange, and therefore appear to have had little vertical movement owing to the stiffness of the plate in that position; hence the distortions in the wrapper plate appear to have developed about the top ends of the stays as points of substantial support.

A slight spreading of the upper ends of these stays would take place with the flattening of the circular crown.

Sydney, Australia. ALFRED R. WILLIAMS.

Comparative Strength of Dished Heads

TO THE EDITOR:

An interesting feature of the November issue of THE BOILER MAKER was the chart which showed the allowable working pressures for dished heads. The chart is based on the A. S. M. E. formula and is of course acceptable within its sphere of activities. Compared with the British Board of Trade formula for dished heads, the A. S. M. E. values are considerably lower. Both formulas are of course of interest to those who follow the trade in its technicalities as well as for a living. The A. S. M. E. formula is repeated herewith, viz.: $t = \dfrac{5.5 \times P \times L}{2 \times TS} + \frac{1}{8}$ inch.

t = the thickness of the plate in inches.
P = the maximum allowable working pressure.
L = the radius of the dish in inches.
TS = the tensile strength of the plate in pounds.

The chosen example was a boiler drum having a plus head of 54 inches diameter, 50 inches radius of the dish, and ⅝-inch thick plate having a tensile strength of 55,000 pounds. The chart says this head will stand a working pressure of 200 pounds per square inch. Compare the same head with a Board of Trade formula, and note the difference.

Board of Trade formula for dished ends:

$$\frac{15 \times S \times (t - 1)}{R} = WP$$

15 is a constant.
S = the tensile strength in tons per square inch.
t = the plate thickness in 32nds inch.
R = the spherical radius of the head.
WP = the allowable working pressure.

In working out the Board of Trade formula we will take S as 26 tons which is 58,240 pounds or 3,240 pounds more than we need take for a true comparison.

$$\text{Thus, } WP = \frac{15 \times 26 \times (20 - 1)}{50} = \frac{7,410}{50} = 148$$

pounds per square inch.

If we take S as having a tensile strength of 25 tons the allowable working pressure would be 142 pounds per square inch.

Working on the Board of Trade formula for the same diameter, radius and working pressure for a head to stand 200 pounds per square inch, we would require a plate ⅞-inch thick, viz.:

$S = 25$ tons.

$$\frac{15 \times 25 \times 28 - 1}{50} = 202 \text{ pounds per square inch } WP$$

It will be observed that there is a difference of ¼-inch in the thickness of plate required by the respective formula, taking the tensile strength, radius and diameter on an equal basis.

In all probability we would in this country specify the plate to be 28 to 32 tons tensile with an elongation of 20 percent in 10 inches, and a plate ¾-inch thick would meet the requirements for 200 pounds pressure. Technically and commercially there is a considerable difference and whereas both formulae are standards in their respective countries one is too thin or the other is too thick, and the sooner we have an international set of formulae the better.

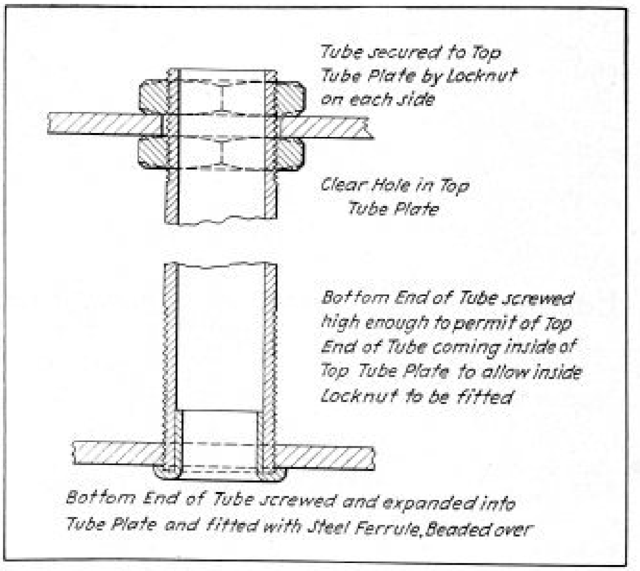
Batley, Yorks, England. JOHN GORDON KIRKLAND.

Vertical Boiler Construction

TO THE EDITOR:

An article appeared in the January issue under the heading "Defective Construction of a Vertical Boiler," and described the experience of a boiler inspector during the examination of a boiler of the vertical multitubular type with vertical smoke tubes. He found that the upper course of the boiler was slightly cone shaped, thus resulting in the water gage fittings being out of alinement and concluded the article with a query as to why the boiler had been so constructed. It is certainly a curious point and one which perhaps could not be explained correctly by anyone outside the firm who built the boiler, but perhaps I may be permitted to offer one or two suggestions after giving the matter considerable thought.

In the first place, the only thing which could be considered *defective* in the construction was that the tappings for the water gage connections had not been tapped squarely into the upper course; if they had been, the gage glass



Method of fitting stay tubes

would have been parallel with the shell of the boiler and no trouble would have been encountered, incidentally perhaps it would never have been discovered that the upper course was drawn in at the top. Now obviously this drawing in could not have been a mistake as the plate would have had to be developed to get the result, therefore it was done with deliberate intention. As far as I can see, there are only two possible reasons for it; one is that either a mistake was made with the head, making the diameter too small, or that the firm already had one in stock slightly under diameter which they wanted to use up.

The other reason may very probably be concerned with the staying of the boiler. The upper tube plate on this class of boiler is of course larger in diameter than the lower one, therefore, the space from the tubes to the commencement of curvature of the flange is naturally larger in the former, very often necessitating the use of some form of stiffeners, usually either gusset stays between the tube plate and shell of boiler, or a certain number of the tubes acting as stays. Taking the boiler in question, if the upper course had been made parallel for its whole length, the tubes may have been so set out that a larger unstayed flat surface occurred in this locality than was permissible for the pressure for which the boiler was originally designed, and the designer may have considered it cheaper (as it naturally would be), to reduce these spaces by drawing in the top course rather than to have recourse to staying. Either method of staying mentioned above would add considerably to the cost of the boiler, whereas the difference in the size of plate used in the making of the upper course tapered instead of parallel would be practically negligible; the extra cost would be little more than the time taken to develop the plate. Apart from these two suggested alternative explanations, I can see no further reason for the peculiar construction, but if any other reader can put one forward, I should be very interested to hear it.

While on the subject of staying for this type of boiler, the accompanying sketch may prove of interest. It illustrates a much cheaper method of fitting a stay tube than the usual practice of screwing through both tube plates with a continuous thread. The illustration is self explanatory, and it will be seen that the tube is inserted through a clean hole in the top tube plate and screwed far enough into the bottom plate to allow of the inside lock nut at the top being fitted; with this in position, the tube is partly withdrawn into its correction position and expanded into the bottom tube plate; the lock nut on the outside of the top plate is then screwed down with a suitable joint. The ferrule at the bottom is fitted and beaded over to protect the end of the tube from the fire, and should be fitted to all tubes on these boilers, whether stay or otherwise. Of course with a stay tube of this type, it is unnecessary for the ends to be upset, the tube being simply ordered thick enough to give the requisite cross sectional area at the bottom of the thread. Nuts should never be fitted on stay tubes at the combustion chamber end owing to the action of the fire.

New Pellon, Halifax, England. Norman Wignall.

Location of Feedwater Discharge in Boilers

To the Editor:

Our attention has been called to the "Letter to the Editor" that appears on page 32 of the February, 1927, issue of The Boiler Maker, in regard to location of feedwater discharge in boilers. Mr. L. F. Wilson, vice president of the Bird-Archer Company, has therein offered a recommendation for what he has considered the most desirable point of delivery of feedwater in the horizontal boilers of the firetube type, apparently viewing the matter solely from the standpoint of water treatment and ignoring the best interests of the boiler itself. While his recommendation may be entirely satisfactory for certain special types of horizontal firetube boilers, the arrangement that he recommends is not suitable for the standard horizontal return tubular boiler, and in fact, his arrangement would not be acceptable to a requirement in the A. S. M. E. Boiler Construction Code for the delivery of feed to that type of boiler.

Location of Discharge of Feed Water

Paragraph P-314 of the Code stipulates that the feedwater shall be introduced into a boiler in such a manner that the water will not be discharged directly against surfaces exposed to gases of high temperature or to direct radiation from the fire, and to accomplish this for the standard horizontal return tubular type of boiler, the second section of the paragraph is worded as follows:

> "In a horizontal return tubular boiler the feedwater shall discharge at about three-fifths the length from the front head (except a horizontal return tubular boiler equipped with an auxiliary feedwater heating and circulationg device), above the central rows of tubes, when the diameter of the boiler exceeds 36 inches."

I am taking the liberty to call this matter to your attention in the thought that you may care to publish a correction so that no boiler operator may make the mistake of changing his feed delivery connection for a horizontal return tubular boiler in such a manner as was recommended in the communication and thus be in variance with the state or municipal requirements wherever the A. S. M. E. Boiler Construction Code is effective.

New York, N. Y. C. W. Obert,
Secretary to the Boiler Code Committee.

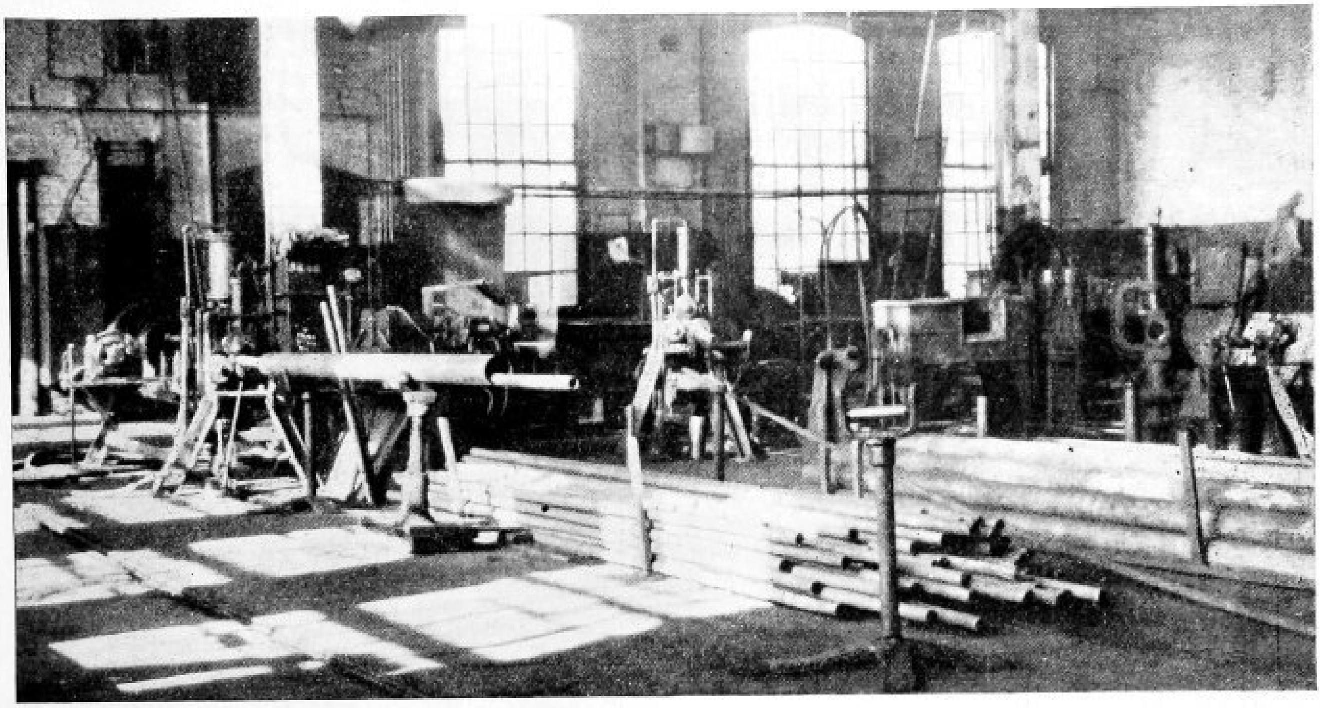
New Books

Instruction Manual, Arc-Welding. *Published by the Lincoln Electric Company, Cleveland, Ohio. Bound in paper, 5 inches by 7½ inches, 92 illustrated pages.*

The Instruction Manual for electric arc welding is revised annually to cover the latest practices and is of interest to practically every one who employs the arc welding process. Among the subjects treated are: High-speed steel welding; high pressure pipe welding; automobile frames; boiler repairs; welding cast iron; manganese steel welding; carbon arc welding and the manufacture of machinery and equipment, using welded steel in place of castings. This manual is intended for the use and information of the electric welder and contains much information of value in railroad shop work.

Tool Foremen's Proceedings. *Compiled and edited by G. G. Macina, secretary-treasurer, 11402 Calumet Avenue, Chicago. Imitation leather, semi-flexible binding, 176 pages, 5 inches by 9 inches, illustrated.*

This book contains a detailed report of the fourteenth annual convention of the American Railway Tool Foremen's Association held at Chicago, September 1, 2, and 3, 1926. In addition to a number of important addresses bearing on the tool foreman's work the book contains committee reports presented at the last annual meeting together with the subsequent discussion. Drawings are included of the recommended standard boiler taps, the adoption of which constituted one of the most important works ever undertaken by the association. The illuminating discussion of the Standardization Committee's report alone makes the 1926 proceedings well worth study, not to mention the numerous illustrated descriptions of air brake and locomotive shop kinks and devices. The book is well arranged and indexed for convenient reference.

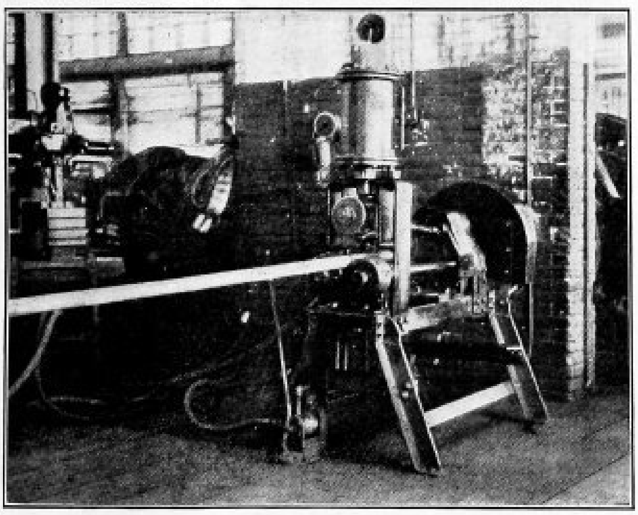


General View of the Boston & Albany, West Springfield Flue Shop

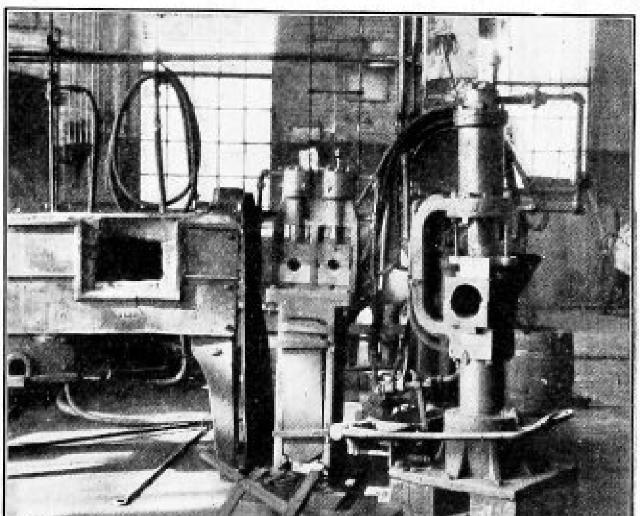
Repairing Flues at B. & A. West Springfield Shops

**Modern equipment reduces cost and shop force—
Monthly output averages 5,000 flues and 550 tubes**

THE locomotive repair shop of the Boston & Albany at West Springfield, Mass., contains 19 locomotive repair pits from which are turned out every month an average of 19 classified repairs. The locomotives repaired at this point are from two divisions, namely: The Boston division, which extends from Boston, Mass., to Springfield, and from the Albany Division, which extends from Springfield to Albany, N. Y. The water used on the Boston division contains considerable lime which forms a soft brown scale that is easily removed. The water used on the Albany division forms a hard white scale more difficult to remove.



This machine is used to cut the flues to the proper length after safe ending



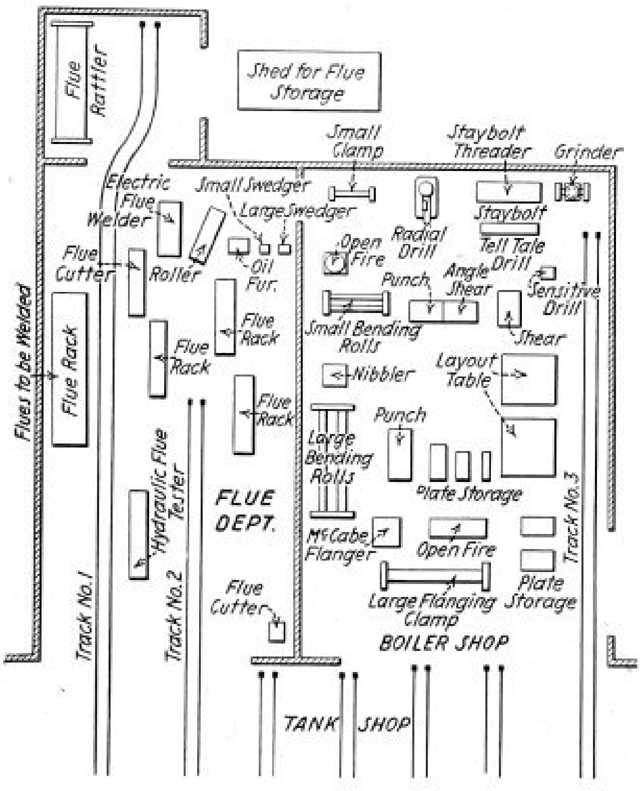
The oil furnace and the two swedging machines

The flue shop at West Springfield repairs approximately 5,000 small flues and 550 superheater tubes every month. Until about two years ago, this shop was equipped to safe end the flues by the oil furnace method. This method was not entirely satisfactory for several reasons: First, owing to the excessive heat of the furnaces, the labor turnover was high; second, the percentage of flue failures while undergoing the hydrostatic test was excessively high; third, it was felt that the cost per flue was considerably higher than it should be.

It was decided to change from the oil furnace welding method to the electric welding method. This necessitated a complete change of flue shop machinery. The following table shows the present equipment as compared with the retired equipment.

Present Equipment	Retired Equipment
Flue cutter	Flue welder
Electric flue welder	Oil furnace
Flue roller	Universal flue welder
Oil furnace	Pneumatic welder
Small swedger	Flue welding oil furnace
Large swedger	Flue welding oil furnace
Flue tester	Hot saw and tube expander
Flue cutter	Hot saw and tube expander
Flue rattler	
Four flue racks	

The relative location of the present equipment may be determined from the shop layout shown in one of the



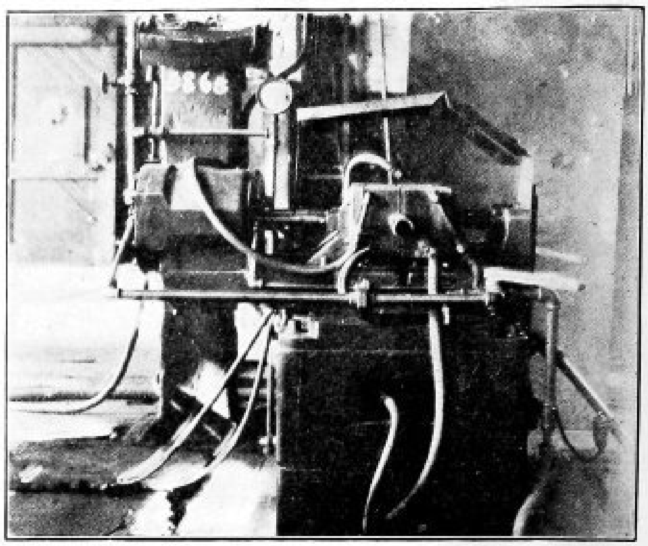
Arrangement of the equipment in the flue and boiler shops

illustrations. It should be noticed that in the list of retired equipment are three oil furnaces while only one is used at the present time. The retirement of two oil furnaces has improved the working conditions in the shop.

As a result of this change of machinery the labor turnover has been reduced to practically zero, the shop force has been reduced from nine to five men, the percentage of flue failures under hydrostatic test has been reduced and the cost of safe ending has been reduced approximately four cents per flue.

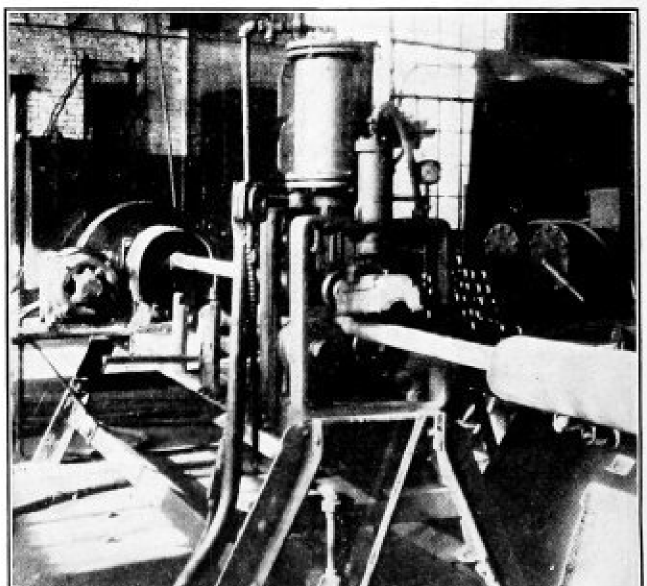
Method of Handling the Flues

Referring to the layout of the flue shop, the flues are taken on shop track No. 1 to the flue rattler which is located in a small building adjacent to the northeast end of the shop. The flue rattler is of the revolving drum water type. To insure that the flues are cleaned properly, the drum is not overloaded. The flues remain in the rattler for 30 minutes. The flues are then sent back along track No. 1 and placed on the rack near the flue cutter. After the ends have been cut off the flues are placed in the rack directly opposite the electric flue welder. The flues are now



The electric butt flue welder which safe ends both large and small flues

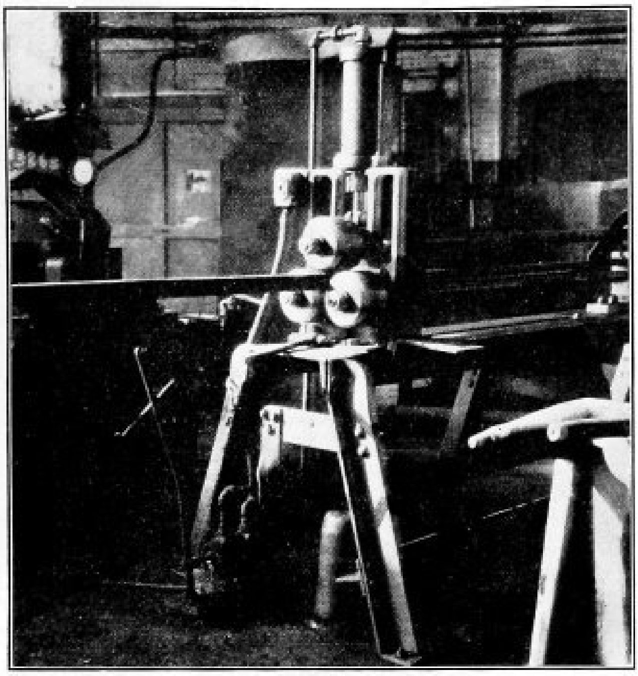
ready for safe ending. The safe ends are cut from new flues. When the butt weld is made the flue is immediately pulled out of the electric welder and placed in the flue roller next to it, where the weld is rolled smooth. The flues are then placed in the rack opposite the oil furnace. They are



A motor driven flue cutter

now ready for the swedging operation. The flues are taken from the rack in groups of four or five, depending on their size, brought to a working heat and swedged down in one of the two swedgers, depending on the size of the flues. This heating tends to anneal the steel safe ends of the flues, which is very desirable and necessary as it makes for easier and better working when the flues are being installed in the boiler. This operation completed, the flues are placed in the rack to the right of shop track No. 2 from which they are taken to the flue cutter at the southwest end of the shop where they are cut to the proper length.

The flues, now completely finished, are taken to the hydraulic flue tester where the welds are subjected to a water pressure 50 percent greater than the working steam pressure.



Internal and external roller type of flue welder used in the flue shop

When the flues are put in the boiler, the new safe end is placed in the back flue sheet as the new material when beaded and welded gives a much better job.

Since the advent of the new process for safe ending the flues, only one flue has had to be removed from the locomotive after the hydrostatic test.

Program of Master Boiler Makers' 1927 Convention

The eighteenth annual convention of the Master Boiler Makers' Association will be held at the Hotel Sherman, Chicago, Ill., May 3, 4, 5 and 6. Officers of both this association and of the Boiler Makers' Supply Men's Association have arranged to make the program an extremely interesting one both from the standpoint of addresses, papers to be read and entertainment. In spite of the advance in the date of the convention over previous years, the response from members of the supply field, of whom about 60 have already reserved exhibition space, indicates that this important feature will surpass the exhibits at any previous meeting. The arrangement of the exposition hall and the names and location of exhibitors who had taken space up to the date of going to press are published on page 98.

The program of the business sessions of the convention appears below and a list of officers for the year 1926-1927 is given on page 119.

Convention Program

FIRST DAY

Tuesday, May 3, 1927.

Registration of Members and Guests
8 A. M.

Business Session

Convention called to order .... 10.00 A. M.

Invocation:
Rev. Christian F. Klerhauser.

Addresses:
Hon. William Hale Thompson, Mayor of Chicago.
H. T. Bentley, General S. M. P., Chicago and Northwestern Railroad.

Responses:
To the Mayor
W. J. Murphy, First Vice President.
To Mr. Bentley
L. M. Stewart, Second Vice President.

Annual Address:
John F. Raps, President of the Association.

Routine Business:
Annual Report of the Secretary, Harry D. Vought.
Annual Report of the Treasurer, W. H. Laughridge.

Miscellaneous Business:
New Business.
Appointment of Special Committees to Serve During Convention.
Resolutions.
Memorials.
Announcements.
Recess to 2 P. M.

Afternoon Session

Convention called to order .... 2.00 P. M.

No. 1. "The Best and Most Economical Method of Scaling the Inside of Boiler When Flues and Tubes Are Removed, Explaining in Detail Tools and Cost in Man Hours." Committee: R. W. Clark, Chairman; H. A. Bell, R. A. Creger .... 2.00 to 2.30 P. M.

No. 5. "What Are the Causes of Boiler Barrel Sheets Cracking at Waist Sheet Angles and Guide Brace Angles?"
(a) What is being done to overcome same?
(b) What are the best methods of applying waist sheet braces and guide yoke angles to shell of boiler?
Committee: Charles A. Karnell, Chairman; Carl A. Harper, A. Hedberg .... 2.30 to 3.00 P. M.

No. 3. "Most Efficient Methods Used in the Laying Out and Flanging Old and New Work; *also*, The Assembling of Old and New Work for Both Welding and Riveting." Committee: O. H. Kurlfinke, Chairman; C. C. Dean, L. W. Steeves .... 3.00 to 3.30 P. M.

Announcements.

Adjournment.

Evening

8:00 P. M. Reception to Officers and Members of the Association.

SECOND DAY

Wednesday, May 4, 1927.

Convention called to order .... 9.00 A. M.

Address:
J. E. Bjerkolm, Assistant S. M. P., Chicago, Milwaukee & St. Paul Railroad.

Response:
S. M. Carroll, Third Vice President

Unfinished Business:

Committee Reports on Topical Subjects:

No. 7. "Boiler Corrosion and Pitting," Lewis Nicholas, Chairman, J. J. Davey, Myron France .... 10.30 A. M. to 12 M.

Announcements.

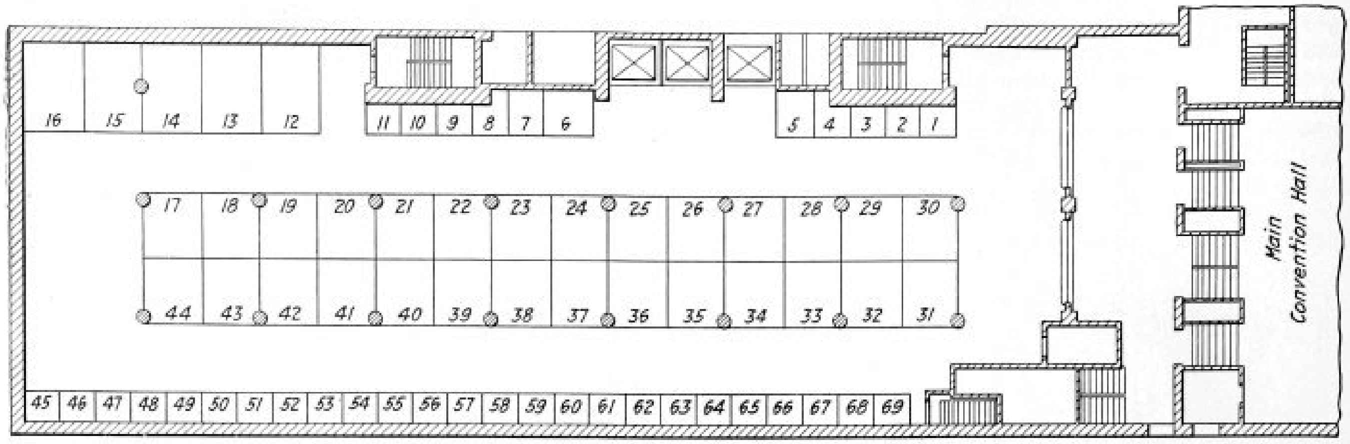


Diagram of convention hall showing location of booths of Boilermakers' Supply Men's Association

Exhibitors at Master Boilermakers' Convention

Name	Booth No.	Name	Booth No.	Name	Booth No.
Air Reduction Sales Co.	18 and 43	Dearborn Chemical Co.	15 and 16	Old Dominion Iron & Steel	39
American Arch Co.	69	Detroit Seamless Steel Tube	33	The Otis Steel Co.	49
American Locomotive Co.	30 and 31	Ewald Iron Co.	64	The Oxweld Railroad Service	6, 7 and 8
American Railway App. Co.	50	The J. Faessler Mfg. Co.	70	The Paulson Tools, Inc.	42
Arrow Tools, Inc.	60	Falls Hollow Staybolt Co.	72	Pennsylvania Iron & Steel Co.	67
Charles H. Besly & Co.	74	Flannery Bolt Co.	13 and 14	Pittsburgh Steel Pro. Co.	51
Bethlehem Steel Co.	56	Gary Screw & Bolt Co.	61	Pratt & Whitney Co.	22
The Bird-Archer Co.	29	Globe Steel Tubes Co.	65	The Prime Mfg. Co.	66
The Boiler Maker	5	Highland Iron & Steel Co.	78	Railway Purchases & Stores	11
The Bourne-Fuller Co.	77	Huron Mfg. Co.	76	Reading Iron Co.	53
W. L. Brubaker & Bros. Co.	62 and 63	Ingersoll-Rand Co.	25 and 26	John A. Roebling's Sons Co.	27
The Burden Iron Co.	52	William H. Keller, Inc.	28	Rome Iron Mills, Inc.	71
A. M. Castle & Co.	1	Lima Locomotive Works	10	Joseph T. Ryerson & Son	68
Central Alloy Steel Corp.	9	Locomotive Firebox Co.	45, 46 and 47	Scully Steel & Iron Co.	20
The Champion Rivet Co.	2	Lovejoy Tool Works	32	The Superheater Co.	59
Chicago Engineer Supply Co.	57	Lukens Steel Co.	3	The Talmadge Mfg. Co.	21
Chicago Eye Shield Co.	4	McCabe Mfg. Co.	12	Thomson Elec. Welding Co.	48
Chicago Pneumatic Tool Co.	58	MacLean-Fogg Lock Nut Co.	83	Torchweld Equip. Co.	73
The Cleveland Pneu. Tool Co.	54 and 55	Mudge & Co.	19	Tyler Tube & Pipe Co.	1
		National Tube Co.	75	Ulster Iron Works	84

Afternoon

No. 2. "The Best and Most Efficient Methods That Are Being Used in the Reclaiming and Safe Ending of Boiler Tubes and Flues." Committee: Henry J. Raps, Chairman; S. M. Carroll, A. J. Redmond ......

THIRD DAY

Thursday, May 5, 1927.

Convention called to order .... 9.00 A. M.

Address:

George F. Hess, S. M. P., Wabash Railroad.

Response:

George B. Usherwood, Fourth Vice President

Committee Reports on Topical Subjects

No. 6. "Standards and Recommended Practice." (Fusion Welding.) Committee: J. A. Doarnberger, Chairman; H. H. Service, H. L. Marsalis, L. M. Stewart, J. J. Mansfield ...... 10.00 to 11.00 A. M.

No. 8. To Report Topics for 1928 Convention. Committee: George Austin, Chairman; Hugh G. Comrie, W. J. Murphy .... 11.00 to 11.30 A. M.

No. 9. Law. Committee: Thomas Lewis, Chairman; T. P. Madden, Charles P. Patrick ...... 11.30 to 11.45 A. M.

Announcements.

Adjournment.

Evening

Banquet at 7 P. M. by the M. B. M. Supply Men's Association.

FOURTH DAY

Friday, May 6, 1927.

Convention called to order .... 9.00 A. M.

Address:

F. N. Speller, Metallurgical Engineer, National Tube Company. Subject: "Corrosion of Boiler Tubes."

Response:

Kearn E. Fogerty, Fifth Vice President

No. 4. "What Are the Best Methods of Applying Staybolts to Fireboxes of Locomotive Boilers, Explaining in Detail Entire Operation?"

(a) How are holes tapped?
(b) How are staybolt taps purchased as to size?
(c) How are staybolt taps gauged?
(d) If staybolts are purchased, what are the allowances and how gaged?

Committee: C. H. Browning, Chairman; E. H. Hohenstein, C. F. Petzinger ...... 10.30 to 10.45 A. M.

Report of Special Committee on "Standard Names for Various Parts of Locomotive Boilers." W. H. Laughridge, Chairman .... 10.45 to 11.00 A. M.

Unfinished Business:

Report of Committee on Resolutions 11.15 to 11.30 A. M.
Report of Committees on Memorials 11.30 to 11.45 A. M.
Report of Committee on Topics for 1927 Convention, George Austin, Chairman; Hugh G. Comrie, W. J. Murphy .... 11.45 A. M. to 12 M.

Election of Officers .... 12 M. to 1 P. M.

Adjournment.

New Type of Welding Electrode

A new type of welding electrode which combines the characteristics of a fluxed electrode, the quality of bead finish and the cleanliness in handling of a bare welding electrode has been introduced by the Merchandise Department of the General Electric Company at Bridgeport, Conn.

This electrode is furnished in 3/32-, 1/8-, 5/32-, 3/16- and 1/4-inch sizes.

Staybolt Taps for Locomotive Boilers

Investigations of the problem of leaky staybolts in locomotive boilers and the tolerances allowable in the manufacture of staybolt taps to eliminate this trouble

By Correspondent

During the past two or three years exhaustive investigations and experiments with staybolts and staybolt taps for locomotive boilers have been conducted in Germany. These studies indicate that the subject has been more carefully investigated by locomotive builders in that country than has been the case in any other country in the world. The work has been done with German thoroughness regardless of time and expense. The main object of the experiments has been to determine why locomotive boilers leak at joints where staybolts have been used. If manufacturers of staybolts and staybolt taps will adopt the results of these studies in whole or in part the major portion of the problem of leaky staybolts will be solved. Exceedingly small tolerances in the manufacture of these parts are allowable so that the burden of the remedy lies essentially with the manufacturer. In the *Hanomag Nachrichten* for June, 1925, an outline was contained of the method under which these experiments and investigations have been conducted. Up to the present time all experiments to produce steam tight threads have been carried out under the suspicion that a tap will produce a threaded hole exactly fitting the tap. It has been believed due to previous experience that when tapping the root diameter of the hole always becomes smaller. As a result of this belief the machine department of the German State Railways in 1924 decided to make the staybolt reamer 0.13 millimeter or 0.00511 inch larger than the root diameter of the threaded hole. In order to produce a correct thread in the hole experiments were conducted based on the idea of producing a tap to very close tolerances. In spite of this, however, satisfactory results were not obtained. At a water pressure of about 44 pounds per square inch the number of non-tight bolts with oversize was 1.5 percent of the installation while at a pressure of 88 pounds per square inch this percentage was increased to over 2.5 percent. At the outset it was supposed that all other bolts were tight; that is, that full contact had been obtained on all parts of the thread. In reality, however, bolts on which a rich quality of lubricant had been used while screwing in place were only tight due to the lubricant hardening after the installation, thus producing a tight fit. Up to 88 pounds pressure these bolts remained tight while at higher pressures and especially under steam pressure they began to leak.

It was particularly surprising that with staybolts screwed into holes tapped with the same tap some could be worked very easily while others screwed in tightly. No other explanation can be found for this condition than that holes threaded with the same tap were not alike and that this variation was the cause of the bolts leaking. Thread gages with full thread profile were used in order to determine if the threaded holes were correct. Such a method is of course unsatisfactory because it is based on the consideration that if only one thread element, that is the outside diameter, the pitch diameter or the root diameter had bearing the hole diameter was considered correct. Even the smallest lead error increased the difficulty of screwing in the full threaded gage and the impression resulted that the hole diameter was too small. It was then found necessary to obtain gages with which the outside pitch and root diameters could be gaged separately. The results from the use of these gages was surprising, it being proven that all three diameters of these elements were too large as well as that the root cut itself comparatively more free than the outside and the pitch diameters.

On account of these experiences "Hanomag" experimented on a new type of staybolt tap which above all would save the root diameter. With this tap it was found necessary to use a yielding or bending chuck to eliminate vibrations and shocks to the tap from the tap driving mechanism or motor.

To check these taps "Hanomag" conducted experiments in its own plant while further tests were made in another shop at Munich during the latter part of 1924 for which "Hanomag" gages and taps, as well as taps made by three other well known manufacturers, were used. An electric motor having a speed of 90 revolutions per minute was used in driving the taps. This was hung in a stand and balanced with counterweights, suitable lubricating mixtures being used for steel boiler plate and copper plate.

Fig. 1 shows a half thread profile about 40 times en-

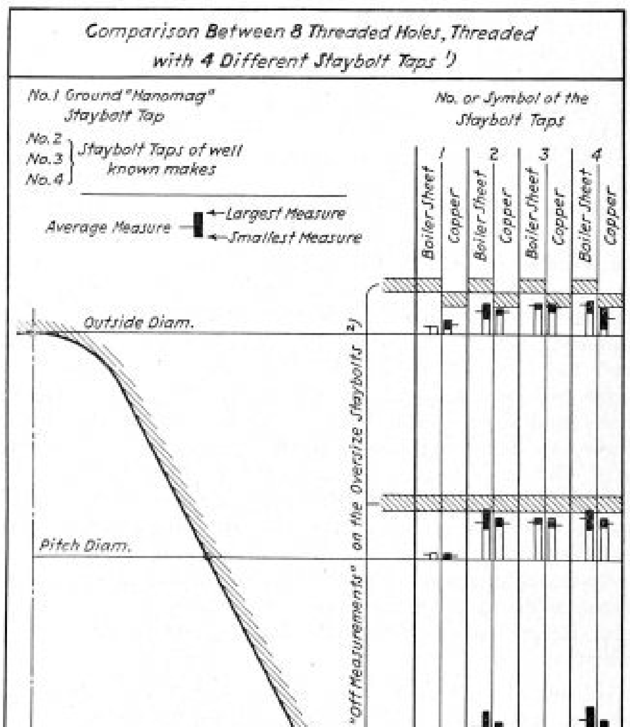


Fig. 1.—Enlargement of staybolt thread profile

larged. On the right of the profile to the same scale are shown the deviations which were found in threading with taps Nos. 1 to 4. For each one are given the maximum and minimum measures as well as the average. It can clearly be seen from this illustration how large the deviations are from the nominal diameter particularly in the case of the pitch diameter and the root diameter. Before tapping with taps Nos. 2, 3 and 4, the four first holes were reamed out with a reamer 22.75 millimeters (0.895 inch) in diameter and the four next holes with a reamer 22.88 millimeters (0.90 inch) in diameter (according to the standard of the German State Railways). In the holes reamed with the 22.75 millimeter (0.895 inch) diameter reamer the root diameter of the hole after threading was on an average 0.145 millimeter (0.00571 inch) larger in the boiler sheet and 0.105 millimeter (0.00414 inch) larger in the copper sheet. The corresponding figures when the 22.88 millimeters (0.90 inch) was used were 0.20 millimeter (0.00787 inch) in the boiler sheet and 0.17 millimeter (0.0067 inch) in the copper sheet. Thus it can be seen that the generally accepted idea that the root diameter in the hole becomes smaller while tapping or rather that the threads in the hole at this point are forced up and together did not hold good with any of these taps. It was, however, shown, as can clearly be seen from the diagram, that the outside diameter had cut itself less free than the sides and the root and that the thread profile of the tap had not reproduced itself in the hole. The section areas on the diagram show these measurements between the oversize staybolts as the outside diameter, pitch diameter and root had been made for trial by the State Railway machine shop.

As the section areas at the root extend into the black fields, this proves that in certain cases there is play between the threads and the staybolt and the threaded hole and that hence the bolt in all cases will not make a tight fit. Even on the sides these section areas go somewhat into the black fields. The diagram further proves that the greatest part of the oversize of 0.20 millimeter (0.00787 inch) becomes of no value as the tap cuts itself free and that error is permitted when on the basis of oversize staybolts it is believed that a staybolt 0.20 millimeter (0.00787 inch) oversize can be screwed in place. The experiments here prove that the oversize which can be used lies between 0.06 to 0.10 millimeter (0.00246 inch to 0.00394 inch) depending on the diameter of the bolt, the length of the bolt, the error in lead and the lubricant used. With a larger oversize the staybolts will twist and cut themselves in. The reason that the bolts made by the State Railway Machine Shop had to have their outside diameter oversize reduced from 0.20 millimeter (0.00787 inch) to 0.15 millimeter (0.0059 inch) in the copper sheet was that the specified oversize of 0.20 millimeter (0.00787 inch) on the outside diameter had partly been exceeded. That it was not necessary to reduce the oversize on the tap when used in the boiler sheet was because of the fact that the bolt in screwing tight, its too great oversize cut away part of the boiler sheet in the form of chips.

It should also be noted as remarkable that holes tapped by the same tap under exactly the same conditions were different in size. With the specially constructed "Hanomag" taps these variations were from zero to 0.03 millimeter (0.00118 inch) and with other taps from 0.02 to 0.13 millimeter (0.000767 to 0.00512 inch). The proving of the above facts has been of particular importance because it has shown the necessity of using other than existing tolerances in the cutting of threads on oversize staybolts. In Fig. 2 the column at the left of the illustration shows the conditions now existing as to these tolerances. In the middle column are shown the tolerances necessary in order that the taps shall not cut too large threaded holes. The tolerances are then comprised of 0.02 millimeter (0.000767 inch) for wear; 0.03 millimeter (0.00118 inch) for the manufacture of the tap; 0.08 millimeter (0.00314 inch) for the manufacturing of the bolts, that is the threads; 0.02 millimeter (0.000767 inch) for minimum pressure; 0.05 millimeter (0.00197 inch) for the manufacture of the oversize bolt. The total of these tolerances for the greatest pressure will thus be 0.20 millimeter (0.00787 inch). As mentioned above, however, according to these latest experiments the greatest oversize which can be permitted is 0.06 (0.00-236 inch) to 0.10 millimeter (0.00394 inch) with the oversize now used; it is hence impossible to obtain tight fits for steam. Even with tolerances which with present means are at our command showing the smallest limits given in the third column, the greatest oversize or pressure fit is 0.11 millimeter (0.00434 inch). Even with this oversize it is not possible to screw in a bolt if it is of more than ordinary length without its twisting.

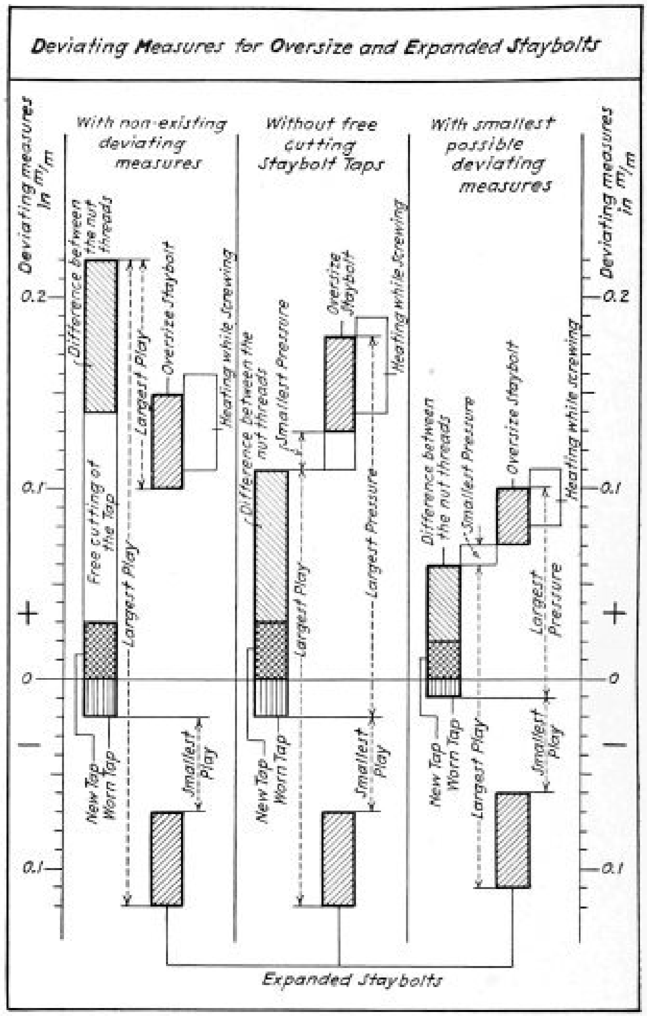


Fig. 2.—Chart showing tolerances in staybolt taps

The threading experiments were renewed in May, 1925, by another firm in the presence of prominent experts who believed in the principle of oversize bolts. The results have been duplicated and verified of trials previously made. It was also found that the play of the leader or guide of the tap had hardly any influence upon the threading results. During a trial in which the bolts were screwed without lubrication in the copper sheet and with oil in the boiler sheet the above results were also verified.

These results obtained during the thread cutting experiments show conclusively the impossibility of obtaining tight fits with the specified tolerances for oversize bolts. The question of staybolts can, therefore, be solved only by holding the diameter tolerances greater and by expanding the bolts after they have been fastened. It is, however, necessary that the profile of the thread be as nearly correct as possible.

During the last two years 42 boilers have been built which have been equipped with expanded staybolts. None of these staybolts has subsequently been found to be broken or loose. One boiler in the State Railway Repair Shop in Munich has also been fitted with expanded staybolts. This boiler is on a Bavarian locomotive of the type S 3/5; of the 1,360 bolts in this boiler only one bolt has proven to be loose at a pressure of 310 pounds per square inch cold and six of them at the same pressure showed a very slight leak—about one drop of water a minute. At steam pressure and during trial trips all the bolts were found to be perfectly tight. The saving obtained as a result of installing these bolts was 30 percent in comparison with the installation of oversize bolts as previously practiced in this shop. So much for the extract from the article mentioned at the beginning.

Practical Application of Staybolt Studies

If we now consider the question of the manufacture of staybolt taps of which only those ground in the thread after hardening are considered by Germany's more prominent boiler manufacturers to the limits here suggested, American staybolt tap manufacturers will find that they are lagging behind in obtaining the accuracy in these details as compared with foreign practice. It is a generally conceded fact that staybolt taps to these close limits are actually made in Germany today. Quantity manufacture of this tool, however, is another matter and may be left to the imagination of the reader. American staybolt tap manufacturers will find that there is a real difficulty to solve here and that the problem is of no mean importance.

The total tolerance permitted on these taps for the 4 important elements are, on the outside diameter, the pitch diameter and the root diameter from standard to standard: 0.03 millimeter (0.00118 inch) and on lead 0.01 millimeter (0.00039 inch) in a length of 25 millimeters (approximately 1 inch); the limit on the angle of the thread is 30 feet.

In the case of staybolt taps not ground in the thread after hardening there is, of course, no insurmountable difficulty in holding the taps within the prescribed diameter tolerances with accurate threading tools, correct hardening methods and raw material well suited for the purpose. The lead, however, will invariably be way off from the specified limits for this element. Where staybolt taps are ground in the thread, on the other hand, the tolerances for this element as well as for the outside diameter and the pitch diameter can easily be held within the prescribed limits but the root diameter is more difficult. As far as the writer knows, no thread grinding wheels have yet been developed which can for any length of time maintain an outside diameter thread point and, at the same time, be productive. Present types of thread grinding wheels on the market which can maintain this point for any length of time will besides create great risks of burning or drawing the temper of the threads on the tap while grinding.

As can readily be figured out, the thread points on the grinding wheels can only be permitted to wear down ½ of 0.03 millimeter (0.00118 inch) or 0.0115 millimeter (0.00059 inch) before the root diameter of the tap will be beyond permissible limits. In other words, the thread grinding wheel can only be permitted to wear down on its diameter 0.03 millimeter (0.00118 inch) before it will produce a root diameter in the tap which will pass inspection. With ordinary thread grinding wheels found on the market today such wheels could not take a single cut across the thread length of the tap before they would be worn down sufficiently to result in a non-acceptable root diameter according to the above limits. In Germany the Whitworth form of thread is largely used and for this tap the thread point on the grinding wheel will wear much better than for the U. S. form of thread used in this country due to the fact that its contour is curved as opposed to the flat formation of the U. S. thread.

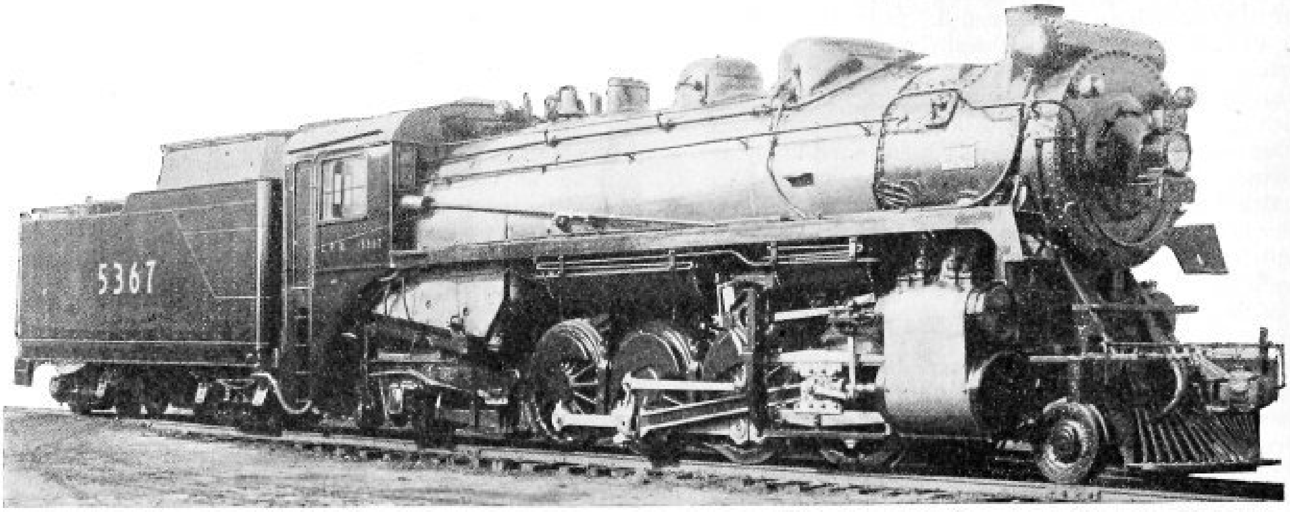
We will suppose, however, that we have succeeded in making staybolt taps to these so-called necessary limits which, of course, is not an impossibility even if impractical and certainly uneconomical. The next problem is to make these taps cut within the prescribed limits. It will surely not do to make flutes hooked or with a positive rake which for most boiler materials has been found necessary in order to eliminate torn threads in the tap holes and to make the taps cut freely and easily. Staybolt taps so fluted will invariably cut holes larger than the tap diameter. Further, it will not do to give such taps relief in the angle of their thread which has also been found necessary for free and easy cutting because this will also tend to make the taps cut larger than their diameter. The specifications for these taps made in Germany call for 4 radial flutes and with no relief on the straight part of the thread, the 4 flutes instead of the usual 5 being used only in order to facilitate measuring.

The question now arises whether it is actually necessary to make the staybolt taps to such close limits and tolerances as these German experiments and investigations seem to warrant. Offhand, the answer, in the writer's opinion, should be an emphatic *no* because no one can claim that American locomotives and boilers are not as efficient and not as safe as any made elsewhere in the world. For tapping such boilers here unground staybolt taps to very much larger limits are used almost exclusively. Here again staybolt taps that are ground in after hardening are considered wholly unnecessary and as a luxury. Someone might, of course, say that American boilers have a much larger repair bill for upkeep than do German boilers. This is a phase of the subject the writer knows little about. He can only refute such statements with the fact that American boiler and locomotive manufacturers seem to be more than holding their own against all European competition in this line both financially and practically. In other words, they are making money and boilers that are satisfactory for all practical purposes.

Annual Meeting of the American Welding Society

THE eighth annual meeting of the American Welding Society is to be held in the United Engineering Societies Building, 33 West 39th Street, New York City, April 27 to 29 inclusive. Briefly, the program is to include the American Bureau of Welding and Committee meetings on Wednesday, April 27, the former being held in the afternoon and the Gas Welding Committee and Electric Arc Welding Committee meetings to be held in the morning. On Thursday, April 28 the main feature of the day will be a "symposium of research activities in the welding field during the past three years," and a "symposium on production welding." On Friday, April 29, the board of directors will hold its annual meeting in the morning while in the afternoon the committee of the joint pressure vessel committee will hold its hearings.

A. R. Chalker, chief draftsman of the Locomotive Stoker Company, Pittsburgh, Pa., has been appointed mechanical engineer with headquarters at Pittsburgh, to fill the vacancy caused by the recent death of L. E. Osborne.



One of the Mikado type locomotives built for the Canadian Pacific by the Canadian Locomotive Company

Canadian Pacific's New Locomotives Give Improved Performance

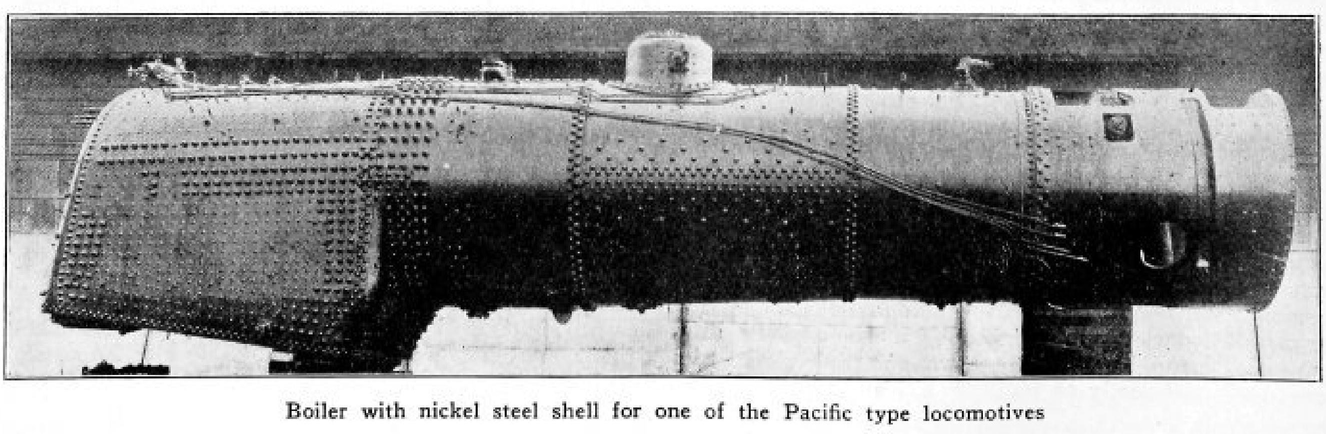
Use of nickel steel boiler plate makes possible increase in boiler pressure and high efficiency

PACIFIC and Mikado type locomotives of 42,600 pounds and 56,300 pounds tractive force respectively, have been the standard heavy passenger and general freight service locomotives on the Canadian Pacific for the past eight years. These locomotives were designed in 1919 by the mechanical staff of the Canadian Pacific as the largest locomotives of their respective types that could be generally used for main line traffic. There was nothing unusual about these locomotives; they were well proportioned power operating at 200 pounds boiler pressure. When the question of additional power was being considered in 1926, it was decided that in general these two classes of locomotives should be perpetuated with the exception that such improvements in capacity and efficiency would be made as was possible without increasing the weight beyond a rather narrow range. What was accomplished in this respect is illustrated in the following table which gives a comparison of the principal weights, dimensions and proportions of the earlier locomotives and the new designs:

Comparison of principal proportions of the former Pacific and Mikado designs with those of the new locomotives

	Pacifics		Mikados	
	New	Former	New	Former
Tractive force, lb.	45,000	42,600	57,100	56,300
Cylinder horsepower (Cole)	2,379	2,252	2,379	2,342
Cylinders, diameter and stroke	23x30	25x30	23x32	25½x32
Diameter of drivers, in.	75	75	63	63
Weight on drivers, lb.	184,300	179,300	244,600	240,100
Total weight of engine, lb.	306,500	300,500	335,200	321,800
Boiler pressure, lb. per sq. in.	250	200	250	200
Grate area, sq. ft.	65	65	70.3	70.2
Total evap. heating surface, sq. ft.	3,272	3,530	3,436	3,562
Total superheating surface, sq. ft.	864	803	970	973
Comb. evap. and superheating, sq. ft.	4,136	4,333	4,406	4,535
Weight on drivers ÷ tractive force	4.08	4.22	4.2	4.27
Total weight engine ÷ total heating surface	74	69.3	76	71.2
Tractive force ÷ comb. heat surface	10.9	9.78	12.95	12.38
Firebox heat. surf., percent of evap. heat. surface	8.9	8.44	9.0	8.59

Modifications eventually decided on included an increase in boiler pressure of 25 percent or up to 250 pounds pressure per square inch, the use of feedwater heaters, the use of front end throttles and the operation of auxiliaries

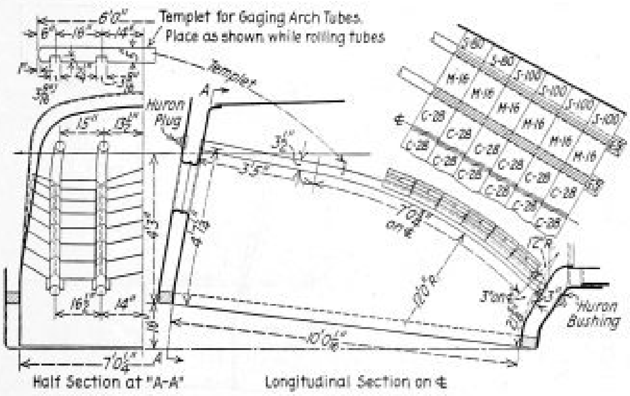


Boiler with nickel steel shell for one of the Pacific type locomotives

by superheated steam. The application of the Elesco closed type of feedwater heater with a C-F1 class duplex pump, accounted for the increase in weight of 6,000 pounds. To increase the boiler pressure 25 percent and at the same time to keep within a total locomotive weight increase of two percent would, on the face of it, appear an impossibility. But, in doing this, the Canadian Pacific put into effect a step in locomotive construction that it has been investigating and considering for a considerable length of time. This was the use of nickel steel boiler plate of 70,000 pounds per square inch, minimum tensile strength, which permitted on the two designs, of locomotives, under discussion an increase in boiler pressure up to 250 pounds per square inch without any change in the thickness of the barrel course plates. Altogether, 44 locomotives were constructed in 1926, 24 Pacific type locomotives being built by the Montreal Locomotive Works, Montreal, Que., and 20 Mikado type constructed by the Canadian Locomotive Company, Kingston, Ont. All 44 were delivered during August, September and October, 1926, and they have fully justified the expectations of improved performance and efficiency due to the higher boiler pressure and other improvements in design.

Boiler of Nickel Steel Permits Increase in Pressure

The boiler has been changed very little over the base design for 200 pounds pressure. It is of the radial stay type and beyond the thickening of the wrapper sheet and firebox

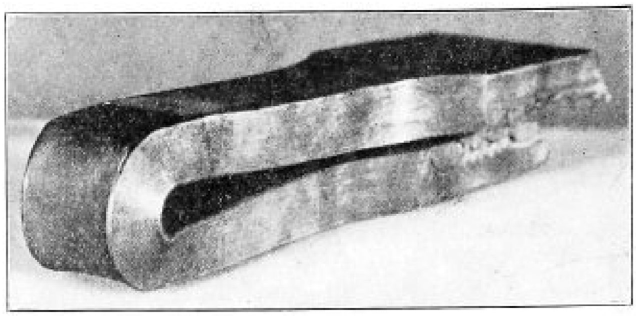


Four arch tubes instead of five are used in the firebox

side sheets and a careful investigation and checking of all details of construction, there are practically no changes made other than the substitution of nickel steel boiler plate for carbon steel in the first, second and third course sheets and welt sheets and the use of steel for longitudinal braces of the boiler.

The nickel steel boiler plate is open hearth basic steel made and rolled by the Lukens Steel Company with the joint inspection and cooperation of the American Locomotive Company, the International Nickel Company and the Canadian Pacific. It was anticipated that the plates would have a somewhat pitted surface typical of nickel steel but the surface conditions were quite equal to carbon steel boiler plate. The use of nickel steel effects a saving of 27 percent in the weight of the barrel course sheets, or permits the use of higher pressure without a corresponding weight increase.

This being the first alloy steel produced by the Lukens Steel Company, there was some preliminary work and investigation required before the material was finally produced on a commercial basis, but once started, very uniform material was produced. To illustrate, an analysis was made of the physical properties of 465 determinations of nickel steel boiler plate and an equal number for carbon steel boiler plate on a previous order for locomotives. The average results obtained on the nickel steel were as follows:



Test specimen illustrating the ductility of the nickel steel used in the boiler construction

Tensile strength, 76,700 pounds; yield point, 46,800 pounds; elongation, 26 percent, and reduction of area, 53 percent. The average tensile strength and yield point for carbon steel boiler plate ran 59,200 pounds and 36,200 pounds, respectively, so that the gain in strength based on average results is 29 percent on both the ultimate strength and yield point basis.

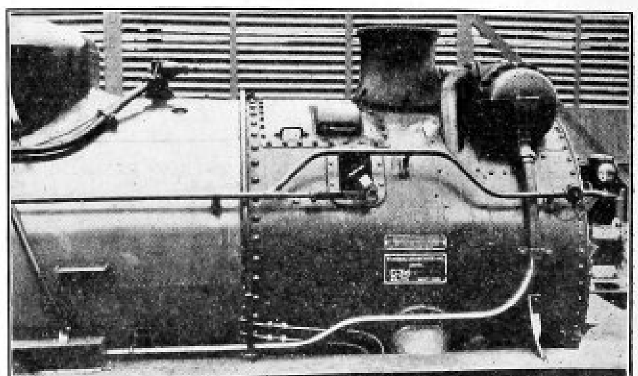
The maximum variation in the various physical properties above and below the average were found to be almost identical for the nickel steel and for an equal number of carbon steel determinations.

The nickel material is remarkably tough and ductile and generally speaking, in the transverse bend tests, the heaviest plate can be bent flat on itself without fracture. Specification requirements call for bending of the plate around a pin, the diameter of which is equal to a certain percentage of the plate thickness, this being worked on a sliding scale based on the usual practice for carbon steel. As nickel steel stood this test readily, the tests were usually carried further until the plate would bend flat on itself and the illustration shows a typical specimen which demonstrates the ductility of the material and its ability to withstand the transverse bend tests. From the shop viewpoint, there is little if any difference between nickel and carbon steel from the standpoint of punching, drilling or reaming.

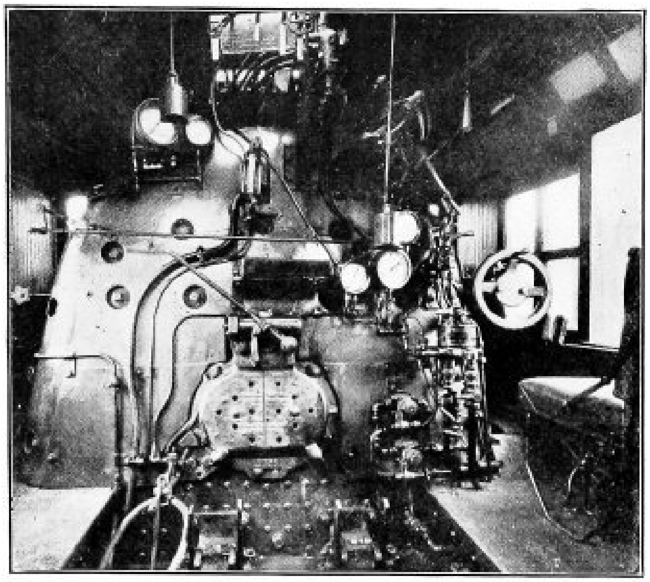
Special Equipment

The Elesco Company's type H-5 feedwater heater has been adopted as standard on the new series of locomotives as the result of a good many years' testing of various types of closed heaters. Considerable attention was paid to the mounting of the feedwater heater itself and it was endeavored to arrange the piping as carefully as possible to present the best appearance.

The weights, dimensions and proportions of the two classes of locomotives are given in the table.



Arrangement of the feedwater heater, and the outside throttle connection—The throttle rod passes through the hand rail



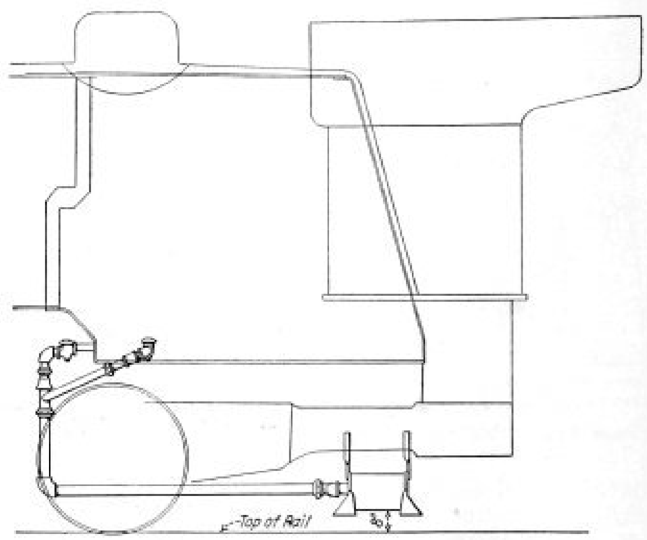
Interior view of the cab showing the arrangement of equipment on the back head

Table of dimensions, weights and proportions of Canadian Pacific class P-2-E and G-3-D freight and passenger locomotives

Type of locomotive	4-6-2	4-8-2
Railroad classification	G-3-D	P-2-E
Builders	Montreal Locomotive Works	Canadian Locomotive Company
Service	Passenger	Freight
Cylinders, diameter and stroke	23 in. by 30 in.	23 in. by 32 in.
Valve gear, type	Walschaert	Walschaert
Valves, piston type, size	14 in.	14 in.
Maximum travel	7 in.	7 in.
Outside lap	1⅝ in.	1⅝ in.
Exhaust clearance	¼ in.	⅛ in.
Lead in full gear	¼ in.	3/16 in.
Weights in working order:		
On drivers	184,300 lb.	244,600 lb.
On front truck	62,000 lb.	30,600 lb.
On trailing truck	60,200 lb.	60,000 lb.
Total engine	306,500 lb.	335,200 lb.
Total tender	192,260 lb.	229,500 lb.
Total engine and tender	498,760 lb.	564,700 lb.
Wheel bases:		
Driving	13 ft. 2 in.	16 ft. 6 in.
Rigid	13 ft. 2 in.	16 ft. 6 in.
Total engine	35 ft. 0 in.	35 ft. 8 in.
Total engine and tender	67 ft. 10 in.	72 ft. 1½ in.
Wheels, diameter outside tires:		
Driving	75 in.	63 in.
Front truck	33 in.	31 in.
Trailing truck	45 in.	45 in.
Journals, diameter and length:		
Driving, main	12 in. by 14 in.	12 in. by 14 in.
Driving, others	10½ in. by 14 in.	10½ in. by 14 in.
Front truck	6½ in. by 13 in.	6½ in. by 13 in.
Trailing truck	9 in. by 14 in.	9 in. by 14 in.
Boiler:		
Type	Straight top—extended wagon bottom	Straight top—extended wagon bottom
Steam pressure	250 lb.	250 lb.
Fuel	Bituminous	Bituminous
Diameter, third ring, outside	88 in.	90 in.
Firebox, length and width	111 1/16 in. by 84¼ in.	120 1/16 in. by 84¼ in.
Arch tubes, number and diameter	4—3½ in.	4—3½ in.
Combustion chamber length	26 in.	26 in.
Tubes, number and diameter	28—2 in. and 160—2¼ in.	32—2 in. and 158—2¼ in.
Flues, number and diameter	40—5½ in.	45—5½ in.
Length over tube sheets	18 ft.	18 ft.
Grate area	65 sq. ft.	70.3 sq. ft.
Heating surfaces:		
Firebox and comb. chamber	258 sq. ft.	274 sq. ft.
Arch tubes	33 sq. ft.	36 sq. ft.
Tubes	1,950 sq. ft.	1,966 sq. ft.
Flues	1,031 sq. ft.	1,160 sq. ft.
Total evaporative	3,272 sq. ft.	3,436 sq. ft.
Superheating	864 sq. ft.	970 sq. ft.
Comb. evaporative and superheating	4,136 sq. ft.	4,406 sq. ft.
Tender:		
Style	Rect. water bottom	Rect. water bottom
Water capacity	8,000 Imp. gal. (9,600 U. S. gal.)	10,000 Imp. gal. (12,000 U. S. gal.)
Fuel capacity	12 ton	16 ton
Wheels, diameter	36 in.	36 in.
Journals, diameter and length	6 in. by 11 in.	6½ in. by 12 in.
General data, estimated:		
Rated tractive force, 85 percent	45,000 lb.	57,100 lb.
Cylinder horsepower (Cole)	2,379	2,379
Speed at 1,000 ft. piston speed (estimated)	44.6 m.p.h.	35.1 m.p.h.
Weight proportions:		
Weight on drivers ÷ total weight engine, percent	60	73
Weight on drivers ÷ tractive force	4.08	4.2
Total weight engine ÷ cylinder hp.	129	141
Total weight engine ÷ total heating surface	74	76
Boiler proportions:		
Tractive force ÷ comb. heat. surface	10.9	12.95
Tractive force × dia. drivers ÷ comb. heat. surface	816.0	816.5
Cylinder hp. ÷ grate area	36.55	33.8
Firebox heating surface, percent of evap. heat. surface	8.9	9
Comb. heat. surface ÷ grate area	63.5	62.8

Universal Blow-off Muffler

A locomotive blow-off muffler for all classes of power has been developed on the Kansas City Terminal railroad by W. E. New, master mechanic, and B. Yoakum, sheet metal foreman. It is designed to permit blowing off locomotive steam and water pressure at any time or place without danger to life or property and without the use of a blow-down box. Instead of discharging a high velocity jet of steam and hot water into the open air when necessary for any reason to reduce the concentration of boiler water on the road or to blow down the entire steam pressure at the terminal, the steam and water is discharged into the muffler and downward as a fine spray between the tracks. Steam and hot water are therefore not permitted to proceed from the side of the locomotive to interfere with the engineman's vision, or possibly to carry sediment-filled spray back over the coaches.



Application of the Universal muffler blow-off

The method of applying this muffler is shown in the illustration. The construction is on the same principle as that of an automobile muffler as the blow-off steam enters at the center and passes through several baffle plates before being discharged downward at each end of the outer wrapper sheet. The two end castings are tapped at the center to receive the 2-inch blow-off pipe connections and is shaped at the bottom to receive and further break up or deflect the blow-off steam as it leaves at the outer wrapper sheet.

Arrangements have been made for the manufacture and sale of this muffler by the Locomotive Finished Material Company, Atchison, Kans.

The Equipment Sales Corporation, Railway Exchange Building, St. Louis, Mo., has been appointed sales representative in that territory for the Flannery Bolt Company of Pittsburgh, Pa.

A Study of the Rivet and Riveting Methods*

Outlining the use of rivets and their characteristics in the present industrial field

By J. C. Hanna†

ONE of the first steps in the comprehensive procedure leading to the change for improvement of a structure or method of construction is a thorough analysis of the existing method in order that all its virtues may be comprehended and weighed. If this is not done, important or even essential good qualities may be lost in the change. The qualities lost may outweigh the qualities gained with the result that the change proves later to be the reverse of the overall improvement originally contemplated. A disregard for this basic principle of engineering procedure has embarrassed many an engineer.

The advent of the fusion welding process is of far reaching consequence. As a new method of joining metal parts it immediately finds many fundamentally sound and legitimate applications.

We are faced with the problem of determining what joints are best made by riveting and what best by welding. In an attempt to draw a line between the practical fields of application of these two joining methods we can and should follow the correct procedure as established by experience. Therefore, one of the first steps should be to thoroughly familiarize ourselves with the rivet and the riveted joint.

Manufacture of a Rivet

The bar from which a rivet is made was reduced by hot working from an ingot less than a foot thick. An ingot of ordinary size worked down to a bar suitable for a ¾-inch rivet will have become nearly two-thirds of a mile long, and will have been subjected to numerous hot workings and incidental heatings. The ingot billet or bar was never quenched but cooled slowly on a hot bed. Each of these heatings was an anneal.

The metallurgical effect of this heat treatment is to break up the coarse crystalline structure of the ingot into a fine grained regular structure. The mechanical hot working has the same effect as well as to iron or squeeze out all pipes, bleed cavities, blow holes and divide the slag or oxide inclusions into microscopic parts which are negligible. The repeated hot rolling has set the grain of the steel longitudinally so it best resists the shear and tension to which it is subjected in service.

The result is a steel of such definite characteristics that various agencies, particularly the American Society for Testing Materials, have found it practical to frame specifications covering both the physical and chemical qualities of rivets. The physical tests specified include bending cold through 180 degrees flat on itself without cracking on the outside of the bent portion. Also the same bend test after quenching in water from 1,200 degrees F. The head shall flatten while hot to 2½ shank diameters without cracking at edges.

Rivets will pass much more severe tests. The art of steel making and of rivet making has advanced since rivet specifications were framed, with the result that rivets are now made which would easily conform to more rigid specifications.

Rivets were originally driven by hand hammer. The boiler maker of generations ago was skillful in wielding a hammer in each hand. A swage was used for finishing the heads. The first yoke type riveters were steam actuated, the piston working direct on the die. Some steam riveters amplified the available pressure by inertia of heavy moving parts and were similar in action to a steam hammer. The hydraulic riveter soon followed. The first portable riveters (1873) were hydraulic. The first riveting gun of which we have knowledge was patented in 1875 and was operated like a steam engine, with fluid actuated D valve. The hydro pneumatic riveter was invented in 1895. In 1877 the plain toggle mechanism, or Allen type riveter, air operated, was introduced. The first toggle lever mechanism was built in 1903—today there are 700 styles and sizes.

Portable pneumatic riveters which weigh as much as 30 tons and capable of driving 1⅝-inch rivets of boiler quality through five-inch grip are in use for heavy steel plate joining, such as hydro electric penstocks and spiral shells. One portable riveter for gas holders of ten million cubic feet capacity drives 2¼-inch rivets cold.

Improvements in Riveting Methods

The near future will bring improvements and refinements of riveting methods, as well as reduced costs. Standardization of design and constant increase in volume of large building steel, mean repetition work in the fabrication shops, which, in addition to the high cost of labor, warrants increased expenditures for shop equipment.

Single machines are now being built into which may be placed raw standard shapes, such as plates and angles, and which will produce a column completely prepared for riveting. A conservative estimate of the saving thus made is $10 per ton.

A multiple riveting unit is to be added to this machine, which will then produce columns completely fabricated ready for milling, splice plates, brackets, and field erection. A further reduction in the cost is thus assured, as three men will do the riveting now done by twelve. It is believed that this machine which entails over $100,000 initial investment will pay for itself in one year. This saving does not include the riveting economy. It is also adaptable to girders and H section columns.

Strength of Riveted Joints

A recent investigation of the behavior and of the ultimate strength of riveted joints under load by Commander E. L. Gayhart (CC), U. S. N., performed at the Bureau of Standards, indicates that two rows of rivets on each side of the joints are weaker than four rows by a negligible quantity, if slip is no consideration and that the outside row should have no fewer rivets than the inner row. This last is particularly true of two row joints (two rows on each side of the joint) since this row assumes at least two-thirds of the load at all loadings. In fact, if alternate rivets are to be omitted in two row or duplex seams, it would seem that they should be omitted from the inner row rather than from the outer, as is now common. By this line of reasoning the maximum support may be had for the calking seam at no expense of plate strength and with an economical disposition of rivets.

It is interesting to note that riveted joints tested by the Bureau of Standards exceeded in test their theoretical efficiency. The joint efficiencies, excellent though they were,

*Abstract of an address delivered before members of the American Welding Society and the Philadelphia Engineers Club of Philadelphia, on February 21, 1927.
†Chief engineer of the Hanna Engineering Works, Chicago, Ill.

would probably have been better if the rivets had been machine driven, particularly in the case of high strength plates that showed relatively poor friction value. It is conceivable, in view of the foregoing, that certain joint designs which indicate a theoretical efficiency of 93.7 percent may have a higher actual efficiency.

The riveted joint is standardized. Research is being constantly pursued. Text books contain full details of every commonly used joint and are revised with progress in the art.

We often hear the statement "The weld was as strong as the plates joined." Just what is meant by "as strong?" Strength of steel can be expressed in various ways. A complete expression of strength must include the data relating to a number of characteristics of strength. The characteristics of strength which are pertinent to a certain piece of steel depend upon the use to which it is to be put.

Weld metal falls short of these specifications chiefly in ductility as a natural result of its coarse, crystalline structure. The plate metal adjoining a weld will probably fall short in the same manner because of grain growth.

A definite set of hard and fast rules for acceptance or rejection of a weld has never been adopted. It is pointed out that such rules are not possible due to the variable conditions surrounding welds. How then can any agency charged with the safety of lives and property formulate any standard measure or procedure whereby it may function effectively where welding is involved? Experience has demonstrated the complications contingent upon discretionary latitude on the part of inspectors.

Failure of steel in fatigue may be said to be due to the fact that it falls slightly short of being perfectly homogeneous. We believe that a material which is perfectly homogeneous will be subject to change of shape (strain) in absolute proportion to the stress placed upon it at any unit stress below that which will result in a permanent change in shape, measurable or immeasurable. If this were true of steel it is believed that steel would not fail under an infinite number of applications of force of any intensity below the proportional limit. In this case proportional limit would be synonymous with endurance limit. That this is *not* true of steel is due to its lack of homogeneousness. The very structure of steel makes perfect homogeneity impossible.

Some steels are more nearly homogeneous than others. The characteristics of structure which contribute to reduced homogeneity naturally lower the endurance limit. These are—large crystalline structure or grain growth—irregular or variable structure—inclusions of impurities—minute cracks—in fact anything which contributes to irregular stress distribution.

It has also been determined that surface finish bears an important relation to endurance limit. A rusted or oxided surface will reduce the endurance limit of a test sample as much as 40 percent. A sharply irregular contour or shape will greatly reduce the endurance limit of a test piece.

There is emphasis in the foregoing on ductility as well as endurance limit. The significance of these test data is explained with great clarity in the following excerpt from an Investigation of the Fatigue of Metals—Series 1922—by Professors Moore and Jasper, University of Illinois:

"The lack of correlation between the endurance limit and some other physical property of a metal does not signify that the latter is of no value as an index of the qualities of the metal. For example, there seems to be no correlation between the endurance limit of a metal and its ductility, yet the ductility of a material must be considered by the user. This lack of correlation simply indicates that under repetitions of a definite stress ductility does not markedly affect the strength of a material and that if there were any certainty that a machine part would never be subjected to extraordinary stresses the ductility of the material would not need to be taken into account. This is the case for springs provided with stops to guard against excessive deflection; and oil quenched high carbon steel, a material low in ductility, is frequently used for those springs. Notwithstanding, for most machine parts there is a probability that occasionally they will be subjected to rather severe overstress. The parts of the running gear of a motor car furnish an excellent illustration of this point. For the material in such parts ductility is important in furnishing insurance against a disastrous shattering failure under overstress. If a material is ductile, some hundreds of overstresses can be endured with no worse result than a slight distortion of the member. Moreover, it may be possible by means of straightening, heat treating, and polishing of parts, to repair this rather severe damage. This illustration has been given at some length, because there is a tendency for engineers to use one test and one test only, for judging a material and to feel that the adoption of one test implies the discarding of others. With our present knowledge, no single test can give an index of the usefulness of a material for all classes of service. The materials engineer should beware of regarding any single property of a metal—elastic limit, tensile strength, endurance limit, hardness, ductility, notched-bar value, etc.—as a complete indication of the usefulness of a steel. Static strength, resistance to impact, ductility under overstress, and resistance to repeated working loads are all important.

"It has been noted before that there seems to be no correlation between the results of fatigue tests and those of impact tests—either single blow or repeated impact tests. It should be carefully marked that such a result does not imply the uselessness of either the repeated stress test or of the single blow impact test; it does signify that the qualities indicated by the tests are not the same. Nothing can relieve the materials engineer of the necessity of deciding which tests will show the qualities in metal demanded by the particular service to which a machine part or structural member will be subjected."

Investigation made by Dr. D. J. McAdam, Jr., at the United States Naval Engineering Experiment Station, Annapolis, indicates that steel from which rivets and structural shapes are generally rolled is less subject to corrosion fatigue, if heat treated in a simple and inexpensive way.

Corrosion fatigue is failure under repeated stress of a corroded sample. The corrosion endurance limit is lower when corrosion takes place simultaneously with the repeated stress rather than when all corrosion precedes the application of stress. However, the latter endurance limit is lower than when corrosion is no factor.

With these facts established, fatigue tests on weld should be made on samples having an oxidized surface at the critical section, as a finished weld oxidizes; if this be impractical a modifying percentum factor should be applied to the endurance limit as determined by ordinary test.

The similarity of weld steel to an ingot before soaking or a steel casting before annealing is often cited, in view of which the following "high lights" of the steel casting industry are pertinent:

Thirty years ago approximately 90 percent of the steel castings poured were annealed, which proportion still exists, regardless of size and weight, both of which in some cases are enormous.

The difficulties encountered by the steel casting industry in the early days were chiefly due to lack of knowledge of the chemistry of steel, as well as the action of steel and gases under high temperatures and subsequent cooling, resulting in blows, shrinks, strains, impurities and weak structures. The high grade and uniformly reliable product of the present day is the result of accumulated and extended knowledge, backed by years of experience. One of the principal results of this knowledge is melting control, which has risen to scientific exactness. In welding no comparable control of melt can be made.

FUNCTION OF ANNEALING PROCESS

Annealing breaks up coarse, crystalline casting structures, and resultant planes of weakness, into fine crystalline structures, and relieves internal stresses, which, in some cases, are sufficient to cause failure before annealing.

Annealing evidences itself in pull tests by more than doubling the elongation and reduction of area as compared with pull tests on unannealed samples and in slightly reducing the elastic limit. All steel foundries, acting on their own volition, will anneal 100 percent of castings. Unannealed steel castings are used in compression only and it is interesting to note that footings, pedestals, and so forth, for bridges, are annealed steel castings.

The ductility of weld metal is similar to that of unannealed steel castings. The average ductility of samples of weld metal listed in S. W. Miller's article appearing in February, 1927, issue of *Mechanical Engineering* is 10.9 percent elongation and 22.37 percent reduction of area. The samples (seven in number) were taken from very large welds made automatically and, therefore, may be presumed to have had the beneficial effects of the annealing supposed to result from layer welding. This welding was done under the most ideal circumstances known to the welding art today.

Can annealing, either by welding in layers, or by general application of heat, be effective in the correction of the adverse results of intense heating? The metallurgist of a steel foundry would answer "Probably not, because we know a casting from a burned or oxidized batch of steel in the furnace cannot be entirely cured by any heat treatment." (The temperature the weld metal passes through exceeds that of an open hearth.)

If an attempt were made to relieve shrinkage or heat strains by local application of heat after welding, the result is only to move the internal stresses from one location to another.

ADOPTION OF WELDING

Commenting on the possible adoption of welding of steel structures, Milo S. Ketchum, Dean of the College of Engineering of the University of Illinois, in a paper on "Research Investigations in Connection with the Structural Steel Industry," before the members of the American Institute of Steel Construction said (quoting from *The Iron Age*, November 4, 1926):

"The allowable stresses, details of design, methods of erection and other phases of steel structure with riveted connections are controlled by specifications that are the result of experimentation and experience in the shop and field and in service. While the tests and experience with welded structures would appear to indicate that welding has an important place in the fabrication and erection of steel structures, much study, investigation, and experimentation will be necessary before welding can be generally adopted in place of riveting.

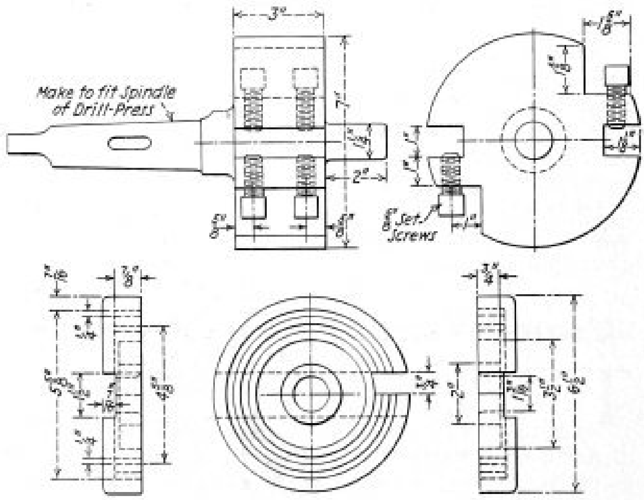
"From this discussion it would appear entirely probable that riveted connections will continue to be used for heavy framework for bridges and buildings, and where difficult erection problems occur and for structures of complicated design where it is necessary to design for deflection stresses. It should be remembered that a riveted structure has sufficient flexibility to change its form to take the load, while the welded structure with its more rigid joints will lack this flexibility. It would appear, therefore, that the economic design of articulated welded structures will require that the stresses be calculated with greater accuracy and that the design be made with greater skill than is necessary in the design of riveted structures."

JAMES S. CLARKE has been appointed general inspector of locomotive maintenance of the Boston & Maine, with headquarters at Boston, succeeding George A. Silva.

Gage for Setting Blades in Superheater Flue Cutters

By J. Robert Phelps*

THE illustration shows a gage used for setting the blades in a superheater flue cutter so that they will have the right clearance and cut the right diameter. The grooves in the gage are cut the exact diameter to which the superheater flue holes are to be cut in the flue sheet. The hole in the center of the gage is the same diameter as the pilot on the flue hole cutter. To set the blades in



By means of this gage the blades in a superheater flue hole cutter can be set to the correct clearance and to cut the right size hole

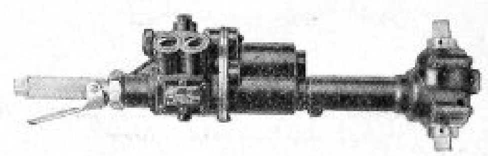
the proper position, the gage is slipped over the pilot of the tool holder and then the blades are set in the proper position. After the correct clearance is obtained the blades are drawn up tight.

With this arrangement there is no guess work and no trial and error. The blades are set to the gage and they cut a smooth hole to the right diameter. This arrangement makes it an easy matter to have a few extra blades on hand and ground ready to apply when needed.

Thor Pneumatic Wrench

A NEW machine, the Thor 71R pneumatic wrench, has been placed on the market by the Independent Pneumatic Tool Company, of Chicago, after several years of research and experimentation on the part of the company's engineers.

This wrench is especially adapted for locomotive work in



Thor type 71R pneumatic wrench

putting on and removing 1-inch nuts, 1-inch dome nuts, ¾-inch and ⅝-inch front end nuts and flexible staybolt caps.

Several large railroads have thoroughly tested this machine and the reports are favorable. Some of the tests to which the machine was put are as follows:

Removing and running up 1-inch hexagon nuts on loco-

*Apprentice instructor, A. T. & S. F., San Bernardino, Cal.

motive cylinder heads—26 nuts to each cylinder. Time allowed under bonus system is 25 minutes per cylinder head. The entire job was accomplished by the 71R in 10 minutes, including final tightening. Machine was also tested on front end nuts and found satisfactory.

Removing and running up 1-inch hexagon nuts in locomotive cylinder heads—type S-1-A locomotive. Thirty-two nuts per cylinder head. Time allowed under bonus system is 14 minutes for removal of nuts and heads. The 71R removed nuts in eight seconds each and the total job, including head removal, was done in 5 minutes.

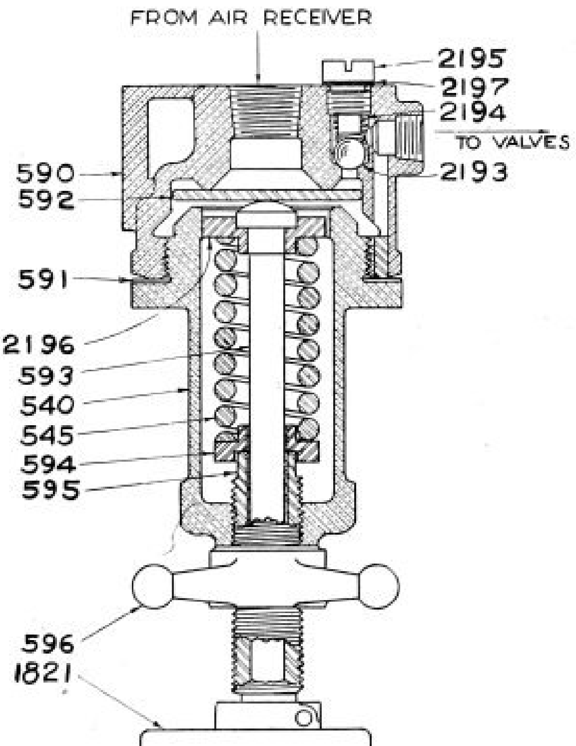
The Thor wrench is a one man tool weighing 25 pounds and is easy to handle. It allows the setting of nuts in close quarters quickly and conveniently.

The free speed of the machine at a pressure of 90 pounds per square inch is 90 revolutions per minute. Overall length of the spindle is 4⅞ inches and distance from center of spindle to outside of case is 1 13/16 inches. Distance from center of spindle to extreme end of throttle is 22½ inches. Maximum torque of machine at the spindle is 756 inch pounds.

The machine can be equipped with various size sockets from ½-inch to 1-inch to accommodate the size nut that a given job requires.

Control Valve for Air Compressors

The accompanying illustration shows the improved "Simplate Differential Unloader" with which the pneumatic air compressors made by the Chicago Pneumatic Tool Company, Chicago, Ill., are equipped. The valve No. 592 is a single plate of stainless steel ground to



Sectional view of new control valve

a perfectly flat surface. The diameter is also ground to fit cap No. 590 with a few thousandths clearance. The cap No. 590 contains a ball check valve No. 2193 spring No. 2194 and ball check screw No. 2195. The flanges by which the unloader is attached to the compressor or panel are on the cap. This permits dismantling the unloader for examination or cleaning without disturbing the piping or valves. The device operates with a five pound range between unloading and loading the compressor. An unloader is set to unload generally with 100 pounds and the reloading pressure is 5 pounds lower or 95 pounds.

As the air pressure rises to 100 pounds the pressure on the upper side of the valve No. 592 balances that of the spring on the under side of the valve and air escapes past the seat into the annular space around the outer edge of the disk. Because of the close fit of the disk in the cap No. 590 and the ball check valve the air cannot escape and a slight pressure is built up, which, acting upon the surface of the disk, balances the pressure of the spring on the lower side of the disk and the disk moves down against the seat in the body of No. 540. The ball check valve is then exposed to full receiver pressure and being held on its seat by a light spring immediately moves off the seat and uncovers a ¼ inch hole for air to pass through on its way to the unloading inlet valves.

Upon a drop of receiver pressure equal to the range, in this case, 5 pounds, the pressure of the spring No. 545 balances the pressure due to the air on the disk and causes it to permit leakage past the lower seat into the space around the stem. This leakage is restricted slightly by the upper spring holder No. 2196 which is a moderately close fit in the body No. 540 and a slight overbalancing pressure is built up which causes the valve disk No. 592 to return to the upper seat with a positive movement and air is vented from the unloading piping past the upper spring holder.

The action of the valve in opening and closing is positive and because of the absence of tight lapped fits its response to pressure changes is accurate.

The unloader is now built for standard pressures from 50 to 125 pounds; for low pressure work of 40 pounds or less; and for high pressure work up to 500 pounds.

Diagonal Seam Patches

In the explanation of diagonal seam patches in an article appearing on page 33 of the February issue of The Boiler Maker, credit should have been given to the Boiler Division of the Department of Safety, Industrial Accident Commission of the State of California as the source of the material.

This oversight was called to our attention by F. A. Page, Chief Inspector of the Boiler Division, who was one of the originators of the diagram and constants and factors used with it. The diagram was developed early in the year 1919 and distributed in April of that year. In 1925, Mr. Page added angles 15, 20 and 25 degrees, with the necessary factors and constants. Changes were also made in the top end requirements of the patch; three pitches in the straight seam were allowed, and a note was added calling attention to this fact. The diagram and explanation in the article published were taken from this latest work of the Boiler Division, Department of Safety of the State of California.

Trade Publications

Welding and Cutting Equipment.—The Smith Welding Equipment Corporation, Minneapolis, Minn., has issued a pocket size junior catalog illustrating and describing oxy-acetylene equipment produced by the company. The catalog also includes a price list.

Automatic Arc Welding.—Under this title the General Electric Company, Schenectady, N. Y., has prepared a treatise on the applications of this latest development in the field of welding to many industrial uses. The foreword of the book states "the application of scientific machine methods together with the elimination of the personal element—makes automatic arc welding, when applicable, the ideal welding process wherever mass production is desired."

The Internal-Combustion Boiler*

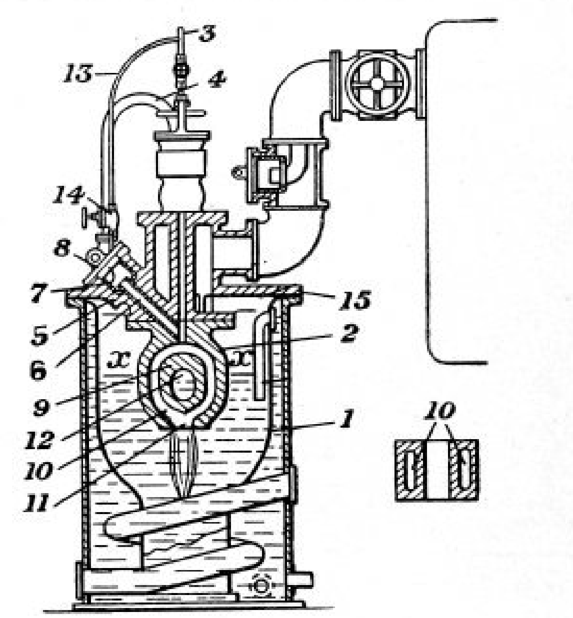
This type of boiler forms a possible solution to the problem of obtaining high steam pressures in boilers

By Oscar Brunler

It is nearly thirty years since the first experiments were made to solve the problem of burning an open flame in liquids. Thirty years ago there was no compressor which worked continuously without breaking down, or which could supply the same quantity of air for a certain length of time. Difficulties of many kinds arose; boiler after boiler was built, experiment after experiment was made, but the difficulty of maintaining a flame burning continuously in water seemed insurmountable. However, fourteen years ago, after persistent effort the first boiler was made which would work continuously. It was not a commercial proposition, and two more years passed before the boiler had reached that stage where it could be guaranteed that it would work for months without breaking down for repairs. The competition between the most efficient internal-combustion engine (Diesel engine) and the steam engine for many years past, has led to great improvements in both. The great rivalry between the steam engine and the Diesel engine is due to the fact that the Diesel engine converts a greater portion of the heat of the fuel into energy than does the steam engine. This fact has been known since the first internal-combustio nengines were built, but it was of no great importance at that time or for many years after. The reason was that the combustion engines needed fuel which was more expensive than coal, and in some countries such fuel could be obtained only with great difficulty. Besides, internal-combustion engines were not as efficient as they are today. During the last twenty-five years, however, all these difficulties have been overcome, and combustion engines have been so designed that they are working efficiently with fuels of an inferior kind.

Although in many respects the steam engine is superior to the internal-combustion engine, it is possible that further improvements in the latter may bring about complete supremacy. The designer of steam engines, who considers these facts with a view to the future, must put the question, what is to be done in order to prevent the supremacy of the oil engine? The answer is easily given—convert more heat into energy. Further improvement of the steam engine itself is very improbable. It also seems impossible to improve the boiler. All designs of boilers are based on the principle of bringing the flame of the fuel in the closest possible contact with the water in the boiler. If this is one of the main ideas why not burn the flame inside the water? Is it possible to burn a flame in immediate contact with a liquid? It is, as every kind of liquid fuel burns in the liquid as long as the quantity of air or oxygen is large enough to ensure complete combustion. This idea is fully demonstrated in the working of the internal-combustion boiler, the principle of which is to maintain a flame burning in the liquid in order to evaporate the latter. During the years of experimenting, liquid hydrocarbons of a specific gravity between 0.8 and 1.2 have been used.

The fuel, crude oil, etc., and the air which is necessary for its combustion are supplied to the burner under a pressure which barely exceeds the pressure of the steam. Before starting, the connection valve is closed, and the water level in the generator must not be above the lower mouth of the burner. The cover of the ignition lamp is removed after heating the fireclay lining of the ignition lamp; the oil and air ignite on the fireclay lining. Then the cover is pulled down again, and the flame of the ignition lamp makes its way to the burner. After a few minutes the main burner is hot enough, and the main regulating valve is opened and the flame burns in the generator. The connecting valve to the water reservoir is now opened and the water in the generator rises up to the middle of the burner. The flame which is burning quietly in the water can be observed through the peep-holes in the generator. By means of the superheater the steam can be superheated to any required degree. The superheater consists of a small burner similar to the ignition lamp, and its flame burns in the steam reservoir.



The Brunler steam generator in section

1. The steam generator body.
2. The burner.
3. The oil pipe.
4. The air pipe.
5. The cover of the steam generator.
6. The ignition lamp tube.
7. The fireclay cap of the ignition lamp.
8. The cover of the ignition lamp.
9. The bridge of the burner.
10. The burner passage.
11. The burner outlet.
12. The water passage through the burner.
13. The oil pipe to the ignition lamp.
14. The air pipe to the ignition lamp.
15. The cover of the generator.

The size of the flame and consequently the quantity of steam is regulated by means of the regulating valve, at the same time the ratio of oil and air are kept constant. By turning one wheel, the size of the flame can be regulated, and the ratio of fuel and air is not changed. Therefore, it is not possible that the combustion can be altered through mistakes of the man in charge of the boiler. The temperature in the center of the flame is approximately 1,800 degrees Centigrade. This temperature diminishes to the periphery of the flame, so that between the center of the flame and the periphery a rapid fall of temperature takes place. Since a permanent stream of burning gas has to pass this fall of temperature, it is evident that the last traces of

* Abstract of a paper read at a Joint Meeting of the Institution of Chemical Engineers and Chemical Engineering Group. Cuts used in this article were prepared from those appearing in *The Marine Engineer and Motorship Builder.*

carbon-monoxide must be converted into carbonic acid. In leading the combustion in such a way the possibility is ensured of burning the fuel more completely than in the open air. The combustion under pressure brings the molecules of the fuel into better contact with the oxygen; therefore, under pressure and in water the most complete combustion can be obtained. Now let us consider how the flame acts and what takes place in the steam generator. At first the flame will give up the greatest part of its heat to the water due to the radiation and because of its contact with the water. Around the flame the superheated steam will be produced which will make its way with the nitrogen and carbonic acid to the level of the water and pass over to the steam reservoir. The heating surface is the surface of the flame and the surfaces of the gas molecules which are passing through the water. It is evident that after a few minutes the required steam pressure can be obtained. According to Dalton's law, in this boiler, in which steam and gas are present, the pressure of the mixture must equal the sum of the pressures of the gas and steam.

The mixture of gases which pass from the steam generator to the steam reservoir contains 60 percent of steam, and 40 percent of gases. These are the same gases which are worked in gas and oil engines, the only difference being that in these engines the amount of steam generated is much less.

STEAM CONDITIONS

Pressure of steam in boiler	9.8 atmos.
Temperature of steam in boiler	350° C.
Drop of temperature in engine from	350° to 80°

COMBUSTION

Calories per kilog. of oil	11.500.
Air required per kilog. of oil	17 kilog.
Volume of 17 kilog. of air. 17 : 1.3	13.1 m³.
Final air temperature	50° C.
Increase of air volume from 13.1 to	15.5 m³.

POWER FOR COMPRESSION

Volume 15.5 m³ to 10 atmos.
15,500 × 10.33 × 2.3 = 368,000 kilogrammeter = 1.36 horsepower.

ENERGY IN OIL ACCORDING TO CARNOT'S FORMULA.

$$11{,}500 \times 427 \times \frac{T' - T}{T'}$$

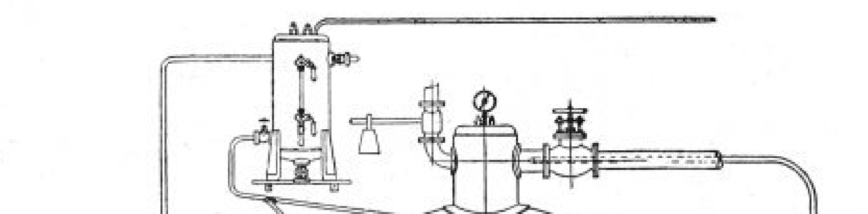
$$T' = 273 + 350 = 623 \qquad T = 273 + 80 = 353$$

$$11{,}500 \times 427 \times \frac{623 - 353}{653} = 2{,}117{,}744 = 7.82 \text{ horsepower}$$

Theoretical power for compression, 1.36 horsepower.
Practical actual power required for compression, 70 percent, compressor efficiency, 1.9 horsepower.
Total power produced in engine, 7.82 horsepower.
40 percent of power produced by gases, 3.1 horsepower.
60 percent of power produced by steam, 4.6 horsepower.
Actual power required for compressor, 1.9 horsepower.
Power regained by gases, 3.1 horsepower. Engine efficiency, 60 percent.
Power of gases produced in engine, 1.86 horsepower.
Power for compressor is regained due to the work of the combustion gases.

As it can be seen from the above calculations, the efficiency will not be diminished, but, on the contrary, increased. By using the air compressor it is possible to transfer that advantage of the gas engine to the steam engine. The gas engine works also with an air-compressor pump, which is relatively even bigger than the compressor for this new boiler. That the compression pump is united with the working cylinder does not alter this fact. In considering the working process of gas and oil engines, we find that at the first piston stroke an inflammable mixture is drawn in, with the second stroke it is compressed, or with the Diesel engine air is drawn in and then compressed, only at the third stroke the gases perform work, and at the fourth stroke the burnt gases are blown out. In calculating the different forces one can easily find out that the power for the compression in these engines is relatively greater than is necessary in this new boiler system. The presence of a great quantity of gas in the steam makes the condensing engine impossible; i.e., steam which is passing off can be condensed, and as feedwater be pumped into the boiler, but a vacuum cannot be used because vacuum pumps of a very large size would be required. But this fact is not a serious disadvantage. The main idea is to save as much fuel as possible, and to obtain the highest efficiency. If this is possible without condensation all the better. Instead of the condenser we have an air compressor, which takes less space and needs less repairs than the condensing plant. At the same time, steam which is passing off can be used for heating purposes.

Practically every engineer and scientist maintains that the determination of the calorific value of any fuel, whether liquid, solid or gaseous, is exact, if we determine it either in the bomb, or calculate it by means of the chemical analysis. However, when we have to deal with the combustion of fuels or explosives we have sometimes to face riddles for which we have no explanation, since they are absolutely opposed to our knowledge regarding the heat theory and to the energy produced by the combustion according to our established formulæ. It is well known to experts of explosives that with the same quantity of an explosive entirely different efficiencies can be obtained. This is not only the case with explosives, but also with the combustion of oils or gases. In both cases, with explosives as well as with oils or gases, efficiencies have been obtained which are not in the least in accordance with our combustion theories. A good many experiments have shown that sometimes a higher efficiency than the theoretical 100 percent was obtained. If we base our calculations on our present formulæ for the determination of heat or energy no higher efficiency than 100 percent can ever be achieved, but in practice in certain cases more than 100 percent efficiency has been obtained, consequently there must be either a slip in the experiments or in the determination of the calorific value.


Typical installation of new Brünler combustion system

THE MISSING FACTOR

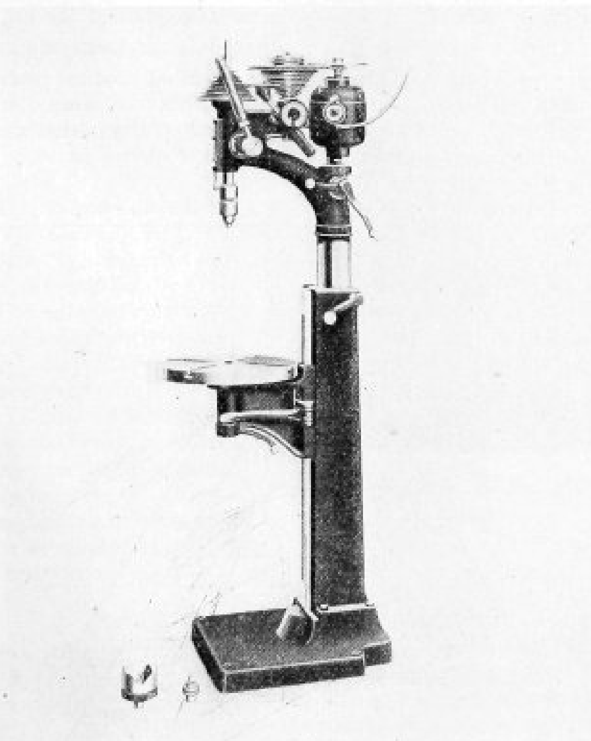
All the experiments to which I am referring have been carried out so carefully that there must be a missing factor in our present formulæ, that is, our formulæ with which we are reckoning nowadays hold good only for combustion under certain conditions; in cases where the oils or gases or explosives are burned in other ways an unknown factor has to be taken into account. There must be some kind of latent energy which is set free during the combustion which we cannot utilize at the present time. So far there are no means for determining this unknown energy. I am of the opinion that under certain conditions which are still unknown to us electric vibrations produced during the combustion are converted into useful energy and thus a higher efficiency than 100 percent is obtained. In such cases we have to add an unknown energy X to our formulæ, which may represent the energy of the electric vibrations during combustion.

New All Purpose Drill

THE "Little General" is a radical departure from the usual type of sensitive drill. It embraces many time-saving features; has quick and flexible adjustments; and obviates all the awkward movements unavoidably present in the operation of drill presses ordinarily in use.

It is designed to meet every need of general shop and tool room service. Its wide range and variety of speeds readily adapt it to production work when required.

Belts and gears have been eliminated. The principle of the drive transmission is known as the "V-Disk." These disks are of fiber, tapered to an 18 degree angle. They



New type drive Ryerson drill

mesh with grooves disposed at a corresponding angle, thus effecting a substantially positive grip.

The spindle swings in a complete circle around the column, thus enabling the operator to reach large and heavy pieces in any position. The table swings in a semicircle and both the table and head have an unusually large vertical adjustment.

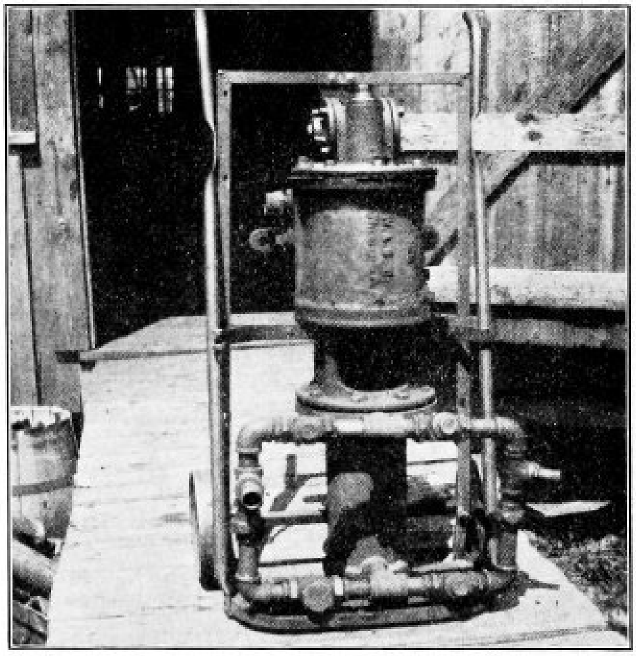
A direct reading speed shift dial indicates each of the 18 speeds and the size of drill best adapted to the various materials. Other advantages claimed for this new principle drill are—the long reach from drill to column; the small number of levers and working parts; the accurate depth gage graduated in both inches and millimeters; and the quick and convenient provisions for shifting and adjusting which reduce to a minimum the waste of time which is unavoidable in the use of many other drills.

The "Little General" has a drilling capacity, straight shank drills, of ½ inch. By using turned down shanks it is possible to drill one inch in brass or with care in iron.

Complete information can be secured by writing Joseph T. Ryerson and Son, Inc., Chicago, Ill.

Hydrostatic Pressure Pump

THE illustration shows a locomotive cold water, hydrostatic pressure pump made from a discarded 11-inch air compressor. The air cylinder has been replaced by a 4-inch cylinder cast in the brass foundry. At each end of this cylinder, beyond the travel of the piston, is located a 1½-inch hole for the supply and discharge out-



Hydrostatic pressure pump made from a discarded air compressor

lets. The piston in the brass cylinder is attached to the end of the steam cylinder piston rod.

A tee and a short nipple is screwed into each of the two 1½-inch holes. Sixteen short nipples, four elbows, four check valves and two unions are assembled with the two tees to form the rectangular loop shown in the illustration. A tee is located in each side of the rectangle for connecting up the supply and discharge pipes. The check valves at one side of the loop operate as admission and those at the other side operate as discharge valves. The steam cylinder is connected to the shop steam line.

John Maher, for sixty years identified with the boiler making industry died of apoplexy on March 18, at Bay City, Mich. For many years Mr. Maher was engaged by the Industrial Works at Bay City and for seventeen years operated the National Boiler Works. For the past fourteen years he had the operation of the Cuyahoga Boiler Works, also at Bay City.

Cutting Any Parabola From Any Cone

By I. J. Haddon

LET *A—B—C*, Fig. 1, be *any* cone, draw the center line *B—D*. From any point *E* on the center line describe a circle to touch the sides of the cone as shown at *F* and *G*, draw *F—G* produced. Draw the line *H* parallel to *A—B* and tangent to the circle and cutting the cone in *J* and produced to cut the line drawn through *F—G* in *K*.

Draw *K—L* at right angles to *H—K*. This line is called the directrix of the parabola; the point *J* is called the vertex and the point *M* is called the focus.

Note: *M—J*, *J—K* and *J—G* are equal to each other. Draw any number of lines perpendicular to *H—K* as *1, 2, 3, 4, 5, 6* and *7*. With *K—1*, *K—2*, *K—3*, *K—4*, etc., as radii and from the focus *M* as center cut the lines in *1′, 2′, 3′, 4′, 5′, 6′* and *7′*; then if a curve be drawn through these latter points it will be half of the true face of the cone cut by the plane *H—K* and will be half a parabola. To show that the distance through the cone at, say, the point *7* is equal to twice *7—7′* we proceed as follows:

Distances Through the Cone

Through the point *7* and perpendicular to *B—D* draw the line *N—O*, the plane of this line would be a semicircle. Therefore, with *N* as center and radius *N—O* describe the quadrant *O—P* and drop the line *7—Q* perpendicular to *N—O* and cutting the arc *O—P* in *Q*. Then *7—Q* would be half the distance through the cone at the point *7* and should be equal to *7—7′*. From *7* as center and *7—Q* as radius draw the arc *R* which will cut the the *7—7′* in the point *7′*. Any of the distances through the cone at the points *6, 5, 4*, etc., may be proved in a similar manner. I have also shown the distance proved at the point *5* in similar manner to that explained for point *7*.

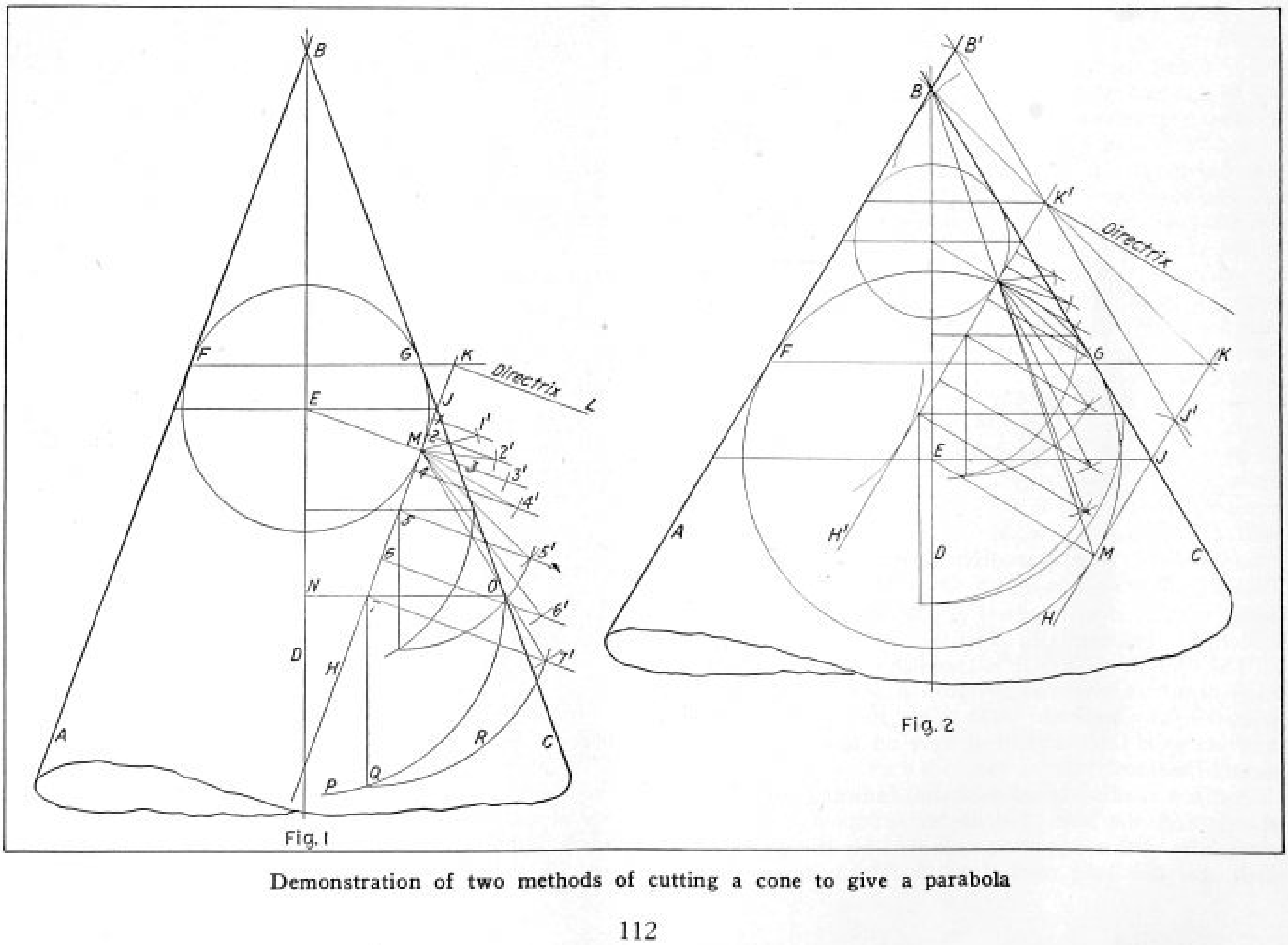
Cutting the Cone

Now let *A—B—C*, Fig. 2, be a cone of a different angle at the apex, as shown; it is required to cut the cone by a plane so that the true face made thereby shall be the same as the parabola on the cone in Fig. 1.

Draw the center line *B—D*, Fig. 2, and from *any point* *E* on *B—D* describe a circle to touch the sides of the cone as at *F* and *G*. Draw *F—G* and produce. Draw *H—K* tangent to the circle and parallel to *A—B* and cutting the side of the cone in *J* and also giving the point *M*, produce *A—B* as shown and from *B* and *J* with radius *J—K*, Fig. 1, draw arcs as shown and cutting the lines already drawn in the points *B′*, *J′*, connect *B′—J′*. Draw *B—K* crossing *B′—J′* in *K′*. Draw *K′—H′* parallel to *A—B*. Then *H′—K′* will be the cutting plane required and whose true face will be a parabola exactly the same as the parabola cut from the cone on Fig. 1. The rest of the drawing can be easily followed as it is the same as explained for Fig. 1.

This method applies to *any parabola* cut from *any cone*.

It will readily be seen that a solution to this problem could have been given with less number of lines, but I thought it best to thoroughly explain to the minutest detail so that anyone could easily follow it.



Demonstration of two methods of cutting a cone to give a parabola

Oxy-Acetylene Welded Construction of a Large High Pressure Storage Tank—II*

Welding saddle plate to manhead—Ventilation provided for operators—Retesting finished tank

By H. E. Rockefeller

IN welding the saddle plate to the manhead, the two pieces were first tack welded at the four corners of the outer flange of the saddle plate. This was accomplished while the head was in a horizontal position and after the saddle plate had been properly alined with respect to the hole in the manhead.

After tacking, the manhead was tilted at an angle of about 20 degrees and the welding started at a point adjacent to one of the tack welds. The oil torch was used to provide additional heat in the vicinity of the point being welded. The welding progressed until the second tack weld was reached. The head was then turned, the welding started in the opposite direction and continued until the seam was completed. This change in direction of welding was pursued in order to reduce the lock-up stresses and minimize the tendency of the saddle plate to lift up from the head.

Fig. 11.—Welding saddle plate to manhead

The manner in which the seam was heated and welded is indicated in Figs. 11 and 12.

The seam having been completed from the inside, the head was turned over and the outside weld made. This seam was welded continuously in one direction, but otherwise the procedure followed was the same as employed on the inner seam.

Providing Ventilation

The sequence followed in joining of the shell sections and the heads was such as to entail the minimum discomfort to the welders. It had been learned from previous experience in fabricating welded tanks, that as long as the cylindrical portion remained open at both ends, no trouble was encountered in keeping the welder cool and providing ample ventilation. In welding the inner V of the head seams and particularly in making the last inner V weld, however, even with the best ventilation system which could be provided with the available equipment, the welders had been subject to some discomfort from the heat. In the construction of the ethylene tank, therefore, it was decided to weld three courses together and then to join the heads to the remaining courses before attaching them to the shell. This sequence worked out very satisfactorily with the improved ventilation system we were able to employ. Figs 13 and 14 illustrate the methods used for ventilating the interior of the tank and drawng the heat away from the welders.

In welding the last seam, furthermore, contrary to the usual practice, the inner V weld was made first. This permitted the elimination of preheating when welding on the inside of the tank and also allowed part of the radiated heat to escape through the unwelded portion of the seam. The welding of the outer V of this seam was accomplished by the use of two welding blowpipes, one used as the preheating medium and the second for welding.

The welding of the nipples and other connections was carried on in accordance with regular accepted practice.

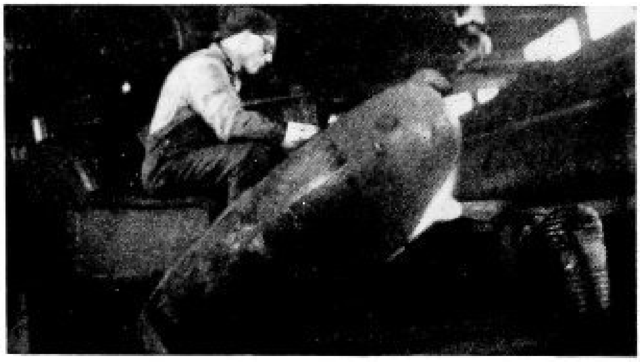


Fig. 12.—Method used for preheating

Because of the considerable difference in thickness between the shell plate and pipe walls, however, the plate had to be preheated to a bright red before the blowpipe flame was allowed to impinge on the surface of the connection being welded.

Test of Tank

On completion of the tank it was first given the regular hydrostatic test imposed on all welded pressure vessels previously constructed. This consisted in applying a pressure of 600 pounds (twice the designed working pressure) and hammering all the welded seams with a 10-pound sledge. The pressure was then increased to 900 pounds (three times the designed working pressure). This is the limit to which all previously constructed tanks were tested and is the test which is called for on welded vessels in the A. S. M. E. Unfired Pressure Vessel Code. (It might be pointed out here that since the A. S. M. E. Unfired Pressure Vessel Code allows a design fiber stress of only 5,600 pounds per square inch, the fiber stress under the required test pressure would be only 16,800 pounds per square inch. On the ethylene tank, the fiber stress at the test pressure was 24,000 pounds per square inch, or about 50 percent greater than called for in the Code.) Having come to the conclusion, during the construction of this tank, however, that the 8,000 pounds per square inch design fiber stress was too low for future construction, the pressure was further

*Abstract of a paper presented at a joint meeting of the Metropolitan Section and Machine-shop Practice Division of the A. S. M. E. with the New York Section of the American Welding Society, New York, January 4, 1927.

increased to 1,000 pounds, or the equivalent of three times the working pressure based on a design fiber stress of 9,000 pounds per square inch.

During these tests strain-gage measurements were taken at various points on the tank. These measurements, which have been analyzed in a detailed report prepared by T. W. Greene, indicated high stresses around the head knuckles

Fig. 13.—Provision made for ventilation

and manhole, particularly about the latter. The tank therefore was again tested to 1,000 pounds pressure to determine if there would be any increase in the permanent set at these points. The second test showed no evidence of distortion except in the metal about the manhole where there was a considerable increase in the permanent set.

The continuous yielding of the metal about the manhole at the 1,000-pounds test pressure indicated a point of danger in the tank, and it was therefore decided to continue the test until no further permanent set occurred at the test pressure, or, if need be, to destruction. At 930 pounds pressure the tank failed through the manhole on the third application of the test pressure. Figs. 15 and 16 illustrate the manner in which the manhead failure occurred under this test.

An examination of the head proved conclusively that the welds were in no way responsible for the failure as they were all intact except as severed cross-sectionally together with the saddle plate and manhead. On the other hand, this failure proved much in favor of the welded joint, the

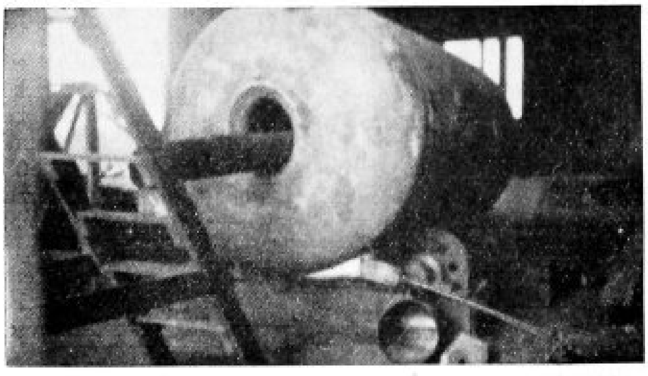


Fig. 14.—Welding inner "V" between fourth and fifth courses

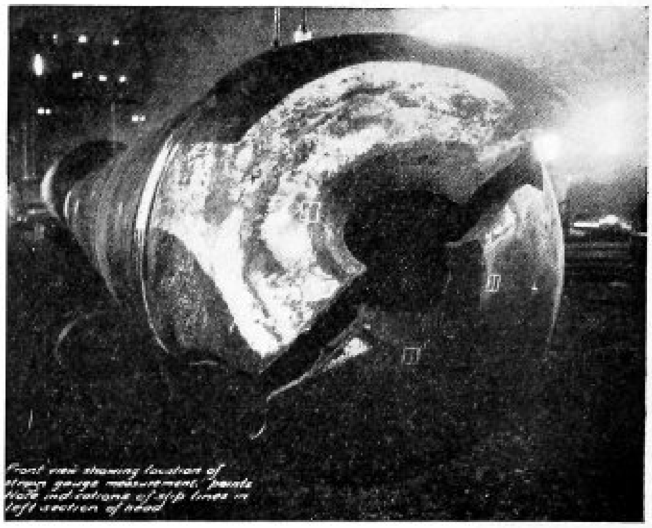


Fig. 15.—Front view showing strain gage measurements

manhead girth weld and the longitudinal weld in the course adjacent to the manhead being in no way affected.

Design of New Manhole Reinforcing Ring

In the repair of this tank it was only necessary to remove the defective head and reweld a new manhead, having in it a manhole reinforcing ring of the requisite strength. The design of the new reinforcing ring, a sketch of which is shown in Fig. 17, was developed by our own engineering department. Because of the high test pressure to which the tank was to be subjected, a cover plate designed for a working pressure of 450 pounds per square inch was specified.

The new manhole reinforcing ring was produced from a steel slab, having the same chemical and physical properties specified for the shell plate. The slab was first cut by means of an oxy-acetylene blowpipe to circular shape and then machined as required to produce the desired fillet and welding bevel. The elliptical manhole was cut out by means of an oxy-acetylene blowpipe and the edges of the opening ground smooth.

The new manhead was constructed in accordance with our previous design, except that an 8-inch flange was specified to replace the metal removed from the first course in cutting off the defective head. After the head had been formed, however, it was necessary to remove a larger section from it than had been done on the previous head as the

Fig. 16.—View of fracture through saddle plate

new manhole reinforcing ring was designed for butt welding to the head rather than lap welding as had been employed in the previous construction.

Welding New Manhole Reinforcing Ring to Manhead

The reinforcing ring was first set up and leveled at approximately the height required for attaching it to the

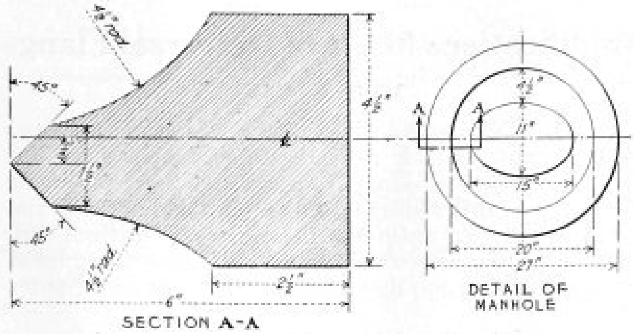


Fig. 17.—Design of new reinforcing ring

manhead. The manhead was then lowered into position and after being blocked up to provide for a draft during preheating, was shimmed as required to bring the abutting edges of the reinforcing ring and manhead into proper alinement.

Four tack welds were next made at equidistant points on the seam, each two being made simultaneously at points 180 degrees apart. These tack welds were about four inches in length and without reinforcement.

Preheating Before Welding

After the tack welds had cooled, a firebrick preheating furnace was built about the entire head. This furnace was constructed in such a way as to provide the greatest amount

Fig. 18.—Method employed to protect welder from heat

of heat at the seam to be welded and in the heavy section of the manhole reinforcing ring. A natural draft was provided, entering through the openings between the blocks on which the head was set up and leaving through the elliptical opening in the reinforcing ring. Charcoal was used as the preheating medium, being distributed within the furnace through the elliptical opening. Asbestos paper was employed to cover the exposed section of the head.

Preheating was carried on until the manhole reinforcing ring and head in the vicinity of the weld had been brought up to a dull red. Welding was then started, using a long-handled blowpipe to keep the welder away from the heat. Fig. 18 illustrates in general the method employed in welding the first side of the double V on the new manhead.

After completing the weld from one side, all openings in the furnace were shut off and the head allowed to cool slowly and uniformly to room temperature. The excess metal was then chipped from the inner V as had been done on all other seams. Following this operation the head was set up for welding the inner V. It was then again preheated and welded. In order to eliminate any locked-up stresses, the head was completely annealed by placing it in a forge fire, bringing it up to an even heat and allowing it to cool slowly and uniformly.

Rewelding Manhead to Shell

The new manhead was welded to the shell by the same method as employed on the last girth seam previous to the head failure. A forced draft was maintained against the head, however, when welding the inner V, to carry away the heat generated and maintain a low enough temperature to permit entrance to and emergence from the tank through the manhole. Figs. 19 and 20 show the new manhole reinforcing ring welded into the manhead and a general view of the completed tank.

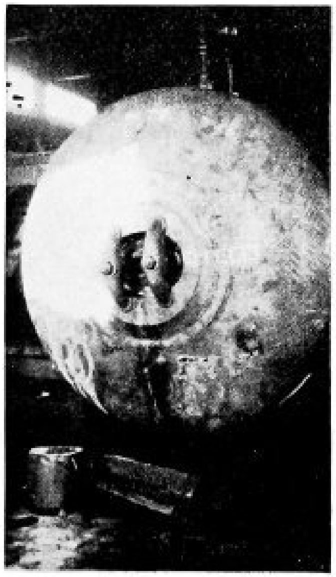


Fig. 19.—End of tank showing new manhole ring

Retest of Tank

The rewelding of the manhead girth seam having been completed, the tank was again subjected to the same tests previously indicated. Following the initial test in which the head adjusted itself somewhat to the theoretical elliptical shape, a reapplication of the pressure indicated that the stress in the head and manhole very closely approximated the design fiber stress. The tank was therefore accepted as safe.

A secondary test for gas tightness was next applied, the tank being subjected to an air pressure of 450 pounds per square inch. Under this pressure all the welded seams were tested with soapy water, but not a single leak was discovered. The tank was therefore accepted and shipped to the customer.

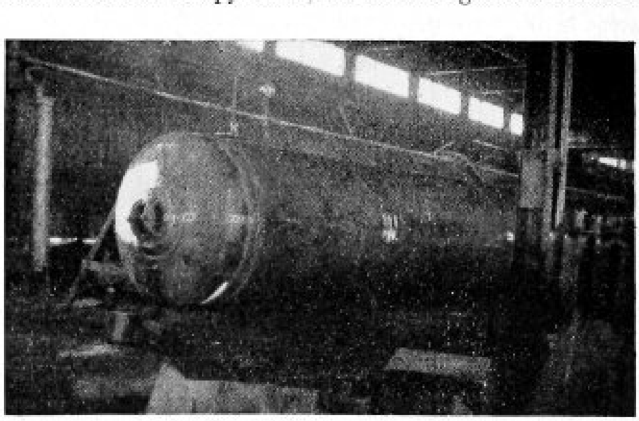


Fig. 20.—General view of tank during final test

Lincoln Arc Welding Prizes

THE American Society of Mechanical Engineers has accepted the custody of Seventeen Thousand, Five Hundred Dollars given by the Lincoln Electric Company of Cleveland, Ohio, U. S. A., to be awarded, under the rules of the competition, to those contributing the best three papers disclosing new information that will tend to advance the art of arc welding.

The purpose of this competition is to encourage improvements in the art of arc welding, the pointing out of new and wider applications of the process, or indicating advantages and economies to be gained by its use, as these latter will be the chief bases upon which the winning papers will be selected. Prizes will be awarded as follows: First prize, $10,000; second prize, $5,000; third prize, $2,500.

Rules of the Competion

1. *Anyone, in any country of the world, may compete for these prizes.*

2. All papers must be written in duplicate, in the English language, and submitted to the Council of The American Society of Mechanical Engineers, addressed to the Secretary, Calvin W. Rice, 29 West 39th Street, New York, N. Y. All exhibits shall also be in duplicate, and captions, titles, legends and notes shall also be in the English language. All papers must bear evidence of having been sent before January first, Nineteen Hundred Twenty-eight (1928) in order to be considered in this competition. Any paper arriving after January thirty-first, Nineteen Hundred Twenty-eight, will be disqualified.

3. Every paper should include all necessary drawings, photographs, or other exhibits, in order that the disclosure may completely present the suggestions of the competitor.

(*a*) The utility of the suggestions must be shown not only for the application but also for possible use in connection with other designs and for their purposes.

(*b*) The possible advantages and economies of the methods suggested should be made clear, as these will be the chief bases upon which the winning paper will be selected.

4. The practicability of the suggestions must be evident from the paper. It is not necessary, however, that its actual application be fully shown, if possible uses are made clear.

5. Originality of design is preferable, either in the method of applying the weld or in the design of the welding parts for their arrangement. Designs which are of no practical use will only be considered in case they include suggestions which could self-evidently be applied in other ways than those suggested. Methods of applying the arc or the welding art which will improve existing machines, or make commercially possible machines which, in the light of previous engineering, have been regarded as impractical, are specially desired.

6. It is not necessary that all parts of the structure should be made of welded metal. It is only necessary that one or more parts be so made.

7. In case two or more identical suggestions are received, the one bearing the lowest serial number assigned to the paper on its receipt by the Secretary of The American Society of Mechanical Engineers will have precedence. Because of this rule, competitors are urged to submit their papers as soon as they are prepared.

8. The Council of The American Society of Mechanical Engineers may withhold any or all awards.

9. Each paper must be typewritten on one side of 8½" x 11" paper and bound at the top with a protecting cover or jacket. The name and address of the competitor must appear on the front cover. Both copies of each paper must be enclosed within a sealed envelope, on the outside of which will be placed the name and address of the competitor and the following legend: "Submitted to The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y., in competition for the Lincoln Arc Welding Prize." This sealed envelope must be enclosed within a mailing wrapper. The receipt of each paper will be acknowledged.

10. The Committee of Judges will not pass upon the acceptability of any apparatus suggested as a proper subject for this competition.

11. In submitting papers, each competitor gives to The American Society of Mechanical Engineers the right to publish his paper, should the Society desire to do so in any of its several publications. No papers will be returned to any competitor.

12. The decision of the Committee of Judges in interpreting the foregoing Rules will be final.

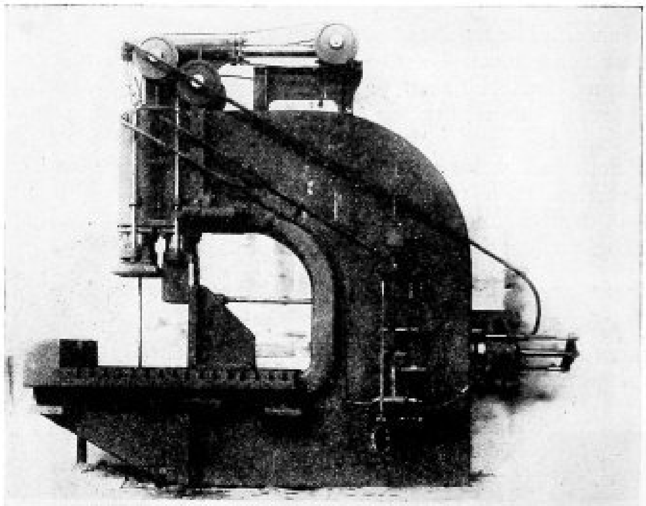
It is the purpose of The American Society of Mechanical Engineers to present these awards at the stated 1928 Spring Meeting of the Society. All competitors will be properly notified of the action of the Judges.

All communications should be addressed to The American Society of Mechanical Engineers Calvin W. Rice, secretary, 29 West 39th Street, New York City, U. S. A.

Modifications Made to Universal Flanging Press

A RECENT modification of the standard universal flanging press, introduced by the Chambersburg Engineering Company, is shown in the accompanying illustration. In addition to the regular line of solid and sectional flanging which this machine will produce, upsetting, forging, and straightening operations also can be accommodated, due to the stops that have been added to the table.

The machine is equipped with two vertical pistons, the outer one being used for clamping the work, while the inner one is utilized for turning the flanging when the work is done sectionally. These pistons can be coupled to a single die for flanging in one operation. The horizontal ram is normally used for squaring and truing up the flanging around the die block upon which the plate is clamped.



Modified Chambersburg flanging press

With the stroke on the bed, the horizontal ram is also available for upsetting, straightening, and forging work. An interlocking device is provided for preventing the fouling of the vertical and horizontal rams. Arrangements are made to limit the strokes of all the rams to prevent damage to the machine.

International Railway Fuel Association Convention

The International Railway Fuel Association has announced the program for its nineteenth annual convention to be held May 10, 11, 12 and 13 at the Hotel Sherman, Chicago. The program includes speakers from practically every department of a railroad, the work of which has any important relation to the utilization and conservation of fuel. Carl Gray, president.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Tapered Piece Developed by Triangulation

Q.—Will you kindly give me a layout of the pipe by triangulation?—O. W. N.

A.—The plan and elevation are reproduced in Fig. 1 and the views divided into a convenient number of sections numbered from 1 to 7 and 8 to 13. These are established by dividing the circles of the ends into a number of equal parts. These are joined by the solid and dotted lines, only in this case to show how the true lengths are found and assembled in the pattern.

The true lengths of the triangulation lines are determined by constructing right angled triangles, thus the base dimensions are transferred from the plan and set off on line *X-Y* and from the perpendiculars *X-X* and *Y-Y*. The lines *X-X* and *Y-Y* are equal in length and to the height of the tapered piece.

Fig. 2 illustrates one-half of the pattern, no allowance being shown for laps.

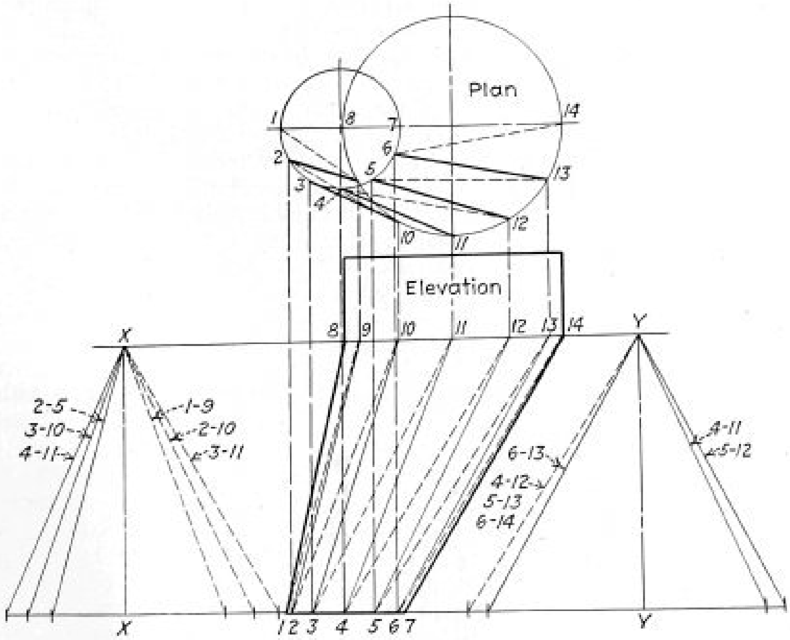
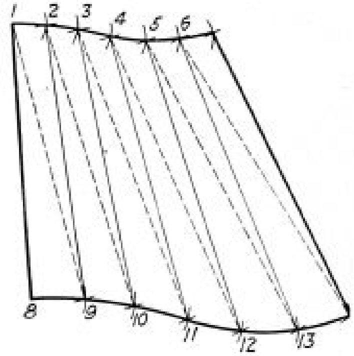


Fig. 1



One-Half Pattern
Fig. 2

Plan and elevation of pipe developed by triangulation

Boiler Horsepower

Q.—I would like to know how to find the horsepower of a stationary locomotive boiler of the following dimensions: Firebox, 84 inches long, 60 inches wide; from grates to crown sheet, 66 inches; 112 three-inch flues 102 inches long; barrel, 66 inches in diameter. The pop valves are set to release at 125 pounds steam pressure.—F. K.

A.—The unit boiler horsepower is an expression of the rate of water evaporation that a given boiler is capable of handling under certain working conditions. It is defined as the evaporation of 34.5 pounds of water, per hour, at a temperature of 212 degrees F. into steam at the same temperature.

To evaporate 1 pound of water from and at 212 degrees F. 970.4 heat units (B.t.u.) British thermal units are expended, therefore for a boiler horsepower $970.4 \times 34.5 = 33{,}479$ B.t.u. are required.

Boilers generate steam at different pressures and receive the feedwater at different temperatures, also are operated under different conditions, therefore for your example the only correct way to determine the boiler horsepower is from carefully run boiler tests, to find the evaporation of water.

There is a commercial rating that approximates the capacity of a boiler, which is based on the area of the heating surfaces. In this practice, 10 square feet of heating surface is assumed sufficient to develop one boiler horsepower.

Example: A boiler that has 1,600 square feet, $1{,}600 \div 10 = 160$ horsepower boiler.

Calculate the heating surface of the boiler in question and divide the value by 10.

Diagonal Patch

Q.—Please find sketches Figs. 1 and 2. Fig. 1 is as explained to me, and I am told there is a chart something like this which has something to do with figuring up the efficiency of the joint in Fig. 2. Would you kindly publish and explain this chart in THE BOILER MAKER? Also I would like to know if this is the best way to apply a patch on a boiler course over a crack? If not, kindly show the best method and figures as to how to find the efficiency of a joint in this type of patch in Sketch No. 2, and oblige.—A. M.

A.—Refer to page 33 of the February issue of THE BOILER MAKER, also to the New York State Boiler Code Rules.

To illustrate the calculation of diagonal joint efficiency, consider the construction as shown in Fig. 3. The joint is

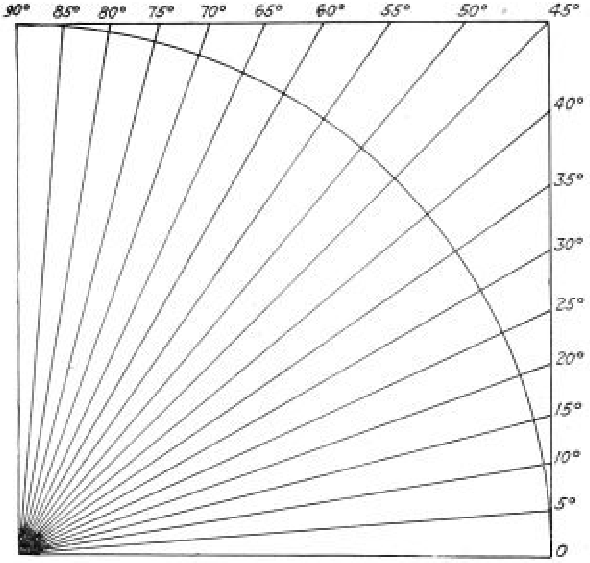


Fig. 1.—Chart used in calculating joint efficiencies

a single riveted lap seam, diameter of rivets driven size 13/16 inch; plate thickness, 3/8 inch; pitch of rivets, 2 inches. The tensile strength of plate is 55,000 pounds per square inch and the shearing strength of rivets 38,000 pounds per square inch. The joint efficiency is figured as for a regular horizontal seam, using as a basis a length equal to the 2-inch pitch. The strength of the solid plate section in a length of 2 inches without rivets equals 55,000 × 2 × 3/8 = 41,250 pounds. Strength of metal between rivets in a 2-inch pitch equals (2 — 13/16) × 3/8 × 55,000 = 24,492 pounds. Efficiency of plate section between the rivets as compared with the solid plate equals 24,492 ÷ 41,250 = 59.4 percent.

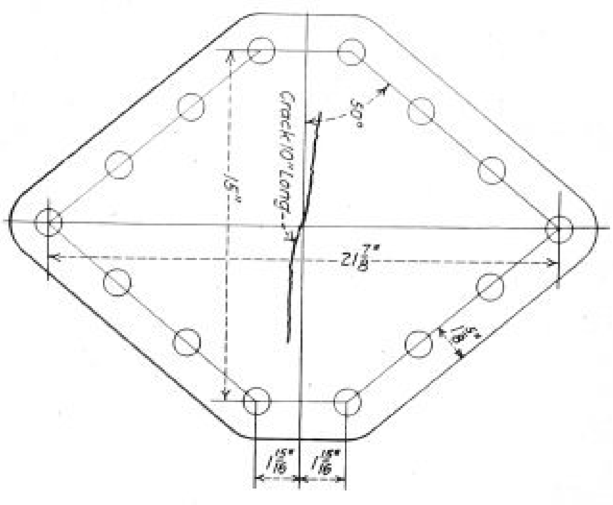


Fig. 2.—Problem to calculate efficiency of joint

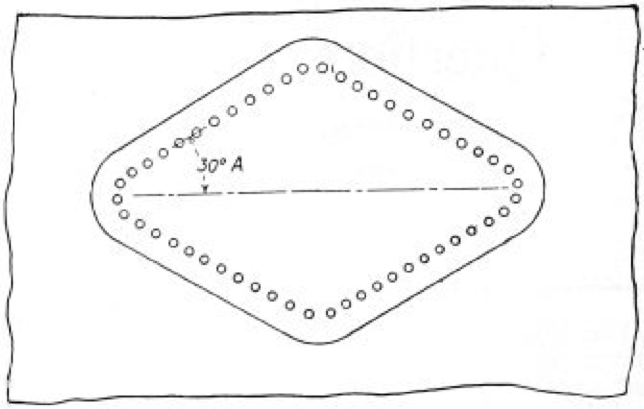


Fig. 3.—Demonstration of joint efficiency problem

The rivet efficiency is found as follows:

Area of rivet driven size equals $13/16^2 \times 0.7854 =$ 0.5185 square inch. Then 38,000 × 0.5185 × 1 (rivet in 2-inch pitch) = 19,703 pounds shearing strength of 1 rivet. Strength of rivet as compared with solid plate section equals 19,703 ÷ 41,250 = 47.8 percent efficiency. The joint may fail in other ways, as crushing the plate in front of the rivet. In all cases the lowest joint efficiency should be used in basing the allowable working pressure.

STRESSES ON JOINT

It can be proven that for a given pressure, the stress per inch of joint is twice as great in the longitudinal seam as in the girth seam, hence the girth seam need only be one-half as great as the efficiency of the longitudinal seam. This explains why the girth seams are usually single riveted. The ratio of the stress being 2 to 1, it is clear that a diagonal seam of the same character as the longitudinal seam lies between the girth and longitudinal seam efficiencies. The factor to be used in multiplying the longitudinal seam efficiency may be found by use of the following formula:

$$\text{Factor} = \frac{2}{\sqrt{3 \times \text{Sin}^2\ A + 1}}$$

in which A equals the angle the diagonal seam makes with the girth seam.

Angle A Degrees	*Factor*
30	1.51
32	1.47
34	1.44
36	1.40
38	1.37
40	1.34
42	1.31
44	1.28
46	1.25
48	1.23
50	1.20
52	1.18
54	1.16
56	1.14
58	1.13
60	1.11
62	1.09
64	1.08

The inclination of the diagonal seam is 30 degrees and from the table the factor is 1.51. Using the lowest efficiency in the example 47.8 we have, 47.8 × 1.51 = 72.18 percent, the efficiency of the diagonal joint.

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

States

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

Cities

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

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

States

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

Cities

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

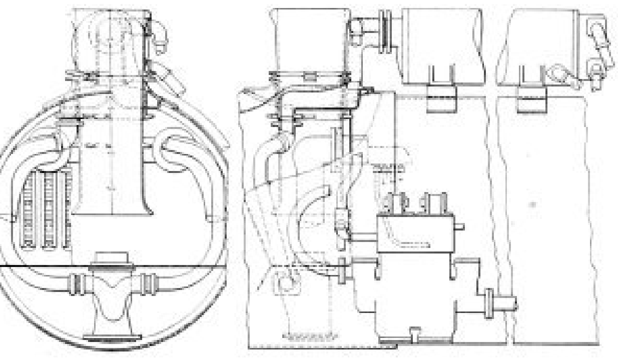
SELECTED BOILER PATENTS

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

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

1,615,625. CHARLES R. HARDY, OF MOUNT VERNON, NEW YORK, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y. LOCOMOTIVE SMOKE-BOX ARRANGEMENT.

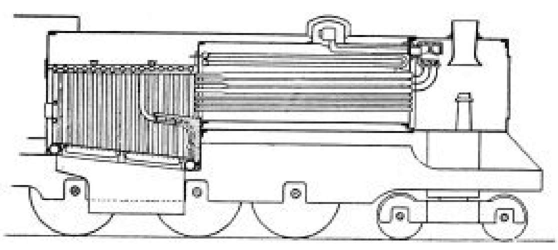
Claim 1.—In apparatus of the class described, a locomotive smoke-box having the usual flange supported stack and engine exhaust pipe therein, a boiler tube sheet at the rear of said smoke-box, engine steam pipes extending downwardly substantially at the periphery of and through said



smoke-box forward of the flue sheet, an exhaust steam consumer located outside the walls of said smoke-box and a steam pipe leading from said exhaust pipe to said consumer, said pipe extending upwardly through said smoke-box substantially at the periphery thereof forward of said engine steam pipes and delivering steam to said consumer through a passage extending through said stack supporting flange, whereby the central portion of said smoke-box is left unobstructed by said pipe for access to said tube sheet. Nine claims.

1,612,866. OTTO H. HARTMANN, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT M. B. H., of CASSELL-WILHELMSHOHE, GERMANY, A CORPORATION OF GERMANY. LOCOMOTIVE BOILER.

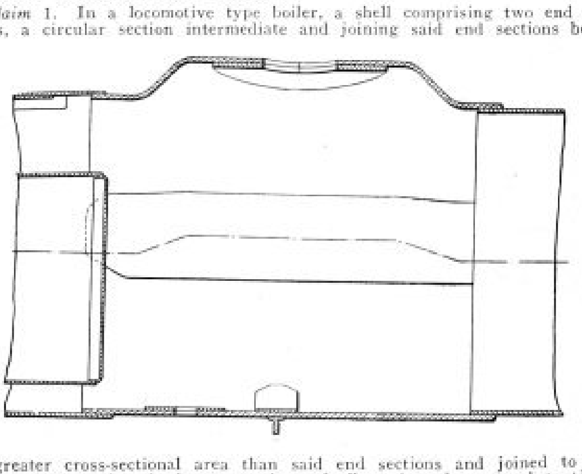
Claim 1.—A locomotive boiler plant comprising a longitudinal boiler having smoke tubes and steam superheating means in said tubes, a water



tube fire box, and connections for the indirect heating of the water in said boiler by means of the steam produced in the water tubes of the fire box. Eleven claims.

1,606,080. WILLIAM F. KIESEL, JR., OF ALTOONA, PENNSYLVANIA. LOCOMOTIVE BOILER.

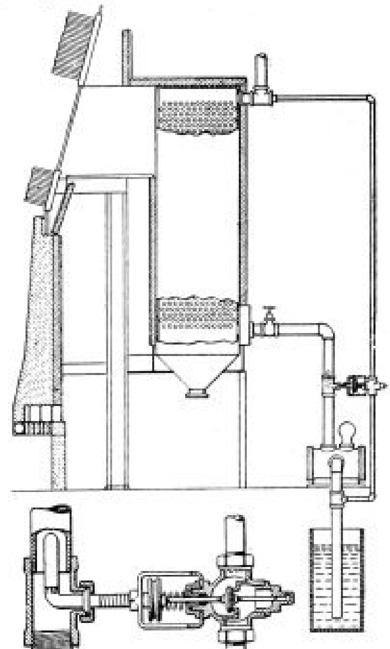
Claim 1. In a locomotive type boiler, a shell comprising two end sections, a circular section intermediate and joining said end sections being



of greater cross-sectional area than said end sections and joined to the end sections so that the lowest portions of all sections form a substantially straight surface, whereby increased steam space is provided. Two Claims.

1,612,854. BENJAMIN BROIDO, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE. FEED-WATER-TEMPERATURE REGULATOR.

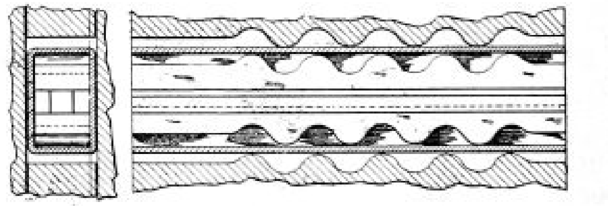
Claim 1.—The combination with an economizer having a feed water inlet and a feed water outlet and a feed water pump, connected with said inlet of a by-pass directly connected with the outlet of the economizer and the



suction side of the pump to cause a portion of the hot water issuing from the economizer to be withdrawn by the suction of said pump and mixed with the feed water flowing to said pump, a valve for controlling the flow of water through said by-pass, and a heat-responsive device associated with the pipe line between the economizer and the by-pass controlling the operation of said valve. Three claims.

1,605,545. CAMPBELL P. HIGGINS, OF ROSELLE, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY. MANDREL FOR USE IN MAKING SINUOUS HEADERS.

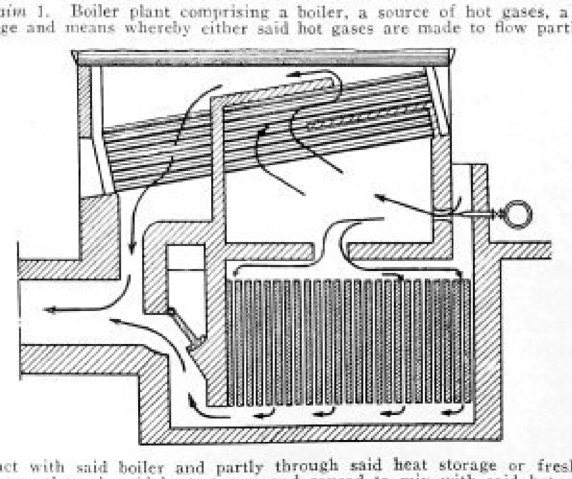
Claim 1. A mandrel adapted for use in making rectangular-cross-sectioned, sinuous headers for boilers, comprising two sets of corrugated



blocks each having a surface configuration to give the desired shape to opposite sides of the header, each of said blocks being substantially as long as the header to be formed, and a main key member between the sets of blocks and extending through the header blank, said key member having parallel sides contacting with said sets of corrugated blocks. Six Claims.

1,609,363. MAX KELTING, OF BOCHUM, GERMANY. BOILER PLANT.

Claim 1. Boiler plant comprising a boiler, a source of hot gases, a heat storage and means whereby either said hot gases are made to flow partly in



contact with said boiler and partly through said heat storage or fresh air is drawn through said heat storage and caused to mix with said hot gases. Four Claims.

The Boiler Maker

Volume XVII 21 May, 1927 Number 5

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

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CONTENTS

American Boiler Manufacturers' Convention

ALTHOUGH no formal program has been issued for the annual convention of the American Boiler Manufacturers' Association, the secretary has sent out the information to all members that the meeting will be held at the French Lick Springs Hotel, French Lick, Ind., May 30, 31 and June 1. The program will be issued shortly before the meeting and will contain a number of interesting features.

The conventions of this association provide an excellent opportunity for members of the industry to discuss problems of production and distribution of their products, cost accounting, administration and the like that are common to all of them and tend to the general betterment of business. The secretary emphasizes the importance of having all members in attendance and suggests that reservations be made at once to insure comfortable accommodations.

Fifth Meeting of National Board

ELSEWHERE in this issue appears the program of the fifth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors which will be held June 14, 15 and 16 at Nashville, Tenn. As the work of this organization has advanced in the practical application of the American Society of Mechanical Engineers' Boiler Code as a standard for power boiler construction so too has its annual meeting assumed a prominent place in the affairs of the boiler manufacturing industry. Without its efforts and the work of its members, the Boiler Code would be left to the individual interpretation of state boards of boiler rules—no two of which could be relied on to make the same decision on points under controversy in their several jurisdictions. The National Board has been able to overcome this lack of coordination in the enforcement of the Code and, as stated in the preamble of the by-laws of the body, "It is organized for the purpose of promoting greater safety to life and property by securing concerted action and maintaining uniformity in the construction, installation and inspection of steam boilers and other pressure vessels and their appurtenances and to secure interchangeability between political sub-divisions of the United States."

At the forthcoming meeting, a number of special addresses will be made by men prominent in various fields allied to the boiler manufacturing industry. The subjects of these addresses cover a broad range including boiler materials, corrosion and its prevention, fusion welding in general, electric arc welding of heavy pressure vessels and the subject of riveting. In addition reports will be made by officers of the board, including one by the statistician. This latter report has assumed great importance in the industry during the past three years since it is the only source outside the Department of Commerce where a record of boiler construction and inspection in the United States is maintained. As at all previous meetings it is expected that the attendance will include all members and the several invited guests who are interested in the work of the Board.

A Record Convention

As will be noted from the account of the Master Boiler Makers' Association convention appearing elsewhere in this issue, the eighteenth meeting of this organization was an unqualified success. The past few conventions have been notable among other things for the breaking of attendance records and the present one proved no exception —nearly 900 members, guests and supply men being registered. In the exhibit feature too the Boiler Makers' Supply Men's Association surpassed all previous efforts in the matter of displaying equipment for the benefit of the master boiler makers.

The reasons for the success of this convention are not far to seek. It would be difficult to find in any body of craftsmen or others a more sincere endeavor to get the greatest amount of benefit out of the discussion of reports presented. This fact may be measured first of all by the promptness with which the men gather at the sessions and by the earnestness shown in the presentation of their views on matters dealing with their trade. It has gradually become a recognized fact in the railroad field that the spirit of work prevails more largely at master boiler makers' conventions than at any other with which railroad men have to deal. This is borne out by the ever increasing extent to which the railroads are making possible the attendance of the boiler shop supervisory staffs in their employ.

Among the notable discussions of the present convention was one on boiler pitting and corrosion which was entered into extensively by water service engineers of several of the largest systems in the country. The part that is being played by the master boiler makers in solving this disastrous problem of locomotive maintenance is no small one since no group of men is in more constant touch with the practical side of the question than the boiler foremen and inspectors. This fact was recognized several years ago when an organized attempt was started to determine ways and means of combating the ravages of corrosion. At that time the Master Boiler Makers' Association was invited to study the question from the maintenance angle and report the findings of its members from all districts of the country to the technical committee on the subject. Since then the matter has been reported on at each convention and interest in finding a solution has grown rapidly. When the problem is finally solved, certain of the credit will be due to the work of the master boiler makers of the country for their assistance.

In another direction—that of fusion welding of boilers, the association has gone on record with recommended practices which during the last year have been referred to the committee of the American Railway Association Mechanical Division on this subject. At the present convention the chairman of the Master Boiler Makers' committee on welding announced that no further action of the association was in order until the American Railway Association report has been made but it had been learned that this report in general would incorporate the same methods as proposed in the recommended practice report.

Several lines of future investigation have been opened for committees of the association to pursue at the last few conventions and these are being conducted advantageously. One possibility that presented itself this year and which deserves study is the practice of one or two large systems to concentrate major boiler repairs at one point, at which the shops are equipped with every form of light and heavy equipment which is required for economical and efficient production.

It should be very gratifying to officers and members alike that their work is being appreciated and the success of the 1927 convention should serve as an inspiration for greater efforts in the future.

LETTERS TO THE EDITOR

Welding Boiler Tubes

TO THE EDITOR:

THE following is a question asked by G. W. T. on page 57 of the February issue of THE BOILER MAKER, viz.:

(If a 2¼-inch boiler tube is worth 15 cents per foot how many pits can be economically welded in a tube 19 feet 6 inches long allowing the reclaimed tube to be 60 percent the value of a new one?)

With characteristic diplomacy our friend and adviser refers the riddle to us, the untutored mass, the readers.

However, if a 2¼-inch diameter tube 19 feet 6 inches long cost 292.5 cents and a reclaimed tube is worth 60 percent of a new one or 175.5 cents and if the cost of welding up the pits amounts to 40 percent of a new one or 117 cents then the best course is to buy a new tube, sell the scrap and make a profit.

To economically weld the tube so as to have a finished value of 60 percent of a new one it is necessary to know what the estimated value of the tube is before being welded. Assuming that the old tube is worth 30 percent of a new tube before it is reclaimed or 58.75 cents; then to make the tube worth 60 percent of a new one or 117.5 cents you can afford to spend 58.75 cents on welding up the pits. A firm of boiler makers or welders would require that sum (58.75 cents) for the use of man, plant and electrodes for about 20 minutes. Assuming that it takes two minutes to handle the tube to and from the welder, the welder will actually have 18 minutes on the job. I think a good welder could spot weld ½-inch diameter pits and file them up at the rate of one per minute, which equals about 1 pit per 1.66 percent value the tube has before being reclaimed.

Of course the average size of the pits and depths are omitted in the question.

The best course open to G. W. T. is to get an estimate for welding up the pits in all the tubes, compare the cost with a set of new tubes, credit the cost of the new tubes with the value of the scrap material, and since he estimates the value of reclaimed tubes at 40 percent below new he will have to credit the new tubes with that amount also.

Batley, Yorks, England. J. G. KIRKLAND.

The Hydrostatic Test

TO THE EDITOR:

BOILER inspectors very frequently complain that the boilers they are detailed to test hydrostatically after which an internal and external examination is made are not properly prepared for the test nor are parts removed for examination in order that the inspector may ascertain to his satisfaction that all parts are sufficiently strong for the pressure allowed, nor are all boilers of any or all varieties sufficiently clean to permit an examination of internal or external parts. The report which he is forced to turn in very frequently bears the NOTE: So far as could be seen externally this boiler is safe for the pressure of—— pounds.

Naturally the inspector must at least have fairly good eyesight or the insurance company or commonwealth would not employ him. It then appears that the engineer in charge of the boiler either did not know how to prepare the boiler for the test or was lax in doing what he is supposed to do at the time of inspection and in the case of a disaster resulting from the explosion of that boiler the engineer is the person most criminally negligent for the reason that he did not prepare the boiler in the proper manner for the test and inspection, while the inspector did incorporate in his report "so far as could be seen" or "so far as open to view" he did believe the boiler safe for the pressure from the extent that he could see the various parts.

Let us picture a boiler that the inspector would like to have cleaned to his satisfaction as we understand the requirements. The boiler inspector walks in to the plant, "Yes I am the Chief Engineer, you are the boiler inspector, knew it by that bag you carried and the dirt in your ears, walk right in here. You can change your clothes here and lock the door when you are ready to leave, I will be waiting for you right here as I know you want to have this over with as well as I do. This way inspector, this is the boiler. Will I attach your test gage or do you wish to attach it yourself?" All ready, start your pump very slowly as there is 25 pounds pressure on the boiler now, give your pump a little more steam 25, 50, 75, 100, 135, 150 and the inspector calls "STOP THE PUMP" and as the pressure is relieved through a ¼-inch valve on the gage line until there is 90 pounds pressure on the boiler the inspector orders that pressure held while he makes his external examination.

Entering the firebox he finds the side sheets swept clean and tubes brushed, a light in the back connections tells him that the tubes are clear as there is some one in there moving the light slowly about. Rivet heads are tight in the furnace and calking edges require no touching up, plates are in good order and there are no signs of defect there. Now for the outside of the boiler; legs are in good shape and no corrosion where the cement saddles support the boiler, clean painted and no leakage so far, into the back connection, say, just as clean as can be, look at those tube ends, no burned off beading or flaring here, new fusible plugs too, name of the manufacturer and the heat number on it too, that number is O. K., so is the maker of it a reliable firm, staybolts are drilled with tell tale holes and clean too are the holes, heads of the boiler are in good shape. Going under the boiler it is just the same way, clean—no oil or old waste or ill smell under the boiler. No use talking, this chief knows his stuff; blow off cock and valve in good order, and now look at the other side sheet, fine, fine you say to yourself, and the chief stands waiting to hear you say "Take off one gag from the safety valve" as you look along the main steam pipe and see that next to the throttle there is a blank flange to keep from filling the engine with water, blanks in between this dead boiler and those with steam on too. All ready for setting the safety valves inspector announces the chief as the pressure on the boiler reaches 95 and at 100 the safety valve opens and water runs down the drain pipe before you. For a wonder that drain pipe is clear, first one you have found clear in a dog's age. "Change your gags," you shout. "Yes," comes the answer from on top of the boiler. The man up there actually knows what you mean the first time. "Let the pressure come up again," shouts the chief 95, 98, 100; water flows down the drain pipe again and the pressure is 102 pounds on the gage, although the safety valve is fully open; "that is fine," you remark to the chief engineer.

You feel like congratulating the chief as he says to the assistants, let us know when she is empty and you follow the chief to his office where you light your pipe and as you just begin to get acquainted with him the assistant knocks at the door and says "All empty chief" and with your spot light and hammer you enter the manhole above the tubes. "Some clean boiler," you remark, as you measure the distance the fusible plugs protrude above the sheet; openings clear, no pitting corrosion, oil or sediment to amount to anything. Emerging, you go through the manhole below the tubes where you find the staybolts sound and taut as you found the braces above the tubes, no greasy balls of oil in this boiler, blow cock clear, no pitting or other defect, and as you again emerge you find all handholes off. Surely this is out of the ordinary as you fully expected the old argument against taking off the hand hole plates as you were sure the chief would tell you that the man before that inspected this boiler did not want them taken off, after which you fully expected to come back with the answer that if they were not off last year it was time they came off and you were going to look in there no matter what the other fellow did last year.

For once you had made a hydrostatic test with external and internal examination and had no recommendations, the boiler was ready and every one about the boiler room knew what his duties were and did it; for once the steam gage and test gage did correspond, openings to attachments were clear, no pitting or corrosion externally or internally in spite of the fact that the boiler was not new. The safety valves were working properly, test cocks were clear as was the drain pipe, there was no plug cock on the blow off pipe to be changed or a guard being placed over it to hold the plug in place in case the nut at the bottom worked off. The boiler was clean, grate bars removed and after the application of the hydrostatic test the handhole plates were removed without the usual argument, even the chief engineer's license or rather certificate was posted in accordance with the law while the boiler number was attached to the uptake instead of wired to a pipe which gave the true impression that there was a live chief engineer in charge of these boilers.

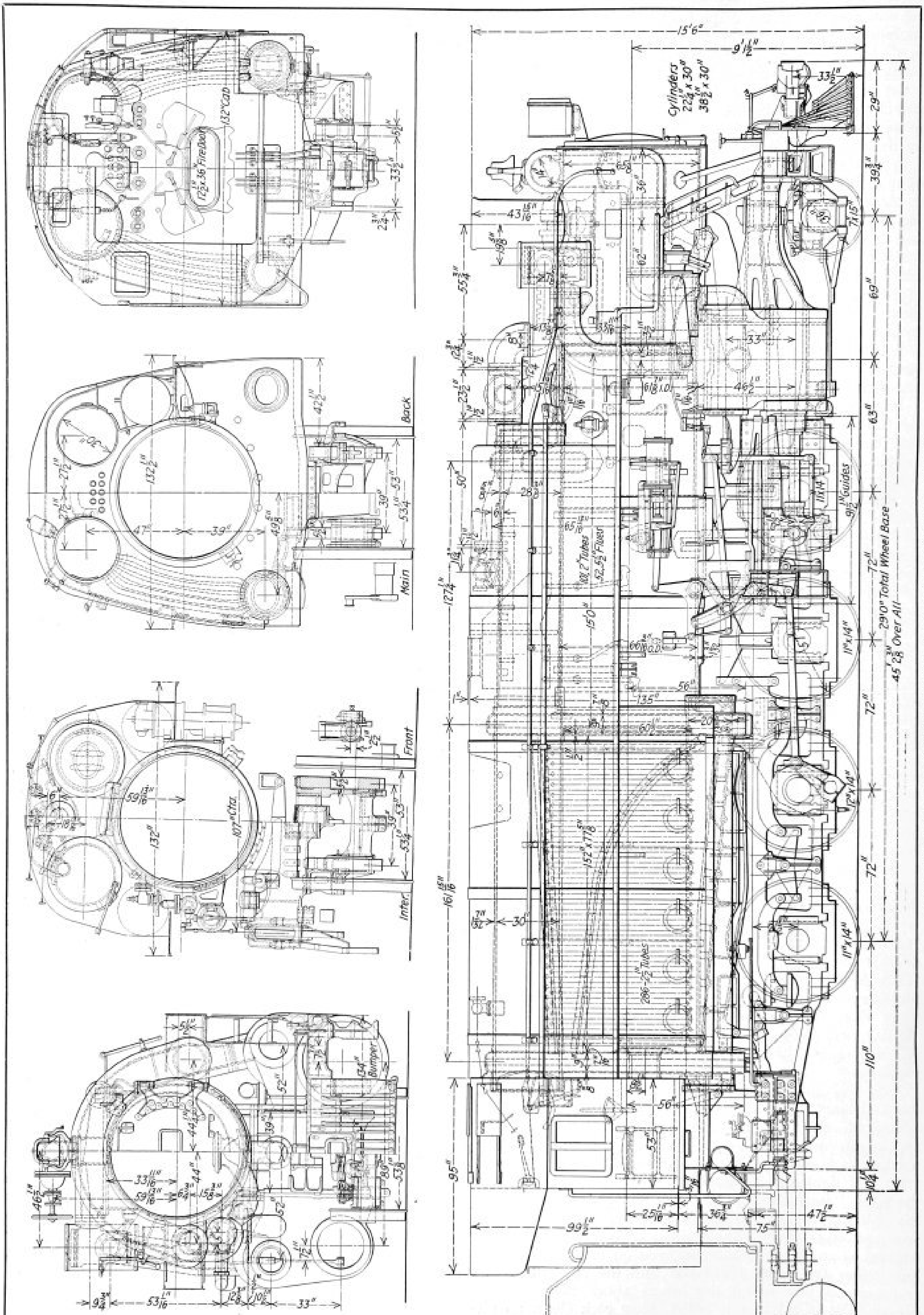
As I shook his hand and assured him I was very glad to have made his acquaintance he added, thank you, I will see you again, I am leaving here the first of the month, going up to the Monarch Building on 14th Street, there isn't money enough here; $1.800 a year isn't enough money for me, I will get $3,000 a year there, and I added, I do not believe you will be there long either. Why he asked disappointedly? Because you are worth more money and as you must have the highest salary offered you, some one will find out that you are worth more and make you the offer. INSPECTOR.

Coatesville, Pa.

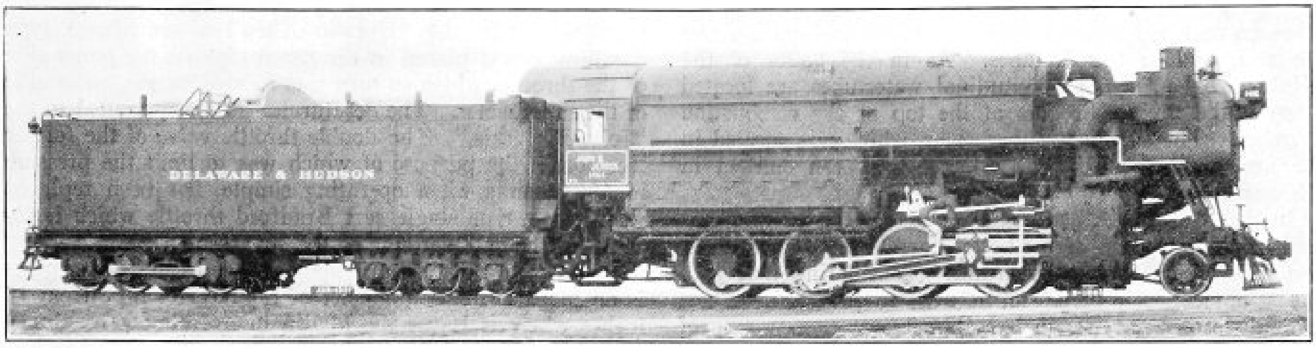
Book Review

LOCOMOTIVE CYCLOPEDIA.—*The 1927 edition, 1,372 illustrated pages, 9 inches by 12 inches. Published by the Simmons-Boardman Publishing Company, 30 Church street, New York.*

The eighth edition of this book has been revised and edited to cover by words and illustrations the modern locomotive and its auxiliaries and also the equipment and practices employed in its maintenance. In the locomotive section a number of tables have been included which give the principal dimensions and proportions of the different types of locomotives acquired by the American railroads during the past two years. The numerous line drawings in the cyclopedia have been revised to cover the outstanding improvements in design made since the last edition of the cyclopedia. For the convenience of the reader, the book has been more completely sectionalized and the indices have been amplified and improved for reference purposes. An entirely new shop and engine terminal section has been included in this edition of the book. This section, which has been written by W. H. Markland, general shop inspector, Altoona Works, Pennsylvania Railroad, contains line drawings showing the layout and the arrangement of machine tools and shop equipment of some of the modern shops and engine terminals of recent construction. The rest of the section is devoted to a description of the construction, operation and utilization of machine tools and shop equipment in railway shops. The text pages are profusely illustrated with actual views of typical railroad jobs.



Cross sections and elevation of the locomotive "John B. Jervis"



The "John B. Jervis," a new watertube firebox locomotive

High Pressure Locomotive for the D. & H.

The "John B. Jervis," second locomotive for this railroad with a watertube firebox, carries 400 pounds boiler pressure

A CROSS-COMPOUND Consolidation type locomotive, carrying a working boiler pressure of 400 pounds, was delivered to the Delaware & Hudson by the American Locomotive Company on February 2, 1927. It has since been operating in freight service between Oneonta, N. Y., and Mechanicsville. This locomotive, which has been named the "John B. Jervis" in honor of the memory of the first chief engineer of the Delaware & Hudson Canal Company, is of essentially the same design as the "Horatio Allen," its predecessor by a little more than two years.

John E. Muhlfeld, consulting engineer for the railroad is responsible for the design of both locomotives. They both have watertube fireboxes of unique construction; both carry much higher boiler pressures than are common locomotive practice, and both have cross-compound cylinders. The boiler pressure of the new locomotive, however, is 50 pounds higher than the 350 pounds of the "Horatio Allen," and several changes have been made in the proportions of the firebox. By the elimination of certain auxiliary devices and by refinements of the design in various details, the weight has also been considerably reduced. The appearance of the locomotive has been changed from that of the "Horatio Allen" by the remodelling of the jacketing.

Aside from the points already alluded to, it will be seen that the cylinder diameters are smaller, so that, with the higher boiler pressure, they develop substantially the same tractive force.

Boiler of the John B. Jervis

The boiler has a watertube firebox and a firetube barrel, the latter of relatively small diameter and completely filled with water. The steam space is in the steam drums of the firebox which are carried forward well beyond the firebox and connected to the barrel near their front ends.

It will be remembered that the heating surface in this firebox is not entirely of watertubes.* The back head and rear firetube sheet connections are waterleg headers, each built of parallel stayed sheets, through which pass the two 20-inch water drums at the bottom and the two 30-inch steam drums at the top. Ports through the drum shells in the header spaces provide for circulation between the drums and headers. The front extensions of the steam drums pass through a saddle connection of parallel stayed sheets which is riveted to the boiler shell. Circulation between the barrel and steam drums, through the saddle, takes place through ports in the shells. The barrel shell is riveted into a flanged opening in the front wall of the front water leg and the rear firetube sheet is riveted into a similar opening in the back wall of this water leg.

The outstanding difference in the boiler of the "John B. Jervis," as compared with that of the "Horatio Allen," is an increase of 15 inches in the length of the firebox, and an increase of 3 inches in the width of the firebox, the water drums having been spread that much farther apart. This effects the increase in grate area noted in the table.

In the "Horatio Allen" the heating surfaces of the sides of the firebox were made up of 306 tubes, about two thirds of which were 2 inches in diameter and the remainder 2½ inches in diameter. The ends of these tubes were arranged in six staggered rows where they entered the water and steam drums, the two outside rows on each side, however, really forming one solid row of tubes along the sides of the firebox against which the lagging was applied. In the new locomotive there are only 286 tubes, all 2½ inches in diameter, arranged in five rows throughout their length. The sides of the firebox are closed with panels of Ascoloy steel sheets, the ability of which to withstand the high temperatures incidental to contact with the fire has been demonstrated by special tests. The lagging is applied outside of these sheets. Just above the water drums along each side of the firebox, a number of handhole openings are secured to the firebox wall sheets. These permit cleaning off from the tops of the drums and from the fire tubes of any accumulation of ash which may have been carried over from the grates, without knocking the fire.

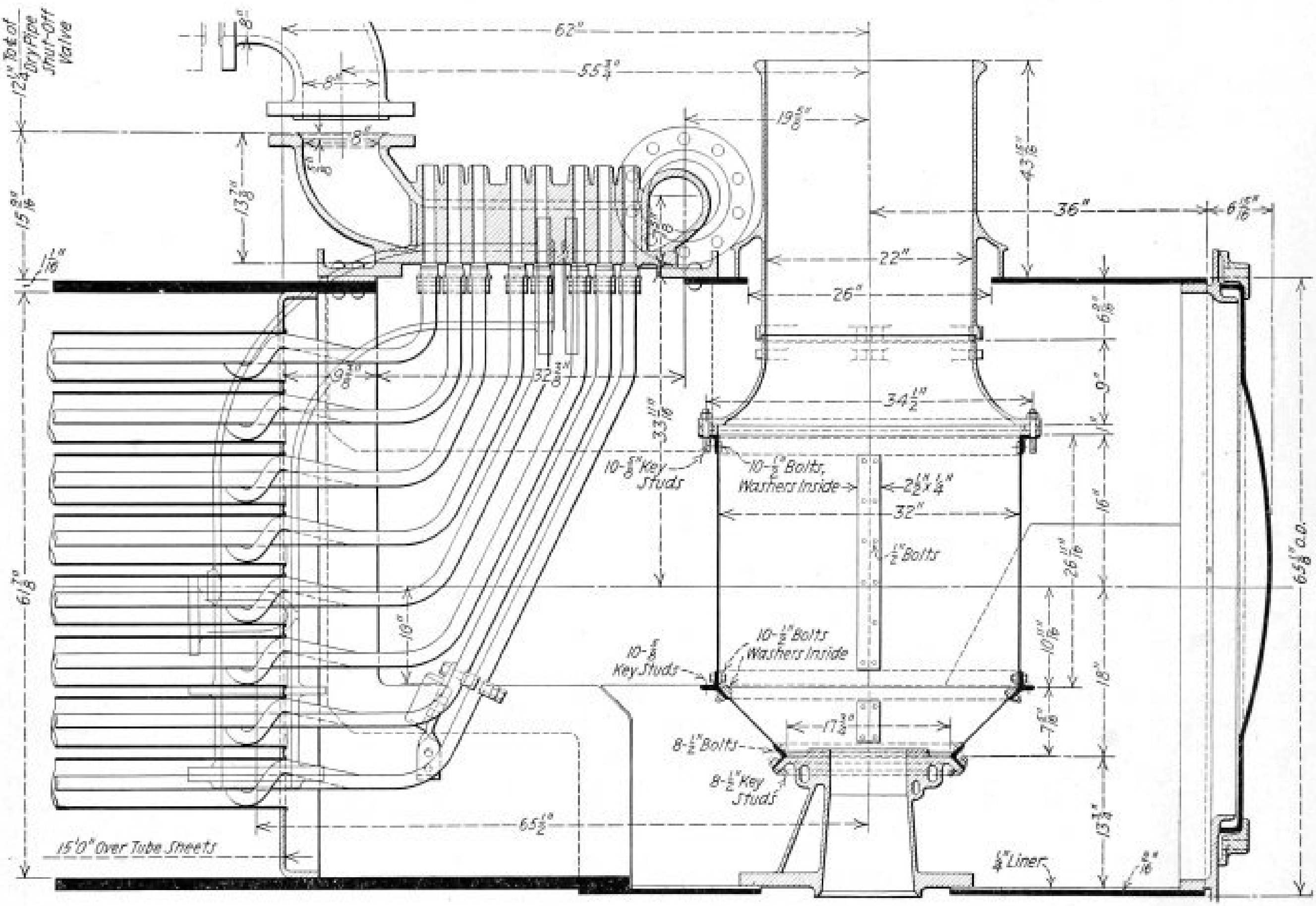
While these changes have effected some slight variations in the heating surface distribution in the two locomotives, the only change of moment is the increase in the superheating surface from 579 square feet to 700 square feet. Experience with the "Horatio Allen" and other tests have indicated that no difficulty need be anticipated from maximum steam temperatures considerably in excess of 600 degrees F., for which the superheater in the "Horatio Allen" was originally proportioned. The superheater in the "John B. Jervis" is proportioned to produce a maximum steam temperature of about 700 degrees.

The interior firebox arrangement is essentially the same in both locomotives. The brick arch extends the entire length of the firebox and causes the gases to flow outward and up through the five longitudinal staggered rows of water

*For a description of the "Horatio Allen," see The Boiler Maker for February, 1925, page 31.

tubes on each side, thence into the combustion space above the arch and to the firetubes. As in the boiler of the "Horatio Allen," eight longitudinal watertubes are located between the firebox headers at the top of the combustion chamber. The auxiliary superheater, which was located in the firebox of the "Horatio Allen," has been omitted in the new locomotive.

In the "Horatio Allen" four pipe connections were carried up from the top of the boiler barrel and connected alternately to the two steam drums. Considering that with the steam collector arrangement used in the steam drums of both locomotives, steam is collected over a wide area of water surface, and that approximately 75 percent of the steam is generated in the firebox, the saddle and header connections between the boiler shell and the steam drums are believed to provide all the communication necessary. These pipe connections have, therefore, been omitted in the boiler of the "John B. Jervis."



The draft appliances consist of a low exhaust nozzle, the stack, and a connecting cylinder of netting—There is no diaphragm or table plate

Steam Distribution

In the main superheater the spiral type of unit construction has been retained in the new locomotive. Each unit of this superheater consists of a single loop, the saturated end of which is formed in a spiral around the straight return pass. Attention has already been called to the increase in the number of units from 42 to 52.

The arrangement of the header is essentially the same as in the "Horatio Allen," but the use of a so-called front end throttle valve permits the superheated steam for the auxiliaries to be taken directly from the main superheater header, on which a flanged opening is cast for that purpose.

Several changes have been made in the steam pipe arrangement. In the "Horatio Allen" a centrifugal type desaturator was placed in the steam pipe on the boiler side of the throttle, which in turn was located on the boiler side of the superheater. The desaturator has been omitted in the "John B. Jervis." The double throttle valve of the former locomotive, the purpose of which was to limit the pressure to 300 pounds when operating simple, has been replaced with a new type single seat Bradford throttle which is located on the cylinder side of the superheater.

Aside from this, the principal change in the steam pipes is an increase in the diameter of the receiver pipe from 10 inches where it leaves the Mellin intercepting valve, to 14 inches where it passes over the smoke arch. The diameter of the receiver in the "Horatio Allen" was 10 inches throughout. Superheated steam for the auxiliary locomotive on the tender is taken from the high pressure cylinder branch pipe. The steam distribution is controlled by a Walschaert valve gear operating a 12-inch piston valve in the high pressure valve chamber and a 14-inch double ported piston valve in the low pressure valve chamber.

Other Changes

Particular attention was given to improving firebox draft and combustion with a view to reducing cylinder back pressure and fuel consumption. To assist toward this end, the new locomotive has been equipped with a trial application of the German State Railways type of draft appliance. In this front end arrangement all baffle plates are removed from the smokebox, and the drafting appliances consist only of a low exhaust nozzle, the base of the tip of which is only about 15 inches above the bottotm of the smoke arch, a cylindrical netting enclosure which extends from the nozzle to the base of the stack, and the stack itself. Beyond these appliances there is nothing in the smokebox except the front ends of the superheater units. The header itself, as in the case of the "Horatio Allen," is located outside of the smokebox.

Special attention was given to the cab and boiler head arrangements, and a very comfortable and convenient cab is the result. Comfortable seats have been provided on both sides of the cab, that on the fireman's side providing room for the head brakeman as well as the fireman. Particular attention was given to the ventilation of the cab and clear vision front windows are provided on both the right and left sides.

In order to eliminate stopping heavy freight trains for fuel and water, a larger capacity tender has been used with the "John B. Jervis." This has a capacity of 16,000 gallons of water and 20 tons of coal. It is carried on a Commonwealth six-wheel front truck and a six-wheel Bethlehem auxiliary locomotive at the rear. Barco 2½-inch metallic connections are used between the engine and tender and between the tender frame and the truck in the 400 pound pressure steam line to the auxiliary locomotive.

The "John B. Jervis" is reported to have gone into service in a very satisfactory manner both with respect to the running of the machinery, the steaming capacity and the superheat. The steaming has been exceptionally free and it is reported that it has been necessary to keep the fire door open a considerable part of the time to prevent loss of steam through the pops. The new throttle has proved to operate very satisfactorily and to be entirely free from any leakage. In order that accurate data may be obtained with respect to the performance of the locomotive, dynamometer car tests will be made.

Table of Dimensions, Weights and Proportions of The "John B. Jervis"

Railroad	Delaware & Hudson
Type of locomotive	2-8-0
Service	Freight
Cylinders, diameter and stroke	22¼ in. and 38½ in. by 30 in.
Valve gear, type	Walschaert
Valves, piston type, size	12 in. and 14 in.
Weights in working order:	
On drivers	295,000 lb.
On front truck	41,500 lb.
Total engine	336,500 lb.
Tender	303,000 lb.
Wheel bases:	
Driving	18 ft.
Rigid	18 ft.
Total engine	29 ft.
Total engine and tender	74 ft. 11½ in.
Wheels, diameter outside tires:	
Driving	57 in.
Front truck	36 in.
Journals, diameter and length:	
Driving, main	12 in. by 14 in.
Driving, others	11 in. by 14 in.
Front truck	7 in. by 15 in.
Boiler:	
Type	Combined water and firetube
Steam pressure	400 lb.
Fuel, kind	Mixed anthracite and bituminous
Diameter, first ring, inside	61¾ in.
Firebox, length and width	152 in. by 77⅝ in.
Arch tubes, number and diameter	6-3½ in.
Firetubes, number and diameter	101-2 in.
Firetubes, number and diameter	52-5½ in.
Length over tube sheets	15 ft.
Grate area	82 sq. ft.
Heating surfaces:	
Firebox	1,150 sq. ft.
Arch tubes	67 sq. ft.
Firetubes	788 sq. ft.
Fire flues	1,116 sq. ft.
Total evaporative	3,121 sq. ft.
Superheating	700 sq. ft.
Comb. evaporative and superheating	3,821 sq. ft.

Spring Meeting A. S. M. E.

Simultaneous sessions have been arranged for the spring meeting of the American Society of Mechanical Engineers, which will be held at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-26. Following a council meeting, conference of local sections delegates and a business meeting May 23, the simultaneous sessions will begin at 2 P.M. and will be held each morning thereafter, varied entertainment being provided each afternoon and evening.

Fifth Annual Meeting of National Board of Boiler Inspectors

The National Board of Boiler and Pressure Vessel Inspectors will hold its fifth annual convention June 14, 15, 16 at the Hotel Hermitage, Nashville, Tenn.

It is very important that those interested in the National Board and its objects should be present at this meeting and lay their problems before the members, in order that some constructive action may be taken to clear up any misunderstandings which might exist. From an inspection of the program given below it will be noted that the papers to be read at this meeting are all upon up-to-date engineering subjects and should be extremely interesting to those concerned in boiler inspection.

Tuesday, June 14

Address—Jos. F. Scott, chairman, Engineers' License and Steam Boiler Inspection Bureaus, and chairman of the National Board.

Report—C. O. Myers, chief boiler inspector, State of Ohio, and secretary-treasurer of the National Board.

Report—E. W. Farmer, chief boiler inspector, State of Rhode Island, and statistician of the National Board.

General discussion on officers' reports and reports of committees.

Afternoon

Address—S. B. Applebaum, assistant technical manager, the Permutit Company, New York. "The Behavior of Materials Used in Boiler Construction When Subjected to Service Conditions."

Address—C. R. Texter, metallurgical department, National Tube Company, Pittsburgh, Pa., "Corrosion, Its Cause and Prevention."

Address—Edward A. Goehegan, The Foremost Superheater Company, New York, "Destructive Effects of Free Oxygen in Steam Due to its Decomposition during Superheating."

Evening

Informal dinner for members, guests and visitors at Hotel Hermitage.

Wednesday, June 15

Address—S. W. Miller, Union Carbide and Carbon Research Laboratories, Inc., Long Island City, N. Y., "Fusion Welding on Boilers and Pressure Vessels."

Address—Professor T. McLean Jasper, director of research, A. O. Smith Corporation, Milwaukee, Wis., "Application of Electric Arc Welding to Heavy Vessel Construction."

Address—A. F. Jensen, president, Hanna Engineering Works, Chicago, Ill., "The Dependability of the Riveting Art." (Note: This paper will be illustrated by motion pictures.)

Afternoon

Sight seeing tour of city of Nashville, ending at a Southern Country Club where an old time southern barbecue will be served.

Thursday, June 16

Executive session for members of the National Board only. The members are requested to be prepared to discuss any problems with which they are confronted in their work in connection with the National Board.

Afternoon

Executive session continued and election of officers.

Obituary

H. N. Covell, general manager of the Virginia Alberene Soapstone Company, Schuyler, Va., died at his home in Charlottesville, Va., May 6. Until about two years ago Mr. Covell was works manager of the Lidgerwood Manufacturing Company, Brooklyn, N. Y. For many years he was active as a member of the American Boiler Manufacturers' Association, serving for some time as secretary for this organization.

Layout of a 90-Degree Elbow in Four Plates

By I. J. Haddon

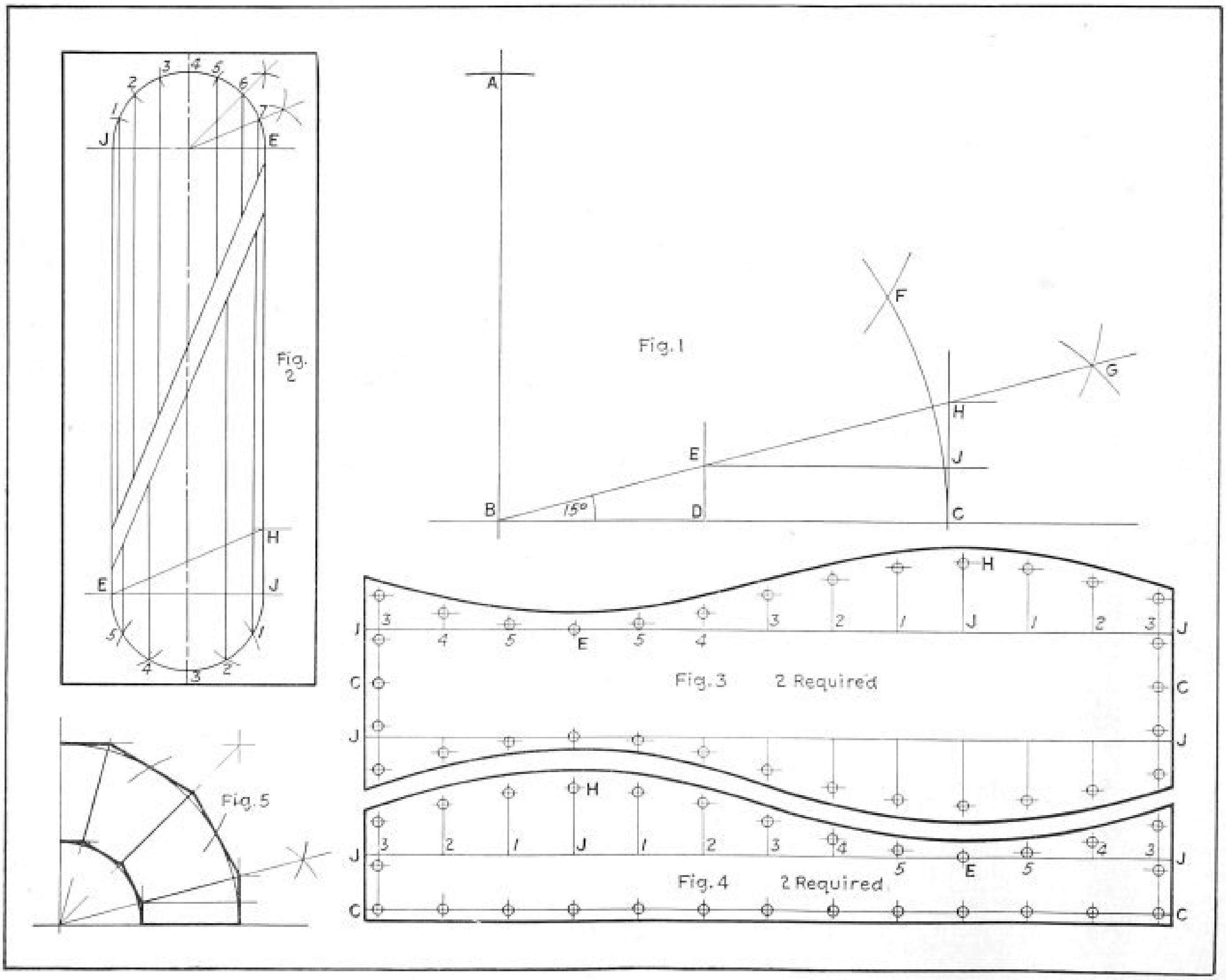
IN the laying out of an elbow in any number of plates proceed as follows for say four plates: (4—1) × 2 = 6. Ninety degrees ÷ 6 = 15 degrees. This will give the angle required as at *G-B-C* in Fig. 1. Another example, say a 90-degree elbow in 6 plates, (6—1) × 2 = 10. Ninety degrees ÷ 10 = 9 degrees. Now an angle of 15 degrees may be obtained with the use of the ordinary set squares or it may also be obtained as follows:

By using your square draw the lines *A-B* and *B-C*, make *B-D* equal to the inside radius of the elbow; draw *D-E* perpendicular to *B-C*, make *D-C* equal to the diameter of the pipe; with *B* as center and radius *B-C* describe the arc *C-F;* also cut the line *B-A* in *A;* then with *A* as center and the same radius cut the arc in *F* as shown. With *C* and *F* as centers and any convenient radius draw arcs intersecting in *G*. Draw the line *G-B* cutting *D-E* in *E;* draw *C-H* parallel to *D-E;* also draw *E-J* parallel to *D-C*. We now have the distances *C-J* and *J-H*, which are all that are required to be used in the development of the plates.

Now obtain a piece of 12 gage black iron about 12 inches by 3 inches and on it draw carefully the sketch as shown in Fig. 2, making *E-J* any size, say 2 inches. Scratch the straight lines in deeply and always keep this sheet in your tool box to be used for *any elbow*. Now mark on this sheet the distance *J-H* and draw the line *E-H* with soapstone or a black lead pencil. This is so that the line may be rubbed out after the elbow is made.

To layout the plate, Fig. 3, draw the two long lines *J-J* and *J-J* a distance apart equal to twice *J-C*, Fig. 1. Make 3 to 3 equal to the length required according to the diameter of the pipes and divide it into 12 equal spaces as shown and erect perpendiculars and number them as shown. Now refer to your plate, Fig. 2, and mark off on Fig. 3 *J-H* equal to *J-H* in Fig. 2. Also mark off all the other distances by taking measurements from the line *E-J* up to *E-H* on Fig 2 and marking them on Fig 3 as shown. These points will represent the centers of holes. Allow on the necessary lap to complete the development.

Develop Fig. 4 in a similar manner as shown. You will notice that the diameter *E-J* Fig. 2 is not the same as the pipe *D-C*, Fig. 1. That is where the usefulness of the sheet, Fig. 2, comes in because it would not matter if the diameter of the pipe *D-C*, Fig. 1, was 1 foot or 20 feet. All



Layout and patterns for 90 degree elbow

we have to bother about is the depth of rake or offset *J-H*. This must be the same on Fig. 2 as it is found to be on Fig. 1.

Fig. 5 shows the 4-piece elbow in miniature. Now supposing the circumference of the pipe to be such that 12 holes are not sufficient and that 16 holes would be better; in that case mark up from *J* at the other end of the plate, Fig. 2, the distance *J-H* in a similar manner to what was done at the end where there are 6 spaces and use that end. It will readily be seen that the other side of the plate, Fig. 2 can also be used to mark out a diagram so as to have 10 or 20 or any number of holes just the same as has been done on this side and would be useful for pipes with very large diameters or where a greater number of spaces or holes may be required.

When bending the edges of the plates to connect together, the knuckle of the bend should be on the *center line of the holes* and by making the seam of the plates always at number 3 there will be no bent part to contend with at the joints.

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

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

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee.

Below are given interpretations of the Committee in Cases Nos. 538-544 inclusive, as formulated at the meeting of February 18, 1927, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 538.—*Inquiry*: An interpretation is requested of the term "brass" in Par. P-321 of the Code. Does not this requirement for brass pipe for the water connections to water columns contemplate the use of monel metal or a bronze not containing zinc, the solubility of which in a hydroxide water is much less than that of brass pipe? Furthermore, with alkaline boiler waters that inhibit corrosion, why should not steel pipe or tubing, wrought-iron pipe, or the equivalent be permitted with steam pressures of 200 pounds or less, the same as is specified for pressures over 200 pounds?

Reply: The purpose of the requirement in Par. P-321 for brass, if pipe is used for the water connections to water columns, is that it was believed that brass would be less susceptible to corrosion, than iron or steel pipe. With hydroxide waters, it is the opinion of the committee that pipe of monel metal or a bronze not containing zinc will be acceptable as the equivalent of brass. Attention is called in this connection to the fact that the requirement for the water connection applies only if pipe is used for the connection. The preference for the use of brass, if pipe is used for such water connections, is that due to the ordinary lower tendency toward corrosion, there is with most boiler waters a less rapid deposit of scale and impurities from the water than with steel or iron pipe.

Case No. 539.—*Inquiry*: Is it necessary in the construction of double-drum horizontal-tubular boilers, comprising upper and lower drums, the lower of which is a short drum at the rear containing tubes for the first pass of the gases, to follow the requirement of Par. P-314 of the Code for introducing the feedwater above the central rows of tubes, when the lower drum of the pair is so arranged in the setting as to be below the fire line and the blow-off outlet is in so cool a portion of the boiler as to be a desirable point of feeding?

Reply: The boiler described is not of the horizontal-return tubular type contemplated in the second section of Par. P-314 and it is therefore not necessary to introduce the feedwater as therein specified. It is the opinion of the committee that if the feedwater is introduced into any part of the boiler so that the water will not be discharged directly against surfaces exposed to gases of high temperature or to direct radiation from the fire, the requirements of this paragraph may be considered as met. While the Code does not specifically so state, it is the opinion of the committee that the boiler should not be fed through the blow-off connection. Attention is called to the fact that this practice is prohibited by the laws of several of the states.

Case No. 540.—*Inquiry*: Is it permissible under the requirement in Par. P-301 of the Code for stop valves of the outside-screw-and-yoke type, to use valves of the globe type where the wheel is permanently attached to the spindle and there is no outside yoke?

Reply: It is the opinion of the committee that if the valve is of such a type of outside-yoke construction that the spindle to which the wheel is permanently attached, rises and falls in such a manner as to give visual indication as to whether the valve is open or closed, it may be considered as the equivalent of the outside-screw-and-yoke type in which the spindle projects through the hand wheel when the valve is open.

Case No. 541.—(In the hands of the Committee.)

Case No. 542.—*Inquiry*: In the application of crown bars for the support of the tops of combustion chambers of wet-back Scotch marine boilers is it permissible to use crown bars formed of two parallel steel bars or plates with cast-iron legs fitted between them at the ends for legs or rests?

Reply: It is the opinion of the committee that the rules in Par. P-230 of the Code contemplated the use of wrought steel throughout for crown-bar construction and that cast-iron supporting legs or ends should not be used.

Case No. 543.—*Inquiry*: Is it not permissible to attach the markings on steel-plate low-pressure heating boilers by means of a cast plate bearing the information called for in Par. H-68? The second sentence of this paragraph stipulates that the markings shall be "stamped."

Reply: The reference in Par H-68 to the stamping of the markings on steel-plate low-pressure heating boilers was incorporated therein with the understanding that stamping would be a convenient method of applying such markings on steel boilers, and it is the opinion of the committee that such stamping directly on the boiler is essential for permanency.

Case No. 544.—*Inquiry*: Is it permissible, under the requirement in the last sentence of Par. P-266 to fit boilers less than 24 inches in diameter with a 2½ x 3½-inch handhole opening and two ¾-inch washout openings, the latter in order to avoid the necessity of applying pads to the shell to afford the number of threads required by Table P-10 for a 1-inch washout?

Reply: The last sentence of Par. P-266 permits of a handhole opening and two washout openings in addition to the blow-off, for the purpose of washing out the boiler, but it is the opinion of the committee that this paragraph intended that the washout openings should be at least 1 inch pipe size.

J. F. Raps
Retiring president

W. J. Murphy
President-elect

L. M. Stewart
First vice president

Master Boiler Makers Hold Eighteenth Convention

Electric welding of boiler tubes and water treatment to prevent corrosion and pitting of tubes and flues important features of discussion

ALL attendance records at conventions held by the Master Boiler Makers' Association were broken this year with nearly 900 members, ladies, guests and members of the Boiler Makers' Supply Men's Association registered at the eighteenth annual convention. Of this number about 375 were members of the Master Boiler Makers' Association. This convention was held May 3 to 6 at the new Hotel Sherman, Chicago, Ill.

John F. Raps, general locomotive inspector of the Illinois Central Railroad, president of the association, opened the convention Tuesday, May 3 at 10:30 A.M. Following the customary invocation and address of welcome by a representative of the Hon. William Hall Thompson, mayor-elect of Chicago, H. T. Bentley, general superintendent of motive power, Chicago & North Western Railroad and an honorary member of the association, addressed the convention in part as follows:

Abstract of Address by H. T. Bentley

The reason I speak about the younger members taking a lively interest in the proceedings is that they are the ones who will have to take the places of those men who have helped to build up this organization and made it so successful. In this world there is no such thing as standing still, and unless new and young blood is injected into a business, it will gradually go down hill, and the same holds true of this organization.

Regarding the papers to come up for discussion, the report on "Causes of Boiler Barrel Sheets Cracking," and what is being done to overcome that trouble, should be of great interest to us all. In this case, and in others brought up by our organization, it is very desirable, where possible, not only to locate the cause, but to suggest a remedy so that everyone will be benefited.

The reclaiming and safe ending of boiler tubes and flues is a live subject. With the pitting and corrosion that is so prevalent in certain sections of the country, it is necessary to reclaim flues where it can be safely and economically done. The amount of money spent on new flues in bad water territories runs into enormous sums, a large amount of which, no doubt, can be saved.

The exhibitors are to be complimented on the splendid display of tools and appliances that have been shown for your benefit, and hope you will see they are given encouragement by looking over their exhibits.

You are fortunate in having the Supply Fraternity behind you. If it was not for them, many useful time and labor saving devices would never be seen. They often find a crude device which appears to have merit, help develop it into a marketable commodity, and then sell it.

The members of the press have been good to you and deserve your thanks.

The president of the association followed Mr. Bentley on the program with the annual address, an abstract of which appears below.

Annual Address of President John F. Raps

The President and officers of this association extend felicitations, and a hearty and cordial welcome to the members, Ladies' Auxiliary and guests at this the opening session of our 18th annual convention.

Since the inception of this association, the membership and financial status has steadily increased to the degree where each member will sense a pardonable glow of pride, when the annual reports of the secretary and treasurer are read. The personnel of the association is composed of men of keen observation, quick perception, broad understanding and clear judgment, are practical men, leaders and masters in their professions, which accounts for the wonderful progress and the prestige attained by the association.

The duties imposed upon the members and those under their supervision have become more intricate with the introduction of the super-locomotive, several types of which are in service at present, and are epochal of the future locomotive. The fabrication of heavy barrel sheets for boilers carrying varying pressures of 250 to 400 pounds, is extremely difficult, requiring ability, efficiency and pre-

A few snaps of the members enjoying the ball game cision in the detail of each operation and will tend to be an incentive to the members of this association to achieve greater prestige and recognition in the mechanical world than ever before.

The tenets of the association as set forth in Article II of the Constitution and By-Laws are commendable and should receive the hearty support of every member by aiding in the preparation and the discussion of the various topics presented for their consideration. I have persistently advocated limiting the number of topics prepared for the convention, in order that more time may be devoted to their discussion, resulting in the disposal of each in a thorough and scientific manner. When possible each topic should be handled as recommended practice. By this method of procedure our actual accomplishments will reflect our yearly progress.

Special acknowledgment is due to the officers, members of the executive board, topic committees and to those who labored so faithfully and industriously to make this convention a success. We are also grateful to the Supply Men's Association, for their assistance and for the opportunity to investigate the exhibits, which they have on display for our enlightenment. Each member should show his appreciation by visiting the exhibits and becoming thoroughly acquainted with the representatives of the various firms and their products.

Members should be punctual and regular in their attendance at all sessions and should take an active part in the consideration and discussion of the various topics, bearing in mind that our time is limited. Therefore, they should be prepared to discuss the topics intelligently and constructively, to the end that our work and the results achieved may merit the commendations of our superior officers.

The first action taken by the association at the conclusion of the opening formalities was the appropriation of a sum of $250 from the treasury to be sent to the Red Cross Relief Fund for flood victims in the region of the Mississippi. The secretary, Harry D. Vought, then submitted his annual report which was followed by the treasurer's report given by W. H. Laughridge, Hocking Valley Railroad.

The active business of the convention was opened by the reading of a paper on scaling boilers, after which the subject was thrown open to a discussion from the floor. The committee report and an abstract of the discussion* appear above:

* NOTE: All discussions appearing in the present running account of the convention are in abstract form. Complete discussions of all papers and business of the association transacted will be published in full from the transcript of proceedings in later issues of THE BOILER MAKER.

G. B. Usherwood
Second vice president

K. E. Fogerty
Third vice president

F. T. Litz
Fourth vice president

The Best and Most Economical Method of Scaling the Inside of Boiler When Flues and Tubes Are Removed

The best method that we have at the present time for scaling boilers on the Northern Pacific at Brainerd, Minn., is as follows:

We use a scaling hammer and tools specially designed for scaling boilers. The time involved in scaling one of our Mikado type engines with 212-2¼ by 18 feet, 1½ inch-flues and 40-5½ by 18 feet, 1½-inch superheater flues, when these engines receive new fireboxes is from 24 to 32 hours, depending largely on the amount of scale in the boiler and its character.

When the flues and superheater tubes only are removed on engine receiving light overhauling it takes from 16 to 24 hours depending mostly on the character of the scale in the boiler. All scaling of boilers is done by helpers at 51 cents per hour.

The boiler braces on engines receiving new fireboxes are not touched with a scaling tool as it is poor practice. It has a tendency to nick and start a fracture and therefore we have all boiler braces sand blasted, which does a perfect job and shows up all defects and the sand blast is cheaper and a better proposition.

The scaling of boilers is an interesting subject. We need to give it considerable thought and study before we can proceed. If not, the scaling tool may do considerable damage to a boiler. It is necessary to get the proper tools and instruct the men how to handle them to avoid injuring the boiler plates. The scaling tool has given good satisfaction to a certain extent, yet we have considerable improvement to make in this line to better the conditions in cleaning boilers.

The sand blast method of cleaning boilers is the best that possibly can be used and which should be developed to such an extent that it could be used on inside and outside of boilers. It can be done with the proper installation of sand blast outfits and it will mean less cost and better efficiency in boiler work. Boilers should also be painted inside and outside after they are thoroughly cleaned.

The cost of man hours for scaling boilers of the Mikado type engine receiving new fireboxes is approximately 32 hours and would cost $16.32. Engines receiving flues only take 24 hours and will cost $12.24. The scaling tools cost $1.00 each.

Practice at the Nashville, Chattanooga & St. Louis railway shops: First, after removing flues, it is good practice to wash barrel of boiler and make a close inspection where the scale on the barrel of the boiler has not been disturbed. Cracks that are developing at seams behind guide yokes and behind pump brackets have often been located. Careful attention will show a yellow streak that indicates a crack that will develop in a short time. If boiler is scaled before examining for cracks of this nature, it is almost impossible to find traces afterward.

Let the inspector make this examination and mark these defects and it will be found very helpful in making a thorough inspection of the barrel of the boiler.

Before, this was the practice on the Nashville, Chattanooga & St. Louis, on several occasions after an engine had received Class 2 repairs and placed in service only a short time, it was found that a crack had developed behind yoke, pump bracket, etc.

This does not cost much and is the only way to make a thorough inspection of the barrel of a locomotive boiler. The bombarding of the shell of a boiler with a No. 90 air hammer is bad practice, as it causes pitting and rupture in the shell sheet.

Report prepared by a committee composed of R. W. Clark, chairman, and R. A. Creger.

Discussion

The discussion was opened with descriptions of various sand blasting machines developed for rapidly and economically effecting the removal of scale in locomotive boilers. The equipment giving the best results is a combined water and sand machine which feeds air from the shop lines and water and sand from reservoirs. This method eliminates the troublesome dust from the operation which ordinarily must be carried on outside the shop or at night. The effectiveness is in fact increased with the washing action of the water. Door holes and openings are covered and a canvas thrown over the boiler. With these precautions the operation can be carried out in any part of the shop without interference with other work. The operator is equipped with a rubber suit. By this method a Mikado boiler can be thoroughly cleaned in from 6 to 8 hours. It is possible to sand blast all parts of the boiler, crown, side sheets, shells, etc. It will also clean between the front flue sheet and shell and the back head braces.

A general sentiment was expressed against the use of the air hammer and scaling tools as a bombardment of this kind in the boiler is detrimental to the metal and has a decided tendency to loosen the parts of the structure. The older method of scraping off the scale is better as it leaves untouched the original mill finish on the metal of the boiler which is thought to be the best protection against pitting and corrosion.

The subject is one of great importance and, with the points in mind that were brought out in the discussion, another committee will study various methods of scaling and render a report next year.

This discussion concluded the morning session.

Tuesday Afternoon Session

The convention was again called to order at 2:15 P.M. by John F. Raps, President.

The first paper to go before the convention for discussion at this time was on the subject of flanging.

Most Efficient Methods Used in Laying Out and Flanging Old and New Work—The Assembling of Old and New Work for Both Welding and Riveting

1. Laying Out—New Work, Complete Firebox

(a) Economy lies to a great extent in preventing waste of material, and to accomplish this the size of sheets to be used should be carefully determined and specified on the boiler drawings to insure uniformity of sizes. This should be desired especially where plate stock is carried at various points on the system. It seems no matter how close you endeavor to govern this, someone will invariably order sheets of larger size to suit his particular method or practice of doing the work. To use unnecessarily large sheets is wasteful. It is the recommendation of this committee that extra allowance oversize actually required should not materially exceed one inch. Also, that in specifying size of firebox side sheets, both sides of firebox be considered, as from 12 inches to 15 inches can be saved in the width of a sheet on account of finished sheet being cut to suit the slope of the crown sheet and the rise of the mud ring. The plate can then be cut in two pieces to suit, one for each side sheet.

(b) The most efficient method in laying out firebox sheets is to have a complete detail of the developed sheet shown by a drawing. This drawing to be absolutely complete as to dimensions. It is then an easy matter to make your templates uniform at all shops over the system. While this committee does not for a moment suggest that layerouts be deprived of the ability to do his own develop-

J. H. Raps
Fifth vice president

A. F. Stiglmeier
Chairman of Board

W. H. Laughridge
Treasurer

H. D. Vought
Secretary

ment of plates when certain jobs warrant, it is wasteful labor for the layerout in each shop to develop layouts for templates as in the case for a new set of engines that may be distributed throughout the system. To follow a drawing insures all templates being exactly alike and it is an important factor in aiding the standardization for size of sheets. Layerouts invariably may decrease or increase depth of flange of door and throat sheets which has its effect on sheet sizes though not materially affecting the staybolt layout. Flue sheet flange depth is generally closely adhered to.

(c) The foregoing, it will be understood, applies to more modern power, but there are many locomotives operating today, which, in general appearance, look similar, but when it comes to firebox sheets, they are widely apart and from the practical point of view it is reasonable to say no two are alike. For these it is difficult to follow the more exacting method above outlined and it becomes necessary to layout the new sheets from the old ones. Considering the age of these engines, and in many cases the remote chance of again fireboxing them due to subsequent retirement from service, it is the opinion of this committee that to prepare a complete set of templates for this class of power would be a needless expenditure.

2. Laying Out—Old Work, Various Sheets

(a) Firebox crown or side sheets should be marked off from templates provided these templates were used in last firebox, otherwise layout should be taken from old sheet. Tube, door and inside throat sheets should have arch tube, staybolt, tube holes and flange lines marked off from templates. When sheets are annealed set flange to proper radius and height to suit old sheet. If a riveted seam is employed lay holes off from old sheet. Then punch holes and scarf, etc. This method gives accuracy when flanged sheets are assembled to the parts that have not been removed from the firebox.

3. Flanging—New Work—Complete Firebox

(a) Where roads have a large number of one class of locomotives and standardization of firebox layouts is had the most efficient method to be used in flanging is by the hydraulic press. Flanging sheets may be done by quantity production in the largest shop and from there supplied to the various smaller shops. This method requires the expenditure of only one press and flanging blocks and dies to suit. When flanged plates are received by smaller shops all that is necessary is to drill the holes and fit up. The flanging can be made accurate so very little fitting up is necessary.

(b) Where shops have the old type of small and non-standard fireboxes and renewals are not required very often, which would not warrant quantity production by hydraulic press, the cold flanging machine is far more economical than the old flange block method.

4. Flanging—Old Work—Various Sheets

For the tube and door sheets, if entire sheets are necessary, the method of flanging would be practically the same as in new work as outlined above. For patches of flue and door sheet use templates followed in original firebox layout and flange to suit the old sheet. If wrapper sheet is tool cracked at calking edge and renewal is necessary, we believe a separate portion of wrapper sheet extended to take in the first row of stays either welding or riveting it to the adjacent sheets, is more economical than flanging patch all in one piece, which, especially on crown bar boilers, would have to be done in a flange fire. Inside throat sheet wings or other portions cut out should be used as templates for flanging, then fit and drill in place and then weld or rivet as the case may be.

5. Assembling New Work

(a) For straight side radial stay fireboxes the entire firebox should be burnt out in erecting shop and mud ring removed. Take mud ring to boiler shop and fit new firebox to same; laying up and reaming all holes except mud ring. Firebox then to be knocked down and taken back to engine. First, slide the wrapper sheet over rear end of engine frame and raise up in boiler to clear line of mud ring holes. Second, place mud ring and hold in position, then drop wrapper sheet in place and bolt up. Third, put in back tube sheet and door sheet. Fourth, ream mud ring holes and then rivet up. Rivets are passed through washout plug holes and held on by cup and wedge bar in water legs only.

(b) This method eliminates removing boiler from the frame. The jacket and lagging is only taken off the back end and will save approximately $400 in applying firebox.

(c) For O. G. fireboxes and crown bar straight side fireboxes, the procedure would be to cut off at connection in erecting shop leaving throat sheet with barrel, and bring back end to boiler shop. The firebox should be burnt out in erecting shop while engine is being stripped. This method saves three days' time in getting boiler back to frame. Firebox is fitted to mud ring; laying up and reaming all holes. Crown bars to be applied, then put box on back supporting it by suitable size bars inserted between bolts laying on horses of convenient height so crown bolts can be held on by air jack on the ground while bolts are being driven in downward position. Firebox then to be inserted in back end, mud ring holes reamed, rivets driven and staybolts applied.

(d) Fireboxes in combustion chamber engines removed in erecting shop as above referred to, boiler removed from frame and taken over to boiler shop after removal of all jacket and lagging, and mud ring removed. Firebox is assembled rough, all holes punched, in fact all holes punched while sheets are flat. Mud ring then fitted to firebox and sheets laid up and seams either riveted or welded.

(e) Firebox wrapper sheets in non-combustion chamber type boilers invariably are made in one piece. With the introduction of the combustion chamber, larger sheets are required from which to make a one piece firebox wrapper sheet. Notwithstanding this, and the fear expressed of being unable to obtain larger size sheets it is the belief of this committee that when shop facilities are adequate, one piece wrapper sheets should be used as considerable economy may be had—this method of building fireboxes eliminating fitting up and the riveting or welding of seams. When wrapper sheet is made up in usual number of four pieces (crown, side sheets and belly of combustion chamber) and welded seams are employed, strong backs of heavy rail, with holes at certain intervals, spaced to suit staybolt holes for bolting and holding, must be laid each side of seam full length of firebox to keep it lined up during welding process. Door and tube sheets should be riveted in place before longitudinal seams are welded or riveted.

(f) After firebox is assembled complete, except mud ring, it is then applied to boiler by placing boiler on its back on a set of rollers. Mud ring is then bolted in place. Then roll boiler over half turn in upright position, square up box centrally and ream mud ring holes and rivet them first and avoid any chance of box getting out of line. Then ream and tap all holes and apply bolts preferably from fireside setting them to extend beyond outside sheet three threads. Then burn bolts to proper length on inside. Turn boiler quarter turn on side and drive firebox side sheet and outside wrapper both in downward position at the same time holding on with air jack. Give boiler half turn and repeat the operation. Then turn on back a quarter turn, and drive all crown stays on inside in downward position holding on with air jack on ground in all operations except when driving outside side sheets, in which case air jack is against firebox side sheet. Boiler then righted and radials driven on roof sheet. Flexibles, of course, are put in and driven with other bolts. Caps are being applied during the operation of driving.

(g) Maximum of nine days' time is taken to fit up and apply firebox for a 4-8-2 or 2-10-2 type locomotive and return boiler to erecting shop. A job of this kind has been done in seven days.

6. Assembling Old Work—Various Sheets

(a) For front tube sheet it is economical to remove sheet leaving in the dry pipe and braces and apply a three-quarter sheet. While it is the customary practice to flange new sheet and drive all rivets, by welding to old flange of front tube sheet considerable saving can be effected as follows: Cut out sheet over tubes as formerly, but let flange remain all way around and cut sheet about the circumference through radius of flange. The new portion of sheet is then placed flat up against old flange and weld is made between old flange and face of new sheet. This method will eliminate flanging and driving all rivets, and gives a flat sheet not susceptible to grooving, pitting or cracking through flange. This method of applying sheet can be done for 52.8 percent less cost than by flanging method or approximately $131 per engine is saved by this method.

(b) For back tube sheet it is also economical to apply three-quarter back tube sheet leaving all throat stays and staybolts intact, providing, of course, the old inside throat is in good condition. For non-combustion chamber fireboxes a flangeless back tube sheet should be applied by raising throat sheet (this is recommended when new fireboxes are applied) in firebox about 4 inches and flanging it outward toward front tube sheet a depth of 4 inches into which a 3/8-inch by 3-inch ring is riveted. The crown sheet is extended sufficiently so as to make up for depth of flange of old sheet so when the flat tube sheet is applied it is set in recess provided and weld is made connecting the flat sheet to the ring which is beveled. On water side sheet may also be welded to crown sheet which should extend beyond water side of tube sheet 3/8 inch to provide for weld. This weld only needs to extend over crown and down on sides 12 inches or so. When renewals are necessary, a flat flangless back tube sheet may be applied at considerably less cost than the present method of flanging and riveting. This new method may be styled as applying a baby combustion chamber.

(c) For side sheets, a large saving can be effected by cutting between second and third row of staybolts above mud ring full length of firebox and extend high enough to take out defective portion of old sheet. Of course, if riveted seams are used, the mud ring rivets should be cut out but welded seams are more economical.

(d) In applying new crown sheet to crown bar type boilers bring it down on sides to take in one or two rows of staybolts. All crown bars set and finished before putting sheet in place. After sheet is in place the two outside rows of sling straps are applied and seam, if weld is to be made, strapped about every 14 inches apart, and then weld; then apply remainder of straps. Measurements are to be taken from work. On radial stay boilers all bolts are to be applied and tube and door sheets riveted or welded in before longitudinal seams are welded.

Minority Report by Mr. Steeves

First: The most efficient method to lay out old work would be to lay out flue sheet, arch flue, and staybolt holes from template. Wrapper sheets for firebox should be marked off from templates. Flue sheet and door sheet flange lines should be marked off from old sheets.

This method will give you complete accuracy when you assemble your sheets to the parts that have not been removed from the firebox.

Second: The most efficient way to flange old and new work would be a McCabe flanging machine or a hydraulic press.

Third: This part of the subject covers a very large field because of different shops having different methods of assembling new work when the boilers are left on the frames, and naturally they all claim that they have the best ideas.

When the boilers are off frames and requiring a new firebox and mud rings removed, the firebox, flue sheet, and door sheet then fit into the mud ring and flue sheet and door sheet riveted, and all the seams in the water space calked. The firebox is then ready to be applied in place. This can be done either by turning the boiler up and dropping the firebox into the wrapper sheet, or you can lift the boiler and drop it over the firebox. Either method is all right, but you can save a great deal of time by lifting the boiler and dropping it over the firebox. You save the time of turning the boiler twice.

Fourth: I am unable to give very much information on the welding of flue sheet and door sheet on account of not being permitted to do this kind of work in our shop, and therefore I could not give you an intelligent report on this subject.

When boilers are on frame and requiring a new firebox, I believe the most efficient way is to lay the wrapper sheet off from a template. The wrapper sheet should then be split a suitable distance down from the crown sheet and then the crown sheet applied in place first. The door sheet should then be applied and riveted to the crown sheet down as far as the side sheet seam. Next, the flue sheet should be applied and riveted to the crown sheet.

You should then bolt your door sheet and flue sheet to the mud ring. The side sheets should be set in place and then staybolts all applied around the side sheets next to the weld; both at the 3/4 seam door sheet and flue sheet flange. The staybolts should all be applied in the side sheets before welding is done if convenient.

On old work, the same operation can be performed for 3/4 side sheets.

Report prepared by a committee composed of O. H. Kurlfinke, chairman; L. W. Steeves and Emil F. Ziegenbein.

Discussion

Boiler sheets and material should be ordered in a way that will promote the greatest economy. It is better to lose slightly in waste of plates by the trimming down to size of sheets not frequently required than it is to stock a number of special size sheets and then not have them move. Where a number of engines of the same type require maintenance, the best practice is to carry full size templates for all sheets needed. The original drawings of firebox or wrapper sheets should not be altered in making repairs. Full size patterns for new locomotives that are to be similar to others in service should be supplied to the locomotive manufacturer.

In using the McCabe flanging machine the best practice is to anneal sheets before flanging.

Although some members have found it satisfactory to renew what is called a 3/4 tube sheet others feel that it is essential to remove the entire sheet so that an examination can be made of the metal back of the flange for checks, corrosion and the like. In the long run it is greater economy to observe this practice and renew complete tube sheets than to cut a portion and weld in a replacement section. Several members who had been in the habit of renewing ¾ tube sheets in the past have discontinued the practice as uneconomical. Trying to save on boiler work in this manner opens the way to the possibility of future failure.

What Are the Causes of Boiler Barrel Sheets Cracking at Waist Sheet Angles and Guide Brace Angles?

(a) What is being done to overcome same? (b) What are the best methods of applying waste sheet braces and guide yoke angles to shell of boiler?

When waist sheet angles and guide brace angles are fastened to the barrel of boiler with plugs or rivets, freedom of normal and equal expansion and contraction is impaired. The shell plates at and near the angles are made more rigid by their application than other parts of shell. The lower part of shell is subjected to a higher tension of stress brought about by the expansion of the top part of shell being greater, and due to temperature at bottom part of barrel being lower. This tension of stress occurs at or near the most rigid points and is governed by expansion and contraction caused by the variation of temperature and steam pressure.

Locomotive boilers equipped with waist sheet angles and guide brace angles, and the angles connected to frames of engine, are subjected to undue strains transmitted through the running gear and frames, while the engine is working under certain conditions.

The duties required of modern locomotives are such that materials of high tensile strength are necessary in the construction of the boiler to meet that requirement, and shell plate of material of high tensile strength is less homogeneous and pliable than material of lower tensile strength.

Therefore, barrel sheets of locomotive boilers which are or have been equipped with waist sheet angles and guide brace angles generally fail at or near the ends of the angles, due to the tension of stress at that point and caused by unequal expansion and contraction, and eventually the material becomes weakened and cracking develops.

(a) Waist sheet angles and guide brace angles are being cut loose from shell of boiler, holes in boiler are plugged or new sheets applied and a liner secured to boiler, and the angles are set to rest on the liner with no connection to the boiler. Some railroads secure the liner to the angles and set same so boiler will rest on the liner with no connection to boiler. Many new engines are received with waist sheet angles not connected to boiler.

(b) We believe the best method is to apply the angles loose at boiler, using a liner (riveted to boiler) between boiler and angle to prevent further wearing of the boiler plate. This liner should be extended approximately six inches beyond the ends of the angle.

Report prepared by a committee composed of C. A. Karvell, chairman, and C. A. Harper.

Discussion

George Austin of the Santa Fe opened the discussion on this subject by outlining the method followed by this road in eliminating cracks in boiler barrel sheets at waist sheet angles. A pad is riveted to the boiler barrel, then the angles are bolted to this pad by studs extending through both the angle and barrel. The pads are the same thickness as the boiler shell and are double riveted and calked. The results over a period of 8 or 9 years have shown that the method eliminates cracks at this point, saves patching and is effective in every way.

Other members follow this method in principle; for example, on the Missouri-Pacific the angles are riveted to a pad of ¾-inch metal with countersunk rivets and this pad and angles are riveted to the boiler shell. A number of roads run their engines with the guide yokes loose to avoid longitudinal strains to the boiler shell which result in cracks. The patches or pads described are in a number of cases tested hydrostatically after being applied to check the tightness.

Standards and Recommended Practice—Fusion Welding

J. A. Doarnberger of the Norfolk & Western, chairman of this committee, reported that the action so far taken by the Master Boiler Makers' Association on the subject had been referred to the section secretary of the American Railway Association Mechanical Division. The American Railway Association committee in conjunction with committees from the American Society of Mechanical Engineers and other interested bodies is now developing a standard code for welding as applied to the locomotive boiler. It is suggested that the Master Boiler Makers' Association take no further action on fusion welding until the American Railway Association has reached its conclusions. Mr. Doarnberger does not believe that the methods adopted by the American Railway Association will differ essentially from the practice already outlined by this association. The subject should be continued and a progress report presented at the next convention. Mr. Doarnberger concluded his remarks by citing examples of structural steel welding, chain welding and the like which are developments in the art since the convention of 1926.

The final report of the afternoon was given by W. H. Laughridge, chairman of the committee on "Standard Names for Various Parts of Locomotive Boilers." After studying the subject carefully the committee recommended the adoption of the "Dictionary of Locomotive Terms" appearing in the *Locomotive Cyclopedia* published by the Simmons-Boardman Publishing Company, as containing the best information of this nature available. The convention accepted a motion to adopt this dictionary and passed the resolution unanimously. For the information both of those attending the convention and of other readers, this dictionary of terms where it applies to locomotive boiler parts will be published in an early issue of The Boiler Maker.

Wednesday Session

This session opened at 9:15 A.M. with John F. Raps presiding. J. E. Bjerkolm, assistant superintendent of motive power, Chicago, Milwaukee & St. Paul Railroad, was introduced as the speaker of the day, who addressed the convention in part as follows:

Responsibility of Supervision

By J. E. Bjorkholm

Our transportation problem, while not always appreciated by the great American public, or at least by some of its chosen spokesmen, is a problem that in all its ramifications holds first place among the institutions responsible for the prosperity of the country, and the development of its vast resources. To further promote that better understanding, every supervisor working for a railroad should dedicate all his efforts regardless of position and regardless of departmental limitations.

The only article a railroad has to offer for sale on the merchandise counter is service, and on the character of that article depends largely whether the carrier is popular in the territory it serves, or whether the contrary is true.

As supervisors of the boiler department, it is within the opportunity of you gentlemen to add to your road's prestige. The boiler is the vital organ of a locomotive. The energy liberated in the firebox is the heart-throb of the great machine. The valve motion may be ever so perfect, the running and driving gear in a high state of maintenance, but if the hand of the steam gage, regardless of the fireman's efforts, indicates its reluctance to move too far away from the zero mark, then the locomotive fails to function, resulting in delays, and, my friends, engine delays are the greatest disorganizing factor in transportation, causing a disorganized transportation machine with resultant complaints and adverse advertising, and much additional expense.

Always bear in mind that there is no failure to a boiler without a cause; whether the cause is due to faulty material, careless workmanship or outright neglect. For each cause there is a cure, and unless the case is thoroughly analyzed and the proper cure applied, no improvement is forthcoming. Each case may require different treatment, and as supervisors, it is up to you, gentlemen, to diagnose the ailment and apply the proper medicine.

As already stated, one of the fundamental requirements for successful train operation, is well maintained and properly operated locomotives, and unless good train operation is forthcoming, the efforts of the traffic and operating departments are in vain. No matter how carefully a schedule is planned, no matter how eager the operating officials are to render good "on-time" service, in the last analysis it is dependent upon the locomotive, and the crew in charge, whether or not a schedule as planned is to be carried out, and on the supervisors of the boiler department rests a large portion of the responsibility whether or not the service rendered by the road is commended or criticized. One of the things to always keep before us is that no engine delay, no matter how small, should be allowed to pass into history without first being thoroughly investigated and measures taken to avoid a repetition, because small delays caused by minor defects, if allowed to pass without notice, will soon develop into difficulties of serious proportions.

The problem of economy is one that is confronting every railroad today. Increased cost in material, increased cost in labor, a higher character of service, increased taxes, added legislation affecting railroads, and an increased demand in matters affecting the safety of travel, necessitates an increased efficiency on the part of everyone connected with the railroad, be it officer or employee.

A pauper cannot contribute towards the prosperity of others, nor can a bankrupt corporation be as liberal to its employees and to the community it serves, as a prosperous one. Thus it rests with every one connected with a corporation to assist in the development of its economic welfare. It is here that the real makeup of a supervisor often meets its hardest test. As a leader of men, a supervisor should endeavor to develop the trait that causes him to be recognized by his subordinates as a trustworthy leader, one whose influence among his men and in the community is such that he is looked upon as a true leader in fact. Honorable dealings with his subordinates is undeniably a factor without which there can be no real success in our modern industrial life, and undivided loyalty to the employer is equally essential.

We are living in a period of industrial and scientific progress, the equal of which history does not recall. Transportation is becoming more and more complex and competition keener. Highly developed motor transports, traveling on a right-of-way maintained by the nation's tax payers, are making heavy inroads on the income of the railroads. Water borne traffic on rivers maintained in a navigable state by public funds, do likewise, and as the rate making bodies which have it in their power to regulate intra-or inter-state rates that the carriers may charge for their services, cannot be accused of any undue liberality, only through frugality and improved methods of meeting its problems, whether out on the road, in the shops, or in the offices, can the carriers hope to be able to so regulate their income and expenses in a manner enabling them to carry on as going concerns. "A dollar saved is a dollar earned," and for every dollar that you as supervisors save in your department by so-called "shop kinks" and improved methods of doing your work, you have contributed that much towards the economical operation of the corporation which you serve, and we must not overlook the important fact that whether an atmosphere of economical management or careless and wasteful practices prevails, it is usually due to whatever examples are set by the supervisors.

To keep abreast of the time, we must all devote our attention in an increased measure to modern developments. Our locomotives, due to certain limitations imposed by roadways, bridges, tunnels, etc., have reached their limit in size, and still progress demands more powerful and more economical machines. The boiler from which the energy is put to work, must of necessity be called upon to deliver more than ever, and still it must not be increased in size. Higher pressure requiring steel of a higher quality, better braces, stronger seams, improved stays, etc., all will call for the greatest ingenuity of engineers and boiler makers, and to meet these demands we must all appreciate the larger responsibilities that we will be called upon to face, and be prepared to meet them.

The day is happily passed when the qualifications of a foreman were largely based on his ability to drive. Today his worth is gaged by his ability to lead. A successful boiler foreman today must be entirely familiar with all the details of his department. He must know the cost figures, labor as well as material. He should know the time required to do a certain job so as to be able to accurately plan ahead, so as to be able to schedule the work, thus insuring system instead of "hit and miss" methods, and he must be entirely conversant with all state and federal requirements relating to boilers and their appurtenances.

One of the things that sometimes is permitted to interfere with true economy, particularly on a large property where the line of demarcation between different departments is quite prominent, is departmental selfishness, something that is happily becoming less noticeable as time goes on. Just because your jurisdiction may be confined to the boiler department, you should not fail to realize that your department as constituted on a railroad is not one of producing direct revenue, but the manner in which the boilers under your jurisdiction are cared for, indirectly is responsible for considerable economy or loss in operation, as the case may be. The economical operation of a railroad cannot be brought about without good locomotives, and no locomotive is good without the boiler properly maintained in strict accordance with federal requirements, and the requirements prescribed by the owner.

It is claimed by eminent authority that a 1/16-inch scale on the flues and sheets in a boiler is responsible for 10 percent loss in fuel. It only requires some very simple arithmetic to ascertain that on a carrier similar to the property with which I am associated, this would amount to an annual sum of $1,100,000. We have found that by covering the stack and the grates on our locomotives as soon as the firebox inspection and hot work is completed, thus retaining the heat as much as possible in the boiler by preventing circulation of cold air through the firebox and flues, that considerable coal can be saved in firing up the engine. Supposing that you are firing up 1,000 engines a day and a saving in fuel accomplished would be only 10 scoops of coal per engine by this method, the saving in fuel for the 24 hour period would be 75 tons of coal, and at the end of the year, you would have a respectable pile of a little better than 27,000 tons to your credit Always bear in mind that there are only 133 ordinary scoops full of coal in a ton, and I am sure you can very readily find means of saving a lot of coal, and the coal bill on a railroad is of such proportions that it offers singular opportunities for economy. I am mentioning this one item because fuel economy and boiler maintenance are very closely related.

Following Mr. Bjerkolm the subject of pitting and corrosion was taken up. The entire session on Wednesday was devoted to this important phase of boiler maintenance. The report follows:

Boiler Corrosion and Pitting

In its search for information as to progress in combating the evils of pitting and corrosion, your committee sent out a questionnaire to which 39 replies were received. This number was large enough to make possible a general statement as to what has been accomplished and what may reasonably be expected to be accomplished in the immediate future.

Of the 39 replies, 30 stated boiler feedwater is being treated in some manner or other and a number are using the wayside method on one section of the railroad and internal treatment with some prepared compound on other sections. The majority report improved conditions through the use of both methods.

Feedwater heaters of the open type are reported by three railroads as having been of some assistance. One of the largest users of feedwater heaters reports no benefit in control of pitting. Where benefit has been noted, it is pointed out that care must be taken to pass all water through the heater and its pump and not through an injector. The difficulty is that operating conditions would normally force resort to the use of the injector at times.

Taking up the answers to the questionnaire in their order, we have attempted to give the association all of the information received in as brief a form as possible.

Questions and Answers

1. What steps have been taken with respect to the operation of boilers under your jurisdiction to reduce or overcome the pitting in locomotive boilers?

Treating of water in wayside plants	18
Use of internal treatment in form of compounds	16
Closer attention to boiler washing	4
Increased circulation	8
Use of various kinds of flues, charcoal iron, steel and copper content	5
Thin copper ferrule in front flue sheet	1
Copper bearing steel in firebox sheets	1
Hot water washing plants	2
Use of Hickman air separator	1

2. Has there been noticeable improvement in boiler conditions in your jurisdiction during the past year? This question has particular reference to the pitting conditions.

Improved condition	19
No change	13

3. If there has been improvement in this relation, please advise how it was accomplished.

Treating of water	19
New water supply	2
Closer supervision of boiler washing	2
Improved circulation	8
Discontinuing the use of soda ash	1
Charcoal iron boiler tubes	1
Feedwater heater, open type	1
Copper bearing firebox steel	1
Hot water washing plants	1

4. What tests, if any, are you carrying on with a view to reduction or elimination of boiler pitting?

Open type feedwater heaters	1
Various kinds of steel and iron flues	5
Use of Sodium Aluminite	1
Testing with different compound	3
Copper ferrules in front flue sheet	1
Hickman air separator	1

5. Where the water supplies are treated in wayside plants, has it been your experience that conditions with respect to pitting have improved or become worse?

Pitting increased	4
Pitting decreased	12
No change	9

6. What effect on the pitting condition have you noticed, if any, where feedwater heaters, of the open or closed type, are in use?

Pitting decreased	3
No change noted	1
Not in long enough to ascertain	8

7. If you are using an internal treatment in the form of boiler compounds, what results have you been able to obtain in the prevention of pitting, as well as of scale?

Pitting increased	1
Pitting decreased	14

8. If you are using soda ash as an internal treatment, have you found that an increase, or decrease, in pitting tendency results?

Pitting increased	8
Pitting decreased	5

Your committee finds that reduction in pitting tendencies may be expected by attention to the following items:

Secure the best boiler water available.

Use of internally applied compounds properly designed for the purpose or by the wayside method and free use of the blowoff cocks.

Application of modern appliances to increase circulation.

Use of homogeneous boiler construction to prevent setting up of electric couples due to presence of two or more kind of metals.

Use of de-aereators where possible.

Further trial of non-pitting steel alloys.

Search for means to offset the pitting tendencies of soda ash and lime.

Report prepared by a committee composed of Lewis Nicholas, chairman; J. J. Damey and Myron France.

Discussion

The discussion consisted mainly of remarks on the subject by prominent railroad water service engineers.

The first paper presented was by C. R. Knowles, superintendent of water service of the Illinois Central Railroad, and was read by D. A. Steel, associate editor of the *Railway Age*. This paper was profusely illustrated with interesting lantern slides. Following Mr. Steel, C. H. Koyl, Chicago, Milwaukee & St. Paul Railroad, R. C. Bardwell, Chesapeake & Ohio Railroad and R. E. Coughlan, Chicago & North Western Railroad outlined their views on the subject and on the progress being made to eliminate the disastrous effects of pitting and corrosion. Frank N. Speller, metallurgical engineer, National Tube Company, took this occasion to combine the address which he was to have made on the "Corrosion of Boiler Tubes" Friday morning with the more general subject of boiler pitting and corrosion and to present it before the convention at this time.

A number of members then outlined their experiences from the practical side of the subject. These remarks will appear in full in a later issue.

Thursday Session

George L. Hess, superintendent of motive power, Wabash Railroad, gave the opening talk of the Thursday meeting which began at 9:15 A.M. with John F. Raps in the chair.

Improvement of Locomotive Boiler Maintenance

By George F. Hess

Years ago, the boiler making part of the locomotive was not considered by a great many railroad men to be of very much importance. They realized it was necessary to have a boiler that would generate steam, and outside of that there did not appear to be much thought given the matter. During recent years, the boiler maker's work has been recognized to be of greater importance to a railroad. There have been numerous improvements in boilers, the size of them has naturally increased in proportion with the remainder of the locomotive, and sometimes more. The work and responsibility of the boiler maker has been increased by the addition of superheaters, brick arches, combustion chambers, stokers and other auxiliaries, and one of the most important items is to have a thorough knowledge of the rules issued by the Interstate Commerce Commission, governing the inspection and maintenance of locomotives. I feel that the enforcement of these rules by the chief inspector and his assistants has brought about more to improve the physical condition of locomotives than any other single item we know of, and it should be the endeavor of each master boiler maker to not only comply with these rules, but have the work done before some government inspector compels us to do it. In that way, we will have locomotives that will give satisfactory service.

In designing locomotives today, the first thought of all concerned is to get a boiler of such capacity as to always furnish a sufficient amount of steam. A great many of you know that years ago, when new locomotives were purchased, the management of the railroad asked for a locomotive that would haul a certain number of cars. A locomotive would be designed that would haul this number of cars, and then it would be found the locomotive was too heavy for the track and bridges. Instructions would be given to lighten the locomotive. One of the easiest ways of cutting weight from a locomotive was to reduce the size of the boiler and then a locomotive would be built that made the crew continually fight in order to have enough steam. This has been changed and today we build a boiler not only large enough for the locomotive, but also to take care of the auxiliaries, such as booster engines, stoker engines, air pumps, headlight generators, steam heat, heating of cabs and numerous other auxiliaries that are a part of the modern locomotive. It is necessary that our boiler forces know how this boiler should be built, in order to give the best results and be operated at the lowest possible maintenance cost. In order to get these results, boiler foremen are consulted and are told from time to time to give ideas as to improvements that can be made so as to get a better boiler and keep the maintenance cost at a low figure.

Another item that is now recognized as being part of the boiler maker's business is fuel conservation. Up to a few years ago, when we talked about fuel conservation, all we did was talk to the engineer and fireman. Now every employe of the railroad is called upon to assist in saving fuel, and the boiler maker foreman and the boiler maker, especially those in the roundhouse are big factors. If they will see that air is excluded from the smokebox, that flues, particularly superheater flues, are kept tight and clean, that the grates are in good condition, it will result in the saving of fuel.

Fire losses are a big item with most railroads, and how often a fire is set due to the carelessness of some boiler maker not making the front end netting, draft plates, etc., tight so as to keep the sparks in the front end instead of going out the stack. Very few fires are set by sparks that pass through the mesh of the netting. The fire setting sparks are thrown out through holes in the netting or spaces where netting is improperly fitted; also, the proper inspection of grates to see that there are no holes in them, allowing the fire to fall into the ash pan, the inspection of ash pans so there are no holes and places where fire can fall out on the tracks, setting fire to the ties, bridges, etc.

The boiler force should be studying at all times relative to not only better designs, but the proper application of material. How often we find locomotives with leaky flues, frequently due to the method of application when the locomotive is receiving classified repairs. On one road with which I was connected some years ago, we had a great deal of trouble with flues leaking and the boiler makers did everything that was thought could be done. Finally, a boiler maker had an idea that if we used a different thickness and longer copper ferrule, we would get results. It was tried, and strange to say, it worked. This may not be applicable to all roads, but it was to that certain road, where water conditions were such that it was difficult to maintain tight boilers.

The boiler forces should study at all times water treatment. We realize the average boiler maker could hardly be expected to be a chemist or a water engineer, but at the same time he could give the matter considerable study, and there is no reason why every man should not know something about water treating. Its importance is so great and is such a relief to the railroad that the more study and the more water treating that can be given, the better the results for all concerned. On one of the important railroads in the United States, having 700 locomotives, and where water is treated at practically every tank, there is a roundhouse where they dispatch an average of 90 engines per day. During the year 1926, 100 broken staybolts were renewed in this roundhouse. The average number of broken staybolts replaced on all engines on the road were five per engine per year. On this same road, it used to be necessary to apply from seven to nine fireboxes per month, but after treating water, this number has decreased, and in the past nine years there has been an average of less than 18 fireboxes applied per year. A flue failure on the road is almost unknown, and boiler makers having to calk flues in the roundhouse is almost a lost art.

The Master Boiler Makers' Association deserves a great deal of the credit for the improved condition of locomotive boilers. It is due to their earnest efforts and those of the various committees working together to the end that they make these improvements.

The business session opened with a discussion of the subject of reclaiming boiler tubes.

Most Efficient Methods of Reclaiming and Safe-ending Boiler Tubes and Flues

As your committee considers this a very important subject, we desired to get a general expression of opinion from the membership, and for this purpose sent out 56 questionnaires to members in the United States and Canada. These covered the following operations: Cleaning, cutting, preparation for welding, electric and oil welding, testing, percentage of poor welds and reclamation.

We were very much pleased with the result, and with the enthusiasm and thoroughness of the writers, nearly all replies being complete reports on the topic.

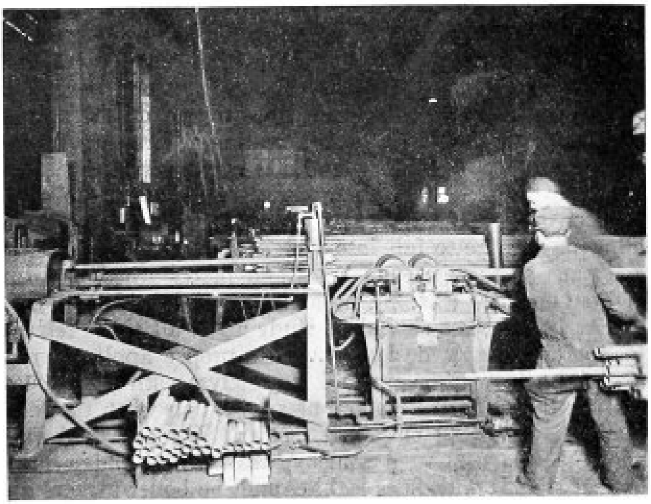


Fig. 1

This made the work of your committee merely a matter of tabulation.

We also were gratified by the speedy replies. The questionnaires were sent out on October 21 and 22; the first reply was received on October 26. The greater part of the answers were received by the end of November, 1926.

Some of the writers did not answer all questions; however, all replies were satisfactory, and enabled your committee to present a report that represents the general, present practice followed in reclaiming and safe-ending boiler tubes and flues.

The replies on kind of rattler used indicate that 42 percent use a dry rattler, 50 percent use a wet, and 8 percent use the dry rattler with water.

Flue rattlers vary in size from 36 inches to 72 inches with a peripheral speed of 188 feet to 471 feet per minute; the average speed is 344 feet per minute. The load varies from 533 pounds to 963 pounds per square foot of area, an average of 742 pounds, based on 2½ pounds per lineal foot of two-inch tubes Seventeen members use the disk cutter, 4 use a pipe cutting machine, 3 use a hot saw, and 1 uses a cold saw for both tubes and flues. One member only uses a hot saw on flues, 2 members heat flues and cut with disk.

The welding of tubes is about equally divided between oil and electric; 49 percent weld electrically, and 51 percent heat with oil. Of those welding with oil 37 percent scarf safe ends, 63 percent do not scarf, 1 member only scarfs flue tips. All oil welding reported is being done with tip inserted in tube.

In electric welding 81 percent make a butt weld, and 19 percent make a lap weld. One member reported making a lap weld with the tip outside. Another member reports making the bevel for tube lap welds 35 degrees, and for flues 45 degrees.

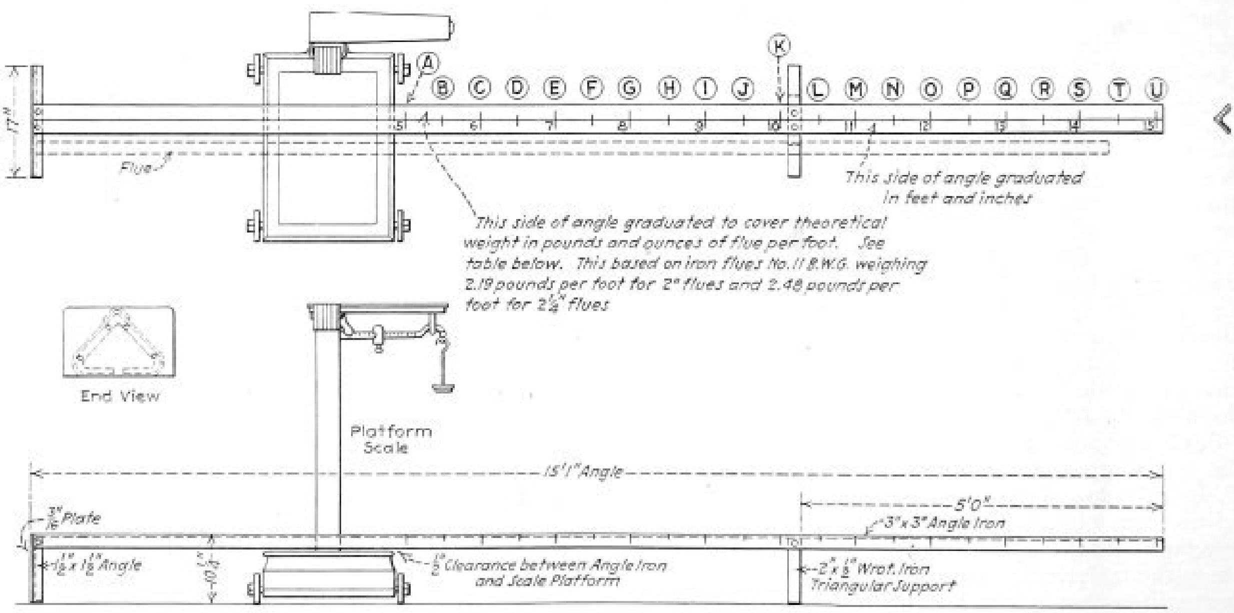
In the polishing of electric welded tubes, flues and safe ends, 2 members polish while cutting, 1 member using a file, the other an air cylinder, 5 members use a belt polisher, 7 use emery or carborundum wheels, 3 use drum rattler for polishing safe ends, and 1 member uses an emery wheel with a small roller attachment to give the safe ends a forward and rotary movement.

For the finishing of electric welds, 86 percent use rollers, and 14 percent use a hammer, one member uses both.

Fifty percent have the finishing machine located at end of electric welding machine, and 50 percent at the side.

For finishing oil welds 86 percent use a rolling machine, 14 percent use a hammer.

Of those that weld electrically 80 percent test tubes and



Tubes meeting the weight shown in table are to be welded. Use the standard as shown when measuring and weighing tubes. The table being 98% of the minimum weight when new.

After tubes are welded they must be subjected to the following test: Tensile Test—Select one tube from every lot of 100 welded tubes and cut from this tube two sections: One including the welded portion and the other from the portion not welded. These test pieces to be carefully marked for identification. Tubes to be subjected to a tensile test while cold until a fracture occurs.

The welded test pieces should develop a strength of at least 90% of the unwelded section. If the welded piece does not meet test, a second tube from the sample lot should be tested and if it fails to meet the test, the entire lot of 100 should be scrapped.

Outside Diam.	Nearest B. W. G.	Nom. Dec. Thickness M-M. Gage	Minimum Weight Per Foot
1¾"	No. 13	0.095	1.52 Lb.
1¾"	" 12	0.110	1.74 Lb.
2"	" 12	0.110	2.00 Lb.
2"	" 11	0.125	2.19 Lb.
2¼"	" 12	0.110	2.26 Lb.
2¼"	" 11	0.125	2.48 Lb.
2½"	" 12	0.110	2.51 Lb.
2½"	" 11	0.125	2.78 Lb.

Fig. 2

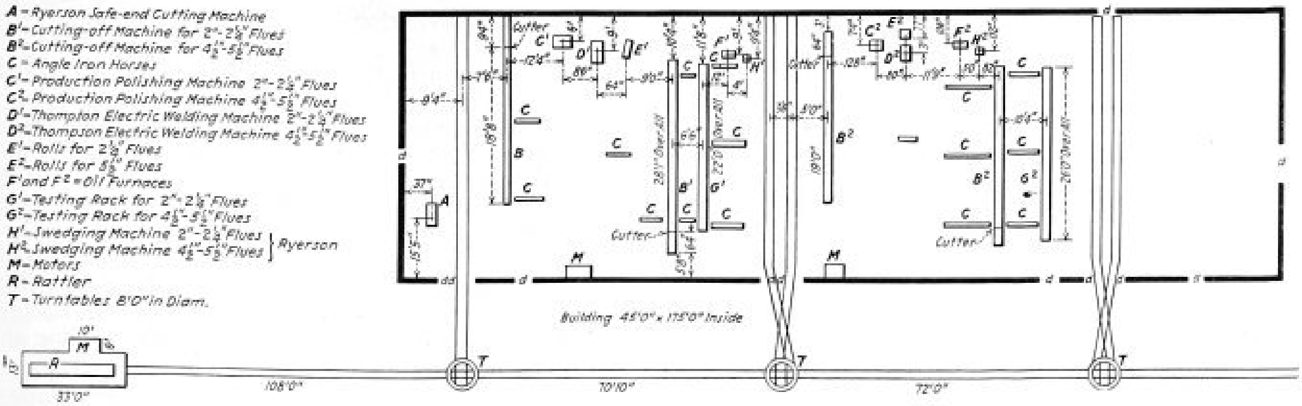


Fig. 3

flues before application, 20 percent do not, and 1 member only tests flues.

Seventy percent test oil welds before application, 30 percent do not. One member only tests flues.

The percentage of poor oil welds is 2, electric welds 1.

The saving by electric welding over oil welding is 27½ percent.

One member reports a saving of 4 cents per flue.

The average number of tubes welded per hour is 37 with oil, and 47 electric, or a 27 percent greater output with electric welding.

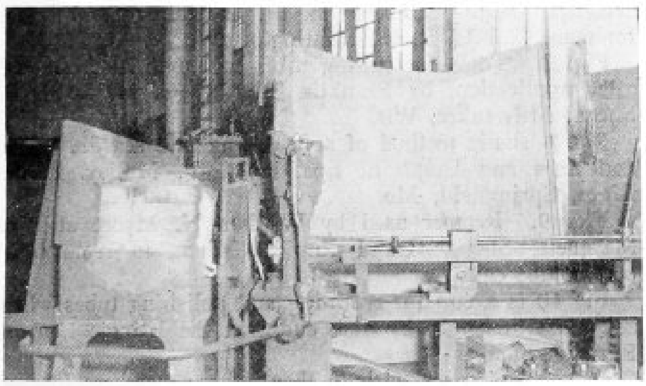


Fig. 4

On speed tests the average for oil welds is 63 per hour, electric 80, or 27 percent greater output with electric.

For cutting tubes to length for application 50 percent use a disk cutter, 14 percent use special pipe cutting machines, 18 percent use a hot saw, 14 percent cut flues in boiler after application, and 4 percent use a cold saw.

In the reclaiming of flues, that is welding two or more long pieces, we found that 30 percent reclaim, 70 percent do not. Several members report having very good results with tubes made up of two long pieces.

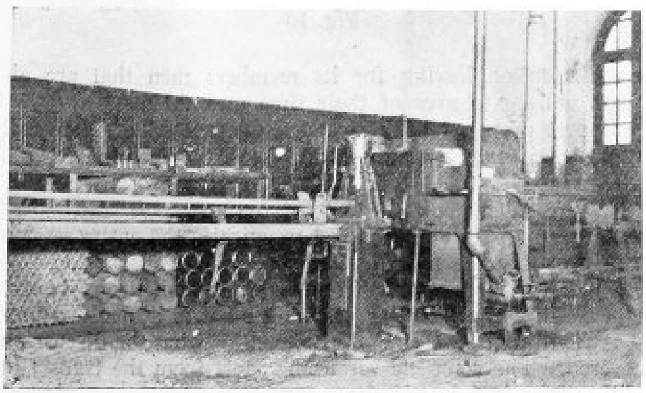


Fig. 5

A. F. Stiglmeier of the New York Central's West Albany Shops reports using a unique machine for the welding of flues at front end. The flue is held in position by a four section air operated clamp which is the exact diameter of the flue. The weld is then rolled on the inside to the original diameter of the flue, making it possible to insert superheater units without hindrance due to reduced section at weld. The process of rolling resembles that of rolling a flue in flue sheet. The machine is directly back of furnace. Its capacity is from 6 inches to 60 inches.

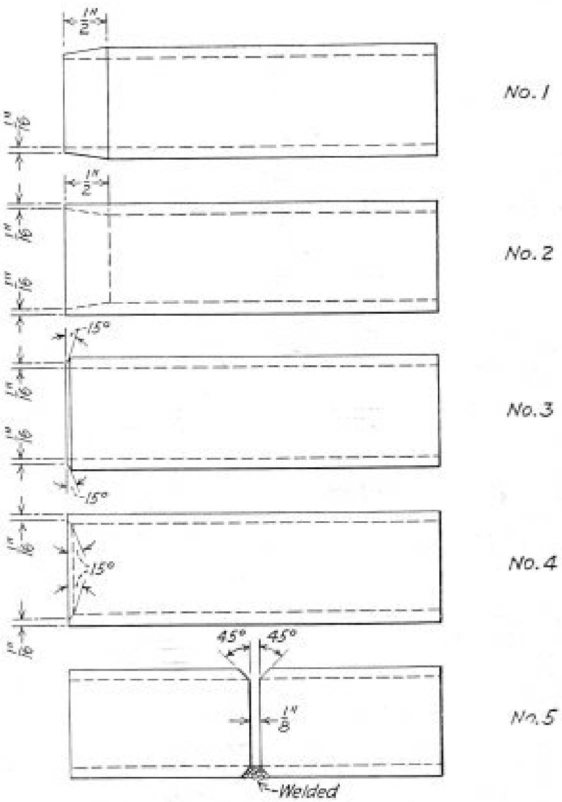


Fig. 6

Based on the opinion of others and our own experience, we have come to the following conclusions:

No preference is shown for either dry or wet rattler; both do good work. The strongest argument in favor of

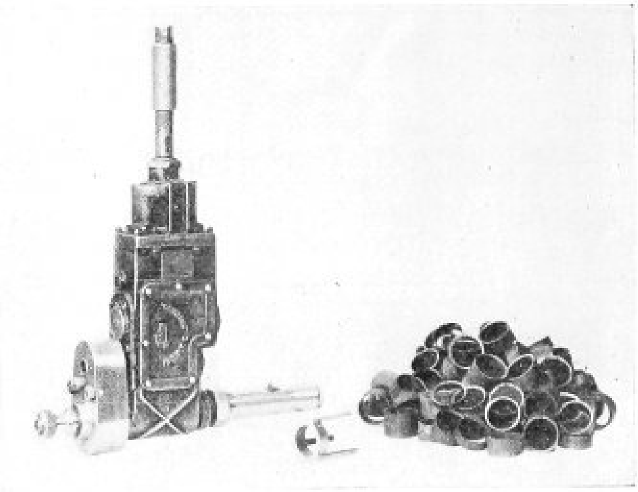


Fig. 7

the submerged wet rattler is, that it is dustless and almost noiseless.

While the disk cutter seems to have the prefernce for cutting off flues, we would recommend the friction or cold saw for both cost and amount of production.

For the welding of safe ends on tubes and flues the electric process is the best and most efficient method. It is safe, clean, sanitary, noiseless, more reliable in service, gives better results going through the rattler, and results in cheaper and greater production.

Regarding the manner of welding, we recommend the butt weld as there is a greater solid surface in contact.

For oil welding it is preferable to bevel the end of tip to at least 25 degrees or 30 degrees.

For the polishing of safe ends and tubes we recommend the belt polishes as being efficient and fast.

For finishing either electric or oil welds, both roller and hammer are giving good results; their ideal location is directly back of electric welder, and back of oil furnace for reclamation work.

Although the majority of replies favor the testing of tubes and flues before application, the committee does not recommend it, believing it to be superfluous and a waste of time.

We further recommend that not more than two safe ends be welded on tubes and flues, believing that this will increase their reliability and therefore the reliability and efficiency of the locomotive.

In reply to our request for photographs of special tools we received drawings and photographs of the tools shown.

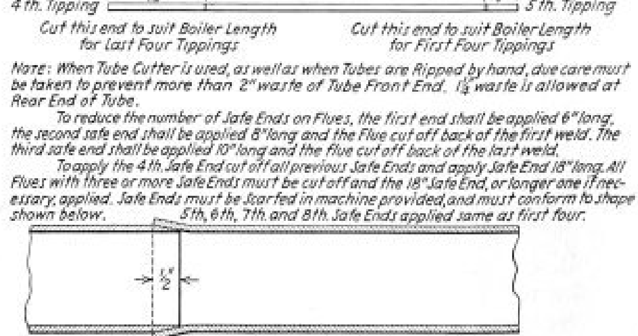


Fig. 8

Fig. 1 shows an electric welding machine with 5 foot roller.

Fig. 2 shows a method of weighing tubes, and testing welds.

Both drawings were contributed by A. F. Stiglmeier of the New York Central shops, West Albany, N. Y.

Fig. 3 was copied from a tracing of the Santa Fe R. R. flue shop at Albuquerque, N. M., furnished by J. H. Lewis, general boiler foreman.

Figs. 4 and 5 are from photos by R. A. Creger, General Boiler Foreman, Northern Pacific R. R., Brainerd, Minn.

No. 4 shows a flue welding and reclaiming machine with an expanding mandrel; No. 5 is a tube welding and reclaiming machine.

Fig. 6 shows method of scarfing tubes and of oxy-

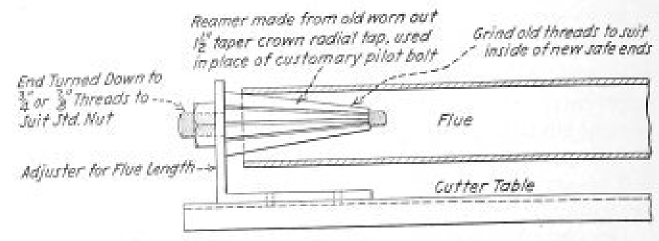


Fig. 9

acetylene welding flues, by S. M. Carroll, general boiler foreman, C. & O. R. R., Huntington, W. Va.

Fig. 7. Tools for cutting tubes to length at front end after application, by Franklin T. Litz, C. M. & St. P. Shops, Milwaukee, Wis.

Fig. 8 shows method of safe ending and scarfing tubes and flues and length of tips, by J. P. Malley, Frisco Lines, Springfield, Mo.

Fig. 9. Reamer used by William N. Moore at Pere Marquette Shops, Grand Rapids, Mich., to ream burr out of tube ends.

Fig 10 is a cup for retaining and polishing tubes while being cut to length by disk cutter at the Illinois Central Burnside Shops.

In conclusion we wish to thank those members that so kindly helped us with our report, and congratulate this

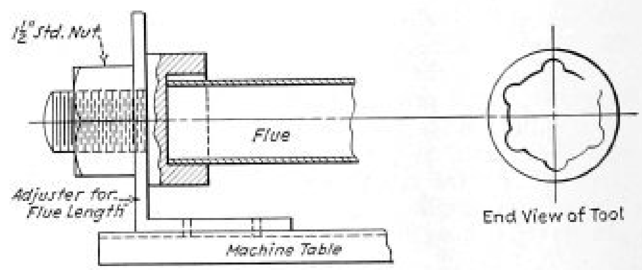


Fig. 10

association on having for its members men that are always willing to give of their time and talents.

Report prepared by a committee composed of Henry J. Raps, chairman, S. M. Carroll, A. J. Redmond.

Discussion

This subject which occupied practically the entire session was probably the most interesting and the discussion was entered into more widely from the floor than probably any other. In a short outline of this kind it is difficult to present anything like a general statement of what the discussion covered. The complete verbatim report from the transcript will appear in a later issue.

Briefly, electric safe-ending seems to have obtained almost a general recognition in the field and as rapidly as machinery can be purchased by various roads one or more electric safe-ending machines are being installed. Where changes in equipment are being made, no other method of welding safe ends on small tubes is receiving consideration at the present time, although comparatively few shops are as yet equipped to electrically weld superheater flues.

In the discussion of electrically welding safe ends a great argument occurred over the relative merits of the scarf joint and the butt joint. A report of laboratory tensile tests on various types of joints was submitted together with samples of the test specimens. Records of mileage obtained from tubes without leaking were cited by various members supporting one or other method of making welds. Many members are making what is known as a flash weld, although they are not designating them in this way. This system seems to provide the best method of welding but it is necessary that educational work be done on the subject to make possible a clear understanding of exactly what flash welding means.

The proper welding heat, the use of flux, cutting off methods, amount of bevel on tubes, method of rolling or hammering welds, and the like were all subdivisions extensively discussed by the members.

The committee on law recommended that the convention adopt as a revision to the by-laws that no supply man might be made an associate member of the Master Boiler Makers' Association unless he was also a member of the Boiler Makers' Supply Men's Association. This motion was adopted.

Friday Session

The closing session of the convention began promptly at 9:30 A.M. The first order of business was the election to honorary membership of a number of members who have been retired from active service.

As F. N. Speller delivered his talk on boiler corrosion at an earlier session, this feature of the program was omitted at this time. The subject of applying staybolts to locomotive boiler fireboxes was taken up.

The report and complete discussion of this subject will appear in the June issue.

Election of Officers

The remainder of the convention was devoted to the election of officers, a complete list of which follows:

President, W. J. Murphy, division boiler foreman, Pennsylvania Railroad, Olean, N. Y.; first vice president, L. M. Stewart, general boiler inspector, Atlantic Coast Line, Waycross, Ga.; second vice president, George B. Usherwood, supervisor of boilers, New York Central Railroad, Syracuse, N. Y.; third vice president, Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy Railroad, Lincoln, Neb.; fourth vice president, Franklin T. Litz, general boiler foreman, Chicago, Missouri & St. Paul Railroad, Milwaukee, Wis.; fifth vice president, Henry J. Raps, general boiler foreman, Illinois Central R. R., Chicago, Ill.; secretary, Harry D. Vought, New York; treasurer, W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio; executive board (one year), Charles J. Longacre, Elizabeth, N. J., R. W. Clark, Nashville, Tenn., O. H. Kurlfinke, San Francisco, Cal.; (two years), George G. Fisher, Chicago, Ill., John Harthill, Cleveland, Ohio, Ira J. Pool, Baltimore, Md.; (three years), Albert F. Stiglmeier, Albany, N. Y., C. H. Browning, Battle Creek, Mich., George L. Young, Reading, Pa.; chairman of the executive board, Albert F. Stiglmeier, general boiler shop foreman, New York Central Railroad, Albany, N. Y., and secretary of the board, Ira J. Pool, district boiler inspector, Baltimore & Ohio R.R., Baltimore, Md.

Supply Men Elect Officers

At the annual business meeting of the Master Boiler Makers Supply Men's Association held May 5, at the Sherman Hotel, Chicago, Ill., the following officers were elected for the coming year:

President, A. W. Clokey, American Arch Company, Chicago, Ill.; vice president, J. C. Kuhns, Burden Iron Company, Troy, N. Y.; treasurer, George R. Boyce, A. M. Castle & Company, Chicago, Ill.; secretary, W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

Executive Committee (one year) C. C. Osterhout, Rome Iron Works, Rome, N. Y.; F. M. Roby, Talmadge Manufacturing Co., Cleveland, O.; Harry Loeb, Lukens Steel Co., New York City; (two years) Frank C. Haase, Oxweld Railroad Service Company, Chicago, Ill., Fred H. McCabe, McCabe Manufacturing Company, Lawrence, Mass.; Irving H. Jones, Central Alloy Steel Corporation, Massillon, Ohio; (three years) E. G. Fitzsimmons, Flannery Bolt Company, Pittsburgh, Pa., P. J. Conrath, National Tube Company, Chicago, Ill., and R. T. Peabody, Air Reduction Sales Company, New York.

List of Exhibitors and Supply Men at Master Boiler Makers' Convention

Air Reduction Sales Company, New York.—Represented by E M. Sexton, B. N. Law, R. T. Peabody, H. L. Rogers, T. M. Hamer, Joe Kenefic, O. F. Wilkinson, Fred Granaman and G. Van Alstyne. The exhibit included Airco 99.5 oxygen and Airco acetylene (in cylinders); Airco Davis-Bournonville oxy-acetylene welding and cutting apparatus and supplies.

American Arch Company, Inc., New York.—Represented by W. L. Allison, J. P. Neff, R. J. Himmelright, J. T. Anthony, A. W. Clokey, T. M. Ferguson, T. F. Kilcoyne, W. W. Neale, A. M. Sucese, George Wagstaff. The exhibit included two "Scenes in Action" signs representing firebox conditions with and without arch respectively.

American Locomotive Company, New York.—Represented by A. F. Pitkin, N. C. Naylor, G. G. Jones, K. Auburn, Arthur Haller, Robert Brown, Hunter Michaels, W. S. Morris and G. M. Wilson. The exhibit included Pitkin articulated staybolt, Alco hand rail posts, Alco flexible bolts and parts, Alco pipe clamps and Alco rigid bolts.

American Railway Appliances Company, New York.—Represented by F. C. Porter. The exhibit included the Superior locomotive flue blower.

Arrow Tools, Inc., Chicago, Ill.—Represented by N. W. Benedict and H. J. Trueblood. The exhibit included beading tools, chisels, chisel blanks, calking tools, rivet sets, back-out punches, etc.

Charles H. Besly & Company, Chicago Ill.—Represented by R. E. Beimer. The exhibit included Besly locomotive taps.

Bethlehem Steel Company, Inc., Bethlehem, Pa.—Represented by Geo. H. Raab, Edward A. Jones. The exhibit included Bethlehem knobbled charcoal iron boiler tubes, Bethlehem special staybolt iron and Bethlehem engine bolt iron.

The Bird-Archer Company, New York.—Represented by L. F. Wilson, P. B. Bird, C. A. Bird, J. L. Callahan, C. J. McGurn, J. J. Clifford, R. A. Wilsey, J. A. McFarland, George E. Chollar, H. P. Mauer, J. C. Hutton and Miss Katherine Alten. The exhibit included literature and samples.

The Boiler Maker, New York.—Represented by George Slate, H. E. McCandless and L. S. Blodgett.

The Bourne-Fuller Company, Cleveland, Ohio.—Represented by Collin H. Aiken, R. W. Hull, J. F. Schumacher and Howard Burket. The exhibit included Climax alloy staybolt steel, Upson rivets, Climax alloy steel staybolts, engine bolts, fitting up bolts, heat treated superheater bolts.

W. L. Brubaker & Bros. Company, New York.—Represented by G. M. Brubaker, W. Searls Rose, C. W. Borneman and H. B. Morrison. The exhibit included a complete line of tools as recommended by the American Railway Tool Foremen's Association; also standard line of taps, dies, reamers, boiler tools, staybolt taps, etc.

The Burden Iron Company, Troy, N. Y.—Represented by John C. Kuhns and William Downs. The exhibit included staybolt iron, engine bolt iron and Burden iron rivets.

A. M. Castle & Company, Chicago, Ill.—Represented by George R. Boyce and Leonard J. Quetsch. The exhibit included rivets, boiler tubes, locomotive firebox and boiler steel. This company represented the Champion Rivet Company and the Tyler Tube Company.

Central Alloy Steel Corporation, Massillon, Ohio.—Represented by I. H. Jones, A. L. Roberts, A. S. Taylor and George T. Ramsey. The exhibit included Toncan firebox iron, Toncan iron tubes, Agathon engine bolt steel and Agathon staybolt steel.

The Champion Rivet Company, Cleveland, Ohio.—Represented by D. J. Champion and T. J. Lawless. The exhibit included rivet display board, literature, etc.

Chicago Engineer Supply Company, Chicago, Ill.—Represented by W. J. Selbie and W. M. Burns. The exhibit included tube cleaners for locomotive arch tubes and stationary boilers, air and water driven.

Chicago Eye Shield Company, Chicago, Ill.—Represented by Robert Malcom, George A. Binder and John N. Liautaud. The exhibit included ESSENTIALITE glass for arc welding, welding goggles and helmets, laminated glass—Acme eye shield, grinding and chipping goggles.

Chicago Pneumatic Tool Company, New York.—Represented by J. L. Rowe, E. K. Lynch, H. R. Deubell, L. F. Duffy, F. O. Duffy, R. M. Porter and G. G. Porter. The exhibit included miscellaneous pneumatic tools.

The Cleveland Pneumatic Tool Company, Cleveland, Ohio.—Represented by H. S. Covey, C. J. Albert, B. H. Tripp and R. E. Ahern. The exhibit included tools—Cleco riveting hammers, chipping hammers, air drills, valve grinders, etc.; fittings—Bowes air hose couplings, Cleco pressure-seated air valves, grooved nipples, etc.

Dearborn Chemical Company, Chicago, Ill.—Represented by George R. Carr, C. M. Hoffman, L. P. Bowen, Roger Q. Milnes, Nelson F. Dunn and L. D. Brown. The exhibit included Dearborn treating plants, No-ox-id rust preventive.

Detroit Seamless Steel Tubes Company, Detroit, Mich.—Represented by C. H. Hobbs, L. R. Phillips, H. E. Ross and W. H. S. Bateman. The exhibit included locomotive boiler tubes, stationary boiler tubes and tubes used for mechanical purposes will be on display.

Dries & Krump Mfg. Company, Chicago, Ill.—Represented by D. E. Dorsey and A. J. Schaefer. The exhibit included photographs of machines, apron brakes and drop brakes; samples of work produced.

Ewald Iron Company, Louisville, Ky.—Represented by W. R. Walsh and J. P. Bourke. The exhibit included samples of staybolt iron and engine bolt iron in rounds, squares, hexagons, flats and round edge spring hanger iron.

The J. Faessler Manufacturing Company, Moberly, Mo.—Represented by J. W. Faessler and G. R. Maupin. The exhibit included boiler makers standard and special tools, tube expanders, cutters, etc.

Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.—Represented by C. M. Walsh, E. J. Raub and Adrian A. Walker. The exhibit included hollow and solid staybolt bars; finished stays, hollow and solid, threaded and headed; also straight, water space, reduced body, crown, radial and flexible types made from Falls hollow iron.

Flannery Bolt Company, Pittsburgh, Pa.—Represented by J. Rogers Flannery, E. S. Fitzimmons, E. G. Flannery, E. J. Reusswig, G. R. Greenslade, W. M. Wilson, John H. Murrian, Blake C. Howard and J. P. Armstrong. The exhibit included Tate and FBC flexible staybolts, rigid bolts, hollow flexible stays and tools for installation.

Garratt-Callahan Company, Chicago, Ill.—Represented by A. H. Baker, A. H. Hawkinson, C. E. Stevens, E. H. Miller, F. E. Williams, W. F. Caspers, G. J. Barclay and H. M. Gray. The exhibit included magic boiler preservative.

Gary Screw & Bolt Company, Gary, Ind.—Represented by Philip Robinson and Gerald J. Garvey. The exhibit included rivets, nuts and bolts.

Henry F. Gilg, Chicago, Ill.—Representing the Mid-West Valve Corporation, Toledo, Ohio, and the Atlas Steel Corporation, Dunkirk, N. Y. The exhibit included crown bolts, radials, etc. made from Dunkirk rolled hollow staybolt steel; Murphy valves for washout and blow-off Atlas fire turning tools.

Globe Steel Tubes Company, Milwaukee, Wis.—Represented by J. W. Floto, T. F. Clifford and J. S. Bradshaw. The exhibit included samples of hot rolled seamless steel boiler tubes, arch tubes and superheater flues.

Highland Iron & Steel Company, Chicago, Ill.—Represented by William C. Wolfe, E. J. Murray and E. L. Morris. The exhibit included engine bolt iron, staybolt iron and rivet stock.

Houseley Flue Connection Corporation, Indianapolis, Ind.—Represented by R. B. Housley and H. Lewis. The exhibit included Housley washout and arch tube plugs.

Huron Manufacturing Company, Detroit, Mich.—Represented by H. N. Reynolds, E. P. Roddie, E. H. Willard and M. T. Willard. The exhibit included Huron washout and arch tube plugs for locomotives.

Independent Pneumatic Tool Company, Chicago, Ill.—Represented by R. S. Cooper, F. W. Buchanan, A. Anderson, H. Keller, W. A. Nugent, C. E. Leonard, E. R. Wyler, W. Hammerly, O. Dallman, J. Cowett and I. T. Cruice. The exhibit included THOR pneumatic drills, pigmy drill, chipping hammers, riveting hammers, sealing and calking hammers, grinders, moisture separator, electric drills, grinders and screw drivers, rivet sets and chisels. A feature of the THOR exhibit was the showing of the new hammer type holder-on and the 71R pneumatic wrench.

Ingersoll-Rand Company, New York.—Represented by J. F. Kroske, G. C. Keherer, T. E. Forbes and F. M. Cross. The exhibit included pneumatic drills, hammers, staybolt motors and flue rolling machines.

William H. Keller, Inc., Grand Haven, Mich.—Represented by Walter E. Hall, Guy S. Warren and Ed. J. Biederman. The exhibit included riveting hammers, chipping hammers, jam riveters, pneumatic drill and pneumatic tool accessories.

King Pneumatic Tool Company, Chicago. Ill.—Represented by J. C. Buckels and F. H. Revell. The exhibit included riveting and chipping hammers.

Liberty Manufacturing Company, Pittsburgh, Pa.—Represented by E. L. Davis, H. A. Pastre and N. A. Butler. The exhibit included 1-0-F Victor cleaner with S. F. head, 3-inch; a 3-inch B. A. water driven arch cleaner; one D 164 arch cleaner; one D 174; one D 255; one D 193 arch tube cleaners.

Lima Locomotive Works, New York.—Represented by M. K. Tate. The exhibit included photographs.

Locomotive Firebox Company, Chicago, Ill.—Represented by W. S. Carr, A. A. Taylor, L. R. Pyle, C. M. Rogers, E. J. Reardon, J. M. Rapp, E. F. Smith and J. Baker. The exhibit included locomotive boiler models demonstrating, particularly, the Nicholson thermic syphons for added firebox heating surface and boiler water circulation.

Lovejoy Tool Works, Chicago, Ill.—Represented by W. H. Dangel, Tom Brown, L. G. Groessl and M. W. Dangel. The exhibit included tube expanders, use-em-up drill sleeves, flue cutters, flue hole cutters, beading tools, chisels, rivet sets, staybolt headers, clips, re-cupping tools, flaring tools, staybolt chucks, taper sockets, backing-out punches, dolly bars, Lacerda sockets, paint scalers, driver nuts, flue pins, countersinking frames, universal joints, laying-up fullers, reamers and plate clamps.

Lukens Steel Company, Coatesville, Pa.—Represented by Harry Loeb. The exhibit included literature, pieces of steel plate, etc.

MacLean-Fogg Lock Nut Company, Chicago, Ill.—Represented by J. A. MacLean, J. W. Fogg, C. Beaumont and F. J. O'Leary. The exhibit included "M-F" lock nuts.

McCabe Manufacturing Company, Lawrence, Mass.—Represented by Fred H. McCabe and Edward McCabe. The exhibit included model flanging machine, flanged flue sheets and moving pictures of machine flanging flue sheet.

Mudge & Company, Chicago, Ill.—Represented by Arthur R. Fletcher and Frank H. DeBrun. The exhibit included the Mudge security unit spark arrester and materials from which this spark arrester can be made.

National Tube Company, Pittsburgh, Pa.—Represented by J. W. Kelly and P. J. Conrath. The exhibit included samples of superheater tubes and hot rolled seamless tubes.

Old Dominion Iron & Steel Works, Inc., Richmond, Va.—Represented by Thos. S. Wheelwright and Major George Brooks West. The exhibit included solid and hollow rolled staybolt iron—both puddled wrought iron and electric steel seamless hollow rolled staybolts.

Otis Steel Company, Cleveland, Ohio.—Represented by George E. Sevey. The exhibit included samples of Otis locomotive boiler and firebox steel.

Oxweld Railroad Service Company, Chicago, Ill.—Represented by A. N. Lucas, W. A. Hogan, H. W. Schulze, F. C. Hasse, H. V. Gigandet, Ross Webster, Wm. Jones, W. A. Champieux and O. F. Ladtkow. The exhibit included Oxweld welding and cutting equipment.

The Paulson Tools, Inc., Wallingford, Conn.—Represented by Charles Loucks, John J. Brosnan, H. L. Burrhus and A. A. Walker. The exhibit included hand and pneumatic chisels, beading tools, blanks, rivet sets, flaring tools, backing-out punch, rivet busters, drift pins, scaling tools, Frenchmen, flue splitters, rippers, gouges, floor chisels; equipment, display board.

Penn Iron & Steel Company, Creighton, Pa.—Represented by Charles J. Nieman. The exhibit included samples of staybolt and engine bolt iron as well as hollow drilled staybolts and numerous tests made of above.

Pittsburgh Steel Products Company, Pittsburgh, Pa.—Represented by Charles H. Van Allen and Charles F. Palmer. The exhibit included a staybolt exhibit showing hollow staybolt screwed into plate and beaded; a superheater unit comprising a superheater and flue and four body grade tubes beaded into plates together with minature superheater unit and samples of $2\frac{1}{4}$-inch (copper content and plain steel) 3-inch, $5\frac{1}{2}$-inch and 2-inch tubes.

Pratt & Whitney Company, Hartford, Conn.—Represented by Elmer E. Cullison, F. A. Armstrong, L. T. Bohnet, H. B. Johnson and Victor Felzman. The exhibit included small tools, principally taps.

The Prime Manufacturing Company, Milwaukee, Wis.—Represented by D. A. Lucas and C. A. Dunn. The exhibit included washout plugs, gage cocks, water glass cocks, clear vision windows, windshield wings, grease plugs and washout nozzles.

Reading Iron Company, Reading, Pa.—Represented by Donald Charlton and H. L. Shepard. The exhibit includes descriptive literature on charcoal iron boiler tubes, staybolt, engine-bolt and doubly refined bar iron; some literature on genuine wrought iron pipe for railroad service.

John A. Roebling's Sons Company, Chicago, Ill.—Represented by E. T. Weart, C. F. Bennecke and H. M. Barber. The exhibit included refillable steel reel for automatic welding machines, Roebling welding wire and wire rope slings.

Rome Iron Mills, Inc., Rome, N. Y.—Represented by C. C. Osterhout. The exhibit included Rome Superior staybolt iron and Rome Perfection engine bolt iron.

Joseph T. Ryerson & Son, Chicago, Ill.—Represented by W. S. Campbell, T. W. Delanty, G. L. Shinkle, J. P. Moses, J. B. Whitenack, L. Widmeier and A. W. Willcuts. The exhibit included Lewis special staybolt iron and Lewis special hollow drilled staybolts.

Scully Steel & Iron Company, Chicago, Ill.—Represented by John W. Patterson, John G. Johnson, A. Nelson and Elmer Stuckum. The exhibit included tube expanders, tube cutters, special tube expanding tools, boiler makers' tools.

The Superheater Company, New York.—Represented by R. M. Ostermann, R. R. Porterfield and E. A. Averill. The exhibit included literature for those interested in feedwater heating and superheating as applied to locomotives.

The Talmage Manufacturing Company, Cleveland, Ohio.—Represented by Frank M. Roby. The exhibit included Cleveland low water alarms, Talmage ash pan, Talmage blow off valve and Talmage grate shaker.

Thompson Electric Welding Company, Lynn, Mass.—Represented by F. H. Leslie and H. B. Warren. The exhibit included samples of electrically welded flues and spot welded sheets.

Torchweld Equipment Company, Chicago, Ill.—Represented by W. A. Slack, Russell Smith, J. L. Jensen and R. C. Gutke. The exhibit included Torchweld gas welding, cutting and lead welding equipment, acetylene generator, welding supplies and accessories.

Tyler Tube & Pipe Company, Washington, Pa.—Represented by A. M. Castle & Company. The exhibit included samples of rivets, charcoal iron tubes and of charcoal iron in various stages of manufacture.

Ulster Iron Works, Dover, N. J.—Represented by John C. Campbell, C. F. Barton, L. E. Hassman, E. W. Kavanagh and Norman S. Thulin. The exhibit included Ulster SPECIAL solid staybolt iron, Ulster boiler brace iron, Ulster SPECIAL drilled hollow staybolts; also bends, etches, step tests, etc., of these quality irons.

The Winfield Electric Welding Machine Company, Warren, Ohio.—Represented by Harry L. Burrhus. The exhibit included electric flue welders.

E. R. Wyler who has been connected with the Cleveland, Ohio, Sales Branch of the Independent Pneumatic Tool Co., has been transferred to the sales department at the general offices of the company in Chicago. Mr. Wyler will make his headquarters in St. Paul, Minn.

Registration of Members

Adair, William C., B. Insp., C. & E. Ill. R. R., Salem, Ill.
Aiken, C. H., Dept. Boiler Equip., Bourne-Fuller Co., Shaker Heights, 3628 E. 163d St., Cleveland, Ohio.
Albert, Jacob, Asst. B. F., C. & W. I. R. R., 6721 S. Peoria St., Chicago, Ill.
Anderson, J. A., G. F., Industrial Wks., 216 N. Madison Ave., Bay City, Mich.
Andre, B. F., B. Insp., C. & O. R. R., 2209 Carter Ave., Ashland, Ky.
Atkinson, Wm. B., F. B. M., Missouri Pacific R. R., 3950 Parker ave., St. Louis, Mo.
Austin, George, G. B. I., A. T. & S. F. Ry., 11 Devon Apts., Topeka, Kans.

Badger, R. L., Supvr. Boilers, Erie R. R., 514 Term. Bldg., Youngstown. Ohio.
Baker, Glenn, B. M. F., N. Y. C., 601 N. Goodman St., Rochester, N. Y.
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Beland, Arthur J., G. F. B. M., Chicago Junction R. R., 7346 Kenwood Ave., Chicago, Ill.
Bell, H. A., G. B. F., C. B. & Q., 316 S. 11th St., Havelock, Nebr.
Bell, Harry, Asst. B. F., M. K. T., 528 N. 11th st., Waco, Texas.
Bennett, G. W., Dist. Insp., I. C. C., 15 Kent St., Albany, N. Y.
Besant, W. F., F. B. M., I. C. R. R., 6450 Kenwood ave., Chicago, Ill.
Biklen, F. L., F., C. B. & T. R. R., 1033 Ash st., Burlington, Iowa.
Billington, Matthew, F. B. M., B. R. & P. R. R., 72 Central Ave., E. Salamanca, N. Y.
Bishop, H. K., B. M. F., C. & O. R. R., 1332 10th ave., Huntington, W. Va.
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Breisacher, G. H., Gen. F., Toledo Term., 1825 Ridgewood Ave., Toledo, O.
Brennan, E. J., G. B. F., B. & M. R. R., Elks Hotel, Boston, Mass.
Brown, Charles C., Asst. B. F., E. J. & E. R. R., 556 4th st., Lockport, Ill.
Browning, C. H., G. F. B. M., Grand Trunk Ry., 53 Cherry St., Battle Creek, Mich.
Bruce, James, B. M. F., Frisco, 2014 Central ave., Kansas City, Kans.
Buffington, C. W., Gen. M. B. M., C. & O. R. R., Richmond, Va.
Burkholtz, G. E., Trav. G. B. I., Frisco, 1019 State St., Springfield, Mo.
Burroughs, W. D., B. F., C. I. & L. R. R., Bloomington, Ind.
Butler, Chas. C., Asst. B. I., C. R. I. & P. R. R., Box 74, Horton, Kans.

Callahan, J. L., G. B. I., The Bird-Archer Co., 122 S. Michigan Ave., Chicago, Ill.
Carstens, R. H., B. M. F., Virginia Railway, Princeton, W. Va.
Chastain, J. H., B. M. F., N. C. & St. L. R. R., 447 S. Blvd., Atlanta, Ga.
Clare, James E., Insp. of Locomotives, Interstate Commerce Commission, 1410 Lytton Bldg., Chicago, Ill.
Clark, R. W., G. F. B. M., N. C. & St. L. R. R., 1806 Division st., Nashville, Tenn.
Cook, James T., Jr., G. F. B. M., Boston & Albany R. R., 96 Southwest st., West Springfield, Mass.
Conrath, P. J., Boiler Tube Expert, National Tube Co., 4712 Drexel Blvd., Chicago, Ill.
Cooke, J. E., M. B. M., B. & L. E., 360 So. Main St., Greenville, Pa.
Corns, Charles C., B. F., C. & N. W., Belle Plaine, Ia.
Cosgrove, P. E., G. F. B. M., E. J. & E., 103 Glenwood Ave., Joliet, Ill.
Costlaw, J. A., F. B. M., M. P. R. R., 326 Cumberland Blvd., San Antonio, Texas.
Craig, W. J., Dist. Boiler Insp., Baltimore & Ohio R. R., 206 Trenton, Hazelwood P. O., Pittsburgh, Pa.
Creger, R. A., G. B. F., N. P. R. R., 421 9th st., South, Brainerd, Minn.
Crimmens, R. F., Dist. B F., Big 4, 1005 Wabash st., Matoona, Ill.

Darrach, H., G. B. F., D. M. & S. R. R., Box 476, Proctor, Minn.
Davey, J. J., G. B. I., Nor. Pac., Central Office Bldg., St. Paul, Minn.
Deen, W. H., F. B. M., C. & O. of I. R. R., 466 W. Main st., Peru, Ind.
Dittrich, A. C., G. B. I., Soo Line, 1409 N. 5th St., Minneapolis, Minn.
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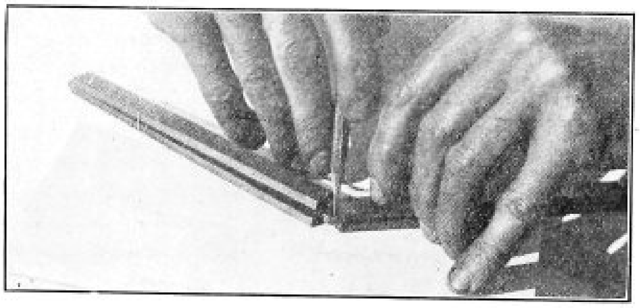
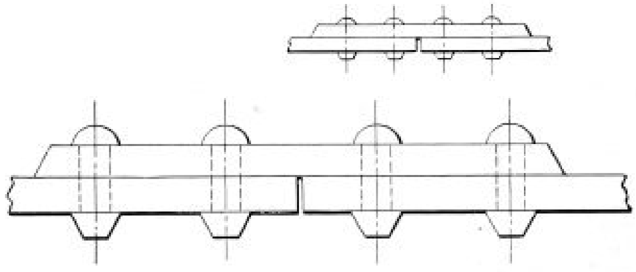
Using a Two-foot Rule for Rivet Sketches

ROUGH sketches made in the shop or out on the job are never expected to measure up to the appearance of a finished drawing made with drawing instruments. However, preliminary job sketches are often made a matter of record and filed away and where there is a possibility





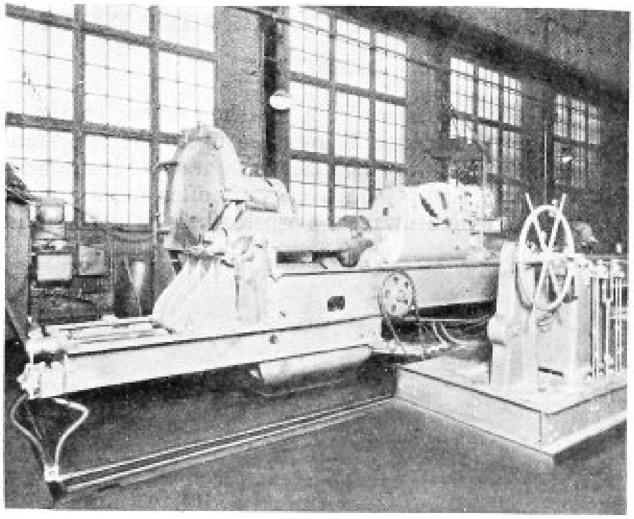
How to use a two-foot rule to make sketches like those shown in the drawing

of this being the case it is worth while to make them as neatly as possible. The illustration and drawing accompanying this article show how excellent sketches can be made of boiler seams or riveted joints by simply using the large and small joints of a two-foot rule. The larger heads and circles are made with the middle joint and the smaller scale sketches are made with the small joint separating the 6-inch sections. It is surprising how easily and neatly a fairly sharp pencil will follow the openings in the rule producing work comparable in appearance to that usually seen on finished drawings.

New Rotator for Cutting Large Rounds and Squares

A NEW rotating attachment has been developed for use with either Nos. 3 or 4 Ryerson high speed friction saws, so that large rounds, pipe, squares, etc., can be cut to the shortest lengths with a minimum of time. For instance, with a No. 3 saw, an 8-inch standard pipe is cut without distortion in 12 seconds.

The attachment consists of a structural framework upon which a carriage for the material travels. A pneumatically operated chuck grips one end of the stock. It is rotated by means of a constant speed motor through a change speed gear box all located on the carriage. Power lines for the motor are located in a protected position on the frame. A center rest mounted on the work table of the saw is arranged to receive bushings for various sizes of material. A sliding gage stop also located on the work table consists of a heavy casting with a screw top providing for fine adjustment. Between the steady rest and gage stop is a "V" shaped support which holds the work while it is being cut and acts as a dumping device for the finished pieces.



Ryerson rotating attachment for friction saws

It is connected to a pneumatic cylinder and operates from the control stand.

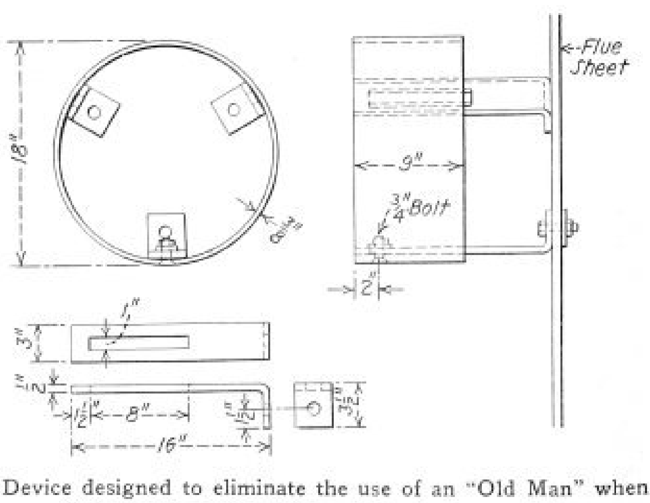
The one central control stand located at the right front of the saw enables one operator to control all production operations from that position. Levers controlling the saw, cooling water for the saw blade, air valves for operating the pneumatic chuck, together with a capstan wheel for moving the material forward to the next cut are all located on the stand. Controls for starting motors can also be placed on the stand if desired. Complete information on this new rotating attachment which is built in various sizes can be had by writing Joseph T. Ryerson & Son, Inc., Chicago, Ill.

Drilling Holes in the Smokebox Ring

ONE of a number of fixtures and devices developed by the employees of the Lehigh Valley shops at Sayre, Pa., is a device designed to eliminate the use of an "old man" when drilling and countersinking holes in the smokebox ring, throat sheet and front flue sheet. Its use not only does away with the "old man" but speeds up the drilling and lets one man do the work formerly done by two.

A piece of 3/8-inch boiler plate is made into a drum, 18 inches in diameter and 9 inches long. Three legs are bolted to the inside of the drum which extend out of one end about 5 inches. The projecting ends of each leg is provided with a foot in which is drilled a hole for a 3/4-inch bolt. The drum is held with its axis parallel to the boiler axis and is bolted to the flue sheet near the center by means of bolts passing through the feet and the flue sheet. In this position a firm foundation is provided for the drilling motor used in drilling or countersinking around the smokebox ring, flue sheet or throat sheet.

No movement of the drum is required as all the holes around the drum may be reached and a firm backing given to the drill motor. After the drum is in place, one boilermaker can drill an average of thirty 1 1/16-inch holes per hour, whereas before it was used, a boiler maker and helper could drill but twelve 1 1/16-inch holes per hour.



Device designed to eliminate the use of an "Old Man" when drilling and countersinking holes in the smokebox ring, throat sheet and front flue sheet

Welding Society Announces Establishment of the Miller Medal

AT the annual dinner of the American Welding Society held in New York on April 28, President F. M. Farmer announced the donation of an award, the gift of Samuel Wylie Miller, to be presented by the society annually in appreciation of work of outstanding merit in advancing the art and science of welding. The award is a gold medal, which will be known as the Miller Medal.

S. W. Miller has been one of the outstanding figures in the advancement of welding ever since its commercial inception. He is a past president of the American Welding Society, and a prominent and active member of the Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers and other scientific and engineering organizations. He has been long noted for his energetic insistence upon high quality and dependable workmanship and upon the development of welding by all processes along lines scientifically well founded. Mr. Miller is consulting engineer, Union Carbide and Carbon Research Laboratories, Inc.

In establishing this award, the details for the administration of which are not yet decided upon, Mr. Miller's object is to promote an appreciation of better welding and to encourage the study of those fundamentals which will lead to raising the quality of work done by the average operator.

In accepting the administration of this award on behalf of the American Welding Society, Mr. Farmer outlined briefly the history and ideals of its donor, and expressed himself as being particularly gratified that during his administration the Welding Society should be granted the privilege of managing such an important contribution to the improvement of the welding industry.

Business Notes

The Lincoln Electric Company of Cleveland, Ohio, announces the appointment of Royal D. Malm as western district sales manager, with headquarters at Chicago, to succeed R. A. Davidson. Mr. Malm is an engineering graduate from Case School of Applied Science, Cleveland, Ohio, class of 1912. For four years after leaving school he was engaged in construction engineering and then became identified with the Elyria Iron & Steel Company. Later he went with the Standard Welding Division of the Standard Parts Corporation as general superintendent. For the past year Mr. Malm has had charge of Lincoln sales in the automotive industries with headquarters in Detroit.

J. P. Armstrong, with offices in the Balboa Building, San Francisco, Calif., will represent the Flannery Bolt Company in that territory, in the sale of staybolts.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Cone and Elbow Layout

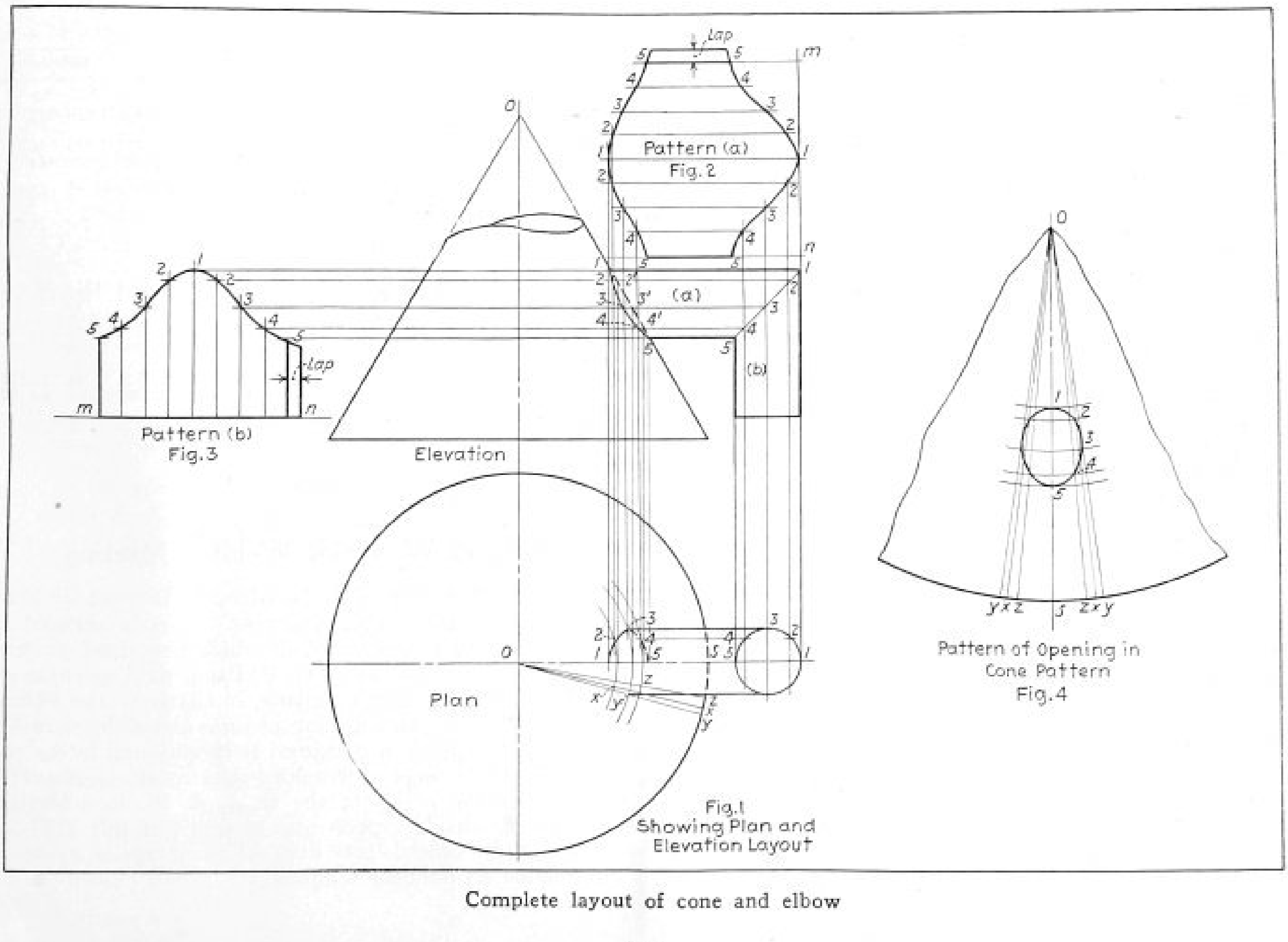
Q.—Would like for you to furnish me with the layout of an elbow intersecting the frustum of a cone at right angle as indicated by the arrow in the sketch.—J. F. D.

A.—A complete layout is shown in Figs. 1 to 4 inclusive. This problem involves projection and radial method development. Construct a plan and elevation, Fig. 1, to find the miter between the cone and elbow. The elbow profile in the plan is divided into a number of equal parts as indicated from 1 to 5 inclusive. Project these to the elbow miter line *1-5* and then to intersect the outer element of the cone. Consider these projectors to pass through the cone, parallel with its base, the sections of the cone cut by these projectors are circles. These are shown partially in the plan. Where the projectors extended from the profile in the plan intersect these circles, locate points on the miter line in the plan. Their relative position in the elevation is then obtained by extending vertical projectors therefrom to intersect corresponding lines in that view, as indicated at 1-2-3-4 and 5.

The pattern of the elbow sections (a) and (b) may be readily laid off by projection. First set off the stretchout on lines *m-n* in both cases, making due allowance for the plate thickness, so as to take care of the "take up" in rolling. Ordinarily the stretchout is figured from the neutral layer of the plate.

Set off on *m-n* the same number of equal parts as in the profile of the elbow. The intersection lines may then be developed as indicated in Figs. 2 and 3.

The opening in the pattern of the cone, Fig. 4, is laid off on radial lines as obtained from the construction in the plan. The lines *o-x*, *o-y* and *o-2* are located in Fig. 4 by



Complete layout of cone and elbow

transferring the arc lengths *s-x*, *s-y* and *s-z* from the center line locating them in the pattern. Transfer the lengths *o-1'*, *o-2'*, *o-3'*, etc., and draw the arcs with these lengths as radii as shown in Fig. 4. The intersection of these arcs with the radial lines at 1-2-3-4 and 5 locates the points for the opening in the cone pattern.

Tank Construction and Stiffener Calculations

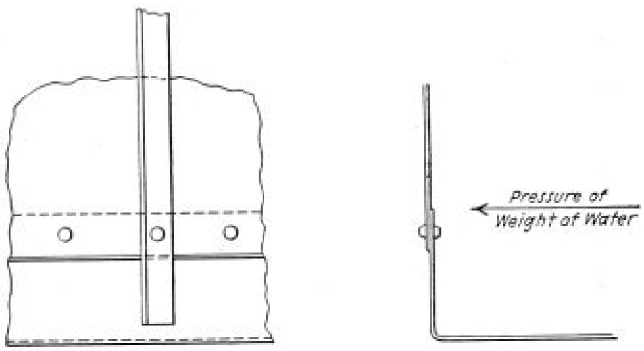
Q.—Taking advantage of your service, I wish to ask your advice concerning the following problems. The enclosed sketch shows a water storage tank with a stiffener shown on the outside of the tank which is projected below the longitudinal seam.

Is it considered good practice to place stiffeners on the outside of a tank or the inside and for what reasons?

When the angle stiffeners overlap the seam as shown, which is considered the most practical construction, to offset the angle or scarf the plate and in either case how is the joint made tight without countersinking the rivets in the back of the stiffeners?

Please supply formula for determining spacing and sizes of angle stiffeners for a tank of this description. F. X. D.

A.—Refer to page 144, May issue, 1925, THE BOILER MAKER—therein is given data on "Stresses in water tanks" and calculation of stiffeners, etc.



Sketch of stiffeners on water tank

The stiffeners may be placed either inside or outside; where tie rods are required, the angles or tees should be placed inside. Offset the angle where it comes over the lap. The joint is made tight by calking.

Boiler Calculations

Q.—I would like to know how to figure the following problem: I design a boiler that will evaporate 32,000 pounds of water per hour; steam pressure, 200 pounds; ratio of heating surface to grate area is 50 to 1; thirty-eight superheater tubes; 9½ pounds evaporation per square foot of heating surface. Please determine for me the size of the barrel of the boiler, and also the thickness of plate to be used, figuring on a factor of safety of 5.—Apprentice.

A.—You have not given sufficient data to answer this question: namely, the area in square feet of the firebox and the length of the barrel required.

The evaporative value of the tubes and flues varies with their length, diameter and spacing, and the difference in temperature of the gases passing through them.

For tubes 2 and 2¼ inches in diameter, an average of 10 pounds of water per square foot may be assumed, for lengths up to and including 18 feet. The spacing of the tubes is an important factor, which is governed by the feed-water conditions. For bad water sections a spacing of from ¾ to 1 inch and more is used and for good water conditions ⅝ to ¾ inch. On the average ¾ inch is used. The evaporation from flues ranges from 10 to 12 pounds of water per square foot in flue length from 14 to 21 feet.

The firebox heating surface may be taken at 55 pounds of water per square foot.

The A.S.M.E. Code gives the following formula for determining the maximum allowable working pressure on the shell of a boiler:

$$P = \frac{TS \times t \times E}{R \times FS}$$

where, TS = ultimate tensile strength of the plate in pounds per square inch

t = minimum thickness of the weakest course, inches

E = efficiency of the longitudinal joint

R = inside radius of the weakest course, inches

FS = factor of safety, or the ratio of the ultimate strength of the material to the allowable stress = 5.

From the above, the plate thickness may be determined when the other factors are given.

$$t = \frac{P \times R \times FS}{TS \times E}$$

February Orders for Steel Boilers

New orders for 1,070 steel boilers were placed in February, as reported to the Department of Commerce by 68 manufacturers, comprising most of the leading firms in the industry, as compared with 1,000 boilers in January and 8,520 in the last six months of 1926. The following table, which presents the number and square footage of boilers ordered during each half of 1926 and for January and February of the current year, inaugurates monthly statistics for this industry, but is not strictly comparable with the annual totals of boiler shipments previously published due to the inclusion of a larger number of reporting concerns.

NEW ORDERS FOR STEEL BOILERS

	1926				1927			
	1st half		Last half		January		February	
Type	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.
GRAND TOTAL	9,939	10,072,873	8,520	8,000,688	1,000	828,421	1,070	985,778
STATIONARY								
Total	9,824	9,916,454	8,394	7,609,473	983	809,485	1,056	958,953
Water tube.	894	4,686,111	673	3,265,300	105	307,316	108	404,985
Horizontal return tubular	882	1,140,202	798	1,002,387	88	105,024	77	106,004
Vertical fire tube..	1,101	299,004	851	229,420	110	21,434	132	36,166
Locomotive (not railway)	202	90,180	172	81,042	21	9,275	20	8,474
Steel heating[1]	5,915	3,084,660	4,876	2,207,869	478	209,944	514	245,936
Oil country.	360	309,961	678	556,295	116	105,488	161	126,836
Self-contained portable[2]...	470	306,336	346	267,160	54	45,607	39	28,141
Miscellaneous	...	......	...	......	11	5,397	5	2,411
MARINE								
Total	115	156,419	126	391,215	17	18,936	14	26,825
Water tube.	46	97,605	46	308,585	2	5,000	6	22,320
Pipe	4	872	3	4,616	..	.....	..	.....
Scotch	53	48,478	70	75,158	12	12,736	8	4,505
2 and 3 flue	10	7,100	7	2,856	3	1,200	..	.....
Miscellaneous	2	2,364	..	......	..	.....	..	.....

[1] As differentiated from power boilers.
[2] Not including types listed above.

D. L. & W. Holds Welding Meeting

Under the direction of J. G. Morgan, Director of Personnel, D. L. & W. RR., supervisory officials attended a meeting at Scranton, recently, at which new developments in welding were discussed. O. P. Lang, welding engineer of The Lincoln Electric Company, in charge of the Philadelphia office, presented moving pictures and slides showing new uses of welding in structural steel work and in the replacement of castings with welded steel construction. The forward looking policy of the D. L. & W. includes the bringing of outside experts into meetings of this kind in order that staff officials may have the advantage of complete information on technical subjects.

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Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.
James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.
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States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

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

Cities

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

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

States

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

Cities

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

SELECTED BOILER PATENTS

Compiled by

DWIGHT B. GALT, Patent Attorney,

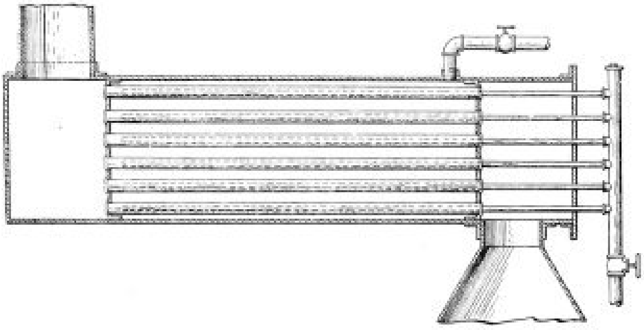
Washington Loan and Trust Building,

Washington, D. C.

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

1,622,577. ALFRED J. EBNER, OF CHICAGO, ILLINOIS, ASSIGNOR TO FREYN, BRASSERT & COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF MAINE. FIRE-TUBE BOILER.

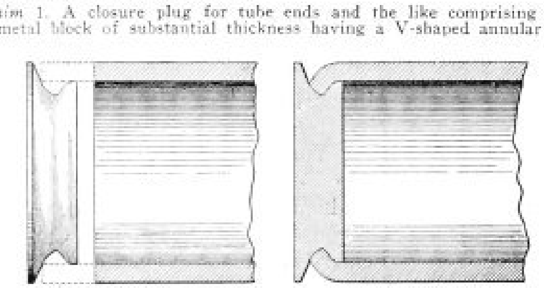
Claim. In combination, in a boiler, tubular flues of substantially uniform diameter extending therethrough, tubes of substantially uniform diameter mounted in said flues, said tubes being provided with spacing



means for holding same in spaced relation with the inner walls of said flues, said spacing means comprising lugs disposed around the periphery of each of said tubes and being formed to provide substantially no obstruction to flow in the space between said tubes and their corresponding flue walls, said tubes being provided with openings through the walls thereof, said openings being inclined in the direction of the normal flow in said tubes.

1,620,728. PERCY JACKSON, OF CHATTANOOGA, TENNESSEE, ASSIGNOR TO WALSH & WEIDNER BOILER CO., OF CHATTANOOGA, TENNESSEE, A CORPORATION OF TENNESSEE. CLOSURE PLUG FOR PIPES.

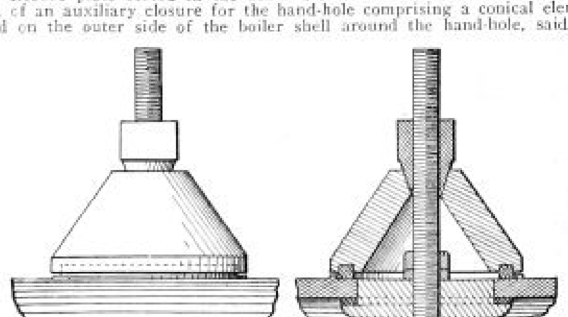
Claim 1. A closure plug for tube ends and the like comprising a disc-like metal block of substantial thickness having a V-shaped annular groove



around its edge, said groove having a rounded portion and having side walls of different inclinations to the plane of the disc thereby to provide one flange to engage the end of the tube and another flange of smaller dimension to fit in the tube, the rounded portion of the groove providing an anvil against which the end of a tube may be crimped. Two Claims.

1,612,749. EDGAR A. SMITH, OF WICHITA FALLS, TEXAS. HANDHOLE-PLATE ANCHOR FOR STEAM BOILERS.

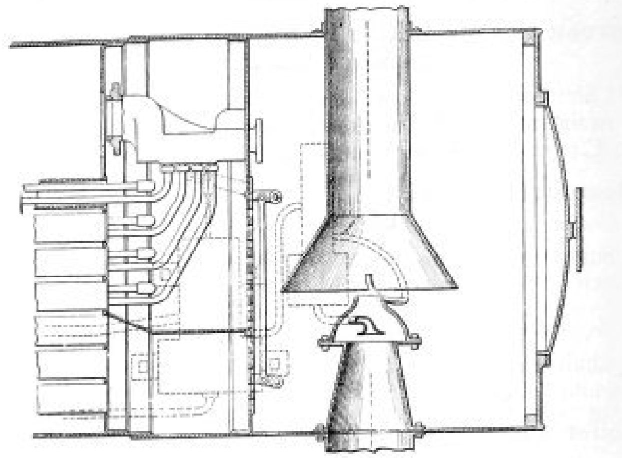
Claim.—In combination with a boiler shell having a hand-hole and a main closure plate seated in the hand-hole on the inner side of the boiler shell, of an auxiliary closure for the hand-hole comprising a conical element seated on the outer side of the boiler shell around the hand-hole, said ele-



ment having a conical bearing in its apex, a cross-bar extending across the hand-hole within the conical element with its ends abutting the outer side of the boiler shell, a threaded stem engaging the main closure plate and extending through the cross-bar and the conical bearing of the conical element, a nut on the stem to bear on the cross-bar to hold the main closure plate seated in the hand-hole, and a plug threaded on the stem and provided at its inner end with a conical bearing to be seated in the conical bearing of the conical element to hold said element in place.

1,612,007. MARTIN J. FURLONG, OF HOUSTON, TEXAS. CONTROLLING DEVICE FOR LOCOMOTIVE SUPERHEATERS.

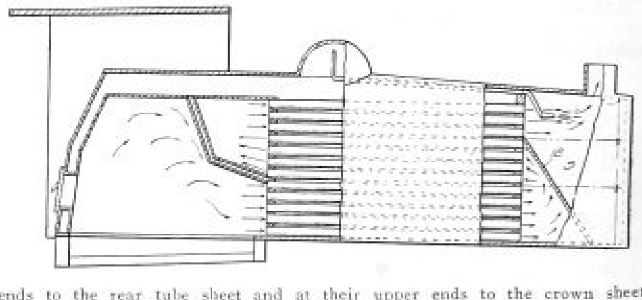
Claim 1. In a locomotive, the combination of a superheater and a front end chamber located one above the other with their front walls in the same plane, a damper therefor normally held in closed position and operat-



ing when partially open to permit a draft through the front end chamber and operating when fully open to also permit a draft through the superheater, a blower line for increasing the draft, a valve for admitting steam to the blower line, means connected with the blower line between said valve and the blower outlet and actuated by pressure therein to partially open the damper, a locomotive throttle line, and means in communication therewith and actuated by pressure therein to comlpete the opening movement of the damper. Twelve Claims.

1,623,012. HARRY S. JARNAGIN, OF RICHMOND HEIGHTS, MISSOURI, ASSIGNOR OF ONE-HALF TO ROBERT W. BIDWELL, OF RICHMOND HEIGHTS, MISSOURI. LOCOMOTIVE-BOILER CONSTRUCTION.

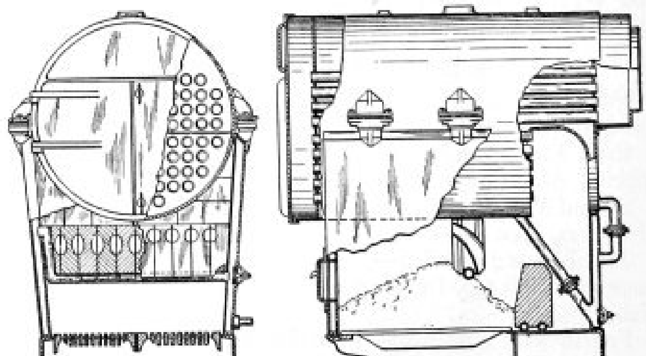
Claim 1. In a locomotive boiler construction, a fire box bounded by a water chamber, boiler tubes in advance thereof and a front compartment for the boiler, a pair of angular spaced baffle plates fixed at their forward



ends to the rear tube sheet and at their upper ends to the crown sheet of the fire box to provide a heat and smoke turning compartment in the upper front corner of the fire box to the rear of a predetermined number of upper boiler tubes and to provide a water passage between the plates and an inclined baffle plate in the front compartment fixed at its upper end to the front boiler sheet and at its lower end to the wall of the boiler. Two Claims.

1,605,554. ALLEN O. MILLER, OF SEATTLE, WASHINGTON, ASSIGNOR TO WESTERN BLOWER CO., OF SEATTLE, WASHINGTON, A CORPORATION OF WASHINGTON. BOILER.

Claim 1. A boiler comprising a shell having cylindrical end portions and a cavity in its underside between said cylindrical end portions, a furnace member provided with water-containing side and end walls, said end walls being provided with arcuate concavities in which the respective circular



portions of said shell are seated in front of and to the rear respectively of said shell cavity, communicative connections between the interior of said shell and the upper portions of the water spaces within the side walls of the furnace member and communicative connections between the rear and medial cylindrical portions of the shell and the upper and lower portions, respectively, of the water space within the rear wall of said furnace member. Three Claims.

The Boiler Maker

Volume XXVII | June, 1927 | Number 6

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

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L. S. BLODGETT, Associate Editor

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

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Expansion of Boiler Industry

A NUMBER of extremely important points were developed during the discussion of the status of the boiler manufacturing industry at the recent annual meeting of the American Boiler Manufacturers' Association, held at French Lick Springs, Ind. The outstanding need to insure the future advancement of business is the development of both domestic and export trade in boilers. Concentrated and immediate action is necessary if the industry is to hold its own with the general advance in other lines of machinery construction.

The United States Department of Commerce, Machinery Division, is in a position to assist the boiler industry in developing foreign markets for boilers. In order that the service which the Department of Commerce can render might be better understood, W. H. Rastall, representing the department, outlined in a comprehensive manner the work that the Machinery Division has been doing in the past few years in establishing trade connections in all important centers of the world. Statistical data covering the requirements of various countries for all manner of products, records of exports to these countries and a great mass of miscellaneous information are all kept on file at Washington for the use of accredited firms desiring to make foreign connections. Unless these data are used for the expansion of American trade and, in this instance, for the sale of American boilers abroad, the entire objective of the Department will be lost. The idea was emphatically impressed on the members of the association at this meeting that the information is being collected for their use and a standing invitation was given to cooperate with the Machinery Division to make the work of practical value to American industry.

Another direction in which the Department of Commerce is assisting boiler manufacturers is in the compilation and publication each month of records of the sale of various type power boilers. The latest output report of the industry for the current year, including April, appears elsewhere in this issue. Practically all of the larger firms engaged in building boilers are sending their report regularly to the Department but a few are still laggard in this respect. In order that the figures presented be inclusive of the whole industry and not fall short of their primary object, a strong plea has been made by the Department that all major concerns engaged in the construction of steel boilers assist in the work by regularly supplying details of their production. All information so obtained is kept entirely confidential in the Department files, the total number and sizes of boilers for the whole industry only being utilized.

The general problem of developing markets for boilers as it is being handled in other similar industries was discussed by E. St. Elmo Lewis who is well qualified by training and experience to present a practical view of the possibilities in the field. His address before the convention as well as that of Mr. Rastall's will appear in full in a later issue of the magazine.

In reviewing the work accomplished at the convention of the American Manufacturers' Association, the reaction is that if the association will take steps without undue loss of time to put some of the suggestions made into operation the results as measured by an increased volume of business will justify the effort.

Centralization of Boiler Repairs

THE larger railroad systems of the country are gradually becoming convinced that the most efficient and economical method of carrying out major locomotive maintenance operations is to centralize all heavy repairs at one point on the system. A practical demonstration of the efficiency of this method is now being carried out by the Chesapeake and Ohio Railroad in the shops at Huntington, W. Va. The new boiler shop at this point, which is described elsewhere in this issue, is designed and arranged with this centralizing idea in mind. The shop was built in 1926 on the site of the old boiler shop and over the old building, while work was going on in it as usual. This accomplishment actually constituted a prophecy of efficiency that is now rapidly becoming a characteristic of work at this point. An excellent supervisory force combined with a skilled and competent shop organization have in the few months that the shop has been functioning increased production to a remarkable degree and this increase of production has been attained with a corresponding increase in efficiency.

The general thought back of this first unit of what will eventually be an almost completely new plant was to provide facilities for boiler construction and repair work that would accommodate requirements for all classes of power for a long period into the future. It is particularly intended to carry out all heavy boiler repairs for the entire system. New fireboxes are built and kept in stock for various classes of engines and as need develops they are shipped to other points on the road and installed. All heavy Mallet repairs are now concentrated at this shop. All heavy flanging work will eventually be done here, as well as all flue reconditioning.

Equipment from the old shop where it was found to be unsuited for the future needs of production work was eliminated and only such machines retained as could be used to good advantage. New equipment was added that provides fabricating facilities for the heaviest types of locomotive boilers. A complete overhead crane system and a full complement of wall and post jib cranes make rapid and easy handling of materials possible.

In the few months of operation of this shop, the expense involved in building and equipping it has been justified. If it is working out so well on the Chesapeake and Ohio, the same principles of centralization of heavy repairs can be adopted advantageously by many other roads which have apparently never given the idea consideration.

Rating of Boilers

IN the report of the American Boiler Manufacturers' Association in this issue mention is made of the intention of the British Power Test Code to change the method of rating boilers. The measurements on which the power is based have always been taken on the gas sides of the surfaces. The Code will probably be changed in the near future to provide for this measurement on the wet side of the surfaces, in order that the water walls and extended surfaces may be included and given credit in the rating. The move seems to be logical and it is to be hoped that when the matter comes before the Power Test Code Committee of the American Society of Mechanical Engineers action will be taken which will result in the promotion of uniformity of practice here and abroad.

LETTERS TO THE EDITOR

Tank Capacity Chart

TO THE EDITOR:

The accompanying chart shows the size of a tank necessary to hold a known quantity of liquid, or, if the size of the tank is known, the quantity it holds.

Example No. 1: What size of tank is necessary to hold 620 gallons? Find 620 gallons on the scale below, follow the vertical line above the mark until it is intersected by the diagonal line. On the left is the depth which in this case

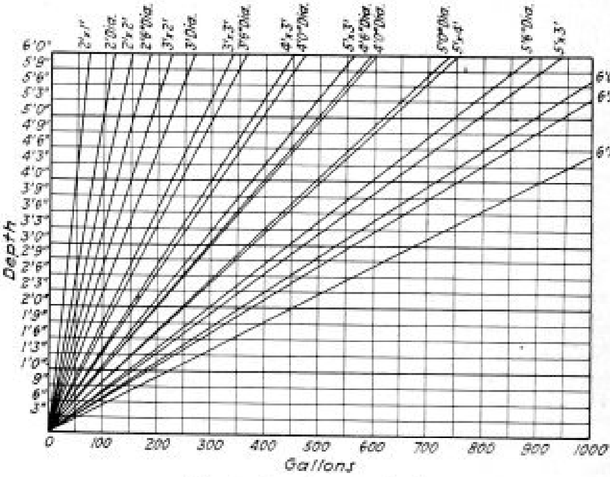


Chart showing tank sizes

is 2 feet 9 inches and the rectangular measurement of the tank is shown on the right, at the end of the diagonal line which the vertical line intersected. In this example it is 6 feet by 6 feet. As alternatives to this a tank 6 feet in diameter by 3 feet 6 inches deep or a tank 5 feet by 5 feet by 4 feet deep would hold 620 gallons.

Example No. 2: A tank is 4 feet 6 inches in diameter by 3 feet 8 inches deep. What is its capacity in gallons?

Find 3 feet 8 inches on the depth scale; follow it along until it intersects the 4-foot 6-inch diameter diagonal line and immediately below on the gallons scale will be found the answer which is 362.

This chart is prepared for 1,000 gallons but there is no reason why a chart for say 20,000 gallons should not be prepared and posted in the drawing office for handy reference.

Batley, Yorks, England. JOHN GORDON KIRKLAND.

On the Way Up

TO THE EDITOR:

Much has been written about the new day of industry—the new relation of capital and labor, or more properly speaking, "The Mutual Investment of Brains"—brawn and money.

The old foreman with his bulldozing methods, loud and rough language is disappearing. Industry is demanding a four square man for this important position—healthy—educated—tactful—efficient. Many will come up from the ranks, they will begin as apprentices and must work their way up.

The following story may be of interest to the ambitious boy as he starts—"On the Way Up:"

The other day I met a man well over middle age, a man who holds a responsible position as a supervisor in a large plant. I knew him as a boy, and was acquainted with the humble home from which he came, and the great handicap which came into his life at an early age. Everything apparently set against his progress, and having to leave school at the age of thirteen, an education was impossible in the usual way. Having this knowledge I wanted to hear his story, and learn what had contributed to his success.

He was a small boy in a small town where there were not many opportunities. His parents were poor, but good people, hard working, and honest in their desire for a good future for the son.

When the boy was thirteen years of age his father met with a severe accident, which laid him aside for a long time. There were several other children in the family, so it became a problem to keep the wolf from the door.

This boy of thirteen and a brother two years younger, very much against the wish of the mother, were forced to seek odd jobs in order to help out in the procuring of food and shelter for the family.

There was one factory of considerable size located in this town. A foundry, structural and machine shop together with boiler making. Into this shop went our small boy and there made his start, "On the Way UP."

His first duties were the usual ones of the apprentice, first sweeping up the floors of the shop, running errands, helping the mechanics, and heating rivets.

The mechanics of that day were considered a hard lot, many of them given to drink and the use of rough language, not a very good example for a young boy. But the boy had been brought up well. The parents had insisted on his attendence at church and Sunday school. So at an early age he had come in contact with people who had somewhat higher ideals than the rough class into which he had been thrust. The home life also was good, the parents were gentle in their dealings with the children. Good literature was read in their hearing, the Bible was read and its principles taught in the home. So the boy was in a measure fortified to meet the rough sea of public morals and coarse living.

Some of the boy's first errands were to be sent out on a Monday morning to find some of the men who had not reported for work, and the first places visited were the bar rooms of the hotels and saloons, trying to induce the workman who was just starting out on the day's spree to come to work. Sometimes he was met with good humor and won his case, at other times he was assailed with a storm of curses and vile language, and often cuffs by the drunken workmen. He was also sent out with the workmen on outside jobs in the territory adjacent to the shop. It was common practice on the men's part to take a pail of beer along, or else if they were near a place where it could be bought to send the boy for it, then he was compelled to listen to their coarse talk and experiences.

The boy knew at this early age that there were two sides to life, the fine and the coarse, and coming so abruptly into contact with the coarse side, it was so magnified that he then and there chose the finer side, and clung to it all the way up, notwithstanding the fact that his lot was to be cast for the most part with the coarser side all the way.

However, it must be said in passing that many of the rough mechanics of that day were good hearted fellows and were quite willing and would often go out of their way to help the apprentice boy along. So, as the years passed, the boy developed in the knowledge of the trade.

The boy was mechanically inclined and took an interest in the work from the start, and his steadiness, and inquisitiveness attracted the attention of the owner of the works, and he encouraged him to study.

The opportunity to get an education without attending school was rare in those days so long ago, and so the boy had to make the best of anything and everything that came his way. Much of his leisure time was spent in reading the few mechanical books that he could procure by borrowing or buying. So as he gained knowledge in a technical way as well as a knowledge in the trade, he soon became interested in going higher.

The great objective of the young mechanics of that day was to become a foreman, and the reason why so many failed was because they would not pay the price; not so with this young man.

Realizing that in order to be a succcess he would have to know the fundamentals of the trade, how to lay out work, and how to estimate costs. Being a lover of books and having a bent for mathematics, he early in his experiences began to keep records and accounts of the various jobs on which he was working as a journeyman, work which he was not required to do, but which he did for his own information and satisfaction.

He took a delight in mechanical drawing. At first it was in a crude way as the shop into which he went did not employ a draftsman, but all sketches and drawings were either made by the owner or some good all round mechanic, for this story has to do with conditions at a time when a man was not considered a mechanic unless he knew all about his trade; there were no specialists in those days except the time keeper. So this young man as he worked on various jobs would remember all he could during the work day and then at home in the evening would make drawings of the work he had been doing. This work he enjoyed and it in a measure prepared him for future usefulness, and so the time came when he could make his own sketches, as they were called, and lay out and fabricate work from them.

As the years passed more and better work came to this shop, contracts from outside came, and it became necessary to do a great deal of erecting in distant cities, and this boy, a young man in his teens at first, was chosen to do some of this outside work. He naturally met men of larger experience than was common in a small town.

Another thing that contributed to this young man's advantage was an opportunity to enlarge his knowledge of life and its problems by attending functions and lectures.

As the years passed more and larger responsibilities were placed upon him. More supervision work and less manual labor was required of him.

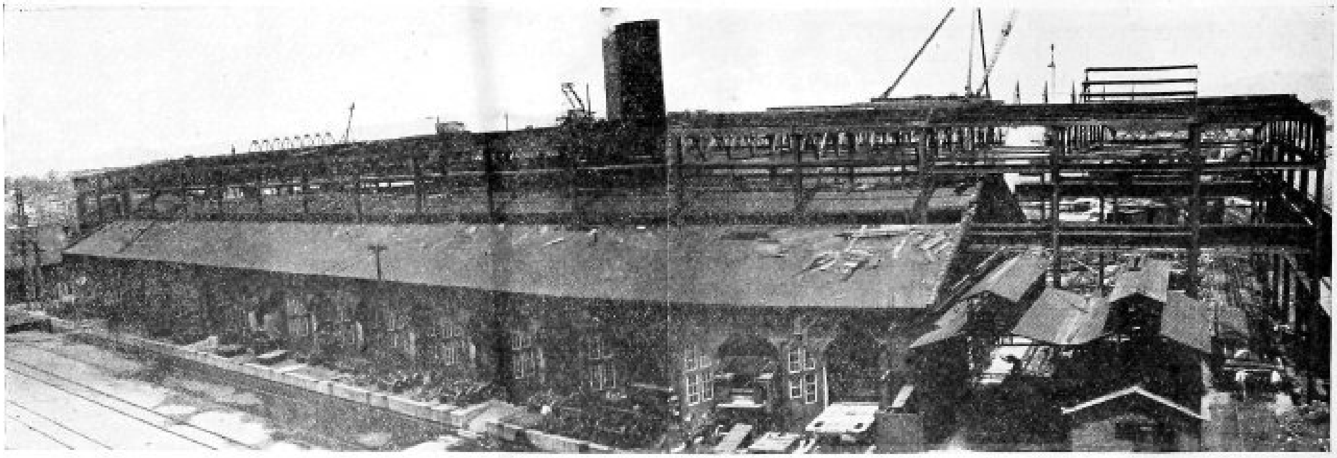
He was thrown more or less among other supervisors, some of whom were educated for the position and others coming up from the ranks. There is one difference among these two classes which he had noted. Those coming up from the ranks often bring up with them, more or less, of the roughness which surrounded them in their early days; they could not seem to forget the rough shop language. Often in executive meetings he heard language used which was not in keeping with the positions they held, and did not reflect much credit to their teachers and instructors on the way up.

It is always interesting to men of experience as they advance in years to look back and try to estimate the value of every experience which contributed to their success.

Considering the elements of a successful business career that is the measure of success in mingling with others in the higher walks of life, this man places the home life as the most important from an ethical standpoint. Take a boy from a home where the father and the mother are real gentlefolks, well bred and with high ideals, where the highest principles of living are taught, he will not soon forget the early training when the time comes to leave home.

As he advances in his studies, if he has the right kind of instructors also, who will supplement and add to his mental equipment, by their example as well as by their instructions, industry will be supplied with the right kind of foremen, qualified to meet and solve all problems which have to do with the new day.

Bay City, Mich. J. A. Anderson.



General view of new C. & O. boiler shop under construction

Chesapeake and Ohio Boiler Shop at Huntington

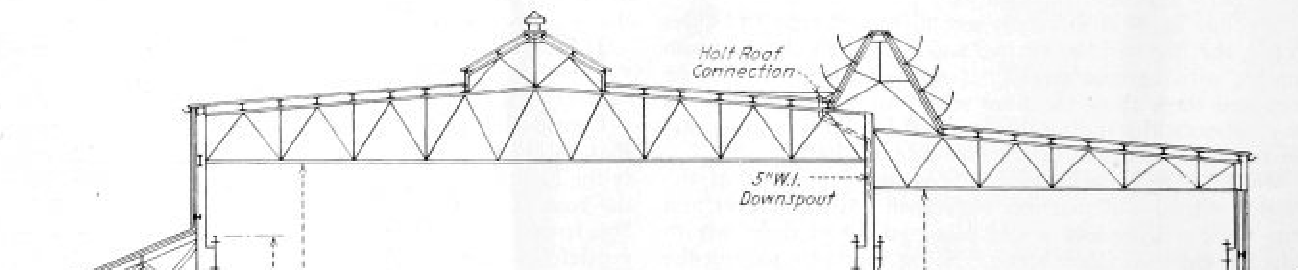
New locomotive boiler shop designed with idea of centralizing departments and equipped to carry out major boiler construction and repairs for entire system

ONE of the outstanding locomotive boiler shops in the country from the standpoint of construction facilities and general efficiency is the new shop of the Chesapeake and Ohio Railroad at Huntington, W. Va. The following description of its facilities and the illustrations used to emphasize the above facts will indicate to our readers—boiler makers, foremen and mechanical officials—the possibilities that now exist in developing the production and centralizing idea of boiler maintenance.

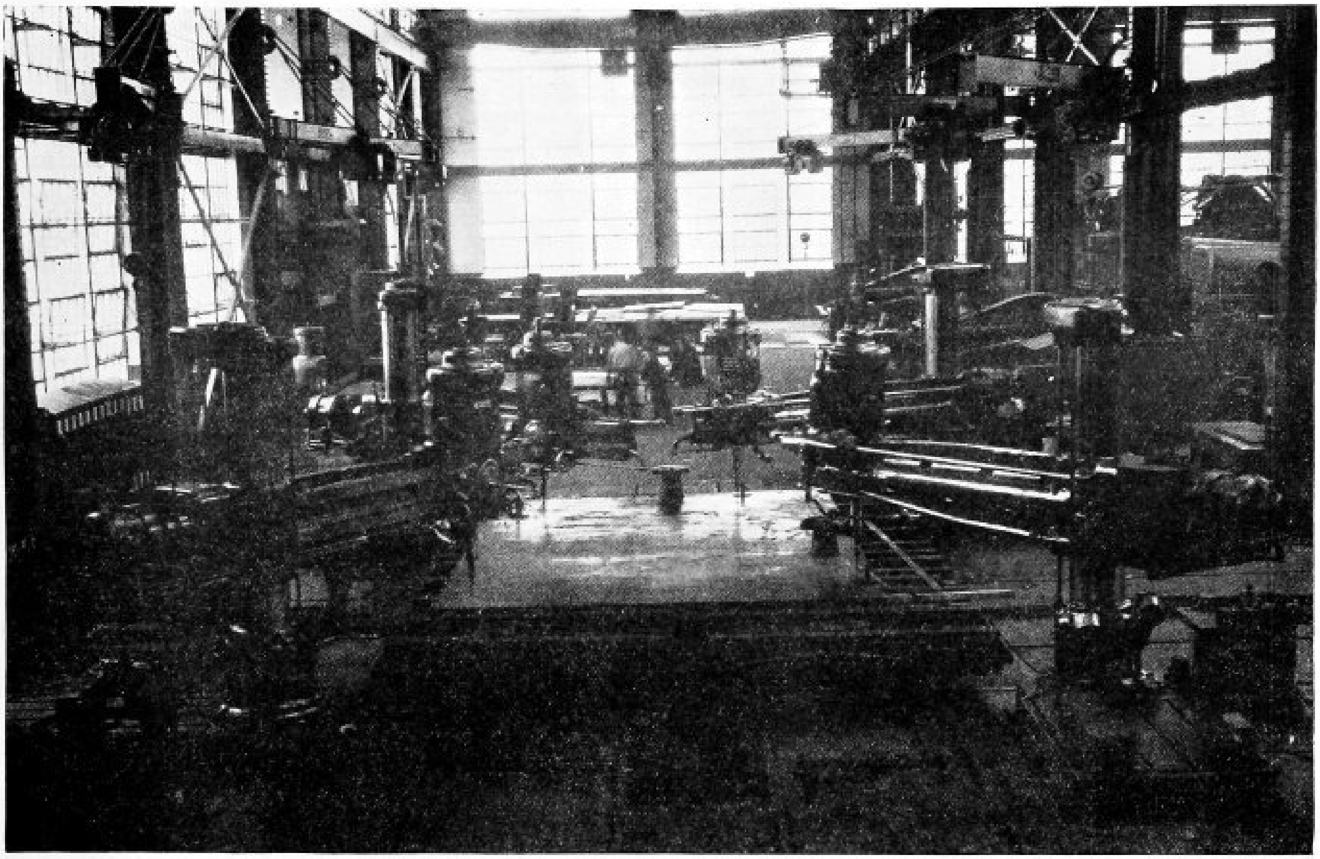
A short review of the history of the old shop at Huntington demonstrates the similarity of equipment and methods between it and the average railroad boiler shop found on nearly every railroad today. The original shop was constructed in 1873 and at first was used as a coach and wood working plant. The boiler shop during that period occupied a building about 80 feet by 120 feet and was quite typical of the facilities of the time—small, dark and generally inefficient. In 1904 it was decided to move the boiler shop into the coach shop which was a vast improvement, at least in point of size, the length being about 260 feet and the width about 100 feet. The building was of an old type with low overhead space and, consequently, not fitted for handling modern, heavy power. For example, all firebox applications for years had to be made in the machine shop or in the Mallet erecting shop. Naturally this method of handling was expensive, due to the fact that boilers had to be cut in two at the connection sheet and the back head removed in order that the firebox might be properly placed. Materials for the application of a firebox had to be brought on trucks to the erecting floor.

Tank cisterns and frames were handled in the old shop by means of hand jacks. The cistern was raised and removed from the frame after which it was placed on trestles and the trucks removed. Nearly 50 percent of the frames and trucks had to be handled outside the shop. In such cases the weather became a limiting factor and delay and extra expense resulted that would be difficult to estimate.

For many years too the old shop housed the pipe and tin shops. About 1922 the balcony on which these departments were located was removed and the two sections changed to



Structural cross section of boiler shop



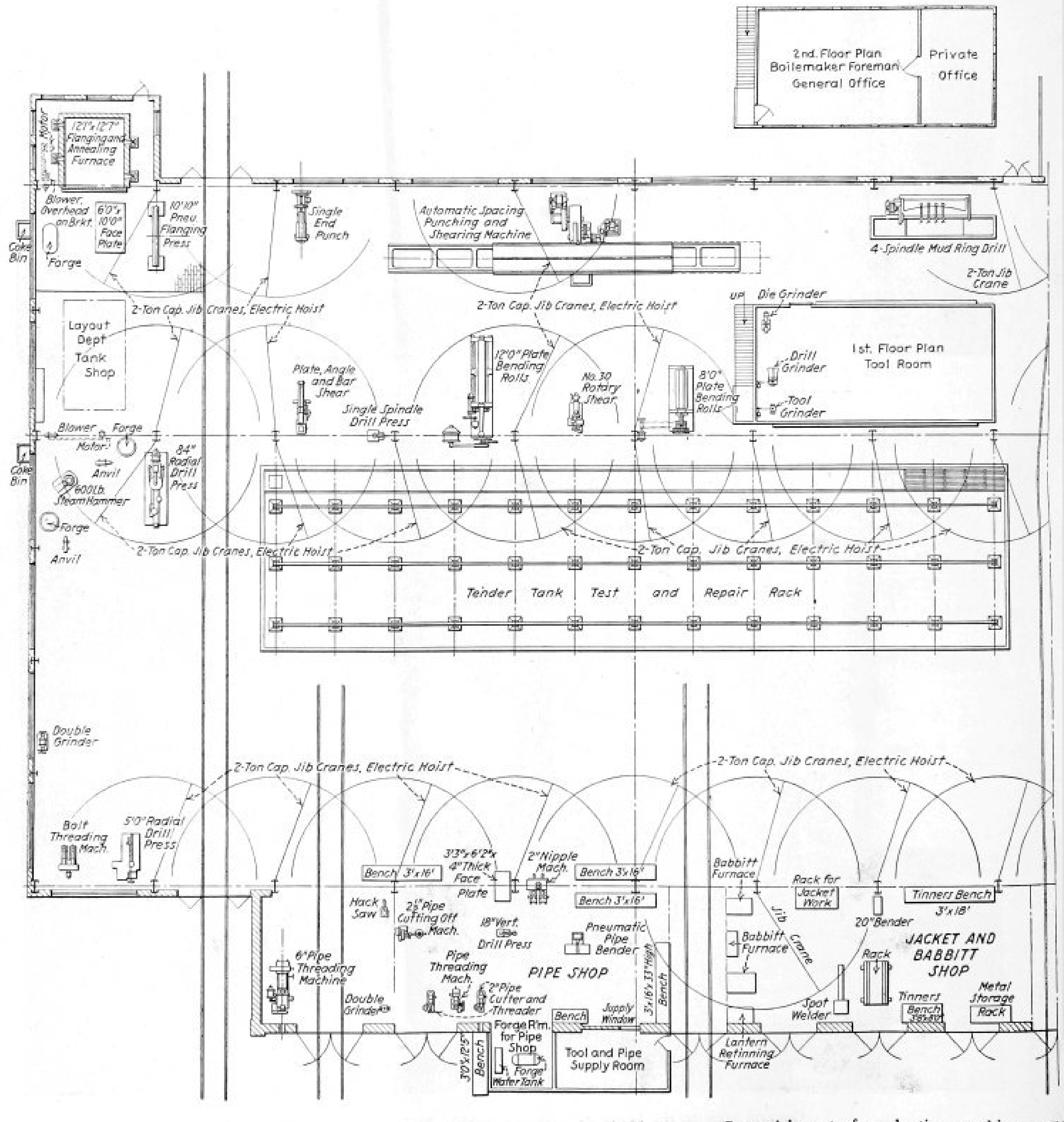
Four heavy duty radial drills are used for multiple drilling operation on boiler sheets

General view in the boiler department looking south across the center bay another building. The pipe department was required to work in a small congested space so that the majority of work and materials were stored outside exposed to the weather.

In addition to other drawbacks, cab work could not be handled in the old shop on account of congestion and lack of facilities so that the cab department was located at the west end of the present erecting shop. The ashpan department was placed in a shed formerly used for a small power house. The flue shop now housed in a building on the east side of the new boiler shop was built about 1913. The distance that flues and tubes had to be handled to the flue department made flue work an extremely expensive operation. All loading and unloading of materials in the old shop had to be done by man power.

Erection of New Boiler Shop

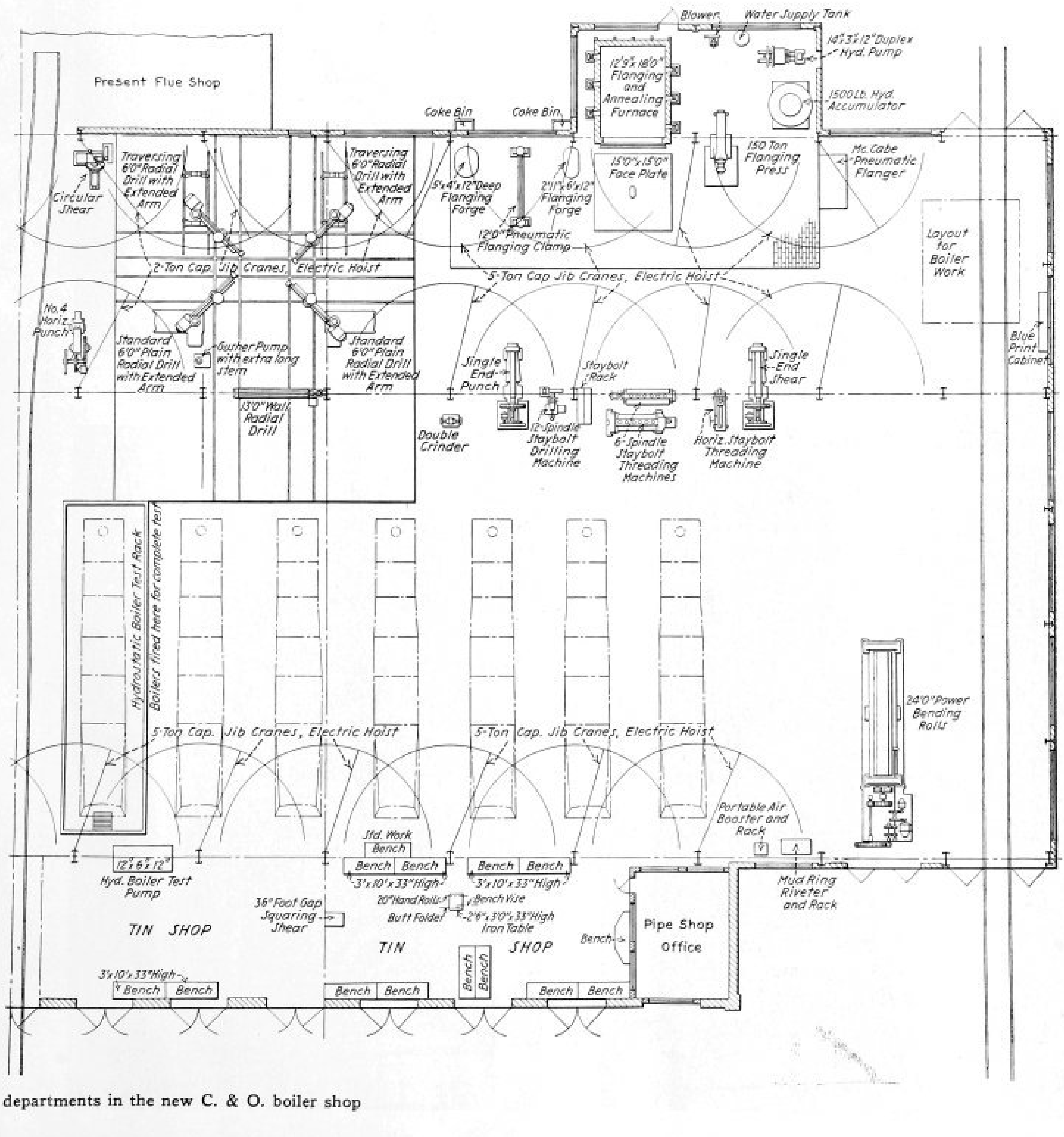
From the foregoing, it can readily be seen that efficiency in the operation of the plant was almost impossible. The work was accomplished practically all by hand labor with correspondingly high cost and overhead charges. When it was decided to build a modern plant, plans were made to centralize all plate working departments that might be considered supplementary to boiler work. With this in mind



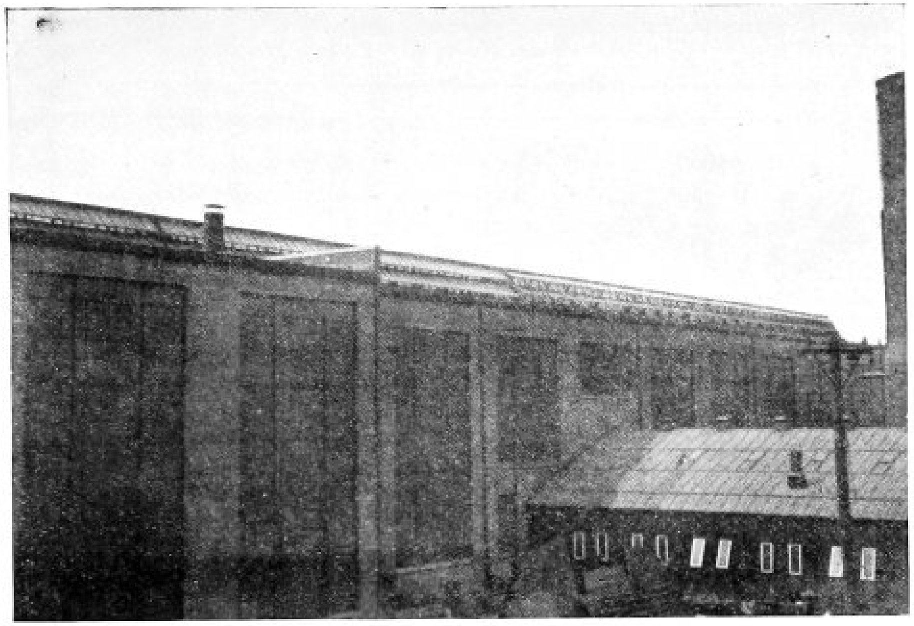
General layout of production machinery and designs were made for the shop layout that would provide two distinct sections—the boiler department to be laid out in the south end and the tank and sheet iron department at the north end. This arrangement also provided space at the north end on the east side of the center bay for the cab department. The accompanying layout of the boiler shop and machinery as it is now operating gives an excellent idea of what may be considered one of the best boiler shop arrangements in the country.

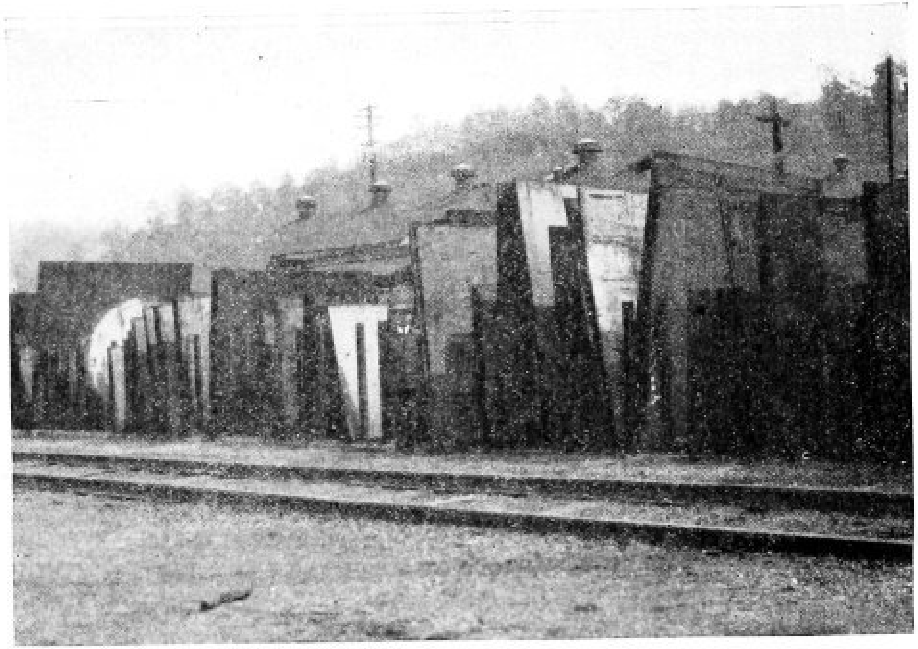
The contracting work was placed in the hands of the Milo Hanke Company, general contractors, of Cincinnati, Ohio. In the construction of the new shop it is interesting to note that the building was erected over the old boiler shop while work was still carried on in the old plant. The new building is of steel superstructure, brick side walls and steel window frames. The roof is made of reinforced concrete, or what is known as a built-up roof. The floor is reinforced concrete with a wood block surface. The building stands 140 feet wide (east and west) and 404 feet long (north and south) with a part of the old building 26 feet wide by 260 feet long left standing on the west side as a wing to the new building. This section of the old building is occupied by the pipe and tin shops. The boiler shop covers an area of 64,360 square feet of floor space. The following material was used in the building: 12,000 tons of structural steel; 800,000 brick; 28 car loads of cement; 165 car loads of sand and gravel; 14 car loads of wood floor blocks; 12,000 panes of window glass, making a total of 40,000 square feet of glass.

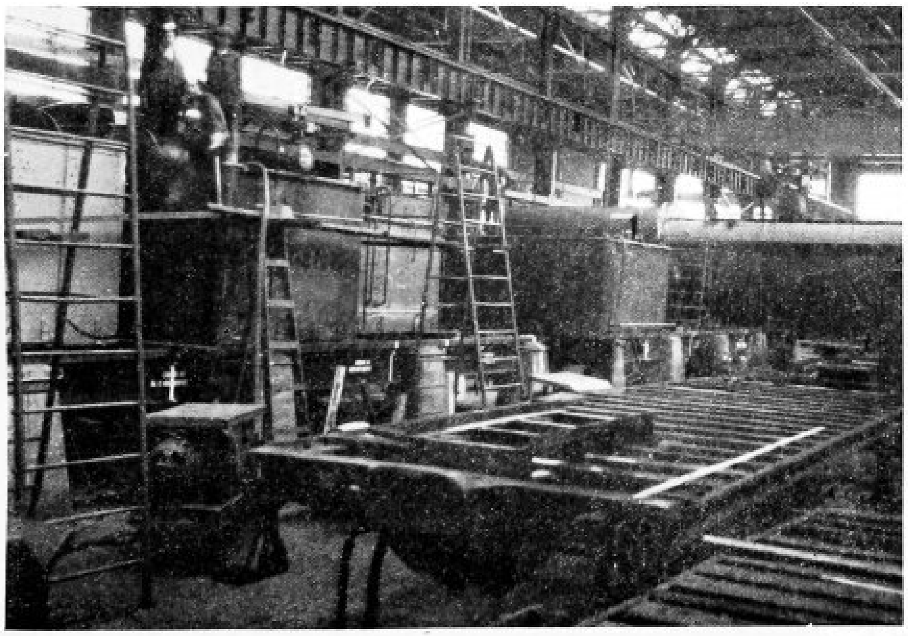
In addition to old equipment that was found usable in the

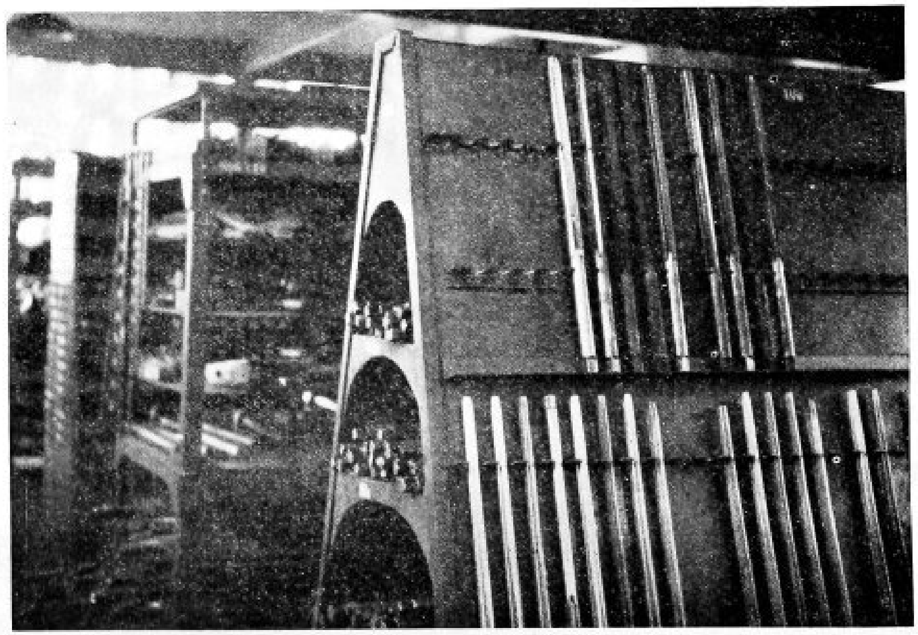


departments in the new C. & O. boiler shop

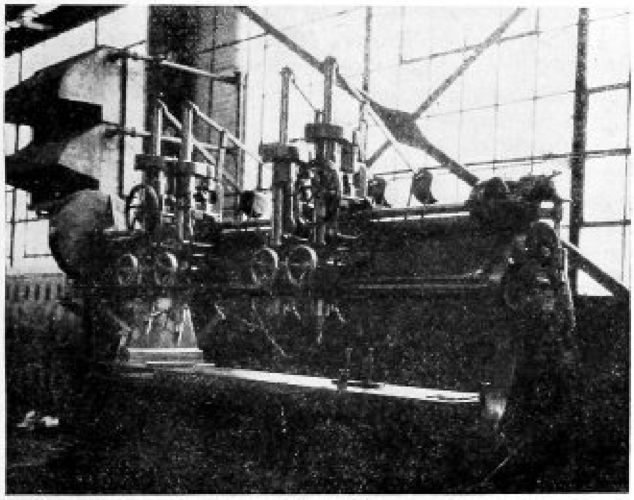

Typical exterior view of boiler shop


Excellent plate storage facilities are provided


The tank department


A corner of the tool room

old shop, many new production tools and heavy machines have been added that make this plant one of the most completely equipped boiler shops in the country. In crane equipment alone the shop is remarkable, there being one 50-ton overhead electric crane, having a 90-foot span and two 15-ton cranes each with a span of 50 feet. In addition, there are 42 jib cranes in the new shop equipped with 2 and 5-ton electric hoists. In the tank department a permanent scaffold has been built of concrete and steel which will hold 10 tanks at one time. The tank department is also



Multiple drill press. In the upper left corner is shown one unit of the electrical heating and ventilating system

equipped with a test pit where the tanks can be emptied after test, no water ever being allowed to remain on the floor. Four 9-foot radial drills were specially built for drilling firebox wrapper sheets and are so arranged that all four machines can be used on one job at the same time. A set of bending rolls, 24 feet 6 inches long between housings, equipped to roll Mallet firebox crown and sides and combustion chamber in one piece has been installed to promote production.

Other new machinery consists of one automatic punching and spacing machine for tank work; one McCabe flanging machine; one pneumatic flanging clamp; one wall drill; one single end punch; one splitting and bar shear; one tapered crown bolt threading machine; 4 single unit electric welding machines; two electric rivet heaters; one steam hammer and two blacksmith forges. All of these machines, as well as the old equipment, are shown in the illustration of the floor arrangement of the shop.

Among the unusual features incorporated in the new plant is the heating and ventilating system for cold weather. At intervals along the side walls are located unit blowers and electrical heating coils which provide heated fresh air to the shop during the winter. As the incoming air is warmed to any degree of temperature required the blowers exhaust it into the shop. The shop temperature can be maintained at any desired point at every season of the year. For summer weather almost half of the shop can be opened to the outside air by means of motor-operated swing sash windows which constitute practically the entire walls. Convenient motor-control buttons along the wall make the opening of the windows a simple and rapid operation.

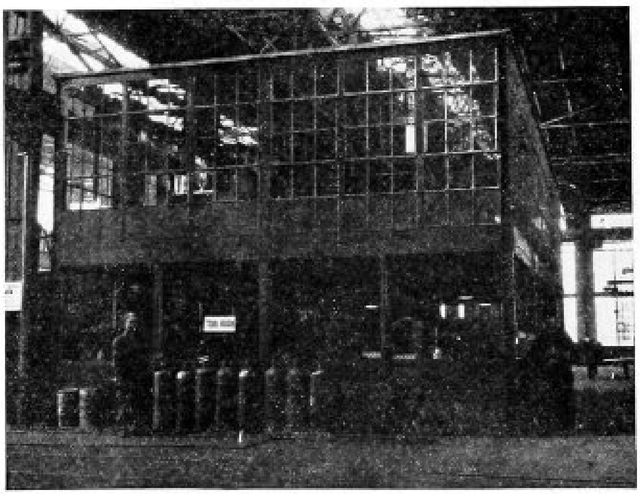
The new boiler shop stands as the first unit of an absolutely modern locomotive repair and construction plant that will be used for centralizing locomotive maintenance on the Chesapeake and Ohio system. Other shops will be added in the near future. Heavy boiler repairs for the entire road, such as the construction of fireboxes, are now carried out at this shop. As time goes on more work of this character will be done at Huntington and other shops on the system will be required to handle only light repairs.

In commenting on the facilities of the shop, it would be well to mention the convenient and efficient arrangement of the boiler foreman's office. In the accompanying illustrations it will be seen that the office, which is centrally located, is elevated and composed almost entirely of glass. The entire staff of clerks and assistants is housed in this office so that complete supervision and smooth functioning of the entire shop is assured. It is possible from the office to keep the entire operation of the boiler shop under constant control since the floor presents a full size schedule board all parts of which are visible at all times. Further, it provides a continuous visual indication of the exact status of all work in the shop. The advantages of a supervisory office of this kind in any type of shop where production is essential cannot be too highly stressed.

Under the office is located a tool room. Because of its convenience to all parts of the floor it saves a great deal of lost time when special tools are required in various departments. Steel lockers are provided along the walls for all men in the plant and lavatories and fountains are conveniently located at several points throughout the shop so that no time is lost from production.

Shop Organization

All boiler work and in fact all plate work at the Huntington shops comes under the control of the general boiler foreman. Under his direction are a boiler shop foreman who has charge of boiler shop work proper and two assistant foremen in charge of tank work and technical work respectively. Eight gang foremen, 5 of whom are in the first shift and 3 in the second, complete the supervisory force for the boiler shop. The personnel of the shop includes two leading boiler makers, 23 welders, 89 boiler makers, 147 boiler maker helpers and 36 apprentices on the first shift. On the second shift are 52 boiler



The boiler foreman's office is centrally located with space under for the tool room

makers and 70 boiler maker helpers in charge of the 3 foremen mentioned.

Nothing has been forgotten in the design of the shop that would promote efficiency or ease of handling work. In this respect it is in marked contrast to the vast majority of boiler shops throughout the country. The crane equipment previously mentioned, for example, is unusual, but the thousand and one ways in which slow, costly hand labor has been eliminated by its use not only makes it worth while but almost a necessity in a modern plant of this kind.

A further article on the work and methods employed at the C. and O. boiler shop at Huntington will appear in an early issue of The Boiler Maker.

A Few Notable Discoveries by Boiler Inspectors

In response to an application for insurance on twelve watertube boilers in a traction company's plant, an inspector was detailed to make the first internal inspection. The boilers were of the two-drum horizontal type, and nothing unusual was observed in the first drum entered. Upon examining the second drum of this boiler, a slight rust streak was observed in the coating of scale along the turn of the flange at the bottom of the rear head. This led the inspector to suspect the presence of a crack.

The scale was removed and some light grooving was found to extend for about one third of the circumference of the head. Feeling confident that cracks existed at the bottom of the grooving, the inspector applied the alcohol and chalk test and found faint indications of their presence. The following day several slots ¼-inch deep were cut across the external surface of the turn of the flange and a hydrostatic test of 175 pounds was applied, but no leaks were visible. Feeling, in spite of this test, that the head was dangerously cracked, the inspector advised the assured to replace it with a new one. The chief engineer, after some discussion, finally decided to have this done.

While the boiler makers were driving out the head after the rivets had been removed, the crack opened up for a distance of 76 inches around the flange of the head so that the defect was easily visible. Later, with a few blows of the sledge, the flange was broken off around approximately one half of the circumference of the head, and the cracks were found to have penetrated half way through the plate for a good part of this distance. The fracture outside of the cracks had the usual crystalline cast iron appearance so familiar to fatigue failures.

Following this alarming discovery, the other heads in this boiler and another one of the same make and age were carefully examined, and as several of them showed indications of the presence of cracks, it was decided to replace all of the heads. Subsequent examination revealed one of these heads to be in an even worse condition than the one first discovered. Although the cracks extended around only 52 inches of the circumference, yet in several places they penetrated to within $\frac{1}{16}$ inch of the full thickness of the plate. Three other heads had cracks extending for 32, 36 and 52 inches, respectively, in a circumferential direction. The remaining three heads, while showing slight grooving, seemed to be free from cracks. These drums were 48 inches in diameter, and previous to inspection, the boilers had been operated between 185 and 200 pounds pressure although they were designed for but 175 pounds.

Upon another occasion an inspector called at a large central station for the purpose of taking data on such of the boilers as were available, as this was a new risk. These were watertube boilers of the inclined, bent tube type, and two of them were found available for internal inspection. While examining the mud drums, the inspector noticed some very fine lines which appeared to be hair line cracks in the front row of tube hole ligaments. The boilers were headed up and a hydrostatic test pressure applied, although the chief engineer jokingly told the inspector that the heat must be affecting him when he suggested the presence of cracks. The test resulted in the exposure of seven cracked ligaments in the mud drum of one boiler and five cracked ligaments in the other. The boilers were again emptied and the inside surface carefully scraped and reexamined. It was found that these hair line cracks extended almost the full length of the drum between the front row of tubes and the longitudinal seam. They varied in length between ½ inch and 4 inches, and the distance from the end of one crack to the beginning of the next varied between ½ inch and 3 inches with the majority of these intervals less than 1 inch. These boilers were well on their way to a most violent explosion, that is, such an accident as results where the shell fails along a longitudinal line. The defective drums were immediately discarded.

Another notable discovery of the approaching failure of an inclined, bent tube type of watertube boiler was made by an inspector under quite difficult conditions. The front side of the mud drum was inaccessible because of the close proximity of the bridge wall and the flooded condition of the pit. However, the inspector thought he saw signs of leakage and corrosion along the front side of the drum. He again entered the furnace and removed a few bricks from the bridge wall, but this was not very satisfactory. A request was made to have a sufficient amount of the bridge wall removed to expose the seam for its entire length and to then prepare the boiler for a hydrostatic test. Two days later the inspector returned and made the test, with the result that leakage was noted at several points along the seam. It was also observed that a majority of the rivet heads in this seam were almost completely wasted away. The rivets were removed and the rivet holes examined with a magnifying glass for cracks. Although no cracks were found it was easily seen that the plates were seriously reduced in thickness by corrosion. The plates were drilled and found to have wasted to a scant 7/32 inch, the original thickness having been ⅜ inch. Under the circumstances, the boiler was discontinued from service.

Each of the foregoing incidents happened to a watertube boiler of the type usually found in large modern power plants, but the horizontal return tubular boiler, which is found in so many industrial plants, is still a fertile field for latent defects. In a recent inspection of a lap seam boiler, the inspector had just finished his examination of the head and braces at one end of the boiler and was working along on top of the tubes examining the seams when he noticed an irregular mark showing against the scale. The cause of it was not clear, but after some of the scale had been chipped away, a crack approximately 10 inches long and running parallel to the axis of the drum was uncovered. The crack was just below the seam and immediately above the rivets of the supporting lug, and it was open wide enough to permit the insertion of part of the blade of a sharp pointed knife. The master mechanic of the plant satisfied himself of its presence by merely looking in through the manhole while the inspector held a lamp so as to make the crack visible. Removal of the brick work on the outside of the boiler failed to uncover the crack because it was behind the supporting lug. The boiler, of course, was discontinued from further use.

The portable locomotive firebox type of boiler is one that is usually badly mistreated and neglected, and it is not surprising that an inspector should occasionally discover a latent defect in one of this type. In this instance the inspector happened to be in the vicinity of a boiler that he was scheduled to make an internal examination of on the following day, so he stopped by to make sure that it would be available the next day. Looking over the boiler while it was under pressure, he observed a rust stain on the lagging under the boiler near the smoke box end. Prying open the lagging a little, further signs of leakage were noted. A considerable amount of lagging

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American Boiler Manufacturers' Annual Meeting

Well attended convention characterized by discussion of commercial aspects of boiler business with special attention to possibilities of developing export trade

THE thirty-ninth annual convention of the American Boiler Manufacturers' Association, held May 30, 31 and June 1 at the French Lick Springs Hotel, French Lick, Ind., continued the work on organization of the boiler manufacturing industry for trade expansion so ably started by George W. Bach, president, at the meeting in 1926. At that time Charles M. Abbott, executive director of the American Steel Institute of Steel Construction, addressed the association on trade expansion work, outlining what other organizations had accomplished in this direction. The same subject with a more direct bearing on the specific needs of this industry, was a special feature of the present meeting. George W. Bach again presided and about 60 members and guests were in attendance. The annual address of the president follows:

President's Annual Address

In my opening address for this convention I want to bring out again the thoughts voiced in my opening remarks at our last convention at Hot Springs, Virginia, in 1926, to the effect that the commercial side of the boiler industry needs more study and action for improvements at this time than the technical side of our business. We have in the past endeavored to have in proper order and importance educational and social matters, tending towards development of the technical side of the industry rather than the commercial, with the result that our association has not kept pace in commercial development with other trade associations. A thorough understanding and development of the technical side is necessary for the advancement of the art; a closer acquaintance and personal contact with each other at these conventions leads to better understanding and fellowship among the members, with a tendency to promote trust and confidence in one another to a degree where the destructive influence of misunderstanding and misconstruing of motives on the part of our competitors is greatly reduced if not entirely eliminated.

As pointed out in my last report, there is undoubtedly a large percentage of over capacity in the boiler industry, for the reasons mentioned in that report, and the trade development work suggested at that time should be carried on for the development of our present markets and opening up of new outlets for boilers.

Again referring to my last report, I am glad to tell you that the committee appointed for the purpose of getting a true survey of the boiler industry through reports from the members and other manufacturers of boilers has been successful in having the Department of Commerce, through its Bureau of the Census and Industrial Statistics, take up this work, and in cooperation with the committee and members presented a report at the winter meeting in Cleveland, which is very illuminating, to say the least. This report indicates that the boiler industry as a whole has about held its own, but has not grown with general business development proportionate to the population, because of the fact that boilers are developing much more steam per rated horsepower and doing it more efficiently, as well as the better and more efficient use made of the steam in prime movers and in process work. This of course is an economic condition that is based on sound progressive engineering lines, but we cannot expect the same rate of overrated capacity output and gains in efficiency in the next few years that we have had in the past.

Department of Commerce Reports

The government tabulation also brings out a remarkable growth in the use of steel boilers for heating service. The report further shows a volume of watertube boiler business that has been about the same in heating surface for 1919 to 1925 inclusive, except the years of 1920 and 1921, which were abnormal and subnormal respectively, but an average for the seven years would show about the same area in square feet of heating surface in spite of the greater demands made on these boilers per square foot of heating surface. The further surprising fact developed that the average size of watertube boilers is around 500 horsepower, showing conclusively that the industrial power field is still the larger factor in our industry. This is further proven by the fact that the greater percentage of contracts is for boilers of less than 500 horsepower in the watertube field.

The government report gives us really the first true picture of the industry for the past seven years' output, and while it does not give us the percentage of excess capacity or to what extent the present capacity is employed, it does show us a fairly accurate cross section of the industry for the first time in our history.

The other types of boilers shown in the classification of the government report, such as horizontal return tubular boilers, show a slight decline in numbers and square feet of heating surface manufactured in 1925 as compared with 1919, indicating that probably many boilers of this type are being replaced with other types of steel boilers in the heating field, where the return tubular boiler had been extensively used.

There is also a decline in the number of vertical fire tube boilers and proportionate heating surface, due probably to the fact that many of these boilers are replaced with internal combustion engines in hoisting machinery and steam shovel service, as well as other fields where these smaller boilers are more generally used. This leads to the thought that there is room for some trade development work in the vertical fire tube boiler field to prevent the serious inroads made into that field by the internal combustion engine.

I cannot impress on you too strongly the importance of keeping up your reports monthly to the Department, promptly and completely. You may rest assured that no one except sworn Department employees have access to these records and they are kept strictly confidential so there need be no hesitancy on the part of any manufacturer in giving them a true picture and honest reports when called on.

Trade Extension Work

Taking up the subject of trade extension work mentioned in last year's report, I believe after careful thought that this work should be carried on by independent groups in our association with the backing of the association as a whole, as for example, the manufacturers of heating boilers as a group should carry out their trade development work, the manufacturers of industrial boilers in the watertube field should have another division, the return tubular boiler manufacturers should have an organization for promoting this boiler in both the heating and moderate size power field where this boiler serves its purpose, and these three groups should function under the direction of the association as a whole, as they still have many problems in common and in the marketing of their respective products.

It is only through a close cooperation and understanding of the individual members and the groups that our industry will grow and the markets be properly developed. We cannot allow internal competition in our own association work to the destruction of the morale of our own organization to a point where a manufacturer of one type boiler is competing with that of another type in the same field, as all boilers have a certain field of usefulness that should be recognized by the manufacturers.

We have with us at this meeting a speaker who has had considerable experience in the marketing of products by manufacturers in certain fields. This gentleman will advise us along the right lines in that direction and will show how several groups in our industry can work through one sales service organization for the promotion of sales in their particular field without interfering with the individual sales effort or practice of each manufacturer.

Code of Practice for Industry

Taking up next the matter of better code of practice for our industry in the matter of terms of payment, forms of guarantee and warranty, preparation and method of presenting proposals and specifications, and other work of this nature where there is now considerable duplication and waste of effort, I believe that these should also be solved by each individual group who can work out a code of practice for their particular field, as their problems are such that no one general code would cover the situation.

Guarantees of Performance

I want to express myself first on the matter of guarantee of performance, to say that we should avoid the making of definite guarantees on a bonus and penalty basis, as that will lead to the *selling* of guarantees rather than boilers, and would be destructive to the general result. A code of practice should be worked out and such matters as guarantees and other details handled in a way that will act as a deterrent rather than an incentive in the making of guarantees as to capacity and performance, in operation as well as workmanship and material. The results that may be expected from certain boiler installations, according to plans submitted by reputable manufacturers, are fairly well known to engineers, and outlandish guarantees tend to confuse the issue and make trouble rather than help in settling a point of importance in negotiations with engineers and users of boilers.

The same thing applies to guarantees on boilers proper and their settings, where it is foolish to assume a guarantee for brick work and other details beyond the specifications agreed upon, and while it might be good business in some instances to assume certain responsibility, as a general proposition we should not enter into any agreement where guarantees are part of the contract, because of the many conditions beyond the control of the boiler manufacturer that are found in operation.

In my opinion this association should have trade extension work carried on aggressively and independently by the various groups through a central agency serving all of the bodies, and the expense to be borne by the individual manufacturers on a pro rata horsepower basis or some other equitable means of cost distribution.

Limit the Technical Work of the Association

The technical side of our business is developing by the efforts of individual manufacturers and outside engineers, and in my opinion the association as a body should not go beyond the present activities in that field, such as its connection with A. S. M. E. Code Committee and other technical bodies, where we should have representation and a point of contact, so that we may contribute our fair share in the development of the art and service to the public.

I feel that we are on the threshold of a big development in boiler history along commercial lines. These meetings should always be on the open door policy with no secret sessions, permitting free access to all our records, and we want to maintain an honorable relationship with everybody from whom we buy and those to whom we sell, so that the conduct of our business will at all times be above criticism and within the full bounds of the law both in letter and in spirit.

Commercial Arbitration

It might be well to call your attention to the modern method of settling disputes by the now legal procedure of commercial arbitration, which is now a law in a number of states, such as Pennsylvania, New York, New Jersey, and others. This provides that two or more parties may provide in a contract that all disputes of any kind or character may be submitted to arbitrators, to be named by both parties or by the Court of Common Pleas in the district in which the contending parties reside, and their action shall be as binding as the result of any action at law. The object of this bill is to save the time of the courts, facilitate the distribution of litigation and eliminate business waste, and the arbitrator would probably be more familiar with the subject in dispute than a non-technical court would be. Such a clause in our contracts would seem a good provision and protection for both parties to the contract.

Touching briefly also on the past year's business, I want to say that the year was about normal, possibly slightly better than 1925, and while the profits for the total volume of business done in the boiler industry are exceedingly small, there is hope for improvement in a better volume of business in all lines after our markets are properly developed and backed up by progressive and economical design and construction of boilers in our shops.

We must realize that the marketing, installation and satisfactory operation of the boilers after they leave our works are of equal importance with the actual manufacture of the boilers in the shop and most of the larger corporations have grown because of better quality and better service and more intelligent sales methods rather than any other reason, such as financial advantages, "pull" or other so-called "wire pulling" that they may be accused of doing by the smaller competitors.

In conclusion, I cannot impress on you too strongly the need for proper action at this meeting leading towards better marketing of our product, a more careful study of the sales and service, and trade extension work carried on by groups, as before mentioned, in an intelligent and aggressive manner.

Standing Committee Reports

The secretary-treasurer, A. C. Baker, presented his report on the financial condition of the association which is on an excellent basis. The membership is now made up of 66 active members and 30 associate members. The secretary appealed to the members to make a concerted effort to induce new companies to join the association especially concentrating on a drive for associate members. Many firms which are eligible for associate membership, supply companies and others allied to the boiler industry, do not realize the fact that their work entitles them to associate membership. It should be the endeavor of all members of the association to make these facts known to the supply companies.

W. A. Drake of the Brownell Company then presented an able report on ethics.

Report of Ethics Committee

We have all heard a great deal of "Ethics"—the "Ethics of Business"—"Codes of Ethics," etc. We have read and reread, no doubt, the Code of Ethics of the Hardware Dealers' Associations, Lumbermen's Associations, Retail Merchants' Associations, Foundrymen's Associations, and many others. They are all good to read and are often printed and broadcast. They do some good and no harm. The idea is that they represent an ideal to aim at—seldom reached but to approach. A Code of Ethics is usually short—made up of six or seven items. The English is usually good. If by reason of strength of two or more members of a committee for the making of a Code, it contains more items, there may creep into it some rather unusual items tending to support certain interests. This is not so good. We have seen such, and the kind can be recognized even by one outside of that organization.

Codes of Ethics came into being in large numbers after the late war. No doubt, we needed them then worse than any time in the last 50 years.

Can a code meet the situation as we really find it?

A code may say, "Honesty is the Best policy,"—"Do unto others as you would they should do unto you" and "Do not criticize a competitor's product, sell your own on its merits." These are far reaching, it is true, but they do not begin to cover the field of experience in carrying on business unless supplemented by much more.

A code is a "drop in the bucket"—a puny effort toward furnishing rules for the conduct of business.

Our business life is deeper and broader than any code consisting of a few rules, which we may write.

Business is the carrying on of trade. Trade is an exchange of commodity or of the medium of exchange. Through trade men may be able to express themselves to the fullest extent, to realize hopes, to build up character. To do these things requires effort or strife when we are making our effort, when we get into the thick of the fight to get our share of the business, is when we need more than a Code of Ethics. We need to be well grounded not only in the principles of honesty, justice and generosity, but in the principles of good business as shown by recent developments in the business world.

Classes of Competition

Competition may be divided into two classes, creative and destructive. The first kind develops an industry and makes for progress. The second is a scourge that destroys. The victims cease to thrive and wither and die. Creative competition is such that those engaged are making an effort to produce something better and better for the service of mankind and expect to receive a just reward for their effort. In the recent British strike, a common saying was, "A laborer is worthy of his hire." A maker of goods is likewise worthy of his hire, for after all we are all laborers.

There can be no quarrel with the manufacturer who strives to make his goods cost him as little as possible. We all are endeavoring to cut our costs. There surely can be no objection to his making his product better if he can and so desires.

He should, however, know his costs, his real costs including overhead (which is a part of cost as much as the cost of material) and should have a profit on his work and for the risk involved. If this is not secured the transaction is unethical. Regarding overhead, one often hears the statement made that Mr. A.'s plant is small and his overhead low so he can make such low prices that others can not compete. This statement is erroneous, we believe. Assuming all other conditions normal, his percentage of overhead is as high as the larger plant. Based on direct labor the figured overhead would be small in total amount for Mr. A.'s plant and large for the large plant with many more employees.

Why should we say the transaction is unethical if a fair profit is not made?

First, because there is not a just return to the company, to be used in many ways besides giving a fair return on the investment. There is the interest of the community in which the plant is located. Is it not right and proper that a business enterprise have a part in the upbuilding of a community in ways not possible through taxation?

Second, because it deprives the employees of something which it is difficult to describe. After all it is the business of our industrial plants and business houses in general to make men. We can do a better job of doing this if we have means to work with. This work is called welfare work mostly.

It may be sympathetic interest or may take many other forms. Boiler makers are often thought of as a rough and tumble lot, but whether white or black, they are susceptible to these things and like them. It is unethical to deprive them of them if it is possible to give them and it is the job of the company to do what it can to make *men*.

Now, let us take you back thirty or forty years ago. Do you remember how shopping was done in the stores? Merchants did not expect to receive what they asked for goods. They asked a price and the buyer made an offer, basing the offer on the amount asked. The merchant skilfully argued his points. If you were buying a suit of clothes, he might gather it up in the back when showing the front and in the front when showing the back, as you looked in the mirror to see how well it fitted or didn't fit. It was a case then of "let the buyer beware."

How can a code, including a few rules, be made to cover the vast field of business experience? The most effective code is written in the hearts of men and if these be right, a great step has been taken toward prosperity in business.

Committee.

Report of Stoker Committee

A. G. Pratt of the Babcock and Wilcox Company, chairman of the committee cooperating with a committee from the Stoker Manufacturers' Association, presented the following report:

So far as the committee has been able to determine the practices and methods of procedure worked out between the American Boiler Manufacturers' Association and the Stoker Manufacturers' Association are still in effect and have been productive of much good to those in both industries. Questions of difference between the two industries which once were common have been eliminated, except in very rare instances. The committee will be glad to entertain suggestions as to how this cooperation may be bettered.

Two years ago the matter of modernizing the methods of expressing boiler performance in terms of uniform flow of combustion gases of stated heat value was brought before the association. The matter was referred to this committee, which has done considerable work on the subject and made reports to the association but without any very definite results. The conclusion has been reached that the members of the association are not ready to accept the idea advanced and the committee has concluded, therefore, to let the matter drop for the time being at least.

Committee.

Discussion

Following Mr. Pratt's presentation, William H. Jacobi of the Springfield Boiler Company referred to the recommendations made at the 1926 meeting regarding boiler performance. Any direct action on the method of expressing boiler performance should wait until the backing of the Test Code Committee of the American Society of Mechanical Engineers can be secured. In other words, as a body the association should drop the technical side of this question for the present and concentrate on the educational feature. The resolution offered at last year's meeting covers the matter sufficiently for the present time. The responsibility for generating steam for the buyer of a boiler should be the limit to which the builder should be required to go, without making final guarantees on performance when only a limited number of factors entering into the operation are available to base estimates on. In explaining this point, Mr. Jacobi cited an example of preliminary designs that had to be revised many times before the boiler in question was finally approved and on the basis of this final design the builder was required to guarantee the performance of the finished product. The whole matter is one to be dealt with by the Test Code Committee of the A. S. M. E. and all facts in connection with it should be presented to this body.

Fred R. Low, editor of *Power*, mentioned the fact that the British Power Test Code is planning to revise the present code in Great Britain to provide for the measurement of boiler heating surface on the wet side rather than on the gas side of the boiler. The present method of determining the heating surface by a gas side measurement is not satisfactory because of the difficulty of correctly finding the values of water walls and extended surfaces. The American Boiler Manufacturers' Association is requested to send suggestions on this matter to the Power Test Code Committee of the A. S. M. E. who will within a short time bring up the subject for discussion. This question was finally submitted to the Performance Guarantees Committee for action.

Report of Cost Committee

The Cost Committee through Starr H. Barnum of the Bigelow Company, chairman, reported that no new developments had occurred since the last meeting. He recommended, however, that members of the association read the United States Chamber of Commerce Bulletin No. 22 on the "Evolution of Overhead Accounting." This bulletin outlines methods of handling the difficult matter of overhead on a fair and sound basis.

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

E. R. Fish, one of the members representing the association on the A. S. M. E. Boiler Code Committee, stated that the committee is actively engaged all the time on revisions and interpretations of the Code. The great changes coming about in the design of boilers have necessitated considerable effort on the part of the committee in dealing with problems which are now coming before that body for decision. The Code Committee makes revision slowly and carefully and full notice is given all interested individuals or bodies to discuss such revisions as have come up and before they have been incorporated in the Code. One point that Mr. Fish emphasizes which does not seem to be clear to all companies is that the Code Committee will not pass judgment on specific designs or details of boilers or apparatus. Questions coming under the head of "interpretations of the Code" are the only specific matters of judgment considered by the committee. All actions of the Code Committee are given full publicity and discussion is invited before any final action on any matter is taken.

Report of Committee on Rules for Dished Heads

In the absence of Perry Cassidy, Babcock and Wilcox Company, chairman of the Committee on Rules for Dished Heads, S. Mensonides of Farrar and Trefts, a member of the committee, outlined the discussion on this subject which occurred at a public hearing on dished head construction held under the auspices of the Boiler Code Committee on March 17, 1927. This conference was attended by boiler and tank manufacturers and others interested in the subject. The discussion was based on a series of four papers dealing with the design, construction and test of a large fusion welded tank which were presented on January 4, 1927, before a joint meeting of the Metropolitan Sections of the A. S. M. E. and the American Welding Society. In order to briefly present Mr. Cassidy's part in the discussion at this hearing Mr. Mensonides quoted the following abstract of the official report:

Perry Cassidy addressed the meeting, stating that he represented a special committee which was appointed by the American Boiler Manufacturers' Association to consider this question of the design of dished heads, to attend the meeting, and to do anything possible to co-operate. He called attention to the fact that Mr. Miller and his associates had done an excellent job in developing the design of pressure vessels, but feared that there might be an implied criticism of the design of riveted drums for power boilers. This was probably not intended, but some people might infer it from the papers and the discussion presented.

Mr. Cassidy said he wanted to go over briefly some of the points in connection with the test and design of power boilers and learn just what, if anything, was to be drawn from these tests and the papers in regard to changing the design of such boilers. This test had been made on a fusion welded vessel, the plate being somewhat softer than the plate in power boilers. It had been made that way purposely, because it was more convenient by fusion methods to weld steel of a carbon range under 0.18 or 0.17 than to weld the ordinary firebox or flange steel used for riveted structures.

Mr. Cassidy went on to say that the tensile strength of the steel as ordered was 10 percent under ordinary firebox steel. This indicated that there might be a reduction of 10 percent of the strength of the welded drums compared with similar drums made from flange or firebox steel. The steel that was used for American power boilers was, fortunately, due to the foresight of those who made the specifications originally, and the work of the American steel manufacturers as good for the purpose as any steel that could be obtained. It was certainly better than any steel that was supplied European countries for boiler construction. The Germans, who had published most of the articles on the design and tests of dished heads, used a steel with carbon around 0.08 or 0.09 and with phosphorus and sulphur several points higher than was found in ordinary American practice. That steel was in a range that when cold worked and subsequently heated to a blue temperature, around 300 degrees C., was put in a brittle and dangerous condition, and due to the high amount of dirt, phosphorus, and sulphur, it was easier to get bad steel in German boilers than in American boilers. The range where that condition stopped was just below the range where the American steel began, and we were not troubled with that difficulty.

The Germans used a factor of safety of 4 in designing their boilers, while in this country a factor of 5 was employed. This probably accounted for the trouble they had had in the failure of heads and the lack of trouble in this country.

Mr. Cassidy called attention to the statement made by Mr. Obert to the effect that there had not been developed a single case of failure of a dished head designed in accordance with the A.S.M.E. Boiler Code from 1914 on. Naturally, the boiler manufacturers did not want to make unsafe boilers. Nor did they want the customers who had been buying these boilers to feel that they had in their power houses boilers that might rupture and cause trouble at any time due to failure of the heads, and unless it was really true, we did not want to do anything that would lead them to believe that their boilers were unsafe.

THE QUESTION OF SCRAPPING DIES

He went on to show why it was not desirable to change the design of boiler dished heads unless there was good reason for doing it. In the first place, the present value of the head dies in this country was probably several hundred thousand dollars. That money could not be scrapped without some good reason for doing it. If the shape of the heads was changed, it would be necessary to scrap the dies. Particularly in battery settings, if the depth of the head was increased much beyond what it was now, it would considerably increase the width of the center wall. That increased the cost of the brickwork and the cost of the boiler house due to the extra space necessary. That, Mr. Cassidy said, was one of the greatest difficulties in changing the depth of the head.

Another difficulty was that if anything was done that required thicker plate in drum heads, the thickness of the plate necessary for the higher pressures of the larger diameters would run over 2 inches, and some boiler manufacturers hesitated to use plate thicker than 2 inches. As it was now, 2-inch plate worked in very nicely at the maximum pressures. Any change in the formula for design of heads would require plate thicknesses over 2 inches.

One of the German papers not published in Mr. Miller's series but distributed to the Committee, seemed to indicate that it was not necessary to design a head of an elliptical shape to get the greatest strength for a given depth. Mr. Cassidy felt that the boiler manufacturer would very much rather stick to the basket-shaped head than change to an elliptical head without any difference in the strength. Increasing the knuckle radius would tend to increase the depth, and it had already been explained why it was undesirable to do that unless there is some good reason for it. It had been known for a long time that the stress in the knuckle around the manhole of manheads was greater than the theoretically designed stress in the heads. As far as that went, it was known that there were a number of other places in the boiler where the actual concentrated stress was considerably greater than the theoretical designed stress.

Following the reasoning that the stress at the edge of a hole in a plate was 2½ times the average stress in the plate, the same thing applied to every tube hole in a drum, and there was theoretically a concentrated stress at the edge of the holes equal to 2½ times the average stress in the drum plate. Due to the ductility of the plate used, that stress was distributed and tended to be equalized in the remainder of the plate, so that no particular harm came from it and boilers were safely operated with the theoretical stress in the edge of the tube holes considerably greater than the elastic limit of the metal.

Mr. Cassidy said he felt certain that the boiler manufacturers would not oppose any reasonable and necessary change in the design of heads. All that was wanted was that we should keep our feet on the ground and not do anything that was hasty or inadvisable or that had not been proved to be applicable to the particular design of drums for power boilers. The American Boiler Manufacturers' Association, he said, were willing to cooperate in any way that they could, and would be glad to make any changes that were necessary, but they wanted to know first that such changes were necessary.

Monday Evening Session

At the session held Monday evening W. H. Rastall of the United States Department of Commerce, Machinery Division, Washington, D. C., addressed the association on the "Possibilities of Boiler Export Business." Mr. Rastall created a new line of thought for members of the association to follow in connection with plans for trade expansion. The department is in a position through its records and trade investigations in every country of the world to assist in a material way any boiler manufacturer who wishes to enter foreign markets with his products. This address will appear in a later issue of the magazine.

Tuesday Morning Session

The Tuesday morning session opened with a continuation of the study of the commercial aspect of the industry. E. St. Elmo Lewis, a consultant in many fields on the promotion of sales, gave a most interesting talk on the subject of marketing boiler products. Following Mr. Lewis, Professor S. W. Parr of the University of Illinois took up the subject of "Caustic Embrittlement of Boiler Steel" on which he and F. G. Straub of the university, who was also present, have carried out exhaustive researches during the past two or three years. The subject which is a highly technical one was handled very ably by Professor Parr and Mr. Straub. In order to bring out clearly all the points developed, the complete report on this subject, which was presented by Professor Parr before the American Society of Testing Materials a few months ago, will be published in an early issue of THE BOILER MAKER.

The talk on marketing, given by Mr. Lewis, will also appear in a later issue, as the transcript from the proceedings is not available for publication at this time.

Wednesday Morning Session

The business meeting Wednesday opened with a report by E. R. Fish, chairman of the Committee on Boiler Performance Guarantees.

Report of Committee on Boiler Performance Guarantees

AT the winter meeting of the association held in Cleveland last February there was some little discussion regarding boiler performance guarantees. It was rather generally conceded by those present that boiler guarantees are a burden upon the business and that the making of any such is fraught with uncertainties and possible financial loss. A committee consisting of the undersigned was appointed to study further into the matter and now wishes to report as follows:

The following is a brief discussion of the factors entering into the problem and which may form the basis for a discussion of the whole question.

Developments in recent years in the steam generating field have greatly magnified the importance of the furnace and fuel burning apparatus. Also have the greater evaporative demands on the boiler, higher superheat, etc., greatly changed the design and arrangement of the boiler proper. The problem of separating the performance of the furnace or heat producing means from the boiler or heat absorbing apparatus has been recognized to be practically impossible, certainly at least with that degree of accuracy necessary to satisfy both parties. With the growing use of water cooled walls directly connected with the boiler circulation this separation is still further complicated. In order to determine the operating characteristics of a boiler unit the accurate measurement of various phenomena is necessary. Some of these can be determined with considerable accuracy but others such as gas quantities and high temperatures cannot, with the apparatus and methods now available, be measured so that there is no doubt as to their accuracy. Indeed there are relatively few of the quantities that can be so measured as to leave no doubt that they are correct within reasonable limits of error.

With the changes in operating conditions has come a decided tendency on the part of engineers concerned with the design and purchase of boiler plants to demand predicted performance results over a considerable range of conditions. Not infrequently are concrete guarantees of performance demanded as one of the conditions of a contract, and which at times is tied up with bonus and penalty clauses. It is generally conceded by those best qualified to judge that predicted performances are and can be only intelligent guesses, based on purely theoretical premises or on previously observed results of more or less similar units and modified to provide for changes in conditions in such ways as the manufacturer deems to be indicated by theoretical considerations. At best, therefore, predicted performances can only be intelligent approximations of what may be expected.

If absolute guarantees are demanded the presumption is that the maker of any such will keep them within the limit where there can be relatively little if any doubt that they will be fulfilled on test. In these days of intense competition, however, there is always the fear that one's competitors will give a higher guarantee and be thereby given a preference in awarding the contract. This thought encourages each bidder to stretch his imagination and faith in his apparatus to otherwise unwise limits. The result is very often, as doubtless everyone will agree, that difficulty is encountered in demonstrating a guarantee and not infrequently some sort of a compromise, usually financially beneficial to the buyer, is finally made.

Be the conditions what they may, both as regards operation and types of apparatus the purchaser must have some information as a guide for his general design and is, therefore, entitled to, as nearly as may be, a statement of what performance can be expected. This may either cover a combination of all the several parts or may be segregated, as circumstances dictate.

While it is becoming the practice more and more for the whole unit to be bought under one contract, it will continue to be usual for a long time to come that fuel burning and other apparatus will be purchased separately from the boiler.

In view of all the above, manufacturers would, in our opinion, be justified in refusing to make guarantees of performance as one of the conditions of a contract, but unless all would so agree the present practice must necessarily continue.

This demand for operating characteristics is not one wholly in connection with larger central stations but also frequently comes from relatively small industrial plants and is a practice which will doubtless continue to grow.

However, guarantees embodied in a contract usually have to be demonstrated by tests, and as all those who have been concerned with boiler tests well know, the outcome is always in doubt until the results have been figured up.

No recommendations are made for any specific action. It would be well, however, if the association, or at least those interested in this particular aspect of the boiler business, could agree on some plan of procedure.

COMMITTEE.

DISCUSSION

In the discussion of this subject various opinions were brought out as to the way in which the association might best assist the members in settling the troublesome question of performance guarantees. It was thought that some standard form might be drawn up which would give a general statement of boiler performance. Such a form could be made adaptable to various conditions by providing for the insertion of different values by the several companies using it. As opposed to this idea some of the members felt that the association should not go on record with a resolution that would bind the members by hard and fast rules. The members themselves should clearly realize that it is to their advantage to avoid in every way possible the making of guarantees. It was finally decided to have the committee on this subject prepare a standard form of guarantee and those companies desiring to do so might use it without its being binding officially on any members.

Committee on Boiler Suspensions

In an informal report the Committee on Suspension of Watertube Boilers made certain recommendations for the fixing of maximum stress values in cross girders and hanger bolts; the distribution of load between the front and rear braces; the use of loads other than given on contracts and how to allow for these by providing heavier supports; the standardization of suspensions and the use of certain factors of safety for certain loads.

Report of Committee to Confer with Smoke Prevention Association

We had several conferences with the Secretary of the Smoke Prevention Association, Mr. Chambers, in Chicago. We find that they are reluctant to adopt any standard setting heights or construction details for the reasons they expressed several years ago when we had a joint committee meeting with them in Cleveland, when they stated that due to certain conditions around each district and character of the fuel used, they found it would be unadvisable to establish standards along the lines we suggested at that time.

Your committee further feels that this situation is working out in a generally satisfactory manner, due probably to the talk that a representative from the American Boiler Manufacturers' Association gave the Smoke Prevention Association convention in Minneapolis four years ago, when we pointed out to them that it was a hardship on the public and boiler manufacturers to have these constant changes of setting heights and furnace details coming through with each change of administration in city government, which usually meant a new smoke inspector, who, in turn, had his own ideas along that line. At their next meeting in Buffalo our association again appeared before them with the result that they of their own volition adopted certain setting heights that are in general about what we proposed to them originally, and as a result of our work with them at these two conventions and a joint committee meeting in Cleveland three years ago, there has been less trouble and confusion in setting heights than formerly.

However, we believe that there is still room for improvement in the standardization of furnace details, particularly as applying to internally fired boilers, where we find a great difference of opinion as to the length of gas travel in the furnace before the gases are brought in contact with heating surfaces, usually in the lower element of a two-pass self-contained boiler.

Your committee feels that some action should be taken with the Smoke Prevention Association through their secretary, Mr. Chambers, to clear up and, if possible, standardize furnace details of this particular type boiler.

The return tubular boiler settings have been fairly well standardized in the different cities, and the watertube boilers due to mechanical firing usually avoid violation of the smoke laws in general.

COMMITTEE.

Activities of Return Tubular Boiler Group

H. E. Aldrich representing the return tubular boiler section did not give a formal report but simply outlined the progress made by this group in completing the standardization of the 72-inch by 18-foot horizontal return tubular boiler. Blue prints of the standard boiler are now available to all members of the society desiring them for use. A great deal has been accomplished in the standardization of settings and fittings. The section has adopted slightly higher values for stress in supporting members than has the watertube boiler section—supporting members having an allowable stress of 15,000 pounds per square inch and hanger bolts 10,000 pounds per square inch. It is now the intention of the section to devote time and study to the standardization of other boiler sizes and possibly eliminate some of them.

Report on American Uniform Boiler Law Society

A. G. Pratt, Babcock and Wilcox Company, presented a report on the activities and financial condition of the American Uniform Boiler Law Society. For some years now the work of the society has to a considerable extent been limited by lack of funds. Numerous associations have voluntarily contributed to the society but there is no assured income for its work. The boiler manufacturers probably obtain the greatest amount of benefit from the promulgation of the A.S.M.E. Boiler Code and for this reason the association should be more active in the support of the Boiler Law Society. A definite schedule for subscriptions from all members based on the amount of business done would seem the equitable basis for supporting this society. It was decided to prepare a schedule of this character for the future support of the organization.

Steel Heating Boiler Committee

The discussion of members of the steel heating boiler branch of the industry centered about the advisability of forming an organization of their own outside of the A. B. M. A. or to form a group within this association. Consensus of opinion seemed to be that the interests of the steel heating boiler companies are closely allied to those of the makers of power boilers in many respects and in view of the development of the group idea with manufacturers of other boilers in the association for the expansion of trade and other purposes, the main object of the steel heating boiler members could best be gained by entering into the activities of the A. B. M. A. as a group. In such a scheme specific questions pertaining to steel heating boilers can be taken care of by group discussions while the interests in common with all other groups of the steel boiler industry can be handled through the association as a whole.

Election of Officers

New officers were elected for the ensuing year at the end of the Wednesday session. The results of the election follow:

President—Starr H. Barnum, the Bigelow Company, New Haven, Conn.

Vice President—M. F. Moore, Kewanee Boiler Company, Kewanee, Ill.

Executive Committee—Joseph H. Broderick, the Broderick Company, Muncie, Ind.; George W. Bach, Union Iron Works, Erie, Pa.; A. C. Weigel, Walsh & Weidner Company, Chattanooga, Tenn.; H. E. Aldrich, Wickes Boiler Company, Saginaw, Mich.; A. G. Pratt, Babcock & Wilcox Company, New York; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; E. R. Fish, Heine Boiler Company, St. Louis, Mo.; J. F. Johnston, Johnston Bros., Ferrysburg, Mich.; J. R. Collette, Pacific Steel Boiler Corporation, Waukegan, Ill.

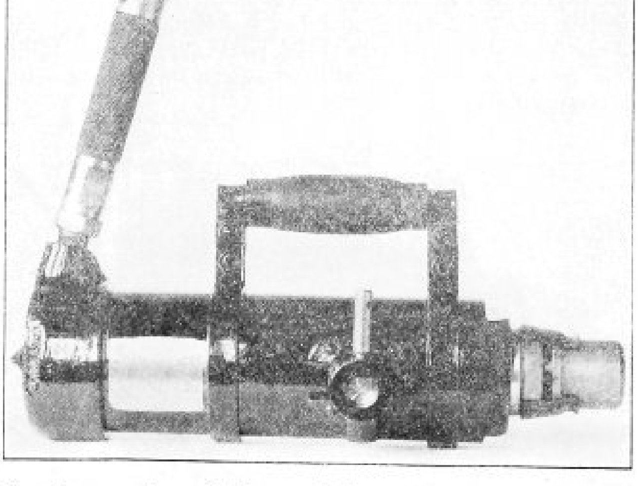
Registration at A. B. M. A. Meeting

The following members and associates were registered at the thirty-ninth meeting of the American Boiler Manufacturers' Association:

Aldrich, H. E., Wickes Boiler Company, Saginaw, Mich.
Bach, George W., Union Iron Works, Erie, Pa.
Baker, E. E., Kewanee Boiler Works, Kewanee, Ills.
Barnum, S. H., Bigelow Company, New Haven, Conn.
Blodgett, L. S., The Boiler Maker, 20 Church Street, New York.
Bradford, S. G., Edge Moor Iron Company, Edge Moor, Del.
Bradshaw, G., Andrews-Bradshaw Company, Pittsburgh, Pa.
Broderick, Jos. H., The Broderick Company, Muncie, Ind.
Brining Frank, Erie City Iron Works, Erie, Pa.
Bronson, C. E., Kewanee Boiler Company, Kewanee, Ills.
Boxman, Wm., *Power*, New York City.
Champion, D. J., The Champion Rivet Company, Cleveland, Ohio.
Champion, F. Pierre, Champion Rivet Company, Cleveland, Ohio.
Coburn, J. F., J. F. Corlett and Company, Cleveland, Ohio.
Collette, J. R., Pacific Steel Boiler Corporation, Waukegan, Ills.
Connelly, W. C., Connelly Boiler Works, Cleveland, Ohio.
Cook, Arthur, Kewanee Boiler Company, Kewanee, Ills.
Cox, F. G., Edge Moor Iron Company, Edge Moor, Del.
Dillon, John, Titusville Iron Works, Titusville, Pa.
Drake, W. A., Brownell Company, Dayton, Ohio.
Eury, J. G., Henry Vogt Machine Company, Louisville, Ky.
Fish, E. R., Heine Boiler Company, St. Louis, Mo.
Gates, R. M., Superheater Company, New York City.
Gorton, Chas. E., Uniform Boiler Law Society, New York City.
Hammerslough, J. F., Springfield Boiler Company, Springfield, Illinois.
Harris, W. B., J. F. Corlett and Company, Cincinnati, Ohio.
Heggie, J. F., Heggie Simplex Company, Joliet, Ills.
Jacobi, W. H., Springfield Boiler Company, Springfield, Illinois.
Jeter, S. F., Hartford Steam Boiler Company, Hartford, Conn.
Johnston, J. F., Johnston Bros., Ferrysberg, Mich.
Kelly, J. W., National Tube Company, Pittsburgh, Pa.
Low, F. R., *Power*, New York City.
McAleenan, Geo. R., McAleenan Brothers Company, Pittsburgh, Pa.
McCulloch, H. L., Babcock-Wilcox-Goldie-McCulloch, Galt, Ontario, Canada.
McGowan, L. H., Casey Hedges Company, Chattanooga, Tenn.
Meier, C. R., Heine Boiler Company, St. Louis, Mo.
Mensonides, S., Farrar and Trefts, Buffalo, N. Y.
Meyers, C. O., Chief Boiler Inspector, State of Ohio, Columbus, Ohio.
Middleton, C. W., Babcock & Wilcox Company, New York City.
Moore, M. F., Kewanee Boiler Company, Kewanee, Ills.
Nevin, W. A., Heggie Simplex Company, Joliet, Ills.
Pillen, H. A., Stanwood Corporation, Cincinnati, Ohio.
Pratt, A. G., Babcock & Wilcox Company, New York City.
Rocklitz, O. A., Brunswick-Kroeschell Company, Chicago, Ills.
Snow, N. L., Diamond Power Specialty Company, New York City.
Tudor, Clift, Tudor Boiler Company, Cincinnati, Ohio.
Weigel, A. C., Walsh & Weidner Company, Chattanooga, Tenn.
Wickes, E. B., Wickes Boiler Company, Saginaw, Mich.

Thor Hammer Type Holder-on

The Thor hammer type holder-on manufactured by the Independent Pneumatic Tool Company, 600 West Jackson boulevard, Chicago, is particularly designed for driving rivets in tight places and corners where it is im-



Thor hammer type holder-on designed for driving rivets in tight places

possible to use a regular size riveter. It is also used as a holder-on to buck up rivets.

The hammer proper is the standard Thor long stroke riveter hammer. The head block over the valve has the Thor ratchet lock to the barrel. The holder-on barrel is made of a solid piece of steel with the rear cap threaded on. Into this cap is screwed a throttle which admits and releases the air to the rear end of the hammer. The front end of the holder-on barrel is solid with an internal groove for a U-shaped packing, which is self-adjusting. The poppet type choke valve has its seat in the wall of the holder-on barrel. The body of the valve fits loosely in the guide which is assurance that it will always hold tight but will not easily stick. It is opened and closed by a cam action through the handle and is provided with a tension plug and spring and a flattened surface on the body to hold it either positively open or closed. A return spring is provided so that the holder-on action will instantly release as soon as the throttle is closed. A side handle is securely clamped to the body of the holder-on in addition to the regular throttle.

A number of thin steel washers are placed between the holder-on barrel and the rear cap so that the position of the throttle can be easily changed by removing or adding to these washers. This tool is made in four sizes. The weight of the smallest size is 30 pounds. The largest size weighs 35 pounds. The lengths of the four sizes without the center or set are as follows: 12¾ inches, 14¾ inches, 16¾ inches, and 17¾ inches. The stroke in all sizes is 3¼ inches.

Pneumatic Scaling Tool

A PNEUMATIC scaling tool has been developed by the Ingersoll-Rand Company, 11 Broadway, New York, for use in cleaning rust and scale from boilers and tanks. It is particularly effective in close quarters or around rivet heads. It consists of only four parts.

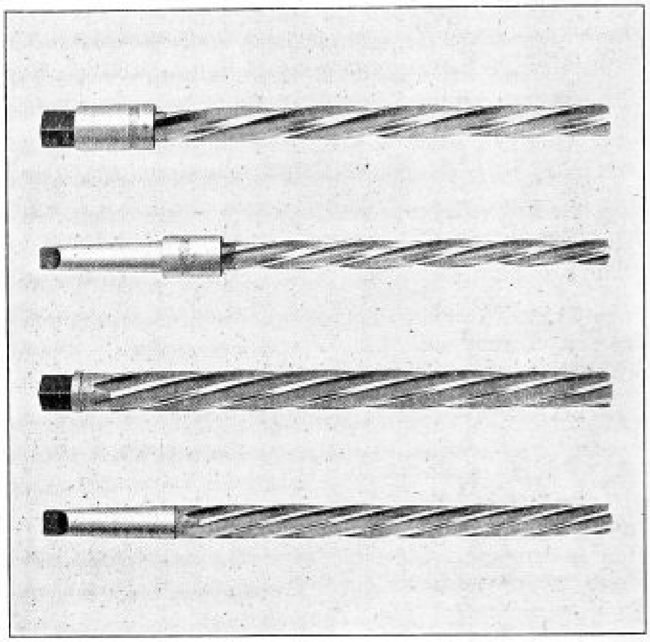
The piston projects from the lower end of the barrel and is finished at this end with hardened teeth. In operation, the piston vibrates back and forth in the barrel at a very high speed. The teeth which are held on the work thus, deliver a succession of sharp, quick blows which cut and knock off any rust, scale or old paint from the side of a boiler or tank.

Two lengths of pistons are furnished. One projects ⅞-inch from the barrel and has a working face ⅞-inch in diameter. This style piston is supplied in the Size 16 hammer and is used on flat work and around cone head rivets not over 1 inch in diameter. The other piston projects 2⅛ inches from the barrel and has a ⅝-inch working face. This is used around cone head rivets larger than 1 inch. The weight with the throttle, as shown in the illustration, is 4¾ pounds.

New Reamers for Railroad Use

THE Cleveland Twist Drill Company, Cleveland, Ohio, has recently brought out new four and six-fluted taper locomotive reamers, certain sizes of which are made in accordance with standards adopted by the American Railway Tool Foremen's Association at its 1925 convention. The four-fluted reamers, Nos. 647 and 648 are made in square and taper shank, as are the six-fluted types, No. 651 and 652. All have a taper of 1/16 inch per foot of length and are made of high-speed steel.

In all four of the styles, the small end diameters range from ⅝ inch to 2 inches, in variations of 1/32 inch, while

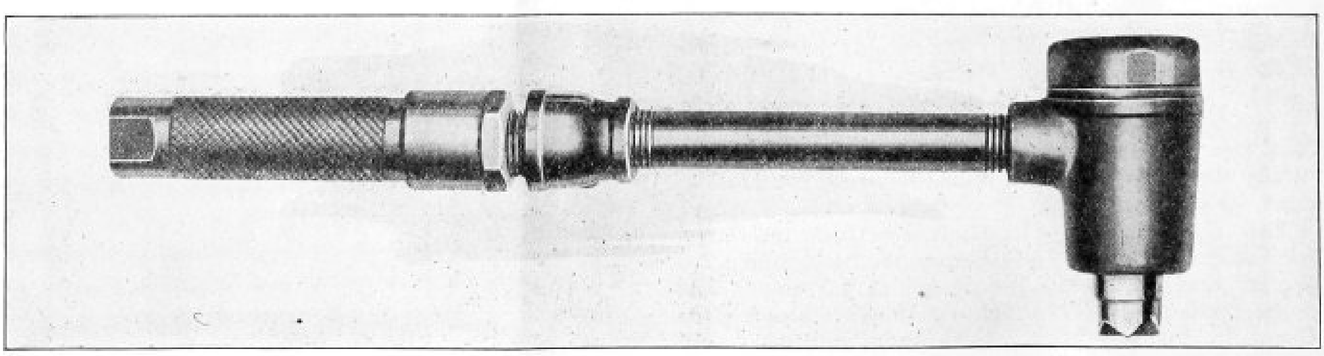


The new Cleveland locomotive taper reamers—From top to bottom the styles are No. 647, No. 648, No. 651 and No. 652

the flute lengths run from 8 inches to 26 inches. The taper shank styles, Nos. 648 and 652 have No. 3 Morse taper shanks in the ⅝ inch to 31/32-inch diameter sizes; No. 4 shank in the 1 inch to 1 15/32-inch diameter and No. 5 shank in the 1½ inch to 2-inch sizes.

The four fluted reamers are milled after twisting in order to assure spiral accuracy, and to provide a correct flute shape for cutting and clearing the chips from the hole.

While both styles of reamers are manufactured in accordance with the Tool Foremen's Association standard, certain sizes and four intermediate lengths are provided in addition to the specified standards required in railroad shops.



Ingersoll-Rand pneumatic scaling tool for cleaning rust and scale from boilers and tanks

Dictionary of Locomotive Boiler Terms

Definitions of boiler parts adopted by Master Boiler Makers Association at annual convention

At the recent annual convention of the Master Boiler Makers Association, W. H. Laughridge, chairman of the committee on "Standard Boiler Terms" proposed that the association adopt such portions of the "Dictionary of Terms" appearing in the *Locomotive Cyclopedia* published by the Simmons-Boardman Publishing Company, New York, as applied to boiler work. The convention passed the motion unanimously and adopted the definitions of terms which for the benefit of members of the association and all others connected with locomotive boiler work appear in part below. Further instalments of these terms will be published in later issues.

Definition of Terms

A

American Articulated Compound Locomotive. The steam at reduced pressure is admitted direct from the boiler to the low pressure cylinders by means of the intercepting valve located in the left high pressure cylinder saddle. This allows the locomotive to develop full tractive effort in starting trains. As soon as the driving wheels have made a few revolutions, and the low pressure cylinders have received their full supply of steam from the high pressure cylinders the intercepting valve automatically changes the locomotive from simple to compound by admitting the exhaust steam from the high pressure cylinders to the receiver from which the low pressure cylinders draw their supply. In changing from compound to simple when running, in order to increase the power of the locomotive, an emergency or high pressure exhaust valve enables live steam to be admitted directly to the low pressure cylinders. See MALLET ARTICULATED COMPOUND LOCOMOTIVE for further description.

American Locomotive (4-4-0). A type of locomotive having a four-wheel front truck and two pairs of coupled driving wheels, but no trailing truck. Frequently called Eight-Wheel Locomotive. Now used principally in light service—not extensively.

Angle Globe Valve. A Globe Valve having the inlet and outlet connections at an angle with each other, commonly 90 degrees.

Angle Valve. See ANGLE GLOBE VALVE.

Apron. See CAB APRON.

Arch. A term sometimes applied to the Smokebox. See also BRICK ARCH.

Arch Brick. A unit of refractory material used in the construction of a brick arch in a locomotive firebox.

Arch Tube. An iron or steel tube placed in the firebox to support the brick arch. One end connects to the firebox throat sheet and the other to the door sheet at a point below the crown sheet. When a built-in combustion chamber is used the arch tube is curved and connects to the bottom sheet of the combustion chamber.

Arch Tube Plug. A pipe plug for closing the holes, either in the boiler back head or throat sheet, opposite the ends of the arch tubes, and through which the arch tubes can be washed out.

Articulated Locomotive. A locomotive having two sets of cylinders driving independent groups of wheels which support two sets of frames, joined by a hinge or pivot joint. The leading set of frames, cylinders and driving wheels support the forward end of the boiler and swivel radially about the pivot connection, giving the effect of a truck, and thus reducing the rigid wheel-base. In compound articulated locomotives the usual arrangement is to drive the rear section by the high-pressure cylinders and the front section by the low-pressure cylinders. In single expansion articulated locomotives all cylinders receive steam at boiler pressure. See AMERICAN, BALDWIN and MALLET ARTICULATED LOCOMOTIVE.

Asbestos. An incombustible fibrous material, which is mined in various forms. Some varieties are in compact form similar to wood while some are loose like flax.

Asbestos Felt. A preparation of asbestos in loose sheets for use as a non-conductor of heat in the covering of steam pipes.

Asbestos Insulating Cement. A composition composed chiefly of asbestos combined with plaster of paris, hydrates of lime and other binders. It is applied in plastic form in place of other lagging. See LAGGING.

Ashpan. A receptacle underneath the grate for holding the ashes that drop through the grate bars. In order to control the admission of air under the grate, it is provided with dampers at either end operated from the cab by rods and levers. The ashes are dumped from the bottom through one or more hoppers closed by hinged or sliding doors.

Ashpan Air Opening. In order to have perfect combustion, it is necessary to provide sufficient air openings in the ashpan. A topical discussion, relating to the amount of air opening, particularly for wide firebox locomotives, will be found in the Master Mechanics' Proceedings, 1904, page 165.

Ashpan Angle. An angle iron hanger or support bolted to the lower rail of the frame or to the bottom of the firebox ring, to support the ashpan.

Ashpan Axle Guard. A piece of sheet steel underneath the ashpan and over or partly surrounding a driving axle for the purpose of protecting the axle from the excessive heat of the ashpan. Used on locomotives having one or more axles under the firebox.

Ashpan Blower Valve. A valve for controlling the ashpan blower for removing ashes.

Ashpan Damper. A door arranged to swing or slide through the operation of the damper rigging for the purpose of regulating the amount of air admitted under the grate bars.

Ashpan Damper Crank. A bell-crank transmitting the motion of an ashpan damper handle to a damper rod. In some designs, where dampers are arranged to slide vertically in ways or guides, two bell-cranks are used, one connecting the lower end of the damper handle to the damper rod, the other connecting the damper rod with the damper by an intermediate lever. The bell-crank nearest the damper is provided with a counterweight to balance the weight of the damper.

Ashpan Damper Crank Support. A casting secured to the ashpan or firebox to support the damper crank by a pin or short shaft.

Ashpan Damper Handle. An operating handle attached to the ashpan damper crank and with its upper end passing up through the deck within easy reach of the fireman.

Ashpan Damper Hinge. The pivot or support on which the ashpan damper turns in opening or closing.

Ashpan Damper Hinge Bearing. A lug on the ashpan to hold the hinge on which the damper is hung.

Ashpan Damper Latch. A fastening device for holding an ashpan damper in any position. A catch consisting of a small lever is secured in the casting through which the ashpan damper handle passes, and drops a pin or detent into a notch in the edge of the ashpan damper handle.

Ashpan Damper Lever. A lever making connection between the damper rod and the damper.

Ashpan Damper Lug. A projection cast on a damper for attaching the damper lever by pins.

Ashpan Damper Rod. A slender bar connecting the damper with the ashpan damper crank for opening and closing the damper.

Ashpan Damper Shaft. A transverse shaft with a bellcrank attached, resting in bearings on a support or bracket, for operating an ashpan damper.

Ashpan Damper Shaft Bearing. A bracket attached to the frame of the locomotive for holding the end of the ashpan damper shaft.

Ashpan Drop Cross Brace. A transverse angle connecting the two sides of an ashpan hopper to strengthen it at the opening of the drop door or dump.

Ashpan Drum. A hopper underneath an ashpan, used on some locomotives where the firebox is over one or more driving axles.

Ashpan Dump. A door or slide that closes the bottom of an ashpan hopper, commonly called hopper slide or door.

Ashpan Dump Connection. The rods and levers comprising the mechanism for operating a dumping ashpan.

Ashpan Dump Connection Pins. Pins used in the ends of the rods and levers of the ashpan dump connection.

Ashpan Dump Crank. A crank connecting the ashpan dump with an operating rod and handle.

Ashpan Dump Crank Support. A bracket on which an ashpan dump crank is pivoted.

Ashpan Dump Cylinder. A cylinder in which a piston and piston rod, operated by air from the main reservoir, pushes or pulls a rod connected to the ashpan dump crank and thus operates the ashpan hopper slide.

Ashpan Dump Lever. An arm or lever connected to the ashpan dump and operated by a rod.

Ashpan Dump Plate. A steel plate or casting covering the opening in the bottom of an ashpan or ashpan hopper. Also called hopper slide or door.

Ashpan Dump Shaft. A rod or bar connected with the handle of an ashpan dump rigging.

Ashpan Dump Shaft Arm. A lever or arm attached to an ashpan dump shaft for connection to the rod that operates the dump.

Ashpan Dump Shaft Bearing. The bearing of the dump shaft in a bracket attached to the locomotive frame.

Ashpan Dump Shaft Connection. The rods or bars by which an ashpan dump shaft is operated.

Ashpan Dump Shaft Connection Rod. A light bar connecting the lever on the dump shaft with a lever that moves the dump. Also called hopper slide rod.

Ashpan Dump Shaft Handle. A handle for operating a dumping ashpan. Usually but not always arranged to be worked from the foot plate.

Ashpan Dump Shaft Handle Catch. A fastener for securing the dump shaft handle in place.

Ashpan Dump Shaft Handle Lock Pin. A detent for fastening the dump shaft handle catch in place.

Ashpan Dump Valve. A valve controlling the admission of air to the ashpan dump cylinder.

Ashpan Heater Valve. A globe valve attached to the boiler to control the steam supply to pipes placed in an ashpan to prevent the accumulation of snow and ice, which would interfere with the operation of the dampers and dumps or hopper slides.

Ashpan Hopper. A receptacle fastened underneath a grate to receive and retain the ashes that fall through. More commonly, simply ashpan. Usually made of cast steel or sheet steel plates.

Ashpan Hopper Slide. A casting or plate, sliding in guides to close the bottom of an ashpan hopper.

Ashpan Hopper Slide Guide. Ways formed on the bottom of an ashpan hopper for holding the hopper slide or door.

Ashpan Support. Braces or hangers made either of castings or forgings and bolted to the firebox mud ring or locomotive frame for supporting the ashpan. Each support is named according to its location.

Ashpan Wheel Pocket. That portion of an ashpan that is arched or bent up to pass over a wheel.

Atlantic Type Locomotive (4-4-2). A locomotive having a four-wheel front truck, two pairs of coupled driving wheels and a two-wheel trailing truck. Formerly used for fast passenger service.

Auxiliary Dome. A dome placed on a boiler in addition to the regular dome and used for attaching the safety valves and whistle, as a Safety Valve Dome. Sometimes used to accommodate the throttle valve and placed ahead of the regular dome in order to do away with the inside dry pipe.

Auxiliary Exhaust Pipe Connection. A pipe connecting the auxiliary or emergency exhaust pipe to the exhaust pipe combination and nozzle. Used on Mallet compound locomotives.

Auxiliary Exhaust Pipe Smokebox Connection. A flange riveted to the smokebox shell and forming the connection between the outside auxiliary exhaust pipe from the high pressure cylinders and the exhaust pipe connection in the smokebox. Used on Mallet compound locomotives.

Auxiliary Steam Pipe. A pipe through which steam is admitted, at a reduced pressure, directly to the low pressure cylinders of a compound locomotive when the maximum tractive effort is required.

B

Back Head (Boiler). The plate forming the back end of a boiler and in which the firedoor opening is placed. It is separated from the back firebox sheet by the back water space. Sloping back heads are largely used to increase the grate area and provide more room in the cab. See Boiler.

Back Head Brace. Supports for the back head extending from the side sheets and the roof sheet. They are attached with pins to angle or channel brackets riveted to the inside face of the back head.

Back Head Brace Angle. A commercial angle or channel iron, or a steel plate bent to a right angle, riveted inside the boiler back head to hold one end of a brace binding the back head to the side sheet, or to the roof sheet of the boiler.

Back Head Brace Jaw. A jaw on the end of a back head brace for attaching the brace to a lug on the back head or boiler shell.

Back Head Brace Lug. A projection riveted to the boiler shell or back head sheet for securing one end of a back head brace. See Back Head Brace Angle.

Back Head Brace Pin. A bolt passing through the jaw of a boiler brace and through a corresponding hole in a lug, for holding the brace.

Back Head Crow Foot. A bifurcated lug riveted to the inside of the back head for the attachment of a brace. See Crow Foot.

Back Head Tee Iron. A T-shaped piece of iron riveted to the inside of the back head for the attachment of a brace. See Back Head Brace Angle.

Back Tube Sheet. See Tube Sheet.

Back Water Space. The water space at the rear end of the firebox. See Water Space.

Badge Plate (Boiler). A cast or stamped metal plate fastened to the back head of a boiler, usually just below the fire door, to indicate the steam pressure allowed to be carried. See also Boiler Test Plate.

(Tender.) A similar plate indicating the tender tank capacity in gallons and pounds.

Baffle Plate. See Diaphragm.

Balanced Compound Locomotive. See Compound Locomotive.

Baldwin Articulated Compound Locomotive. The steam at reduced pressure is admitted direct from the boiler to the low pressure cylinders by opening a starting valve in the cab. This allows the locomotive to develop full tractive effort in starting trains. When the driving wheels have made a few revolutions and the low pressure cylinders are receiving their full supply of steam from the high pressure cylinders, the starting valve is closed and the locomotive works compound. See Mallet Articulated Compound Locomotive for further description.

Baltic Type Locomotive (4-6-4 T). A tank locomotive having a four-wheel front truck, three pairs of coupled-driving wheels and a four-wheel trailing truck. Designed for heavy passenger service. Used to some extent in Europe. See Hudson Type.

Band. A metal strip or hoop surrounding the outside of a boiler to hold the jacket in place.

A piece of iron shrunk around the middle of a spring to hold its leaves or plates in their relative positions. See Spring Band.

Barrel (Boilers). Also called shell. That portion of a locomotive boiler extending from the smokebox to the firebox and enclosing the tubes.

Belly Brace. See Throat Brace.

Belly Washout Hole. A hole in the bottom of the boiler shell through which the mud and scale can be washed from the boiler. Usually located a short distance ahead of the back tube sheet and also back of the front tube sheet.

Belly Washout Hole Flange. A flange riveted around the belly washout hole to strengthen the boiler shell and to furnish a secure attachment for the belly washout plug or cover.

Belpaire Firebox. A firebox with a flat crown sheet joining the side sheets by curves of short radii and having the roof sheet and the upper part of the outer side sheets flat and parallel to those of the inner firebox. These flat parallel plates are then stayed by straight direct vertical and transverse horizontal stays, obviating the necessity of crown bars to support and strengthen the crown sheet. See Firebox.

Berkshire Type Locomotive (2-8-4). A locomotive having a two-wheel leading truck, four pairs of coupled driving wheels and a four-wheel trailing truck. First used on the Boston & Albany in 1925.

Bicycle Type Locomotive (4-2-2). A locomotive having a four-wheel front truck, one pair of driving wheels and a two-wheel trailing truck. Not in general use.

Blow-down Cock. See Blow-off Valve.

Blower Pipe. A pipe to convey steam from a valve in the cab to the exhaust nozzle tip or to the base of the stack in order to create a draft and thus stimulate the fire when the engine is standing. Also used to diminish black smoke when steam is shut off, as when approaching a station.

Blower Pipe Connection. A threaded nipple in the side of the smokebox for attaching a steam pipe while the locomotive is standing in the engine house to create a draft and start the fire.

Blower Pipe Coupling Nut. A union for joining the blower pipe with the pipe leading to the stack or exhaust nozzle, also for connecting the enginehouse blower pipe to the blower pipe connection on the smokebox.

Blower Pipe Drain Fitting. A device placed in the blower pipe for automaticaly draining off the water of condensation.

Blower Pipe Fittings. The couplings, unions, elbows, nipples, etc., used in connecting the blower pipe from the valve on the boiler back head to the point where it enters the stack or exhaust pipe.

Blower Valve. A valve attached to the boiler back head, or more usually to the turret, to admit steam through the blower pipe to the stack, in order to increase the draft.

Blow-off Cock. See BLOW-OFF VALVE.

Blow-off Valve. A valve having a large opening, which is screwed into the water leg of the firebox, but sometimes into the back head above the crown sheet, used for emptying the boiler and carrying off accumulated mud and loose scale. See PNEUMATIC BLOW-OFF COCK.

Blow-off Valve Arm. The handle or lever by means of which the blow-off cock is opened and closed.

Blow-off Valve Hole. The hole in which the blow-off valve is fitted.

Blow-off Valve Extension. A pipe, usually having an elbow or right angle bend, screwed on a blow-off valve to conduct the water from the boiler into a pit or other opening between the rails.

Blow-off Valve Rod. A light rod connected to a blow-off valve for operating it and extending out to the side of the engine, where it is connected to a shaft and handle.

Blow-off Valve Cock. A valve, controlling by means of air pressure, the operation of a blow-off cock. See PNEUMATIC BLOW-OFF COCK.

Board. See RUNNING BOARD.

Boiler. A steel shell for containing water which is converted into steam by the heat of the fire in the firebox to furnish energy to move the locomotive. Locomotive boilers are of the internal firebox, straight fire tube type, having a cylindrical shell containing the fire tubes or flues, an enlarged back end for the firebox and an extension front end, or smokebox, leading out from which is the stack. Boilers are classified by their shape as straight top, having the cylindrical shell of uniform diameter from the firebox to the smokebox; as wagon top, having a conical or sloping course of plates next to the firebox and tapering down to the cylindrical courses; as extended wagon top, having one or more cylindrical courses between the firebox and the sloping course which tapers on the top and sides to the diameter of the main shell; as conical type, having one or more cylindrical courses between the firebox and the sloping course and a conical connection course which tapers to the diameter of the main shell. They are further classified as WIDE FIREBOX, NARROW FIREBOX, BELPAIRE FIREBOX, BROTAN FIREBOX, JACOBS-SCHUPERT FIREBOX, MCLELLAN FIREBOX, and WOOTTEN FIREBOX. See also: FIREBOX, HEATING SURFACE, RADIAL STAY BOILER, STAYBOLT, TUBE, VANDERBILT BOILER, LENTZ BOILER, SEPARABLE BOILER, WATER TUBE BOILER, FLEXIBLE BOILER.

Boiler Bearing. A casting secured to the top of the frames of the leading unit of an articulated locomotive and upon which the forward end of the boiler is carried by means of a sliding bearing.

Boiler Bearing Plate. A metal plate, usually of steel, forming the bearing between the boiler bearing saddle and the boiler bearing casting.

Boiler Bearing Saddle. A casting, the top part of which is shaped to fit the boiler shell to which it is secured, and the bottom part forming a flat surface to which a bearing plate is attached. It transmits through the boiler bearing, the weight of the forward portion of the boiler to the leading unit of an articulated locomotive.

Boiler Brace. A stay or brace used to support the boiler back head or tube sheets and shell and deriving its name from the part it supports as TUBE SHEET BRACE CROWN BAR, STAY BOLT and SLING STAY.

Boiler Brace Foot. The end of a boiler brace through which the brace is riveted to the boiler plates. Sometimes made in a separate piece and attached to the boiler brace by a pin. Integral with the boiler brace in many designs. See CROW FOOT.

Boiler Centering Device. A device by means of which the boiler is brought into line after the locomotive has passed through a curve. Used on articulated locomotives.

Boiler Check Valve. A check valve placed in an injector delivery pipe and an opening against boiler pressure to admit water forced in by an injector.

Boiler Cross Brace. A rod or bar placed transversely across the boiler to support the two plates to which it is attached. Usually used to tie the flat surfaces of the firebox side sheets and roof sheet above the crown sheet of a Belpaire firebox.

Boiler Feed Pipe. See INJECTOR DELIVERY PIPE.

Boiler Filler. A metal plug screwed in a hole in the upper part of a boiler for convenience in filling with water.

Boiler Jacket. See JACKET.

Eoiler Lagging. See LAGGING.

Boiler Materials. See SECTION 17, MATERIALS.

Boiler Plate. Sheets of iron or mild steel from 1/4 to 1 1/4 inches thick, of which the boiler is made.

Boiler Pressure. See STEAM PRESSURE.

Boiler Shell. The cylindrical part of a boiler in front of the firebox, and the roof and firebox outside sheets.

Boiler Steel. (Specification for.) See STEEL.

Boiler Tee. A T-shaped piece of iron riveted to one of the boiler plates for attaching a boiler brace.

Boiler Test Plate. A plate showing the allowed steam pressure, attached to the boiler head in the cab. See BOILER INSPECTION.

Boiler Tester. A device for forcing water into a boiler under pressure for the purpose of testing it for leaking joints.

Boiler Testing. See BOILER INSPECTION.

Boiler Tube. See TUBE AND FLUE.

Boiler Washer. A device for forcing water into a boiler under pressure for the purpose of washing out the mud and scale.

Brace. An inclined beam, rod, or bar of a frame, truss, girder, etc., which unites two or more of the points where other members of the structure are connected together, and which prevents them from turning about their joints. A brace thus makes the structure incapable of altering its form from this cause, and it also distributes or transmits part of the strain at one or more of the joints toward the point or points of support, or resistance to that strain. A brace may be subjected to either a strain of compression or tension. See BOILER BRACE, BACK HEAD BRACE, THROAT BRACE, TUBE SHEET BRACE, FRAME BRACE, PILOT BRACE.

Brick Arch. A baffle of fire brick units set in a firebox in an inclined position and extending backward from a horizontal line on the tube sheet just below the tubes. By virtue of its position the firebox space is divided into two compartments, a furnace chamber and a combustion chamber. Its purpose is to promote combustion, force the flames to impinge the back surfaces of the firebox, baffle sparks, abate smoke and protect flues.

Brick Arch Stud. A bolt or fastener for holding a brick arch in position.

A nipple or short threaded pipe, screwed into the crown sheet or tube sheet for connection to a brick arch tube.

Brick Arch Tube. See ARCH TUBE.

Brotan Firebox. A design of water-tube firebox used to some extent in Europe.

(To be continued)

Best Methods of Applying Staybolts to Fireboxes of Locomotive Boilers*

(a) How are holes tapped? (b) How are staybolt taps purchased as to size? (c) How are staybolt taps gaged? (d) If staybolts are purchased, what are the allowances and how gaged?

Many articles have been written and much discussion has taken place, on the proper method of applying staybolts to locomotive boilers. There is, as a rule, a difference of opinion on all railroads as to the way of applying staybolts. This condition, at times, exists in different shops on the same railroad.

This subject, no doubt, will create an argument at any gathering of boiler makers. Without a doubt, the staybolt problem is one of the most serious with which a boiler foreman has to deal.

In order to thoroughly cover the subject of staybolt installation, it is necessary to start with the removal of the old sheets, and work up to the testing of the boiler. Old sheets are removed, either by drilling the staybolts and breaking them down with a ram, or by cutting the bolts with an acetylene torch.

There is some difference of opinion as to the merits of these two operations. In breaking the bolts with a

* Report presented at annual convention of Master Boiler Makers' Association, held at Chicago, May 3 to 6.

staybolt ram, it is the opinion of some boiler makers that this places an undue strain on the wrapper sheet and has a tendency to open the pores of the iron, and that, in districts where the water condition has a pitting tendency, the sheet is more apt to begin pitting in a shorter period of service. On the other hand cutting the bolts with an acetylene torch no doubt has a bad effect on the sheet. However, the method of removing the staybolts is entirely dependent upon each individual railroad and boiler foreman, and their experience should fully cover this matter.

Some roads require that all staybolts be renewed one size larger than the bolt which was removed. This arrangement quickly enlarges the holes in the outside wrapper sheet, and, unless the holes in the wrapper sheet are reduced, the renewal of outside wrapper sheets will be rather heavy.

The proper closing of the holes in the outside wrapper sheet is readily accomplished by using a flat die with a long stroke hammer and holding on the inner side as well as outside, care being taken to only close the holes enough to obtain a full size thread.

The question arises as to the largest size bolt to be applied to a side sheet. There is a difference of opinion on this subject. The smaller the bolt, the more flexible it will be, and as flexibility governs the service given by the staybolts, it is necessary then to keep the size as small as possible. On some roads, when building new boilers, in the first installation staybolts are 7/8 inch diameter. This practice, if within the factor of safety, will lengthen the wrapper sheet service.

Several methods of reducing the size of staybolt holes are in use at the present time; namely, bushings, solid plugs and welding. Bushings are readily made on an automatic screw machine or turret lathe, from solid bars. Where these bushings are made on an automatic machine, it greatly reduces the cost of manufacture. Bushings should be applied in the smallest possible size, so as to allow for renewal, if necessary, when the firebox is next removed.

Solid plugs, or sunflowers, are also used to a great extent. These, as well as the bushings, should be riveted over inside and outside, and great care should be taken in their application to insure tight fit. Applying bushings or solid plugs to crown bolt holes is not practical, owing to the radius of the sheet.

Welding of staybolt holes has its advantages and disadvantages. This system is no doubt the easiest for the boiler maker, as it is only necessary for him to countersink the holes. Tapping a welded hole, especially electrically welded, is very hard on the staybolt taps. Shop conditions should govern the manner of reducing staybolt holes.

Staybolt holes should be drilled 1/8 inch smaller than the required tap size. It is permissible to punch staybolt holes in the outside wrapper sheet. The holes should be punched undersize and reamed to 1/8 inch smaller than the required size for tapping. By reaming the holes, this will give the holes in the outside wrapper sheet the same angle as the holes in the firebox sheet.

The question arises as to the proper kind of taps. Practically all tap manufacturers have their own idea as to the size, amount of taper, and amount of full threads for the taps of their own make. Also, much has been written as to the relative merits of a straight or fluted tap. On a great many stock taps, both straight and spiral fluted, the maximum reamer diameter is so much smaller than the root diameter of the sizing threads, that the threaded section of the tap must do a certain amount of reaming, and, as a result, the cuts are very fine, and, being very light, do not clear themselves, but wad up in the flutes, or gum up between the teeth. The heat generated when this occurs is sufficient to draw the temper of the teeth causing the tap to tear instead of cut.

The most nearly perfect tap will have a maximum reamer diameter of not more than .025 below the root diameter of the sizing threads, the root of the sizing threads to have the same taper as the reaming portion of the tap.

In re-tapping a hole 1/16 inch larger, the teeth, on the first few revolutions of the taper section, have the same form as the old thread, and have a tendency to act as a lead screw, so that the new thread will follow the old. The remainder of the taper section will cut out part of the old thread, and form a means of steadying the tap in the hole before the new root diameter is reached, and prevent oversize reaming.

A great many railroads have their own specifications for staybolt taps. Others use what is known as the standard stock tap, supplied by the different tap manufacturers.

In selecting taps, the proper procedure is to purchase taps from a number of tap manufacturers and test each make of tap and, from the test made, the tap which gives the best service should be adopted as standard.

In making a tap test, laboratory methods should be followed as nearly as possible. Tapping variables, such as boiler plate hardness and thickness, distance between sheets, size of drilled holes, air pressure, tapping speed, and kind of lubricant, should be strictly adhered to. As far as practical all tests should be made under actual working conditions; that is, a locomotive that is undergoing repairs should be used for the tests. An old sheet, from which staybolts have been removed, will give a more accurate test than two new sheets. Staybolt taps, while on test, should be carefully checked with a ring gage, as to size, and the tapped holes checked with a plug gage, and should be sharpened whenever necessary, and used until the allowable undersize is reached.

Staybolt taps of standard manufacture, unless made to a railroad company's specification, have an allowable oversize of approximately three one-thousandths.

All new staybolt taps, when purchased, should be gaged, and taps of the same size should be marked and used together, so as to have all tapped holes approximately the same size.

When applying staybolts to side sheets, a few holes should be tapped and staybolts applied, so that there will be no possibility of the sheets getting out of alinement while being tapped.

When staybolts are being applied at the same place where threaded, it is better to fit the staybolts to the sheet, rather than to a gage. About one in 50 staybolts threaded should be fitted by the threading machine operator. This will eliminate the possibility of staybolts becoming too tight, due to tap wear.

The question of lubricant used for staybolt tapping and threading rests entirely with the boiler shop foreman. A lubricant should be selected that will give the longest tapping service, cut the cleanest threads, and that will not harden if allowed to stand for some time before the bolts are applied. With certain makes of lubricant, the cuttings will harden on the foundation ring, if allowed to stand for any length of time.

The question arises, "When tapping for crownbolts, should a tap be used with continuous threads the full length of the water space, or a short tap with long leads." If the crownbolts are threaded on a turret lathe, threading both ends at the same time, it is better to use a continuous thread tap. If each end of the bolt is threaded separately, it will make no difference if the short tap is used, as the treads on one end may not line up in respect to those on the other.

Staybolts may either be purchased in the required length or the iron purchased in long bars and made up as required. Either arrangement will prove satisfactory.

It requires a larger amount of storage space to store staybolts than it does to store the iron bars. Bolts should never be purchased ready-threaded, as it is cheaper and more desirable to fit a bolt to the hole, rather than to fit the hole to the bolt.

Both staybolts and staybolt iron should be purchased 1/32 inch oversize, to allow for variations in the roundness of the iron.

The merits of steel and iron for staybolts is being brought up from time to time. The tensile strength of steel staybolts is greater than that of iron, and the elastic limit is increased. By increasing the tensile strength and elastic limit, the flexibility of the bolt is reduced. The more flexible a staybolt is, the less likelihood that it will break.

The question of staybolt material rests entirely with each individual railroad, and their standard for material should be governed by their experience.

When applying staybolts, application should start at the foundation ring and work up. This will insure the long bolts being used where they belong. Staybolts should be run in with a motor one size larger than that used for tapping, and this will insure the proper fit. It should not be necessary to use more than a 12-inch wrench when setting bolts. A bolt that is too tight in the sheet is just as bad as a loose bolt.

Hollow staybolts can be applied from the outside, but solid bolts must be applied from the firebox side. Where an entire installation of hollow bolts is applied, the difference in the cost between the hollow and the solid is somewhat reduced, as it is not necessary to drill tell-tale holes in the hollow bolts; also, application from the outside is faster than from the inside.

The question has been asked, "When using reduced body bolts, should the tell-tale hole extend into the reduced part of bolt?" Reduced body bolts are more susceptible to breakage in the body than on the threaded portion of the bolt.

Discussions have arisen as to the advisability of burning off staybolts for riveting with the acetylene torch. It is the opinion of some that staybolts cut on the firebox sheet with acetylene, have a tendency to become brittle in a short time, allowing the firebox sheets to pull away from the bolts and causing the sheets to corrugate. Where solid bolts are applied, they must be cut off on the firebox side. Acetylene cutting being the quickest and cheapest method, its use for this purpose is general today.

Riveting of staybolts is best accomplished by using a long stroke, special staybolt hammer, and holding on the bolt with a large dolly bar. Double gunning of staybolts is being practiced on some roads. Where a boiler is removed from the frame for repairs, the bolts can be held on with an air jack, providing it is possible to turn the boiler. This should be decided by the boiler shop foreman, and the system used which gives the most satisfaction. Flexible staybolts should be held on with a special air jack, which can be made in any shop. This has proven the most satisfactory plan yet devised as the air jack protects the sleeve threads. The jack is easy to handle, and the air cushion holds the bolt at the same tension all the time.

At a recent test of staybolt taps, and motors, it was proven conclusively that a reversible motor, with speed governor having a speed of approximately 300 revolutions per minute, was the most satisfactory, and that a spiral fluted tap was superior to a straight-flute; a spiral fluted tap with dimensions as mentioned elsewhere in this report proves to be the nearest perfect tap obtainable.

Report prepared by a committee composed of C. H. Browning, chairman; E. H. Hohenstein and C. F. Petzinger.

Discussion

The consensus of opinion seemed to be that a $\frac{7}{8}$-inch bolt on the first application, because of its greater flexibility, was better than a 1-inch bolt unless breakage occurred. On the removal of 1-inch bolts the limit should be the $1\frac{1}{8}$-inch size after which it is advisable to reduce the hole by means of welding. If holes become too large the best practice would seem to be removal of the sheet or a part of it. Reducing the size of holes with bushings or plugs is too expensive for general practice.

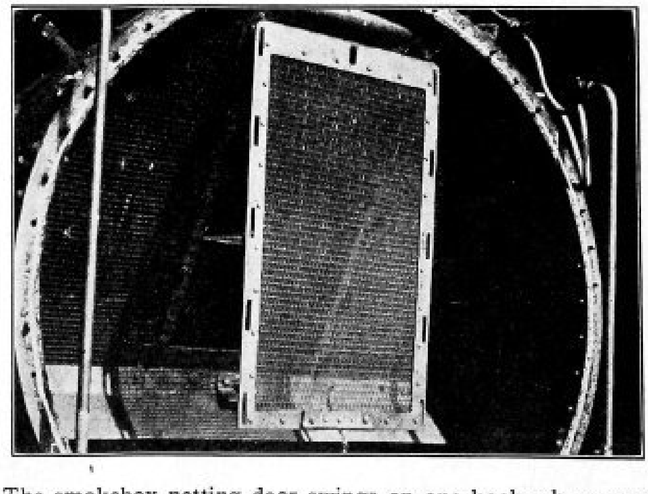
Most shops burn off the staybolts with the acetylene torch. Some do so with the boiler filled with water but this practice is expensive. Others seem to feel that the heat developed in the sheet is not sufficient to cause any difficulty with the boiler empty. Some of the members did not think that it is necessary to burn off staybolts inside the firebox. If the staybolts are designed and ordered accurately to length they can be inserted to the proper distance, leaving only the square heads on the outside to be burned.

The best practice of driving bolts seems to be with an 80 or 90 pound hammer with a snap holder on the inside of the boiler. The bolts should be driven from the outside.

In order for the convention to go on record W. H. Laughridge made a motion to adopt as recommended practice the burning off of staybolts with the oxy-acetylene torch. This motion was passed by the convention.

Novel Fastening for Smokebox Netting Doors

A NOVEL means for securing smokebox netting doors to the netting frame has recently been invented by B. H. Pedigo, boiler inspector, Illinois Central, Jackson, Tenn., for which he has made patent application. The object of this invention is to facilitate the application and removal of the door. The door is held against the frame of the door opening by means of hooks, the inside faces of which slope toward the frame so that it rests tight against the frame. Located directly on the center line over the door opening is a hook made of round bar iron which has a short extension arm on which the door hangs when it is

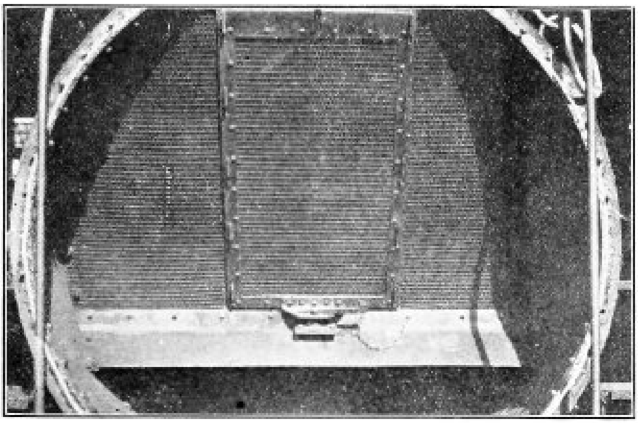


The smokebox netting door swings on one hook when open

open, as shown in one of the illustrations. Slots are provided in the door frame for each hook.

The door is closed by holding it against the hooks, raising it until the ends of the hooks engage the top edges of the slots and then allowing it to slide down into position.

It is securely fastened in place by means of a stud and



This door can be removed or applied to the front end in less than one minute

key located at the bottom of the door as shown in the illustration showing the door closed. The key is secured to the smokebox netting frame by a short piece of fire door chain to prevent its becoming lost when the locomotive is in the shop for repairs.

This door is being tried out by the Illinois Central and the Mobile & Ohio. It is said that netting doors secured by this fastening can be removed or applied in less than one minute.

Stromeyer Investigates Mysterious Failures of Boiler Steel

By G. P. Blackall

THE memorandum for the year 1925 by the chief engineer of the Manchester Steam Users' Association (C. E. Stromeyer, O. B. E., M. I. C. E.) has recently been made public by the association, which is the foremost body of its kind in the United Kingdom. One of the two main subjects with which the memorandum deals is a number of cases of mysterious failures in boiler steel which have been collected during the past twenty years or more and kept on record.

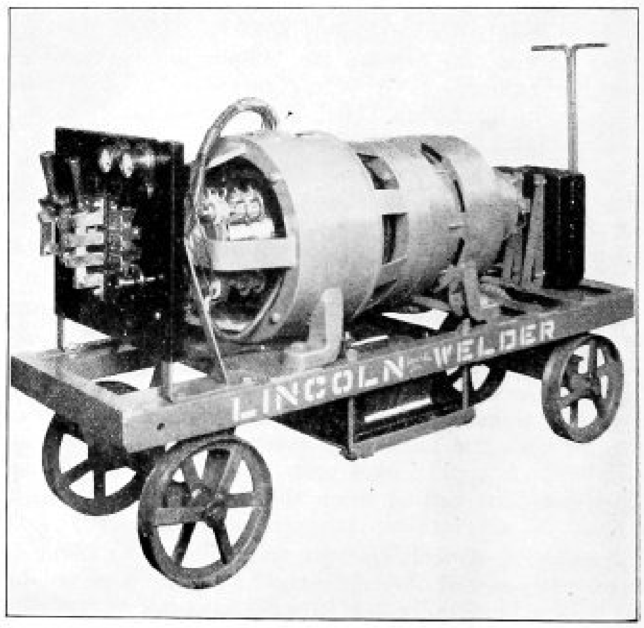
While it has long been known that phosphorus in steel has to be kept below a very low maximum, cases of such failure repeatedly occurred in which the phosphorus was well within the necessary low limit. Mr. Stromeyer has been led to consider the influence of nitrogen in these cases, as this element was found inappreciable quantity in many of the steels which had thus failed. Unfortunately this element was not reported in the usual analysis of steel, though for some time he had suspected that the sum of the percentage of phosphorus and five times the amount of nitrogen provided an important figure. In earlier days this figure had been set too low, but the ratio was a fairly correct one.

Another cause of brittleness was found to be caustic soda, so frequently introduced into boilers as a softening material for hard feedwaters. Experiments showed that in caustic soda stressed material became brittle and though a recent bulletin issued by Illinois University suggests that the detrimental influence of caustic soda could be largely counteracted by the addition of carbonate of soda, this policy is not considered by Mr. Stromeyer to be a safe one. Cases have occurred in which it has been possible to trace the change in the use of purifying materials by the number of rivet heads which have had to be renewed.

Mr. Stromeyer gives a number of cases of failures and some interesting chemical data. Even when phosphorus, nitrogen and caustic have been used to account satisfactorily for many failures, there remain a not inappreciable number for which these explanations cannot hold, and an effort is being made to discover some adequate cause of the failure.

Welding Machine Made of Welded Steel

THE Lincoln Electric Company, Cleveland, Ohio, has made an interesting improvement in the construction of its Stable-arc welding outfits by the substitution of welded structural shapes for iron castings. The illustration shows a 300-ampere alternating current outfit in which only two gray iron castings weighing about 15 pounds, have been used. Other sizes and types are being changed over to the steel construction as rapidly as possible. The motor and generator end rings, brackets and connecting ring are all made of structural angles rolled up into the proper shape and welded together. The feet of the motor generator set are made of drop forgings. The truck wheels are made of tee-sections rolled on a special machine. The hub of the wheel is made of steel tube. Control panels are



Lincoln arc welding outfit showing how welded joints are used in the truck frame and motor generator frame

usually made of slate or special non-metallic compounds, but the panel illustrated is made of sheet steel welded together and welded to the two supports.

The underlying idea in this application welded steel construction is to meet the severe conditions to which portable welding equipment is subjected. It is claimed that the steel construction, owing to the fact that it will bend rather than break, reduces the liability of failure; the bent parts may be straightened and the equipment put in operation without waiting for the replacement of castings which ordinarily would be required.

Arc Welding Speeds in Tank Construction

Use of proper electrodes at higher heats for any given work accomplishes gain in speed of manual operation

By Robert E. Kinkead*

THE changing idea about the speed at which electric arc welding may be done on boiler and tank steel is well illustrated by the welding done in railroad shops on locomotive firebox seams. In 1921, eighteen inches of weld per hour on 3/8-inch firebox side sheets was considered good welding speed. Today, 60 inches of welding on the same job in one hour is done in several shops without exciting comment. An increase of more than 300 percent in welding speed on a routine welding job in six years would seem to indicate that people are learning more about the use of welding.

In the tank building field in 1921, one side of a lap weld on 3/16-inch tank steel was welded at the rate of 23 feet per hour to the amazement of everyone familiar with the work. Today the same job is done manually with the metal electrode process at the rate of more than 60 feet per hour.

It has been remarked that the speed attained in welding the seams on a tank depends entirely on the condition of the boss's mind. Actually the speed attained depends on the condition of his mind and also on the size of welding equipment he has available for the work. Using electric heat from an arc welding machine is similar to using air from an air compressor. A little compressor which will operate the smallest size riveting hammer will not make much speed on heavy work, in fact it will not do the work satisfactorily at all. The same is true to a considerable extent of welding machines.

C. F. Kettering, president of The General Motors Research Corporation, once said, "If you will tell me *why* you can't do a job, I will tell you how to do it."

The reasons why people couldn't weld at present day speeds in 1921 were as follows:

1. It was believed that use of larger amounts of heat would "burn the metal."
2. It was believed that the higher heats would prevent perfect fusion.
3. Efficient individual unit welding machines of large capacity were not available.

It is known now that "high" heats will not burn the metal any worse than "low" heats. The temperature to which the metal is heated is practically the same using a 1/8-inch diameter welding rod with 110 amperes as it is using a 1/4-inch diameter rod and 450 amperes. Microscopic examination of the metal of the two welds discloses no metallurgical difference.

The amount of perfect fusion depends on the operator's manipulation of the arc and the current density in the electrode. In general it is easier to get perfect fusion at high heats than at low heats because at high heats, conduction losses of welding heat at the point at which the welding is being done become negligible. Increasing the amount of heat melts more metal but does not increase the maximum temperature.

The general trend in attaining high speeds for manual operation on production tank welding seems to be in the direction of using large welding rods and more heat. While it was believed at one time that mechanical feeding of the welding rod would greatly increase the speed of welding, due to elimination of time required to change electrodes, the more modern view point is that larger amounts of welding heat are responsible for all of the increases in welding speed which have been attained. Changing the electrodes appears to give the welding operator the relief from eye strain which is essential to all day concentration on the hot metal of the weld. With the mechanical feeding devices (semi automatic) the operator merely stops welding from time to time so that the net increase in welding speed is not appreciable. Such increase in speed as has been attained by mechanical feeding devices is due to the use of much larger amounts of welding heat than had previously been used.

New practices have followed the use of larger amounts of welding heat. Probably the most helpful of these practices is the use of copper confining bars on each side and under the weld. The effect of the copper bars is to confine the welding heat to the seam being welded, increase the maximum amount of heat which may be used, decrease the amount of distortion due to application of the welding heat.

The accompanying table shows the welding speeds which may be obtained with present day welding practice on tank steel.

WELDING SPEEDS, MANUAL OPERATION

Butt Weld, Tank Steel
(Using Copper Confining Bars)

Thickness of Plate	Welding Rod Diameter	Current Amperes	Speed Feet per Hour*
1/8	3/16	225	60
3/16	1/4	300	50
1/4	1/4	400	40
3/8	5/16	500	34
1/2	3/8	700	30

* NOTE—This speed is the speed at which the seam is welded during operation. Set up, change welding rods, etc., is not included.

WELDING SPEEDS, MANUAL OPERATION

One side of Lap weld, Tank Steel

Thickness of Plate	Welding Rod Diameter	Current Amperes	Speed Feet per Hour
1/8	3/16	200	80
3/16	1/4	350	80
1/4	1/4	400	78
3/8	5/16	450	70
1/2	3/8	500	60

*Chief Engineer Welder Division, The Lincoln Electric Company, Cleveland, Ohio.

Layout of an Irregular Cone

By Johann Jaschky

THE cone to be laid out is shown in Figs. 1 and 2. Its ground is half a circle and its top a smaller circle. A part of the mantel surface is a flat triangle and the other part is conical shaped.

For the layout it is necessary to find the point *T* in Fig. 2. It is the intersecting point of the lines *a'*-*e'* and *I'*-*I"*. Then project *T* from Fig. 2 to *T'* in Fig. 1. Now the quarter of the greater circle may be divided in three equal spaces and the half of the smaller circle in a double number of spaces, in this case six, as shown in Fig. 1. Now with *T'* in Fig. 1 as a center draw circles through the points *a*, *d* intersecting the miter line. These intersecting points may be projected in Fig. 2, giving the points *a'*, *d'* on line I.

With *d* in Fig. 1 as a center, circles should be drawn through the points h, l intersecting line I, which is a perpendicular to line d-d. These intersecting points may be projected to Fig. 2 giving the points h', l' on line I.

Now draw lines in Fig. 2 from the points a', d' to T, on intersecting line III giving points e', h'. Further draw lines from h', l' to point l''. The lines d'-h', a'-e' and l''-l', h'-l'' give the true length of same lines in Fig. 1.

Draw a line in Fig. 3, mark on it the points m and l. Its distance is equal to m-l'', Fig. 2. In m erect a line perpendicular to m-l on layoff on both sides and equal to l-d, Fig. 1. With d as a center draw arcs with $l''l'$, $l''k'$,

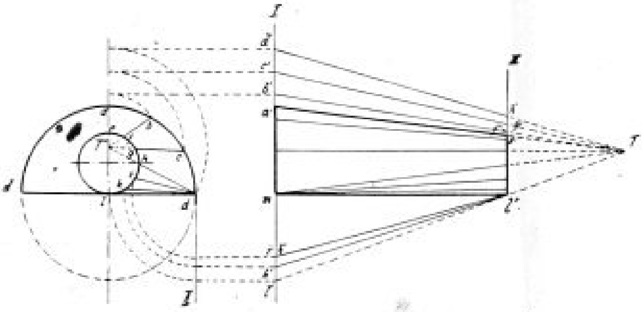


Fig. 1 Fig. 2

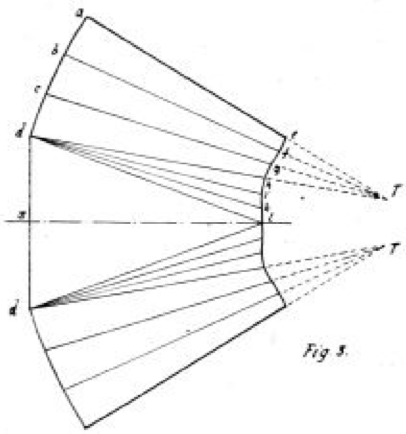


Fig 3.

Development and pattern for irregular cone

$l''k'$ from Fig. 2 as radii; from l in Fig. 3 step off on the arcs as before with a space lk in Fig. 1, equal to the sixth part of the half of smaller circle. In this way the points l, h in Fig. 3 are reached.

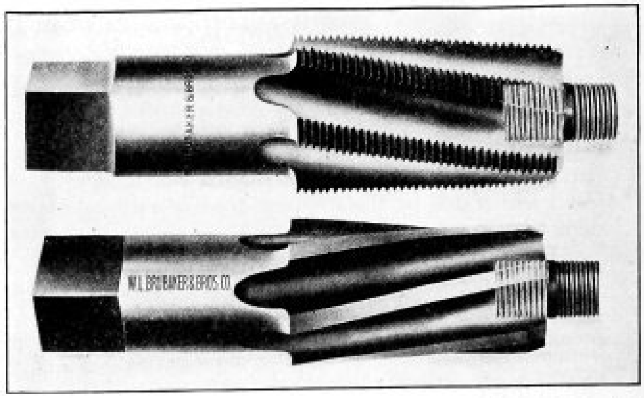
Now draw the line d-h, Fig. 3, a little longer and step off from h to T the length h'-T from Fig. 2. Having found T take it as a center and draw arcs with Td', Ta' from Fig. 2 as radii. From d step off with ab from Fig. 1 a third of the quarter of great circle, finding thus the points c, a.

In connecting the points d, a, e, l in Fig. 3 the layout is found.

Flexible Staybolt Tap and Reamer

To increase the service life of the flexible staybolt taps and reamers manufactured by W. L. Brubaker & Bros. Company, 50 Church street, New York, they are now made according to the design shown in the illustration. In place of making the pilot screw a solid part of the tool, these taps and reamers are made with a threaded (U. S. S.) hole in which is inserted an unhardened adaptor stud with its outer end threaded with a standard pipe thread for use with the usual extension.

The unhardened pilot screws are not brittle and consequently are less liable to break than those tempered with the tool. In case of breakage and stripping of the threads of the stud, the adaptor is quickly removed and a new one



Brubaker flexible staybolt tap and reamer with removable pilot screws

inserted, thus prolonging the usefulness of the tool. The same tools may be used with an extension having either an inside or outside thread.

Notable Discoveries by Boiler Inspectors

(*Continued from page 162*)

was then removed and the sheet cleaned, which resulted in the discovery of a longitudinal crack 5 inches long. The boiler was in operation under 115 pounds pressure and so the inspector recommended that it be removed from service immediately and cooled for further examination. The inspector returned the following day and definitely established the presence of the crack.

The foregoing are merely a few of the numerous dangerous defects in boilers that inspectors are finding every day. Boiler inspection, the pioneer "safety first" movement, is still a vital factor in the saving of human life and of wealth.—*The Locomotive.*

Business Notes

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, has recently installed an Acme upsetting machine, and is now equipped to forge reduced body bolts, flexible, button head and tapered crown stays, in fact, any special type bolt from Falls Hollow Staybolt Iron.

The Lincoln Electric Company of Cleveland announce the appointment of the Wade Engineering Company, 1855 Industrial Street, Los Angeles, California, as distributor of Lincoln products in California. This company maintains a branch at 69 Webster Street, Oakland, California, both main office and branch carrying stock of Lincoln "Linc-Weld" Motors and "Stable-Arc" welders, as well as service parts. The Los Angeles branch is in charge of Henry N. Wade, who is also president of the company.

Obituary Notice

P. WILLIAM KROMER, Buffalo district manager, Air Reduction Sales Company, died at the Buffalo General Hospital, May 21, aged forty-seven years, following an illness of five weeks.

Mr. Kromer had been identified with the oxyacetylene industry for nearly twenty years, of which eleven years were with the Air Reduction Sales Company.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Riveted Joint—Boiler Pressure and Head Calculations

Q.—(1) A horizontal return tubular boiler constructed of plate ½-inch thick and having a tensile strength of 55,000 pounds per square inch has a triple riveted double butt strap joint with every alternate rivet omitted in the outer row. The driven diameter of the rivets is 1 1/16 inches; the pitch of the rivets in the inner rows is 3¾ inches and in the outer row is 7½ inches. The inner rows of the rivets are 1 1/16 inches, the pitch of the rivets in the inner rows is 3¾ inches and in the outer rows is 7½ inches. The inner rows of rivets are in double shear and the outer row is in single shear. The diameter of the boiler is 54 inches. Taking the shearing strength of the rivets as 42,000 pounds per square inch in single shear and 77,000 pounds per square inch in double shear, what working pressure is allowable on the boiler shell using 5 as the factor of safety?

(2) A circular boiler head made of ¾-inch plate is to have an outside diameter of 66 inches after flanging. The total depth of the flange is to be 5½ inches and the inside radius of the curved part of the flange is to be 2¼ inches. What should be the diameter of the blank for the boiler head?—E. G.

A.—In the calculation of riveted joint efficiency, it is necessary to figure the strength of the different parts of the joint in which it may fail. To illustrate this the respective items of the joint will first be designated as follows:

TS = tensile strength of plate = 55,000 pounds per square inch
t = thickness of plate, inches
d = diameter of rivet hole, inches
a = cross sectional area of rivet, driven size, inches
s = shearing strength of rivets, in single shear, = 42,000 pounds per square inch
S = shearing strength of rivets in double shear = 77,000 pounds per square inch
c = crushing strength of boiler steel = 95,000 pounds per square inch
t_1 = thickness of butt strap, inches
n = number of rivets in single shear, in a unit length, called pitch of rivets
N = number of rivets in double shear in the unit length or pitch
P = pitch of rivets in inner row = 7½ inches in this example

With these data the strength of the respective parts of the joint are calculated.

A = strength of solid plate section, in a unit length or pitch of 7½ inches = $P \times TS \times t$ = 7½ × 55,000 × ½ = 206,250

B = strength of plate between rivet holes in pitch P = $(P - d) \times t \times TS$ = 7½ − 1 1/16 × ½ × 55,000 = 177,031

C = shearing strength of 4 rivets in pitch P in double shear and one rivet in single shear = $N \times S \times a + n \times s \times a$ = 4 × 77,000 × .8866 + 1 × 42,000 × 0.8866 = 310,309

D = strength of plate between rivet holes in second row plus shearing strength of one rivet in outer row = $(P - 2d) \times t \times TS + n \times a \times s$ = (7½ − 2 × 1 1/16) × ½ × 55,000 + 1 × 0.8866 × 42,000 = 185,049

E = crushing strength of plate in front of four rivets, plus the crushing strength of butt strap in front of one rivet in outer row = $N \times d \times t \times c + n \times d \times t_1 \times c$ = 4 × 1 1/16 × ½ × 95,000 + 1 × 1 1/16 × 7/16 × 95,000 = 246,035

F = strength of plate in second row, plus the crushing strength of butt strap in front of one rivet in outer row = $(P - 2d) \times t \times TS + d \times t_1 \times c$ = (7½ − 2 × 1 1/16) × ½ × 55,000 + 1 1/16 × 7/16 × 95,000 = 191,972

G = crushing strength of plate in front of four rivets, plus the shearing strength of one rivet in single shear = $N \times d \times t \times c + n \times s \times a$ = 4 × 1 1/16 × ½ × 95,000 + 1 × 42,000 × 0.8866 = 239,112

The efficiency of the riveted joint is the ratio of the strength of the weakest section in the unit length P to the strength of the same length of the solid plate section. Then in this case the weakest section is B, therefore

$$\frac{B}{A} = \frac{177{,}031}{206{,}250} = 0.858 \text{ or } 85.8 \text{ percent.}$$

The maximum allowable pressure on the boiler shell may be calculated from the formula

$$\frac{TS \times t \times E}{R \times FS}$$

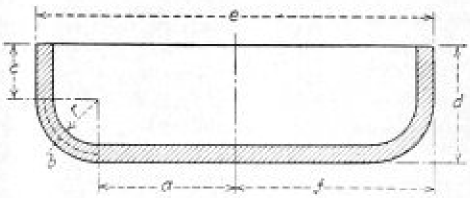
in which

TS = tensile strength of plate, pounds per square inch = 55,000
t = thickness of plate, inches
E = efficiency of riveted joint in percentage
R = inside radius of boiler shell
FS = factor of safety = 5

Substitute the values of the example in the above formula, then

$$\frac{55{,}000 \times \tfrac{1}{2} \times 0.858}{27 \times 5} = 174.7 \text{ pounds per square inch.}$$

In circular boiler heads, flanged, as shown in Fig. 1 there is considerable gather of material in the knuckle of the flange. There must therefore be some allowance made for the gather, which tends to increase the depth of the flange.



Details of circular head dimensions

The theoretical radius of the blank is equal to the sum of the dimensions $a+b+c$ as shown in Fig. 1. Note that the length b is taken at the center of the plate thickness.

The amount to be deducted from the above calculation depends on the diameter, and depth of flange, but there is no definite rule that we know of. This may be approximately figured as follows:

$$\text{Amount to be deducted} = \frac{8(a+c)}{d \times f}$$

Boiler Heating Surface Calculations and Safety Valves

Q.—Please answer the following question through THE BOILER MAKER: How to find the heating surface of a vertical tubular boiler, and how to find the size of a safety valve.

Length of boiler..8 feet 4 inches
Diameter of boiler..60 inches
Number of tubes..283
Length of tube..5 feet 3⅝ inches
Diameter of tubes..2 inches
Grate area..15.9

Please let me know the rule for watertube boilers and for horizontal return tubular boiler heating surface, safety valve size.—J.D.B.

A.—In computing the heating surface of a boiler, consider only the surface in contact with the fire. Usually the inside area of firetubes and the outside area of watertubes are the basis for the calculation of the tube heating surface areas.

In a firetube boiler of the vertical type, the tube area in contact with the water is figured and also that of the firebox.

For horizontal return tubular figure ½ of the area of the shell and the total area of the tubes. Some engineers figure the two-thirds of the area of the rear tube sheet less the area of the tube holes, others do not consider this area as effective.

Complete data is given on safety valves in Par. 269 to 290 inclusive of the A. S. M. E. Code and calculations in the Appendix Par. A-11 to A-17 inclusive.

Department of Commerce Reports Orders for Steel Boilers

New orders for 1,544 steel boilers were placed in April, as reported to the Department of Commerce by 72 manufacturers, comprising most of the leading firms in the industry, as compared with 1,397 boilers in March and 1,101 in February. The following table, which presents the number and square footage of each kind of boiler ordered for January, February, March and April of the current year, is not strictly comparable with the annual totals of boiler shipments previously published, due to the inclusion of a larger number of reporting concerns.

Boiler Pressure—Welding Tubes

Q.—As a boiler gets older should the steam pressure be reduced? Of course, I know if a part becomes bad due to overheating or bad water it is removed and made good but should it still carry the same pressure?

Respective of electrically welded flues; give the reason for starting to weld the superheater flues first, and then starting on the small ones at the top and working toward the bottom.

(2) Please tell me where I can purchase a Birmingham wire gage such as is used for measuring sheet iron.

(3) What determines the diameter of a petticoat for a shay engine?—J. F. D.

A.—The rules of the Interstate Commerce Commission, Division of Locomotive Inspection, state that the factor of safety for locomotive boilers which were in service or under construction prior to January 1, 1912, shall be 3.25.

Effective October 1, 1919, the lowest factor shall be 3.5.

Effective January 1, 1921, the lowest factor shall be 3.75.

Effective January 1, 1923, the lowest factor shall be 4.

Refer to Par. A-22, to A-24, page 154 A.S.M.E. Code.

If a boiler repair is so made as to maintain the strength of the original construction no reduction in pressure is necessary, otherwise the pressure must be reduced in accordance with that allowable on the strength of the weakened section.

In welding tubes and superheater flues the copper ferrules must be set back in the head at least 1/32 inch to prevent the copper from working into the weld and under the head. Remove all grease or oil between the tubes and head. This is done by heating up the boiler and sand blasting.

The top row of tubes should be welded first, the second next, continuing with each succeeding row. Weld the tubes or flues starting from the bottom working to the top on one side and then finish the other side in the same manner. This is necessary to get satisfactory results, thus proper penetration and incorporation of the electrode with the parent metal.

If it is necessary to re-weld a tube that has been previously welded, cut away the old weld and expand the tube, then re-weld as explained.

(2) Write Pratt and Whitney Company, Hartford, Conn.

(3) This question we are not familiar with. Will some of our subscribers explain.

Motion Picture on Riveted Steel Available

A motion picture film "This is the Age of Riveted Steel" visualizing the story of the inconspicuous but dependable rivet has just been announced by Hanna Engineering Works, 1765 Elston Ave., Chicago, Illinois.

It illustrates in detail the production of rivets, steel building and bridge fabrication, the building of railroad equipment, automotive chassis frame production, boiler manufacture, etc. The picture tells the complete story of the rivet's contribution to progress and safety.

Type	Total 4 months No.	Total 4 months Sq. ft.	January* No.	January* Sq. ft.	February* No.	February* Sq. ft.	March* No.	March* Sq. ft.	April No.	April Sq. ft.
Grand total	5,062	5,547,457	1,020	1,178,383	1,101	1,389,984	1,397	1,481,970	1,544	1,497,120
Stationary										
Total	4,997	5,462,228	1,903	1,159,447	1,079	1,363,159	1,384	1,459,031	1,531	1,480,591
Water tube	469	2,865,084	108	648,598	108	789,051	132	713,600	121	713,835
Horizontal return tubular	493	588,435	91	106,274	87	115,304	167	184,662	148	182,195
Vertical fire tube	601	154,072	120	23,284	145	39,986	150	43,661	186	47,141
Locomotive (not railway)	101	48,753	21	9,275	24	12,674	26	11,576	30	15,228
Steel heating[1]	2,616	1,248,038	479	213,074	514	245,436	717	353,529	906	435,999
Oil country	443	374,681	116	105,488	161	126,836	117	106,907	49	35,450
Self-contained portable[2]	238	164,058	57	48,057	43	31,461	65	41,293	73	43,247
Miscellaneous	44	19,107	11	5,397	5	2,411	10	3,803	18	7,496
Marine										
Total	57	85,229	17	18,936	14	26,825	13	22,939	13	16,529
Water tube	9	29,495	2	5,000	6	22,320	1	2,175	....	......
Pipe	1	2,091	....	......	....	......	....	......	1	2,091
Scotch	44	52,443	12	12,736	8	4,505	12	20,764	12	14,438
2 and 3 flue	3	1,200	3	1,200	....	......	....	......	....	......
Miscellaneous	....	......	....	......	....	......	....	......	....	......

[1] As differentiated from power boilers. [2] Not including types listed above. *Revised.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

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

Secretary—C. W. Obert, 29 West 39th Street, New York.

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Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.

Vice-Chairman—C. D. Thomas, Salem, Oregon.

Statistician—E. W. Farmer, Rhode Island.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.

William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.

H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.

International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Avenue, Columbus, Ohio.

Master Boiler Makers' Association

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First Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line, Waycross, Ga.

Second Vice President—George B. Usherwood, supervisor of boilers, New York Central Railroad, Syracuse, N. Y.

Third Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy Railroad, Lincoln, Neb.

Fourth Vice President—Franklin T. Litz, general boiler foreman, Chicago, Milwaukee & St. Paul Railroad, Milwaukee, Wis.

Fifth Vice President—Henry J. Raps, general boiler foreman, Illinois Central Railroad, Chicago, Ill.

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Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.

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Vice President—J. C. Kuhns, Burden Iron Company, Troy, N. Y.

Treasurer—George R. Boyce, A. M. Castle & Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—Starr H. Barnum, the Bigelow Company, New Haven, Conn.

Vice President—M. F. Moore, Kewanee Boiler Company, Kewanee, Ill.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.

Executive Committee—Joseph H. Broderick, the Broderick Company, Muncie, Ind.; George W. Bach, Union Iron Works, Erie, Pa.; A. C. Weigel, Walsh & Weidner Company, Chattanooga, Tenn.; H. E. Aldrich, Wickes Boiler Company, Saginaw, Mich.; A. G. Pratt, Babcock & Wilcox Company, New York; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; E. R. Fish, Heine Boiler Company, St. Louis, Mo.; J. F. Johnston, Johnston Bros., Ferrysburg, Mich.; J. R. Collette, Pacific Steel Boiler Corporation, Waukegan, Ill.

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

States

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

Cities

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

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

States

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

Cities

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

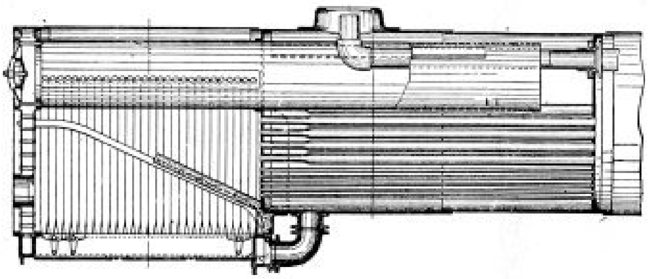
SELECTED BOILER PATENTS

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

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

1,624,655. ALFRED W. BRUCE, OF NEW YORK, N. Y. LOCOMOTIVE BOILER.

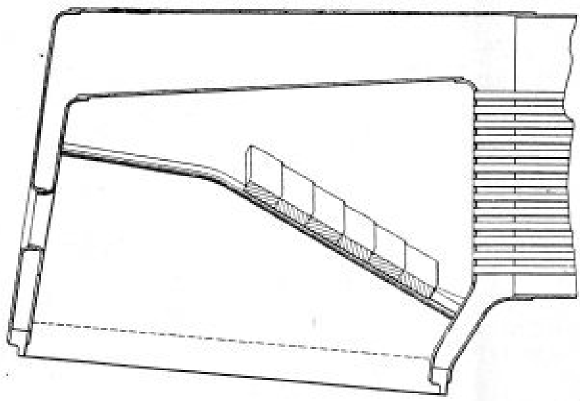
Claim.—In a locomotive boiler, the combination of a barrel and a fire box; the fire box having a steam drum at the top thereof, side wall water



tubes leading into said drum, a hollow mud ring connected to the bottom of the tubes to supply feed water therefor; and a wrapper sheet rigidly secured to the barrel and the fire box, forming a stiffening means for the parts of the fire box, and a housing for the sides and top of the fire box. Seventeen claims.

1,624,198. LYLE STOCKTON ABBOTT, OF CHICAGO, ILLINOIS, ASSIGNOR TO CHICAGO FIRE BRICK COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS. FIRE-BOX ARCH BLOCK.

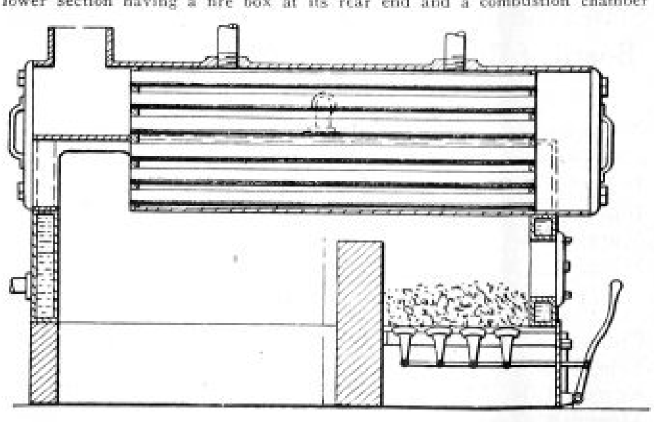
Claim.—The combination with a side wall, of an arch having an upwardly inclined supporting member extending longitudinally of said side wall and spaced therefrom, and a block of refractory material supported



by said side wall and said supporting member and inclined upwardly from said supporting member to said side wall with its lower edge substantially parallel to said supporting member, the major portion of said block extending upwardly in the direction of inclination of said supporting member at an angle to a line drawn perpendicular to said lower edge in the plane of said block. Seven claims.

1,605,100. EDWARD J. DINNEEN, OF OGDENSBURG, NEW YORK. BOILER.

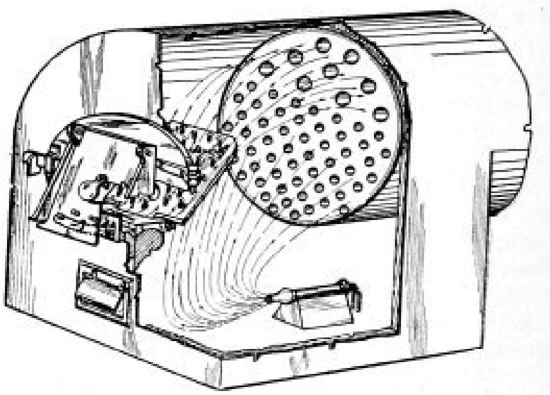
Claim.—A boiler of the character described, comprising a double walled lower section having a fire box at its rear end and a combustion chamber



at its forward end, said double walled lower section being provided at the tops of its ends with substantially semi-cylindrical transverse recesses, a cylindrical shell supported at its opposite ends within the substantially semi-cylindrical recesses, the entire area of the ends of the cylindrical shell being accessible from the exterior of the ends of the double walled lower section, tube heads arranged within said shell and spaced from the ends of the same forming smoke boxes, tubes of the same length extending between and carried by the tube heads, detachable outer heads secured to the ends of said cylindrical shell and covering the smoke boxes, a substantially horizontal bridgewall arranged within the forward smoke box and dividing the same into upper and lower smoke box sections, the upper set of tubes communicating with the upper smoke box section and the lower set of tubes communicating with the lower smoke box section, said cylindrical shell being provided in its forward portion with an opening to establish communication between the combustion chamber and the lower smoke box section, a stack leading into the top of the upper smoke box section, the gases passing from the gas chamber rearwardly through the lower set of tubes and forwardly through the upper set of tubes and discharging into the stack, means of communication between the interior of the double walled lower section and the interior of the cylindrical shell, inlet means for the lower section, and outlet means for the cylindrical shell, the outer detachable heads providing access to the opposite ends of the upper and lower sets of tubes.

1,623,054. ALBERT JOHNSON, OF LOS ANGELES, CALIFORNIA, ASSIGNOR OF ONE-FOURTH TO L. V. HUGHES AND H. E. HUGHES, BOTH OF LOS ANGELES, CALIFORNIA. DRAFT CONTROL FOR LOCOMOTIVES.

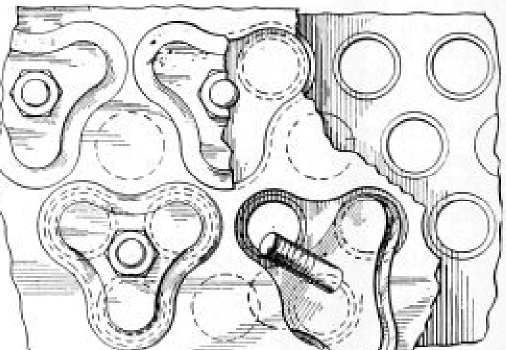
Claim.—In combination with a locomotive fire box and boiler having boiler tubes opening into said fire box, an oil burner in said fire box below said boiler and discharging into said fire box, means for admitting air into said fire box for combustion with the products from said oil



burner, a door into said fire box above said oil burner level, and an adjustable baffle member within said fire box inwardly from said door, said baffle member being positioned in an inclined manner from within the fire box, opposite said door, upwardly and inwardly toward the upper boiler tubes for the purpose of directing the products of combustion from said oil burner and said air admitting means into said upper boiler tubes. Two claims.

1,622,947. THOMAS F. HARTY, OF ROSEBANK, NEW YORK. BOILER STRUCTURE.

Claim 1. In a boiler structure, the combination of an inner tube sheet having tube receiving openings and tubes fitted therein, said openings being arranged in horizontal rows and in groups of three openings to each group disposed in triangular formation, each triangular group comprising two adjacent openings of a horizontal row and a single opening of a next adjacent horizontal row, said single opening being arranged in a vertical plane lying between the companion pair of openings of the same group,



and the group forming openings of each two cooperating horizontal rows of openings being staggered with relation to the group forming openings of similar adjacent rows of openings overlying or underlying the same, an outer sheet having hand-holes, one for each group of tubes in the inner sheet, and arranged in alinement therewith, each hand-hole being of trifoliate-form and having the outer walls of its lobes curved on arcs concentric with the center of the hand-hole, and coincident with the said common center of the alined group of tubes, said walls of the lobes substantially conforming to the curvature of the halves of the walls of the tubes most remote from their common center and lying in alinement therewith and at intervening points extending inwardly on lines coincident with the spaces between adjacent relatively inner sides of the tubes, a cover plate for each hand-hole of a trifoliate form corresponding thereto, and means for fastening said cover plate in position.

Three Claims.

The Boiler Maker

Volume XXVII — July, 1927 — Number 7

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
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Cleveland: 6007 Euclid Ave.
Mandeville, La.
Washington: 17th and H. Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.

Cable address: Urasigmec, London.

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

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CONTENTS

Embrittlement of Boiler Plate

The subject of embrittlement of boiler plate which has become of considerable importance in the manufacture and operation of boilers was one of the most important matters discussed at the annual meeting of the American Boiler Manufacturers' Association held recently at French Lick Springs, Ind. Professor S. W. Parr and F. G. Straub of the University of Illinois presented an outline of the work now being carried on at the University to determine the cause of embrittlement and to discover a satisfactory remedy for the trouble. In this issue the first section of their report is published in order that those who were present at the meeting may study the matter more carefully and to provide an opportunity for all those interested to become familiar with the lines along which scientific boiler investigations are progressing.

The trouble now designated as embrittlement occurs in the form of cracks along the riveted seams in a boiler below the water line. In some cases rivet heads have been so weakened that it has been possible to dislodge them with a slight hammer blow. Two schools of thought have developed in accounting for the cause. The first, for which Professor Parr has done the most extensive research, is of the opinion that the presence of caustic soda in feedwater is responsible while the second, admitting that caustic has some effect, maintains that other unknown agencies are at work to bring about the embrittled condition. In either case it is acknowledged that the cracks which occur are inter-crystalline in character and that they almost invariably follow the line of rivets. This fact immediately precludes the idea that fatigue of the metal is responsible since fatigue cracks develop across the grains and not between them. That the defect is not due to faulty material is proven by the fact that the cracks occur in plate of the highest purity and quality as well as in the average commercial material.

The results of Professor Parr's and Mr. Straub's investigations so far indicate that sodium carbonate is always present when embrittlement occurs. Under conditions of temperature and pressure in a boiler when raising steam the sodium carbonate undergoes a chemical change, one of the products of which is caustic soda. If, while this caustic is present in sufficient quantities, stresses are imposed upon parts of the boiler that will strain them beyond the yield point, embrittlement will occur. In attempting to prevent embrittlement from taking place, the only practical solution so far developed seems to be the reduction of sodium carbonate present and the inside calking of boiler seams. The stress factor cannot be eliminated in a boiler under operating conditions.

Some question has recently arisen as to the continuation of the investigation because of the individual clients who originally backed the work desiring to discontinue their support. The matter is vitally important to the entire boiler industry and should not be allowed to lapse at a stage of the work where the solution is practically within reach. Some means of support should be devised that could be born by that portion of the industry directly benefitted and not left to the few companies who have so far assumed the expense of the investigations. The matter is now being studied by the American Boiler Manufacturers' Association and undoubtedly a practical means of support for work of this character will be developed in the near future.

Twenty Years of Standardized Boiler Construction*

"TWENTY years ago, on July 5, the late Joseph H. McNeill had a very good idea. This idea made McNeill, then Chief Inspector of the State of Massachusetts, Boiler Inspection Department, and later Chairman of the Board of Boiler Rules, the father of standardized boiler construction which has reduced disastrous boiler explosions almost to a minimum and which should, in the next ten years, reduce them to the absolute minimum; there will be some old, non-standard boilers in use in the United States for about ten years more.

"In the reports of the insurance companies we find records of boiler explosions, and once in a while there are serious and disastrous explosions, with attendant loss of life; but at the present time most of the so-called boiler explosions reported by the insurance companies and others, are really in effect boiler derangements or boiler defects, most of which could be eliminated or would have been eliminated if the operators had been careful.

"However, be the explosions as they may, we are headed in the right direction and are almost free from disastrous holocausts in the way of boiler explosions. Further, some explosions are from boilers not yet under state, insurance company, or governmental control, but the laws are fast being made in the different states covering pressure vessels of every name and nature. This, of course, is the ultimate idea of the standardization of boiler construction in the United States.

"Boilers built in conformance with the standards cost only 10 to 20 percent more than non-code boilers and can be used at least 40 years if properly cared for.

"During this vast amount of work and the vast amount of counsel and advice to boiler manufacturers, boiler users, insurance companies and other interested in steam generation, Joseph H. McNeill stands out, in the writer's judgment, pre-eminent as the father of them all, and it is too bad that he could not have lived to see the fruition of his thoughtfulness, patience and fortitude in starting this great work.

"I might further add, as I have at ten, sixteen and this the twenty-year article on boiler explosions, that we were given—especially in the Massachusetts Board of Boiler Rules and the Boiler Code Committee of the American Society of Mechanical Engineers—every cooperation from the great interests manufacturing and using boilers.

"Most readers know all about standardized boiler construction and the safety carried with it, but reiteration and repetition for the necessity of more careful operation of steam boilers and their accessories never come amiss with the rising generation. In other words, in 1830, nearly one hundred years ago, one of our most eminent engineers stated that boiler explosions were preventable. By this he did not mean boiler derangements or boiler defects, such as the failure of tubes, headers, or accessories. These minor accidents will always take place and probably a few people may be maimed or possibly killed, but the days of great boiler eruptions, the tearing to pieces of factories and the killing of great numbers of people, are over in the United States of America."

Lowell, Mass. JOHN A. STEVENS.

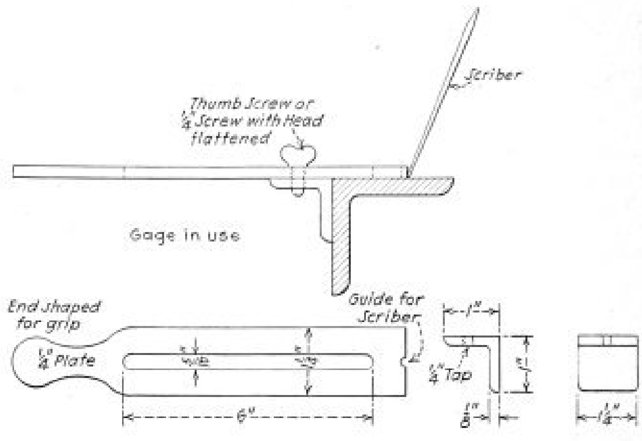
* Reprinted through the courtesy of *Power*.

LETTERS TO THE EDITOR

Uses of the Head Gage

TO THE EDITOR:

I read with interest the article in the April issue of THE BOILER MAKER under the heading "Head Gage for Boiler Shop Use," and I should like to mention that a gage very similar in style is in general use throughout the boiler



One design of head gage

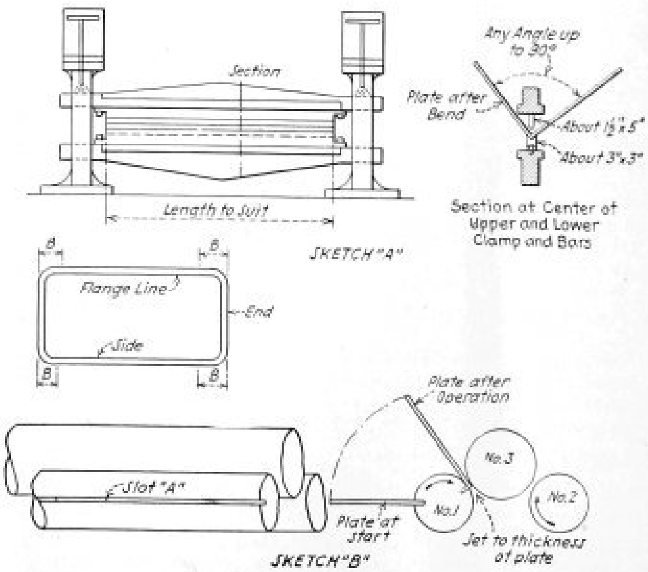
shops that I know of. It is used in several forms on jobs where surface lining with a marking off table as a base is impracticable. In its most popular form it is used for all angle marking as per sketch. As regards using the gage for lining off a boiler head, I should not recommend it, as it is very simple practice to place the head on a level block and run a scribing block around it.

Brighton, Sussex, England. C. H. WHAPHAM.

Suggestions on Flanging Plates

TO THE EDITOR:

In many shops not equipped with flanging or brake machines, especially repair shops, there is considerable bending and flanging work to be done, which can be made



Arrangement of clamps and rolls for bending plate easier where the following ideas can be put into effect. Of course on locomotive work, where there is a back shop there is generally to be found a set of air operated clamps, which it is an easy matter to rig up as per sketch *A*. For general use in light work ash pans, table plates, tank plates, safety guards, which can be done cold and many jobs which are heavier, can be done hot, I have found it a time-saver and inexpensive. The bottom bar is an angle about 3 inches by 3 inches, machined out to 90 degrees, and a cap is screwed on each end to bottom the clamp, to hold it in place only. The center of the V should have a small clearance, which gives a sharper corner. The top bar, which has to operate up or down and is cap screwed to the movable upper clamp, is about 1½ inches by 5 inches of a size suitable to allow the plate to clear the upper clamp after it is bent. It should be machined a few degrees sharper than 90 degrees. The length of bars should suit the general line of work and length of clamps. Plates can be bent to any angle up to 90 degrees, by application of air pressure to suit, but care must be exercised as the action is quick once started. I applied and used one of these in Olean and found it very serviceable, easily mounted and dismounted, turning out work neatly and quickly.

Sketch *B* shows how a set of rolls can be used for flanging straight flange work, by cutting a slot in roll No. 1. This slot is to be governed in size according to strength of housings and class of work to be done. The sketch shows a plate at the start and at the finish of bending operation, rolls to be reversed a quarter turn to lift out work. In the case of a plate flanged on four sides, the sides being done first would have to be knocked back at B to clear roll No. 1, enabling the operator to enter the plate to flange the ends. The corners, flanged hot by hand, finishes the job. Roll No. 3 is lowered to suit plate thickness. As the bending action is general, in the length of flange, the stress is very much lowered, as there are no knuckles, as by hand or sectional work. Hoping that some of our readers will find these suggestions useful and applicable, as they have both been in service.

Montreal, Canada. Alex McKay, Jr.

Lancashire Boiler Flues

To the Editor:

Replying to Mr. Tamkin's comments on the above subject in the February issue of The Boiler Maker. Coincidently his first objection, namely, two thicknesses of plate is answered in the same issue. With regard to repairs, I think the cost of replacing furnace lengths with Adamson flanged seams would be much more costly than welded seams, because when renewing fireboxes of the usual type it is necessary to remove the front plate, pull out the full length of flues, cut off the defective sections, rivet on the new sections, carry the full flues back into position, bolt up front plate to angle and gussets and rivet and calk all around the front shell angle, rivet up the back sections to the back end, and repeat this latter operation at the front end. I think Mr. Tamkin will admit that it is not necessary to remove the front plate or the flues out of the boiler to renew the fireboxes by electric welding, because the front plate opening is greater than the outside diameter of the flues in flat ends, and sometimes greater in ends with the flue opening bunged out. I entirely disagree with Mr. Tamkin that corrugated sections are practically insisted on in the design of Lancashire boilers; in single and double ended marine and launch boilers, built to Board of Trade or Lloyd's, corrugated flues are not only insisted on but are necessary, but in Lancashire, Cornish and Yorkshire boilers their appearance is comparatively rare.

Batley, Yorks, England. J. G. Kirkland.

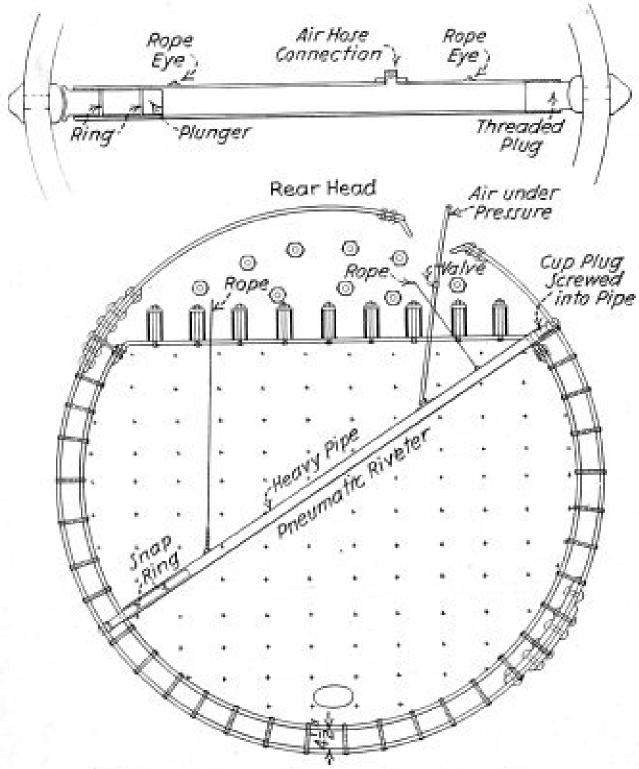
A Pneumatic Holder-On

To the Editor:

The lower half head in a Scotch marine type boiler required to be renewed at once. The top half of this boiler head did not need renewal. It was a hurry up job, as this was the only boiler in the plant and was much needed. A new half head was ordered for delivery as soon as possible. Work was started at once on the removal of the lower half of the old head, which was riveted to the shell on the inside of the boiler, having the flange of the head turned in. Acetylene torches were employed in cutting out the old head and staybolts entering the back combustion chamber, heads burned off the rivets and the rivet shank removed, in short time the boiler was ready for the new head which had not arrived.

A survey of the situation showed considerable work in riveting the new half head to the shell as there was but 4½ inches of space under the combustion chamber, and at the sides sheets scarcely more room could be had. The width of the combustion chamber made holding on for the new rivets a job not sought by any of the shop men.

The space between the back combustion chamber head and the boiler head was practically clear, except three or four rows of staybolts, and on account of their condition it was decided to remove them also and fit the entire back head and combustion chamber head with new staybolts. This gave a clear space at the back of 4½ inches vertically.



Holder-on for use in Scotch marine boilers

The foreman surveyed the situation and asked the diameter of the boiler. Returning to the shop he had a "pneumatic holder-on" made which he thought would do the work easier and quicker with less expense. This device consisted of a piece of extra heavy pipe, bored at one end, into which was fitted a cup head piston with two snap rings fitted to the piston. At the opposite end was screwed a cup head plug; a short threaded pipe was welded at a point nearest the closed end through which the compressed air entered the pipe, the air being admitted or released by a two way cock from the air pipe within operating distance from above the tubes inside the boiler, through the manhole. A couple of rings were also welded to the pipe from which ropes were attached leading to the top of the combustion chamber, with one cup over a rivet, the other cup was to fit over the rivet to be driven.

The apparatus was fitted inside the boiler, connections made with the air, the new half head arrived and was put in place and bolted, rivets were heated and passed through the handhole in the back head to a man inside the boiler. This man inside the boiler entered the rivet in the hole, then fitted the piston cap over the hot rivet. The man at the combustion chamber top fitted the other cap over a diagonal rivet and turned on the air, the piston forced up held the rivet in place while the boiler maker outside the boiler did the riveting. At the finish of the rivet driving, the air was released by turning the valve and by means of the ropes attached to the pneumatic holder-on it was shifted to the next rivet hole and the process repeated.

The circumferential riveting was completed in much shorter time than expected, with no more labor than if held by hand, and much easier. The riveting being completed, an acetylene torch was used to cut the pipe in two and was easily removed from the boiler.

Coatesville, Pa. E. N. TREAT.

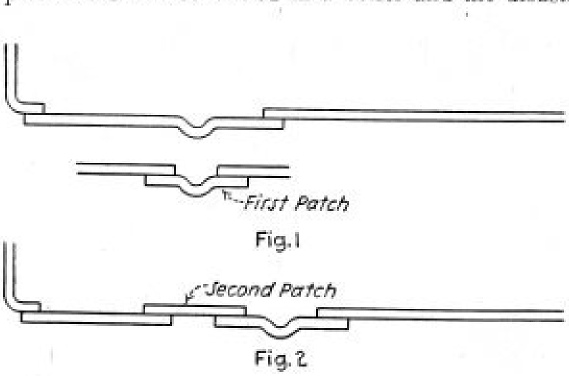
Boiler Repairs

TO THE EDITOR:

Every boiler maker is interested in the above subject, and from time to time we read articles as to how certain repairs were made.

In THE BOILER MAKER there have appeared articles from the pens of inspectors and others, telling us about conditions which have come under their observation regarding boiler repairs, and the operation of steam boilers by incompetent men.

All old boiler makers know that many boilers in the past were operated by men who did not seem to realize the power of steam contained in a boiler and the disastrous results of a boiler explosion. We have in mind two incidents which happened many years ago. The first one will show how steam leaks will sometimes cause alarm, while there might be greater danger from hidden defects, if not discovered by close inspection. The second incident will speak for itself.



Incorrect methods of repairing boiler bottom

A certain saw mill located in Michigan had a battery of three horizontal tubular boilers, which were set up in an old frame building. The condition of the outfit became such that the employees became nervous and demanded that an inspection of the boilers be made.

We were sent out to make the inspection and test. Arriving in the afternoon we found the plant shut down and the boilers made ready for the inspection. The inspection revealed no defects, the boilers were in good condition. We were at a loss as to why trouble was anticipated, until after we attempted to put on the test. After the examination the boilers were filled and the test pump attached, but the pressure could not be forced up on account of leaks in the piping, water spurted in all directions, from all joints and flanges. Then it was that we could understand the condition when steam was up, the boiler room must have been filled with escaping steam from the piping.

Being unable to force up the pressure we ordered all the joints to be taken apart and made tight, and new gaskets put in the flange joints. This was done during the night, the next morning the test was made and everything was found "O K" and all anxiety removed from the minds of the employees.

The other incident which came under our notice and shows the gross ignorance of some men who operated steam boilers in the past (we hope that there are none such at the present time), was an occasion where the inspector was called upon to make an examination and test. Being asked by the operator how much steam he would be allowed to carry, he told him one hundred pounds.

Said the operator, "It is good for two hundred pounds."

Being asked how he knew this, he said, "The clock that came with the boiler was marked up to two hundred pounds."

It is almost incredible that a man of this type should be allowed to operate a steam boiler.

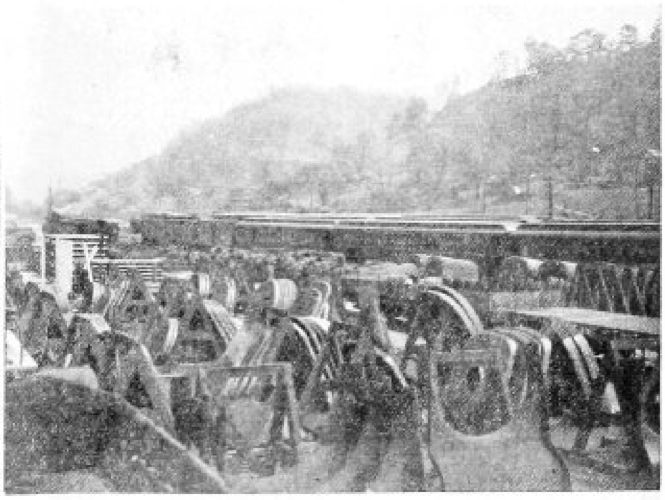
A peculiar repair job which illustrates the truth that good judgment and careful thought must be exercised before proceeding with all boiler work, came under the notice of an old time boiler maker some years ago and may be of interest to the young boiler makers of today. The boiler in question was a standard multitubular one, made in three courses, the end courses being the large or outside ones. The boiler was located at a coal mine in Michigan. A certain boiler shop was asked to send a boiler maker to make repairs to the bottom of this boiler. It so happened that at this particular time, many of the older boiler makers were out on other repair jobs, so a comparatively young and inexperienced man on repair work was sent out on this job.

He found upon arriving that a spot on the bottom of the first course had come down in the shape of a pocket, just forward of the first girth seam, covering an area of about ten inches in diameter. This young boiler maker saw that there was room enough between the center of the bag and the girth seam to put on a patch without running it into the girth seam. So the bag was cut out and a round patch was put on the outside of the boiler shell. This of course left the area of the patch, the thickness of the shell lower than the inside of the front course, and so left a small area for sediment to settle in, and being over the hottest part of the fire it was not many days before this patch came down, just as the shell had come down in the first place.

The same man was sent back to investigate the trouble, and to make necessary repairs. As soon as he saw the condition he recognized at once the mistake he had made by putting the patch on the outside. So the patch was cut off, and a new one put on the inside. But that did not end the trouble, for this patch was so near the girth seam, that another spot was prepared to receive the sediment, and so another bag came down in the front course between the edge of the patch and the edge of the middle course.

After all this trouble, an older and more experienced boiler maker was sent out on this job, and a permanent repair was made by putting in a new sheet running it from the first girth seam to as near the front brick wall as possible, and up on each side as far as the side walls would permit.

Bay City, Mich. J. A. ANDERSON.



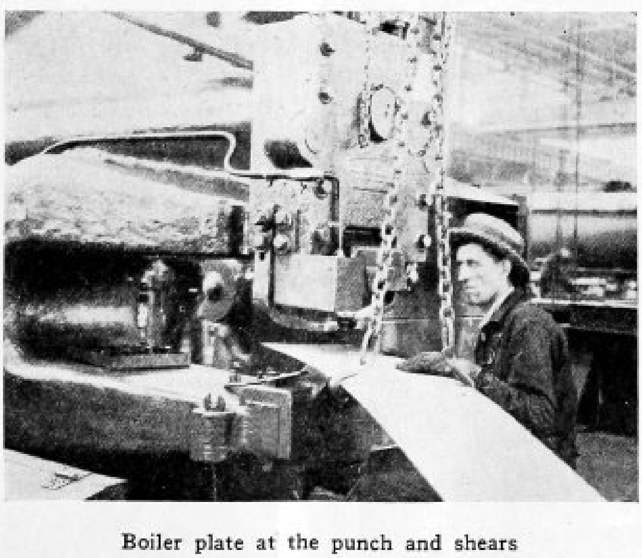
View in the plate storage yard and the storage for finished boiler materials up to complete fireboxes

Boiler Repairs at C. & O. Huntington Shops

Scheduling of repairs, development of standards and methods of conducting repair operations on locomotive boilers and tanks

THE basis for production in construction and repair work at the boiler shop of the C. & O. Railway Company, Huntington, W. Va., which was described on page 156 of the June issue is a scheduling system in most respects similar to that outlined in the article "Co-ordinated Production Control" in the February issue. The four requisites of the system here, as in the case of the North Little Rock Shops of the Missouri-Pacific described, consist of arranging for repairs according to a definite plan in advance of the dates for shopping engines, a properly co-ordinated method of routing work from stripping to erecting, hearty cooperation of officers and men and full cooperation of the purchases and stores department.

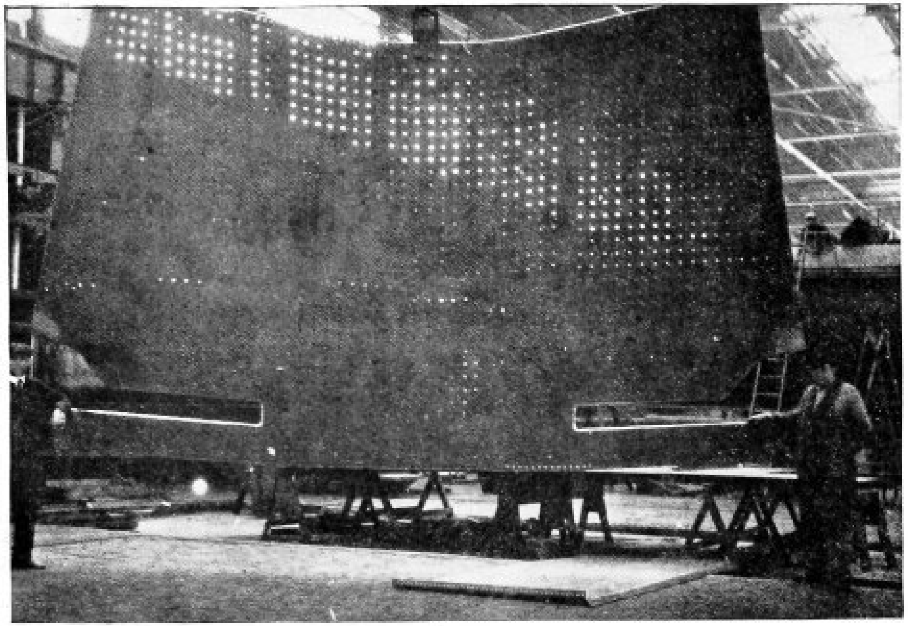
According to the methods developed by the Chesapeake and Ohio mechanical department, locomotives are given mileage ratings and at stated intervals are inspected and brought into the shop for classified repairs as required. The various classes of repairs follow the same order as is almost universally practised in this country. *Class 1* is for a new boiler; *class 2*, a new firebox; *class 3*, general repairs; *class 4*, light repairs between shoppings for former classifications; *class 5*, repairs or mechanical work in which the tubes are rolled, tires turned, tank work done, etc. These latter are usually carried out in other shops of the system, except once in a while when an engine has been in an accident and requires a more complete classified overhauling.



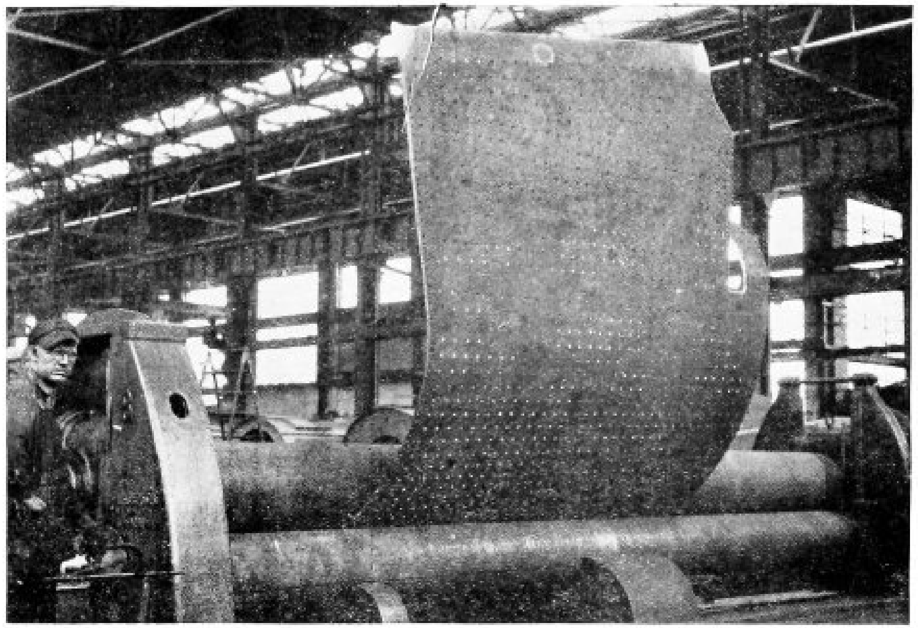
Boiler plate at the punch and shears

The shopping list for all classes of power is made up once a year by the chief mechanical officer but is checked monthly to provide for any changes in the condition of locomotives in service. After general repairs, *classes 1, 2* or *3*, the engines are given an assigned mileage of 50,000 to 100,000 miles, depending upon service and design. After any given engine has completed one-quarter of its mileage it is due for a *class 5* overhaul if inspection indicates the necessity. After one-half its mileage it is brought to the shop for *class 4* repairs. A second *class 5* repair is made after three-quarters of the specified mileage if necessary and the engine is sent out to complete its allotted mileage. The next shopping is for another *class 1, 2* or *3* repair as the case may be.

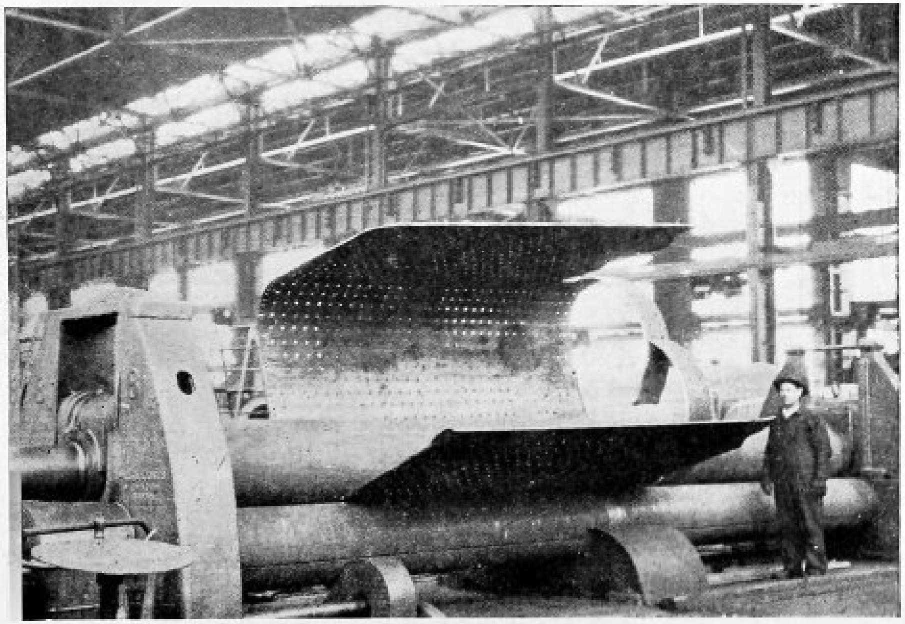
The time allowances for certain classes of repair for different types of power have been carefully evolved and are extremely workable for this shop and equipment. For example, complete *class 2* repairs can be carried out on light engines in 25 days, the firebox being installed in about 8 days. Thirty days are allowed for this class repair on Mikado engines and thirty-five days for Mallet type locomotives. Since the round houses usually carry out *class 5* repairs unless the engine is damaged in an accident, no attempt is



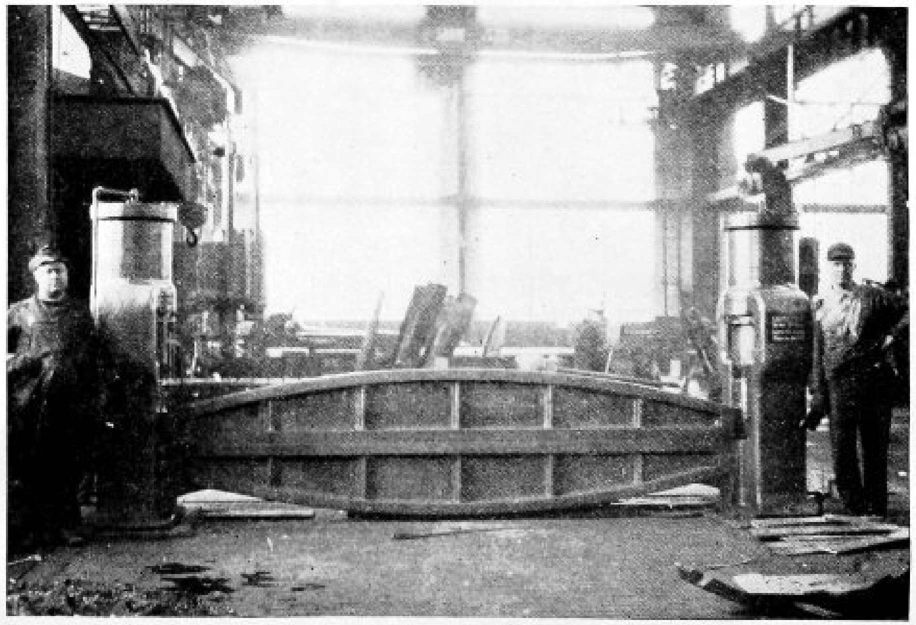
A one piece firebox wrapper sheet on its way to the bending rollls



The same sheet in process of rolling with the combustion chamber part completed



The wrapper sheet at the final operation on the 24-foot rolls



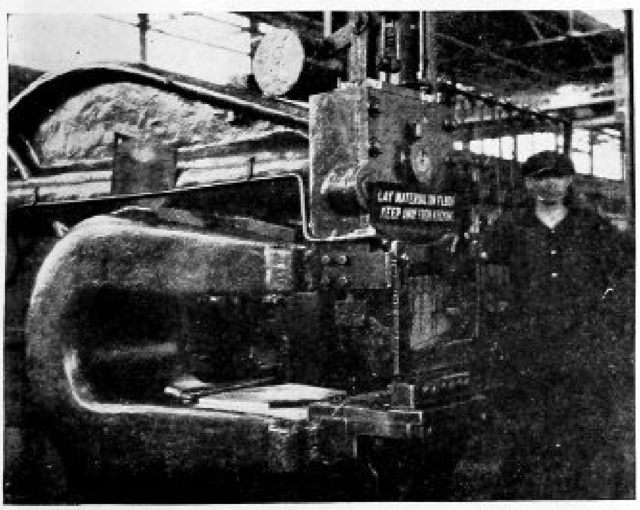
View in the flanging department looking towards the laying out floor made at Huntington to regularly schedule engines for this work. In 1926, for example, there were only 9 in the shop for the entire year.

Class 4 repairs run from 8 days for new Mikados up to 12 days for old small engines of lighter type. When Mikados have been in service for some years, 15 days is allowed. Mallet locomotives require about 17 days for this class repair. *Class 4* as carried out here, however, is practically a *class 3* as it is generally understood, since tires are turned, flues renewed, boxes renewed, shoes relined and the like.

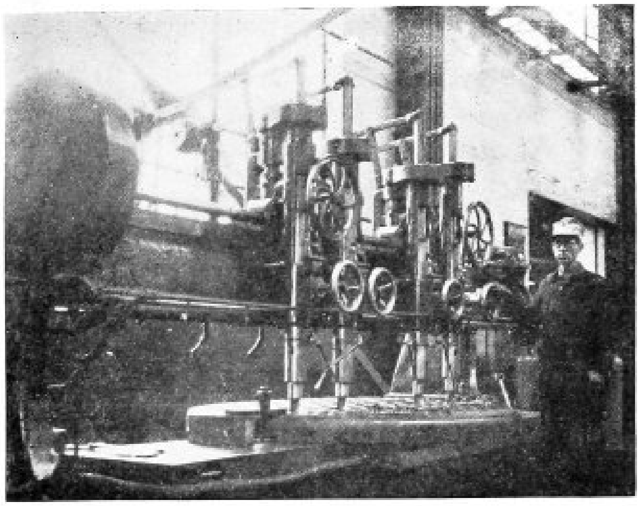
For *class 3* work, 15 days on smaller engines up to 25 on Mallets is allowed in the shop. Practically all of the Mallets require 25 days. When locomotives are brought in for *class 3* repairs occasion is taken to install any new standard equipment that may have been adopted since the last general work.

Chesapeake and Ohio Standards

This matter of standards brings up an interesting development of the C. & O. As is the case with all progressive railroads, the Chesapeake and Ohio has for a long period been adopting standards of practise, equipment and methods which are universal throughout the entire system. These standards are issued in book form to all those on the entire road in mechanical, scheduling or stores department who should be familiar with the requirements. The standards are introduced by an outline of where boilers of the various classes and for different engines should be repaired. Standards are given for all types of welding that are permissible with special attention to boiler patches, side sheet welding, mud ring welding and other firebox and boiler applications. Standard types of staybolts are included, crown bolts, radial stays, flexible bolts, hollow stays, flexible sleeves, flexible caps, boiler studs with specific details of sizes, tolerances, etc. A sheet accompanying the section on bolts represents a stock record showing the amount of each type in the stores at every repair point. Tubes, flues and safe ends are handled on another series of sheets. Under "boiler steel standards" are all sheets of sizes that have nearly the same dimensions and the same thickness so that one standard sheet may be used for several different classes of boilers. Sheets for firebox use, tank use, patches, one-half and three-quarter side sheets are all segregated in the standards book according to their use. When, for examples, domes or other boiler parts cannot be manufactured in the shop the standards book indicates where such parts should be ordered. The standards also cover grates used in different type engines, arch tubes, washout



Machine arranged for shearing plate



Gang drills are used for drilling boiler heads

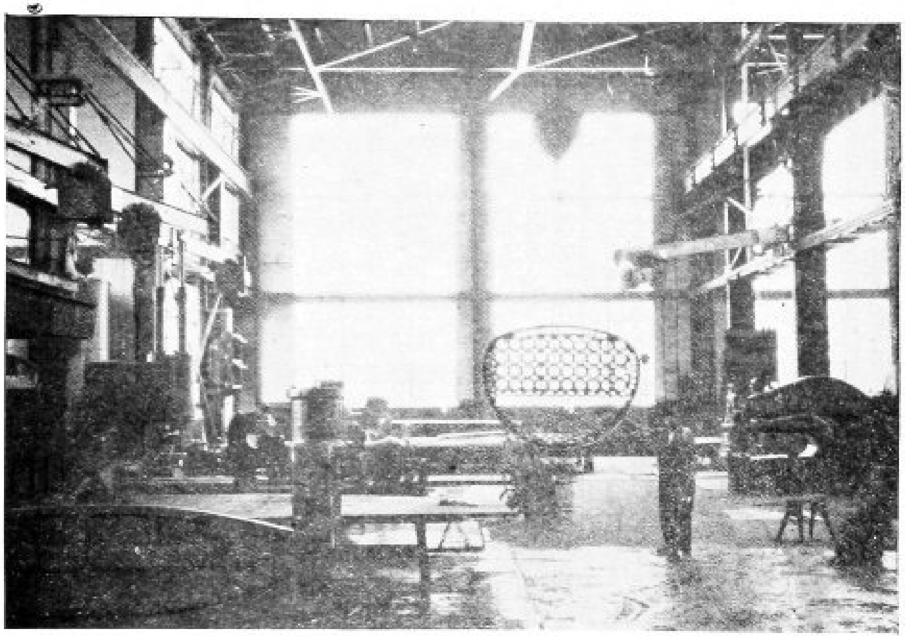
plugs and rivets. Standards are given for all tools so that they may be made in the shops, or outside, to exact requirements and maintain in proper condition without depending on the judgment of the individual man in the tool room.

Meeting of Foremen

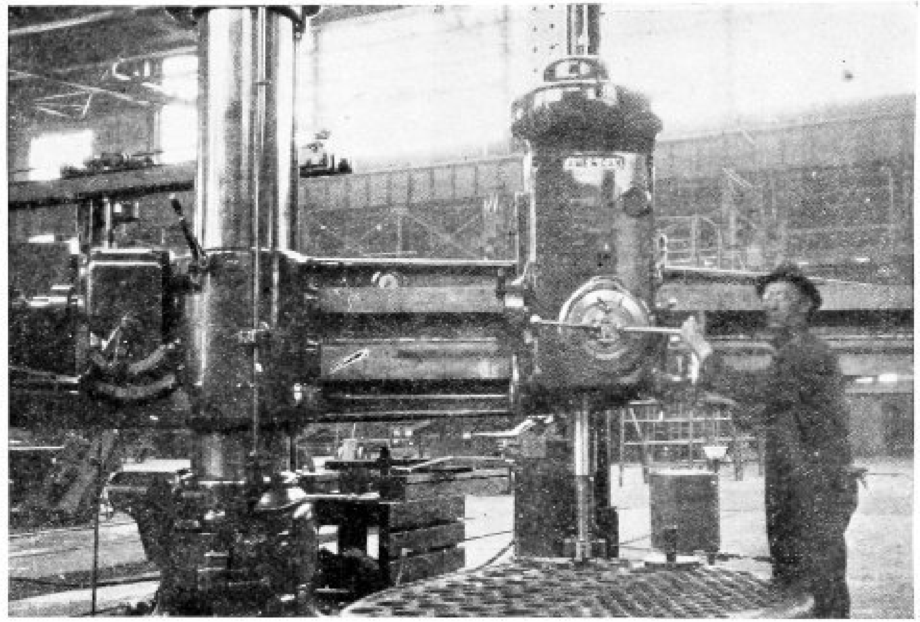
Once a week all foremen in the plant meet with the shop superintendent and the staff to discuss conditions in the shop, to familiarize themselves with the coming schedules of repairs, check up on material shortage and any delays on the current schedule of work. Safety practise, which is an important feature of the shops at Huntington, is reported upon at these meetings and suggestions of the safety committee are discussed at this time and recommendations incorporated in the requirements for the plant. One other committee which plays an important part in the functioning of the shop renders reports at the foremen's meeting—that is the clean-up committee. So far as orderliness and cleanliness are concerned, this shop at Huntington is exceptional. In no part of the plant nor in the yards is litter or waste material allowed to accumulate. Passageways are kept clear and clean and all the usual clutter found in the average shop is entirely lacking. In the boiler shop, for example, provisions are made for storing all equipment not in use. Tools are not allowed to lie around where they are subject to damage and accident. Racks, lockers, tool rooms are ideally arranged to meet all requirements for storage. Each man is provided with a steel locker for clothing and personal effects and tools. These lockers are arranged against the outside walls where they do not interfere in any way with the operation of machinery, handling of materials or other shop procedure. The management, clean-up committee, foremen and men in general employed in the shop are to be highly complimented on the manner in which the plant is maintained. A copy of the stenographer's report of these meetings is sent to the chief mechanical officer for record.

Method of Carrying Out Repairs

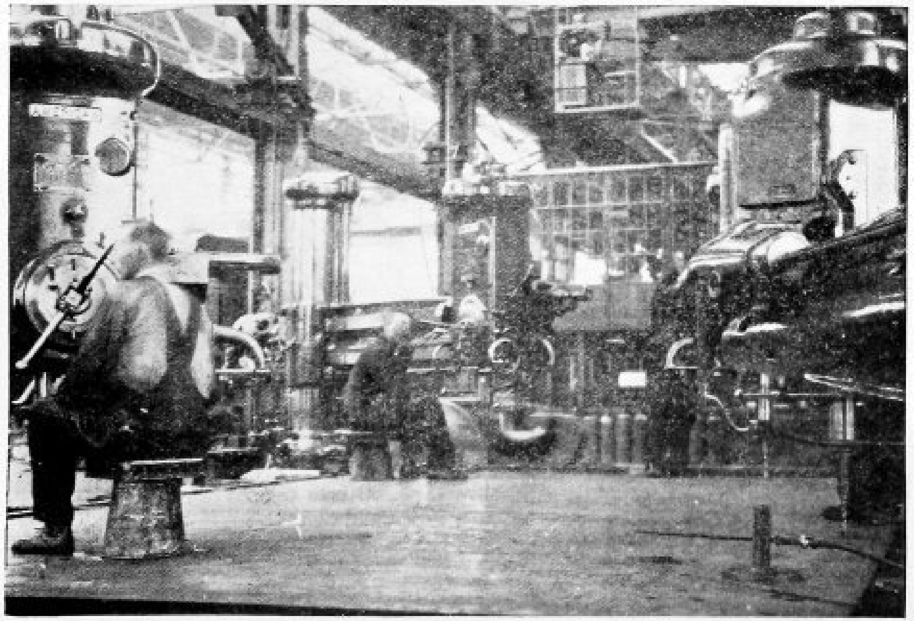
The shop averages about 33 repairs a month, a typical month's work showing six *class 2* repairs with new fireboxes; twelve *class 3* or general repairs; sixteen *class 4*, heavy running repairs and one *class 5* or accident repair. In addition five class 4 and five class 5 repairs are gotten out in the Huntington round-house, all machine and boiler work being done in the main shop. The shop, however, is equipped to handle practically as many firebox jobs as are required on the road. So much of this miscellaneous



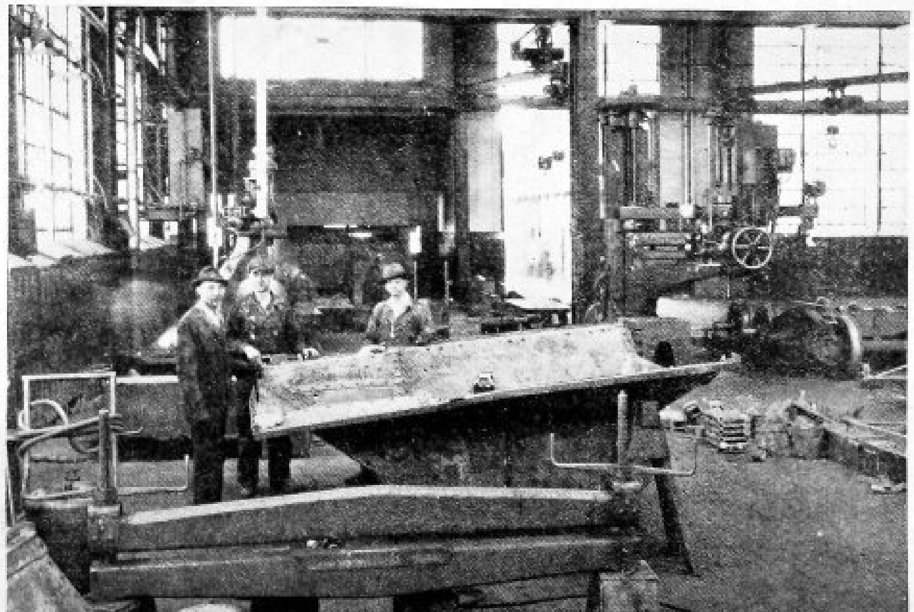
Flanging and laying out departments



One of the four radials in use for boring tube holes



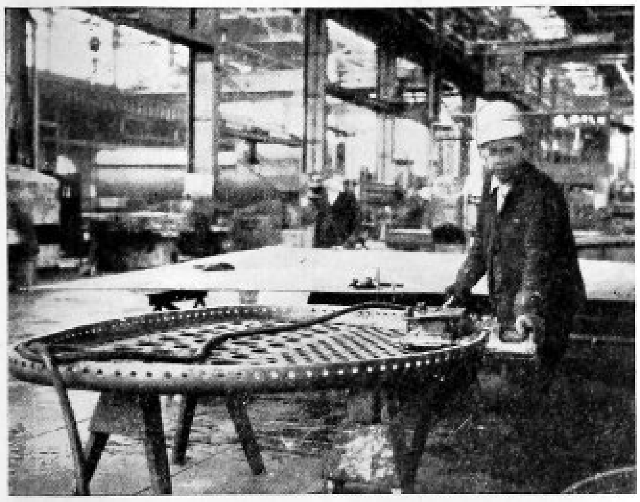
Four radial drills are used for multiple boiler sheet drilling



The ashpan department is located in the north end of the shop work is carried out for other shops on the system that it is actually difficult to estimate what the production is at any given time. All such outside work is carried on without interfering in any way with the regular shop schedule. As noted previously, the shop at Huntington is the main shop for the Chesapeake and Ohio railway and much manufacturing for the entire system is centralized here. Boilers requiring new fireboxes where they are of the smaller type are stripped and brought to the Huntington boiler shop where the firebox is installed and then shipped back to the outside point for erecting. In the case of Mallet engines, the boilers are kept in stock and when a new boiler or new firebox is required the old one is removed in the Mallet shop and a new one applied. Extra boilers for H-4, G-7 and G-9 engines, one each, are always maintained in stock and serve about 500 locomotives.

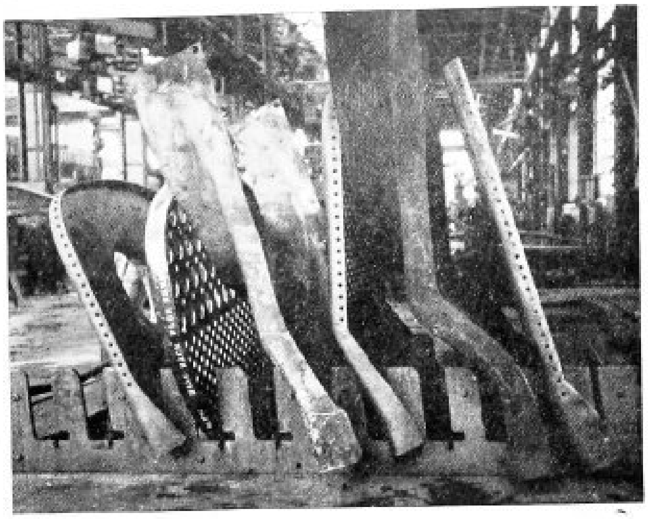
A complete record is kept of every repair on a locomotive from the time it is new. This record includes data on the installation of new sheets, in which case the manufacturer's record is noted, including information on the heat number, physical characteristics, etc.

When a locomotive comes in for scheduled repairs it is of course subjected to a careful inspection during the process of stripping and if there are any signs of corrosion in the shell, reports are made up and, together with a sketch, are sent to the mechanical engineer's office where it is decided whether to apply a new shell, patch, or what other method will be followed to repair the boiler. In order to save time one of the general boiler foremen's assistants is on duty at Huntington to figure out the requirements in every case of this kind. From a careful inspection of a boiler which has pitted or corroded and subsequent calculations he determines the proper repair; that is, the installation of one-half or three-quarter side sheet, new firebox or patches which are to be designed, or whatever other work is necessary to bring the boiler up to its required safety factor. When his calculations are completed, the findings are forwarded to the mechanical engineer's office at Richmond where they are considered in connection with the general report on the boiler. The repair is then confirmed or such changes as may be necessary made. Since the majority of repairs of this character are made according to his report, delays are prevented that would otherwise occur if all matters of this kind had to be handled at long distance from Richmond.



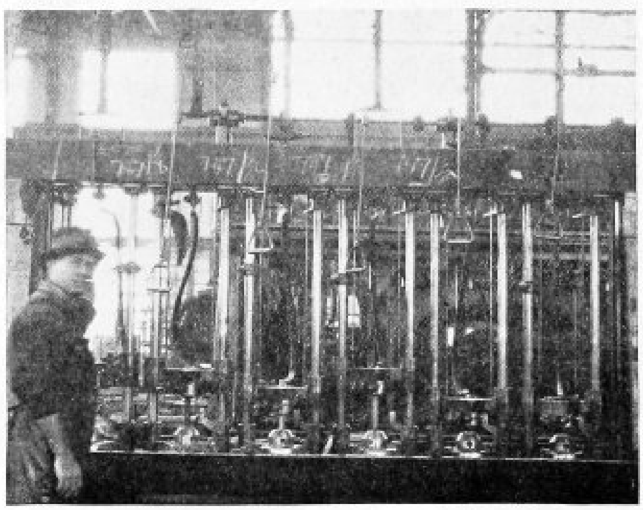
Putting the finishing touches on a tube sheet

The actual procedure for repair work after a locomotive has been stripped and the boiler brought to the shop begins of course with the stock orders for material. These are sent out to the material storage yard which is located at the northeast side of the new boiler shop. In this yard is kept a full stock of standard sheets of all sizes and thicknesses required by any of the various classes of engines, standard domes, bars, rods and other materials up to complete fireboxes. As it is required, material is delivered each day on order cards arranged by each department. All materials are loaded on a car which is brought to the south end of the shop from where it is distributed by overhead cranes to the boiler or tank department or wherever else it is needed. Separate layout departments are provided for the boiler and the tank shop so that sheets for either one are delivered to the respective layout floors for marking if the job is a special one and requires a new layout. If, on the other hand, the sheet is a standard firebox, wrapper, or side sheet or any of the other standards, except flue sheets or heads where templates are maintained for laying out, the sheet is placed at once at the drill presses. The template is placed on the sheet, or usually sheets, and drilled. Two to five sheets are handled at one time on the radial drills mentioned in the previous article. The schedule system provides that when a number of the same class engines are to come to the shop for repairs within a certain time all sheets that are required for replacement are drilled from the templates together.

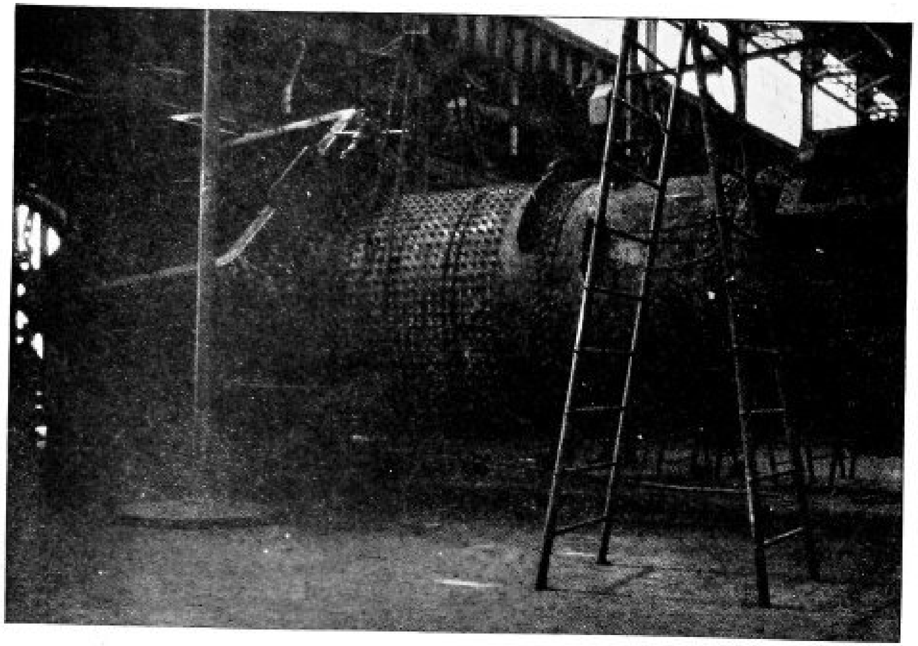


Rack for holding flanged sheets while cooling

The sheet is then moved to the flanging department where the bevel shears are located and it is cut to shape, scarfed

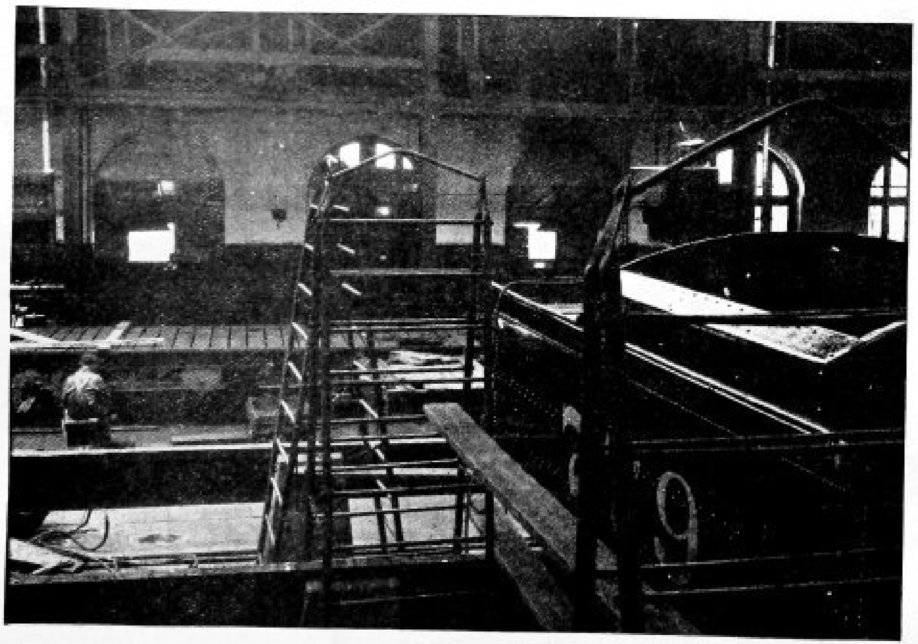


Drilling tell-tale holes in staybolts

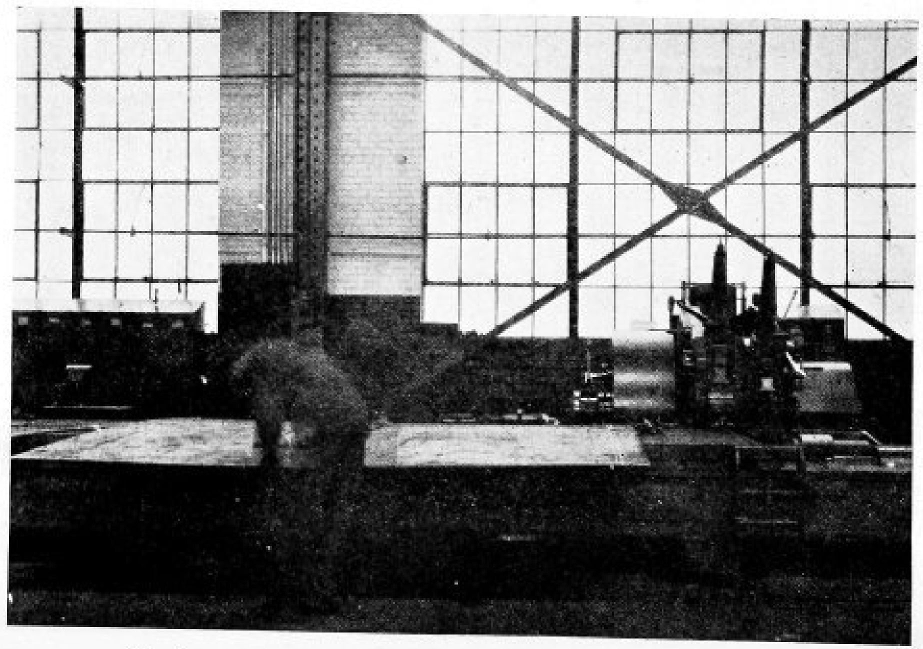


Method employed at Huntington for turning locomotive boilers

Safe-ended tubes on trucks ready for installation in boilers



One corner of the tank department



Spacing table and punch in tank fabricating department and otherwise fabricated to size. When this operation is completed, the sheet is removed to the 24-foot bending rolls where it is rolled to the proper shape. The next operation is to fabricate the firebox and rivet it up ready for the installation of flue and door sheets. These latter sheets are brought from the material car directly to the drill presses if templates are available and a series of them are drilled and removed to the flanging department. Door and flue sheets are annealed before flanging. The McCabe flanger is used for this work with a high degree of success. After being flanged the sheets are then placed again in the annealing furnace, straightened, worked up to the correct size and finally placed in a special rack so that they will hold their shape while cooling off. The next operation is to lay off the sheets for rivet and staybolt holes. Templates are used in most cases for this purpose. The staybolt holes are then drilled and rivet holes punched on the horizontal machine. The final operation in this department is burning off the lap to size with the torch and then chipping to the proper bevel for calking.

The sheets are next taken to the center bay where the wrapper sheets have been placed by the shop crane and the firebox is assembled, riveted, chipped and calked ready to be applied.

The boiler after it is stripped in the erecting shop is brought to the boiler shop and placed on a special rolling device where it can be easily turned. The flues are first removed, then the shell is subjected to a careful examination for defects. Alteration sketches are made, if necessary, and then the firebox is removed with the acetylene torch. The mud ring is dismantled from the firebox by burning off the rivets. The outside wrapper sheet is thoroughly cleaned and inspected, as is also the mud ring. The proper repairs are made to the mud ring and the firebox is placed in it to obtain the proper fit. The wrapper sheet, back head and throat sheet are repaired according to their requirements, after which the boiler is turned and the firebox is dropped in place. Mud ring rivets are driven by a special portable jamb riveter handled by the overhead crane. The mud ring is clipped and calked and the corners electric welded 12 inches each way from the center of the corner. Staybolt holes are tapped out and the proper length of staybolts measured. The bolts are ordered by the foreman from the stores department, applied and cut to proper length with the torch. The staybolts are driven with a pneumatic hammer.

While these operations are going on, the flues are measured and cut to length and brought from the flue department and applied. Arch pipes are next ordered and applied. Machine shop operations have gone along at the same time and have been brought to completion ready for the boiler when it comes on the test pit. A special test pit is included in the shop facilites where both hydrostatic and fire tests on the boiler are made. Oil burners are arranged for firing up the boiler, the proper drains are provided so that the tests can be made conveniently without causing disruption of other shop operations. After the tests are completed, the boiler is taken to the erecting shop for application to the frames.

Work of the Tank Department

Tank cisterns are disconnected from the engine and placed in a spur yard until the date scheduled for them. Then they are brought to the shop, removed from the trucks by the shop crane and placed on a special rack which has been built into the shop of concrete and I-beam construction. The frames are taken to the northwest corner of the shop where they are repaired. The smith fires are located in the north end and all light repairs are handled here; heavy blacksmith work has to be done in the main blacksmith shop.

The material to be fabricated for the tanks goes to the layout floor where it is properly marked and then brought to the punch and shears for these operations. The shop is equipped with a special spacing machine in conjunction with the punch which makes the work on tank sheets rapid and accurate. A set of 12-foot rolls is provided for this department where plates are properly shaped and then applied. Brunswick electric rivet heaters are used in the tank department which saves considerable time in riveting operations.

The tanks are tested hydrostatically, the water being drained into a special pit in the floor directly under the tank racks. Here again the convenience of the facilities is noticeable since when a tank is to be tested it does not have to be moved to a special pit.

An average tank requires from 4 to 8 days to complete, the work up to the final assembly depending on the extent of the repair. The department turns out 34 to 38 tank cisterns a month. All tanks for this division are repaired at Huntington. New tanks are also built at this shop.

A Few Facts About Pipe

By J. A. Shannon

A FEW days ago during the dinner recess one of the men asked the question: "What is pipe?" Everyone knew what pipe was but none could give a clear definition of the term. So consulting the dictionary we found this: "Any long tube or hollow body of wood, metal, earthenware or the like used to conduct water, steam, etc."

In the Encyclopedia Britannica pipe in the sense of a tube used for the purpose of carrying water, gas, etc., is treated under tube.

Tubes play an importance part in engineering and other works for the conveyance of liquids or gases and are made of diverse materials and dimensions according to the purpose for which they are intended, metal pipes being of the greatest consequence. They are made either seamed or seamless. One of the earliest uses of seamed wrought iron tubes was for gun barrels, and formerly these were made by taking a strip of wrought iron, bending so that the edges overlapped and then welding by hammering, with or without the aid of grooved swages. The development of gas lighting increased the demand for tubes and in 1824 James Russell introduced the butt welded tube, in which the edges of the skelp are not made to overlap, but are brought into closest possible contact and the welding is effected in a double swage, having corresponding grooves of the diameter of the tube required; this method required no mandrel as did those previously in use. The following year saw another improvement in making these pipes, when Cornelius Whitehouse effected a butt weld by drawing the bend skelp through a die. Stronger tubes are obtained by using grooved rollers instead of a die, the skelp being mounted on a mandrel. This is the method commonly adopted at the present day for making this class of tube. Seamed tubes, especially of copper and brass, are made by brazing or soldering the edges of the skelp. Another method is to bend the edges so that they interlock, the contact being perfected by rolling. Seamless tubes, which are stronger than those just described, are made by drawing a bloom of the metal perforated by an axial hole or provided with a core of some refractory material, or, in certain cases by forcing the plastic metal by hydraulic pressure through an appropriate die. The seamless steel tube industry is now of great proportions due to its many uses in the engineering field.

Some men ask if the size of a pipe is measured on the inside or the outside; while the fact is that it is neither the one nor the other. A standard full-weight wrought iron or steel pipe one inch given size actually measures 1.315 outside and 1.05 approximately inside, and a fifteen-inch given size measures 16 inches actual outside and 15.25 approximately inside. It is readily seen that the measurement nearest to the given size is on the inside where all pipe fitters measure it, but how very easy for a novice to call a fifteen-inch pipe sixteen inches in diameter.

Here are other examples: one inch given size extra strong is 1.315 actual outside and 0.95 approximately inside; one inch given size double extra strong is 1.315 actual outside and 0.60 approximately inside. The best way when in doubt as to size is to consult tables found in all mechanical engineers' handbooks or the like.

The sizes of standard pipe are: 1/8, 1/4, 3/8, 1/2, 3/4, 1, 1 1/4, 1 1/2, 2, 2 1/2, 3, 3 1/2, 4, 4 1/2, 5 to 15 inclusive full sizes. It should be noted there is no 5/8 or 7/8 size, as many have thought. The thickness of extra strong pipe is about 1 1/2 times that of ordinary pipe, while double extra strong is about twice that of extra strong. Regardless of the weight, the outside diameter is always the same, the inside becoming smaller as the thickness is increased. This is done so the same dies and taps may be used for all pipe of a given size.

The pipe described above is sometimes called inside diameter pipe, but the larger sizes of pipe from 14 to 30 inches are made of even dimensions outside diameter and are known as O. D. pipe. The O. D. pipe is made any thickness from 1/4 to 1 1/8 inches, but the I. D. pipe is only made to the thickness given in the standard table unless ordered special.

Steel pipe has largely superseded wrought iron pipe and is usually supplied unless otherwise specified. To distinguish one from the other, iron pipe is rough in appearance and the scale on it is heavy, while the scale on steel is very light with the appearance of small blisters or bubbles, underneath which the surface is smooth and somewhat white. Steel pipe when flattened seldom breaks, and if it does, the grain will show very fine. Iron pipe when flattened breaks easily and shows a coarse fracture, due to the long fibre of this material. Steel pipe is soft and tough and is threaded without much difficulty as some believe.

Pipe Tested at Mill

All pipe is tested at the mill but no test reports are furnished unless requested. The average ultimate strength of pipe steel is 57,000 pounds per square inch. The relative strength based on numerous tests are as follows: Butt-welded steel pipe 73 percent; lap-welded steel pipe 92 percent; and for seamless steel tubes approximately 100 percent. Butt-welded wrought iron pipe is 70 percent as strong as similar butt-welded steel pipe; lap-welded wrought iron pipe is 60 percent as strong as similar lap-welded steel pipe. Tests on commercial tubes and pipes give the following average bursting pressures in pounds per square inch: Butt-welded steel 41,000; lap-welded steel 52,000; butt-welded wrought-iron 29,000; lap-welded wrought iron 31,000; seamless steel 62,000. The factor of safety for steam piping should not be less than 6. Pipe as a rule will withstand a stress of from six to eight times the pressure for which it is intended to work.

The American or Briggs pipe thread standard was formulated by Robert Briggs about the year 1882.

Red lead though not recommended may be used for making steam tight joints, but an oil and graphite packing will be found more satisfactory, and if at any time it is necessary to break a joint, it can be done easily and with less danger of crushing the pipe.

It is good policy before a pipe is screwed into position to remove any loose scale or metal chips which might injure the seats or disks of valves. Doubling the diameter of a pipe increases its capacity four times.

Master Boiler Makers' Association Topics for 1928 Convention

At a recent meeting of the executive board of the Master Boiler Makers' Association the following list of topics to be discussed at the 1928 convention of the association was approved. The committees on the various subjects named will within the next few months prepare reports which will be presented at the annual meeting and will be discussed by the convention.

Topic.

No. 1. Recommended Practice and Standards: Fusion Welding As Applied to Steam Pressure Boilers. Committee: J. A. Doarnberger, Chairman; H. L. Marsallis, J. J. Mansfield, H. H. Service, L. M. Stewart.

No. 2. What is the Most Efficient Method of Cleaning Scale That Accumulates Around the Root of Crown Bolts on the Water Side of Bolt and Crown Sheet of Locomotive Boilers? Committee: K. E. Fogarty, Chairman; H. J. Raps, Frank Jochem.

No. 3. Best and Most Economical Methods of Scaling the Inside of Locomotive Boilers When Flues and Tubes are Removed. Explain in detail tools, cost and man hours. Committee: I. J. Pool, Chairman; C. F. Petsinger, G. L. Young.

No 4. Is the Use of Self Feed Roller Expanders Injurious to the Flues, Tubes, Arch Tubes and Flue Sheets of Locomotive Boilers? Committee; W. N. Moore, Chairman; E. J. Maneval, F. J. Jenkins.

No. 5. Boiler Corrosion and Pitting. Committee: T. P. Madden, Chairman; A. H. Bell, A. W. Novak, J. A. Callahan.

No. 6. To What Extent Has the Life of Fireboxes, Staybolts and Flues Been Affected by the Present Practice of Operating Locomotives Over Several Divisions Instead of Former Practice of Only One Division? Committee: O. H. Kurlfinke, Chairman; V. H. Dunford, M. V. Milton.

No. 7. Three Types of Water Tube Boilers In Service. What Are the Advantages Over the Present Type of Stay Boilers? Committee: W. Hedaman, Chairman; M. A. Foss, J. T. McKerihan, John A. Clas.

No. 8. To report topics for 1929 convention. Franklin J. Litz, Chairman; Charles J. Longacre, Lewis E. Nicholas.

No. 9. Law: Thomas F. Powers, Chairman; Charles P. Patrick, John F. Raps.

The Chicago Pneumatic Tool Company, 6 East 44th Street, New York, N. Y., has announced the removal of its St. Louis office, service department and warehouse from 813 Hempstead Street to 1931 Washington Avenue, St. Louis, Missouri.

The Lincoln Electric Company announce the following changes and additions to the sales and service department:

L. P. Henderson, formerly connected with the Detroit office, has been transferred to Chicago in charge of welder service.

J. E. Durstine has been transferred from the experimental engineering department to welder service department at Cleveland.

J. W. Shugars of the time study department at Cleveland, and R. D. Layman, also of Cleveland, have been moved to Detroit under the direction of

Possibilities of Boiler Export Business*

Department of Commerce analysis of machinery business in foreign markets and suggestions of how these markets may be reached

By W. H. Rastall†

AMERICAN engineering enjoys a prestige throughout the world that is second to none; American machinery is sent all over the world, sent in very large quantities. This expression, machinery, is rather an unfortunate term, because people immediately think of agricultural machinery, typewriters, cash registers, vacuum cleaners and a great many things that are not of much interest to you, but if you will consider strictly industrial machinery, that is to say the equipment that goes into factories and mines and is used on construction work, you will find that last year the United States exported $156,000,000 worth. Of that $156,000,000, $18,000,000 worth went to the United Kingdom; over $3,000,000 went to Germany, your most serious competitor, and the fact that your competitors absorbed such a volume of this American equipment, is in reality the finest kind of a testimonial to the superiority of American equipment of this sort. It indicates to you most positively the prestige that American engineering and mechanical equipment enjoys in those two countries and throughout the world; and so we come upon a rather queer situation. How can you explain the fact that possibly less than 10 per cent of the boilers in Asia are American, and yet these European competitors find it necessary to come here for their equipment? The matter can be viewed in a somewhat different way. Recently, in one of the German technical papers, there was a rather long article where a prominent German engineer appeared before one of the technical societies and explained the superiority of American steam boiler room practice when compared with their own, or with European practice generally, so that it comes even a little bit closer to your own industry. If the German technical societies are constantly referring to your achievements, why is it possible that the American boiler is not found more frequently abroad?

You have been so engrossed in domestic business that you have not been thinking of the possibilities in foreign countries. In considering any business problem, any sales problem, it is always desirable to see if you cannot set up some sort of ratio or volume that you ought to attain. We, of course, in Washington would not pretend to know exactly what would be possible for you, but we can say this, that the industrial machinery manufacturers of the United States, as a whole, in shipping abroad last year, 1926, $156,000,000 worth of machinery, probably shipped 20 percent of their production and in the absence of any other figures, perhaps it is safe to infer, other things being equal, that American boiler manufacturers should be able to ship 20 percent also. It may be that this assumption is entirely unwarranted but, at any rate, it is the best figure that we in Washington have been able to discover; so that in planning your sales campaign, in planning your advertising campaign, in planning your prospects of the business generally, why is it not in order to set aside 20 percent as the volume that should be secured from overseas markets? There is substantial reason to believe that 20 percent is a conservative figure.

However, American machinery is a quality product, it is never sold abroad on the basis of price. As you get more and more into this export problem, you will receive reports from your correspondents abroad that it is difficult to sell American equipment because the prices are high, the terms are firm, while your German, British, and other competitors are willing to sell at ridiculous figures, and perhaps grant credits to make this possible. You should give no attention whatever to export business unless that business can be kept on a basis that is clean and attractive. We would not encourage you in any endeavor that is the least bit unbusinesslike. We would not encourage you to grant terms unless some businesslike method can be followed that will enable you to handle the transaction on a sound basis. We would not encourage you in anything where the price competition is such as to make the business ridiculous. Export business is not worth anything unless you can make a profit.

Now, on the other hand, if you are to sell your products abroad in the face of ridiculous prices, it will be perfectly clear to you, I think, that your products must be supported by adequate salesmanship and adequate advertising, and I am sorry to confess that as I have traveled in foreign countries, all too seldom has the American boiler and American boiler room equipment been in evidence. Very seldom will you find it supported by an aggressive sales campaign. So I am prompted to ask you, how does this come about? Why is it that 90 percent of the boilers in Asia are of European manufacture? What has happened? Your German competitor will testify to the superiority of your own equipment. The British competitor will acknowledge it, if he is pressed, and so it seems that there is here an opportunity for your organization and the Department of Commerce in Washington to get into some form of co-operation that will result in the solution of this problem.

Work of the Department of Commerce

I mention the Department of Commerce at this time because we are employed for that purpose. Congress, during the last session, appropriated $4,000,000 to this Bureau to promote American trade. With that $4,000,000 we have developed a very large organization. In Washington we occupy most of an eleven story building. We have in this country 600 employees. We have in foreign countries 500 employees. In addition to that, we are in position to call on the Consular service which has representatives in every city of importance throughout the world. We are in touch with over 1,000 men and if it is possible for your problems to be presented to these men in a way that they can be understood, then it is also possible to secure from them information that will contribute to their solution. What is it you would have us do? It is too much to believe that we have been able to read your minds and of our own initiative do exactly the best thing for the boiler industry or the American machinery industry as a whole, but anyway, I know that we have in Washington a wealth of material that you do not realize exists; we have information regarding machinery markets all over the world. Your products, when sold abroad, must be sold through some form of dealer, distributor or agent, and so, for five years, we have been trying to collect information regarding those dealers and distributors. I believe I could make this challenge, that if you grow interested in some problem in Shanghai or Johannesburg, or Berlin, or Vienna, or Buenos Aires, or

*Address before the annual meeting of the American Boiler Manufacturers' Association.

†Representative of the United States Department of Commerce, Machinery Division.

Comparative Exports of Boilers by the United Kingdom and the United States

Exported to—	1922 United States Horse-power	1922 United States Dollars	1922 United Kingdom Tonnage in thousands	1922 United Kingdom £	1922 United Kingdom Dollars	1923 United States Horse-power	1923 United States Dollars	1923 United Kingdom Tonnage in thousands	1923 United Kingdom £	1923 United Kingdom Dollars	1924 United States Horse-power	1924 United States Dollars	1924 United Kingdom Tonnage in thousands	1924 United Kingdom £	1924 United Kingdom Dollars	1925 United States Horse-power	1925 United States Dollars	1925 United Kingdom Tonnage in thousands	1925 United Kingdom £	1925 United Kingdom Dollars	1913 United Kingdom Tonnage in thousands	1913 United Kingdom £	1913 United Kingdom Dollars
1 Belgium	......	......	1.2	70,000	......	18	560	1.6	70,000	......	2	110	1.7	71,000	......	15	330	1.3	66,000	......	2.8	67,000	......
2 Denmark	35	250	0.1	11,000	......	......	......	0.3	18,000	......	......	......	0.3	13,000	......	11	744	0.6	37,000	......	0.5	13,000	......
3 France	52	1,392	0.6	52,000	......	126	3,775	0.3	23,000	......	116	3,759	0.7	48,000	......	684	16,000	0.4	28,000	......	5.0	84,000	......
4 Germany	......	......	...	......	......	5	250	...	......	......	......	......	...	......	......	10	530	...	......	......	4.4	75,000	......
5 Italy	......	......	0.7	49,000	......	......	......	0.6	28,000	......	......	......	0.8	44,000	......	12	1,100	1.7	94,000	......	1.5	43,000	......
6 Russia	......	......	...	......	......	120	5,550	1.6	78,000	......	......	......	2.7	176,000	......	151	4,227	0.08	4,000	......	3.6	159,000	......
7 Portugal	......	......	0.1	8,000	......	40	866	0.4	25,000	......	175	4,200	0.4	13,000	......	......	......	0.05	4,000	......	0.3	10,000	......
8 Rumania	380	26,084	...	......	......	40	1,966	...	......	......	......	......	...	......	......	80	1,690	...	......	......	...	......	......
9 Spain	3	190	0.4	37,000	......	73	2,721	0.8	44,000	......	......	......	0.7	44,000	......	500	33,000	0.5	43,000	......	2.2	68,000	......
10 Sweden	5	100	...	......	......	......	......	...	......	......	31	809	...	......	......	2	190	...	......	......	...	......	......
11 United Kingdom	130	1,120	...	......	......	3	125	...	......	......	22	584	...	......	......	93	1,901	...	......	......	...	......	......
12 Canada	3,497	35,292	0.5	41,000	......	2,818	54,244	0.3	11,000	......	2,693	47,098	0.3	16,000	......	4,496	65,189	0.03	2,000	......	2.6	71,000	......
13 U. S. A.	......	......	...	......	......	......	......	...	......	......	......	......	...	......	......	......	......	...	......	......	0.1	3,000	......
14 British Honduras	185	3,777	...	......	......	104	3,297	...	......	......	151	2,078	...	......	......	23	420	...	......	......	...	......	......
15 Honduras	448	10,363	...	......	......	940	29,365	...	......	......	916	26,350	...	......	......	414	9,130	...	......	......	...	......	......
16 Costa Rica	17	1,412	...	......	......	296	9,054	...	......	......	202	8,339	...	......	......	302	12,593	...	......	......	...	......	......
17 Guatemala	30	1,674	...	......	......	133	4,663	...	......	......	121	5,480	...	......	......	401	9,494	...	......	......	...	......	......
18 Nicaragua	......	......	...	......	......	134	2,757	...	......	......	485	14,804	...	......	......	1,124	27,016	...	......	......	...	......	......
19 Panama	115	2,678	...	......	......	269	6,116	...	......	......	2,052	49,385	...	......	......	715	19,987	...	......	......	...	......	......
20 Salvador	356	6,106	...	......	......	411	7,721	...	......	......	402	8,968	...	......	......	207	5,158	...	......	......	...	......	......
21 Mexico	13,033	247,171	0.3	24,000	......	9,180	176,478	0.3	16,000	......	14,027	346,969	0.3	18,000	......	14,420	335,515	0.2	12,000	......	2.4	56,000	......
22 Newfoundland and Labrador	34	358	...	......	......	501	17,788	...	......	......	293	4,445	...	......	......	55	1,393	...	......	......	...	......	......
23 Jamaica	......	......	...	......	......	35	1,601	...	......	......	140	4,066	...	......	......	93	2,100	...	......	......	...	......	......
24 Trinidad and Tobago	142	4,700	...	......	......	40	1,800	...	......	......	72	1,703	...	......	......	832	21,798	...	......	......	...	......	......
25 Other Br. West Indies	845	9,245	...	......	......	66	5,640	...	......	......	221	4,681	...	......	......	148	3,814	...	......	......	...	......	......
26 Cuba	19,337	370,600	...	......	......	23,308	552,169	...	......	......	24,585	488,638	...	......	......	19,161	365,060	...	......	......	...	......	......
27 Dominican Republic	2,044	40,820	...	......	......	811	17,883	...	......	......	1,746	46,779	...	......	......	1,878	43,411	...	......	......	...	......	......
28 Dutch West Indies	40	750	...	......	......	......	......	...	......	......	108	4,800	...	......	......	1,150	30,935	...	......	......	...	......	......
29 Haiti	196	4,901	...	......	......	112	3,943	...	......	......	191	4,978	...	......	......	165	6,510	...	......	......	...	......	......
30 Argentina	1,611	85,414	0.5	37,000	......	3,727	103,400	0.6	40,000	......	2,238	71,912	1.5	69,000	......	3,732	112,658	1.3	65,000	......	2.2	92,000	......
31 Bolivia	10	375	...	......	......	60	4,251	...	......	......	60	1,723	...	......	......	419	12,613	...	......	......	...	......	......
32 Brazil	11,428	30,521	0.7	43,000	......	1,351	54,239	0.7	44,000	......	3,267	102,730	1.1	96,000	......	3,821	115,635	0.8	40,000	......	1.6	50,000	......
33 Chile	954	16,110	0.4	29,000	......	339	14,340	0.7	30,000	......	536	17,975	0.4	24,000	......	124	4,708	0.6	30,000	......	2.3	65,000	......
34 Colombia	1,096	57,877	...	......	......	2,488	63,865	...	......	......	3,572	92,035	...	......	......	2,010	63,512	...	......	......	...	......	......
35 Ecuador	299	10,516	...	......	......	460	14,612	...	......	......	122	6,126	...	......	......	123	4,072	...	......	......	...	......	......
36 Peru	911	22,856	...	......	......	1,066	29,024	...	......	......	1,132	36,454	...	......	......	1,390	31,142	...	......	......	...	......	......
37 Uruguay	40	1,089	...	......	......	50	1,200	...	......	......	20	962	...	......	......	41	1,989	...	......	......	...	......	......
38 Venezuela	1,617	38,507	...	......	......	3,675	86,859	...	......	......	7,276	167,258	...	......	......	13,543	335,620	...	......	......	...	......	......
39 British India	300	8,461	10.6	678,000	......	437	14,715	8.9	448,000	......	576	11,799	7.7	336,000	......	616	12,876	8.5	408,000	......	9.3	246,000	......
40 China	1,321	27,435	1.9	148,000	......	771	16,568	2.2	106,000	......	1,741	35,593	1.2	67,000	......	892	25,670	1.0	71,000	......	0.2	42,000	......
41 Hongkong	......	......	...	......	......	......	......	...	......	......	......	......	...	......	......	620	9,686	...	......	......	...	......	......
42 Japan	1,843	58,025	3.5	253,000	......	1,007	46,391	3.0	140,000	......	6,311	148,259	5.8	232,000	......	1,907	51,044	4.1	197,000	......	2.0	45,000	......
43 Philippine Islands	1,599	63,812	...	......	......	3,195	54,493	...	......	......	2,969	65,020	...	......	......	4,555	98,828	...	......	......	...	......	......
44 Australia	......	......	2.9	222,000	......	32	1,340	1.8	106,000	......	69	3,700	2.4	131,000	......	12	709	1.3	96,000	......	4.7	136,000	......
45 New Zealand	800	19,790	0.3	30,000	......	......	......	0.5	29,000	......	109	2,435	0.3	15,000	......	72	1,843	0.1	9,000	......	0.3	7,000	......
46 Br. South Africa	......	......	1.0	117,000	......	7	263	1.5	102,000	......	50	2,920	2.7	185,000	......	7	436	0.9	46,000	......	4.3	98,000	......
47 Portuguese E. Africa	......	......	0.6	36,000	......	......	......	0.4	23,000	......	......	......	...	2,000	......	......	......	2.7	130,000	......	1.1	30,000	......
48 Netherlands	......	......	1.5	186,000	......	......	......	1.1	51,000	......	......	......	0.6	31,000	......	2	150	1.4	88,000	......	1.9	42,000	......
49 Other countries	1,253	30,335	5.2	417,000	......	817	17,038	5.8	338,000	......	716	18,530	6.2	339,000	......	1,139	27,310	8.5	492,000	......	13.2	271,000	......
Total	66,006	1,240,106	33.0	2,488,000	11,019,850	59,065	1,432,930	33.4	1,770,000	8,097,396	79,515	1,864,454	37.8	1,970,000	8,701,687	82,167	1,929,736	36.1	1,962,000	9,474,302	68.5	1,773,000	8,628,305
Value per hp.	......	1,879	...	......	......	......	2,426	...	......	......	......	2,345	...	......	......	......	2,349	...	......	......	...	......	......
Value per ton	......	......	...	75.5	......	......	......	...	53.0	......	......	......	...	52.1	......	......	......	...	54.3	......	...	25.8	......
Production	1,577,908	......	...	......	......	2,063,392	......	...	......	......	1,819,374	......	...	......	......	1,836,529	......	...	......	......	...	......	......
Export ratio	4.2%	......	...	......	......	2.9%	......	...	......	......	4.4%	......	...	......	......	4.5%	......	...	......	......	...	......	......
Note—American statistics do not include heating boilers.																							
Ratio of U. S. to U. K. exports	......	11.2%	...	......	......	......	17.7%	...	......	......	......	21.5%	...	......	......	......	20.3%	...	......	......	...	......	......

any other important city, you care to mention, I think I have in my own office in Washington information from which I could give you as much data regarding machinery dealers and distributors in any of those cities as you could get yourself if you went there and stayed two weeks. That is a pretty strong statement, but I think I realize just the strength and the importance of it. Now is that information of any value to you? It is yours for the asking.

There are other directions in which we have been working. We realize that one of the first things that comes up when you consider shipping a boiler to some foreign market, is the law of that country regarding its construction and operation, and so we have collected in Washington a file of these laws for the entire world. Any time you get an inquiry that involves a shipment of a boiler anywhere, we will be very glad to lend you the appropriate law. Now in all these things we realize that you are serious and we realize that you know that we are serious, and we will lend you these reports regarding dealers abroad, or we will lend these boiler laws to you, and ask that as soon as you have finished with them, you send them back to us. Our experience for some years now has been very gratifying. The boiler manufacturers of the country who have used this material, and the machinery manufacturers are very good, they return them promptly and in an undamaged condition, so that they are perfectly serviceable for the next man who needs them. Furthermore, we are making efforts to keep this information down to date, and through the co-operation of these men abroad, we are sending out now for a complete check-up on the laws of all foreign countries and a revision of this dealer information.

Facilities of the Machinery Division

In organizing that Division, we have felt that we should employ men who have sold machinery in some foreign country for a considerable length of time and in an important volume. We have three such men; one of these was in the Caribbean area for some little time and in British India; he is a very good salesman; he knows what is involved in getting a factory full of machinery ten thousand miles away, making the wheels turn, and collecting what is due on the contract and forwarding it promptly. Another man was sent out by the Chicago Pneumatic Tool Company. He went to Paris, opened an office, and after the staff had became experienced, turned the business over to them and went on to Rotterdam, where he repeated the process. He has made market studies for the Chicago Pneumatic Tool Company in practically every country in Europe. In my own experience of nine years in Asia and two rather extensive visits in Europe. We like to feel that here is a combination of experience of a very practical character, and that we can sit down with you and help you solve your export problems that come up, and we want you to come to Washington whenever you can, and come into the Division and sit down with us and go over these problems.

As to the participation of the American boiler manufacturing industry in the trade of various countries, you will find that in China the United States furnished approximately 15 percent, the British 45 percent, and Germany 14 percent. In Japan the United States furnished 20 percent, the British 71 percent, and Germany 2 percent. In British India, the United States furnished less than 1 percent, the British 89 percent, and the Germans 7 percent. In Colombia, the United States furnished 91 percent, and in Venezuela, 76 percent. Probably you will have some difficulty in reconciling those figures. On the table herewith you will find a detailed statement showing the participation of the United States and the United Kingdom in the boiler business of some 48 foreign countries over a period of several years. Unfortunately it is not possible to give you the full figures for the year 1913, because the American Customs did not at that time require a separate classification for boilers, but you can at least compare the tonnage from the United Kingdom and value in pounds sterling and in dollars, and then the other years you can compare the American values in dollars, but instead of tonnage, the American returns are taken in horsepower, and you will also get from these figures a rather interesting index number as to the volume per horsepower during the various years and the value per ton.

I would again remind you that this is a matter on which we want your direction. The figures as presented to you merely represent our own initiative. Probably it is presumptuous for me to say whether you want these figures collected on the basis of horsepower or heating surface or tonnage or something else, but in the absence of any instructions from you, we have been taking them on the basis of horsepower. Possibly that is unfortunate since the British take their figures on a tonnage basis. If those figures are unsatisfactory in any way, it is in your hands to correct the situation. If you feel that we should modify our practice, we will be very glad to do so, but it will be necessary for you to direct us.

Classification of Boilers

The next question that arises here is a matter of classification. I imagine you would like to know to what extent these are watertube boilers, firetube boilers, vertical boilers, locomotive type boilers, or something else. It is impossible to get any subdivision of that kind covering the years that are past. These figures are based on an export declaration that accompanies the shipment when it goes through the customs, and no finer classification has been required, but we could easily arrange for a finer classification if your industry demands it. There are two objections I usually meet when this situation arises: one is, by the statistical section for lack of funds, another is, that we try to avoid introducing any classes involving less than $200,000 a year. On that basis you are entitled to something like seven or eight classes, so that if the boiler industry of this country is really interested, we could probably arrange, beginning, say, in January next year, to collect figures that would show in greater detail whether these are power plant boilers or oil country boilers or some other type that you might be interested in. If you will notice the returns for the oil countries, Venezuela and some of the others, you will probably satisfy yourself that these are substantially oil country boilers. In some of the other instances, by looking at the figures and comparing the horsepower and the price, you could draw your own deductions as to whether they are or are not large power plant boilers. In addition, we issue each month statistics showing the countries to which orders were shipped during that month.

Economy in Combustion Practice

A survey was made in Washington recently with regard to economy in the use of coal in the United States and it showed quite clearly that during something like five years, considering central electric stations and locomotive equipment and almost everything that consumes coal, we have shown an increase in efficiency of something over 25 percent. Europe knows that. Engineers all over the world know that. They are exceedingly anxious to take advantage of the progress you have made. They want the last word in boiler room practice. I wonder if it is not possible to set up some form of sales campaign in those foreign countries? Perhaps a campaign where the boiler manufacturers co-operate with the stoker manufacturer and the economizer manufacturer and the feedwater heater man, and power fuel manufacturers, or whoever may be interested and see if you cannot put forward a concerted sales effort. All the world knows that American development of this character represents the last word in progress. They want to take advantage of that progress, and yet where is this sales effort? Personally I have not seen it, in this sense. It may be that individual manufacturers have made an individual effort, in an individual country. I know a number of such instances, but frankly, it seems from these figures that the time has come for a real campaign. It seems that there is an opportunity to do something constructive. American engineering and American machinery have the prestige I have mentioned, and your own equipment is entitled to a definite prestige, your own achievements are undoubtedly the last word in progress. Now why is it that there is such a feeble effort abroad? The problem is yours, and if you can co-operate, we will be most happy.

Domestic Problems

I know from experience with the old return tubular boiler association, that your industry is confronted with a whole series of problems. You have an excess of manufacturing capacity; you have a form of competition which is unpleasant and unsatisfactory; you are indulging in various business sins. It is unnecessary to go into details, but it will reassure you to know, perhaps, that the other branches of the machinery industry in this country are in the same fix. The machine tool industry is struggling with the same problems. The textile machinery manufacturers have the same problems and so it has occurred to us that an opportunity exists to do constructive work in connection with the domestic side of your business. I have gone to certain gentlemen in Washington who are in control of some of this work and have asked them to make a study regarding the machinery equipment of the United States, with respect to depreciation. Your cost accountants, your business men generally, your insurance companies, and others realize that there is something wrong with this matter of depreciation. Do we handle it as we really should? And so it has occurred to me that perhaps your group, in co-operation with these other groups mentioned, and perhaps many others, could legitimately ask the government of the United States, provided this appeals to you, to make a study of depreciation.

The *American Machinist* recently made a series of surveys of the machine tools in certain shops in this country, through a sampling process where they are trying to find out regarding this same matter of use, and they found that 44 percent of the machines in use in the country were over 10 years old, yet the machinery manufacturers will tell you promptly that any machine that is ten years old is obsolete. Closely related to this matter of depreciation is obsolescence. How many of the factory managers of the United States have a clear idea regarding obsolescence, and the way it should be handled on their books, the way it should be handled for taxation purposes? Should it be handled the same way for both purposes, or is there a difference? If obsolescence should be handled one way for business and another way for taxation, perhaps there is something wrong with our tax laws, and perhaps a study of this kind would reveal inconsistencies that could be corrected.

Now a third question, would there not be real progress if a real investigation were made as to when a machine should be scrapped? To what extent do the industries of this country know when a machine should be scrapped? It occurs to me that there is a very definite opportunity for study along those lines. Do not misunderstand me; I do not mention these things with the idea that anything of a very wonderful or mysterious nature would be produced, but we had this little experience about five years ago. You would frequently read in your trade paper and your newspaper or in reports from consuls abroad or in letters received from machinery dealers abroad that the American manufacturers should sell abroad on credit. You would see repeated statements that he could not hope to get anywhere in export business unless he did. My own experience is exactly the reverse. I have sold millions of dollars worth of machinery abroad and never sold any of it on credit. I have watched my competitors who sold many times more than I did and I never saw them sell any on credit. I have known Germans, particularly, to sell on credit and on unbusinesslike terms, and it generally resulted in trouble. We wrote a booklet on this subject and revised it many times before we released it, but after we gave it a release, we had a broad distribution; it was sent to the machinery builders abroad and to the consuls everywhere. We received letters of criticism from all over the world but I can assure you that from the time that book was released until now, I have not seen any articles published demanding that Americans export machinery on credit. It may be that we are taking too much credit to ourselves on that, but after all, this little booklet was simply a statement of the problems we should certainly consider when about to export machinery on credit. Would it help you in your machinery problems if there were similar little books issued indicating the line of thought a business man should follow when considering such subjects as depreciation, obsolescense and the question of when to scrap? There may be other directions that have not as yet occurred to me, but at any rate there is in the Department of Commerce an organization that is set up to cooperate with you in the solution of such problems.

New British Boiler Specifications

AMONG the recent engineering specifications issued by the British Engineering Standards Association is one dealing with corrugated furnaces and smoke tubes for marine boilers. The specification is divided into two sections. One section deals with plain and stay smoke tubes for marine boilers and covers their manufacture and lays down expanding and hydraulic tests and a weight tolerance. The tubes may be of two types—those enlarged at one end and those of uniform thickness throughout. The stay tubes are threaded to the British Standard Whitworth form, having nine threads to the inch.

The other section of the specification relates to furnaces of the Morison, Fox, Leeds-Forge and Deighton types, all of which are interchangeable.

An Improved Design for Vertical Steam Boilers

By N. Wignall

IN these days of high efficiency it would no doubt cause surprise to most engineers to know the quantity of boilers which are at present in use and are *still being manufactured*, which cannot by any stretch of imagination be considered efficient. True, most of these are small units, as large power users of today are certainly all out for efficiency and obtain it, but there are thousands of small users, not necessarily engineers themselves, who, if they require a boiler, purchase one which will certainly do the duty asked, as guaranteed by the manufacturers, but only very rarely are questions asked concerning fuel consumption, performance, life of boiler, etc. Perhaps the fuel bill in any case is not a large one, therefore nobody worries, but if it were possible to take count of all the small boilers in use throughout the world with a thermal efficiency of say round about 55 percent, and then calculate the quantity of fuel saved to the world annually if this efficiency were raised to about 75 percent, the figures would no doubt prove astounding.

The type of boiler which the writer particularly has in mind, and which, in his opinion, would head the list, is the vertical cross tube, a boiler which is used universally, and, with the gases running to waste at practically furnace temperature, bears the same comparison to an efficient boiler unit as the open fireplace bears to a modern central heating plant. Yet it is cheap and if anybody were to suggest to the manufacturers that they offer something more efficient, they would say the customer would not pay more when he could get some other firm to supply the vertical cross tube 30 percent cheaper than the boiler they would offer. But would he really do so if everything was made clear to him? Is it not partly the manufacturers' fault for not widespreading information, on the grounds that it does not matter to him really what sort of boilers are sold so long as they are sold? Yet can the manufacturers be blamed for so thinking if the people who purchase do not take the trouble to find things out for themselves? Apart from the cross tube type, the vertical multitubular boiler is certainly an improvement as regards efficiency, but the same cannot be said of the construction, as witness the trouble with leaking tubes in the bottom tube plates and in any case the short life of the tubes caused through burning out above the water level.

General Arrangement of Boiler

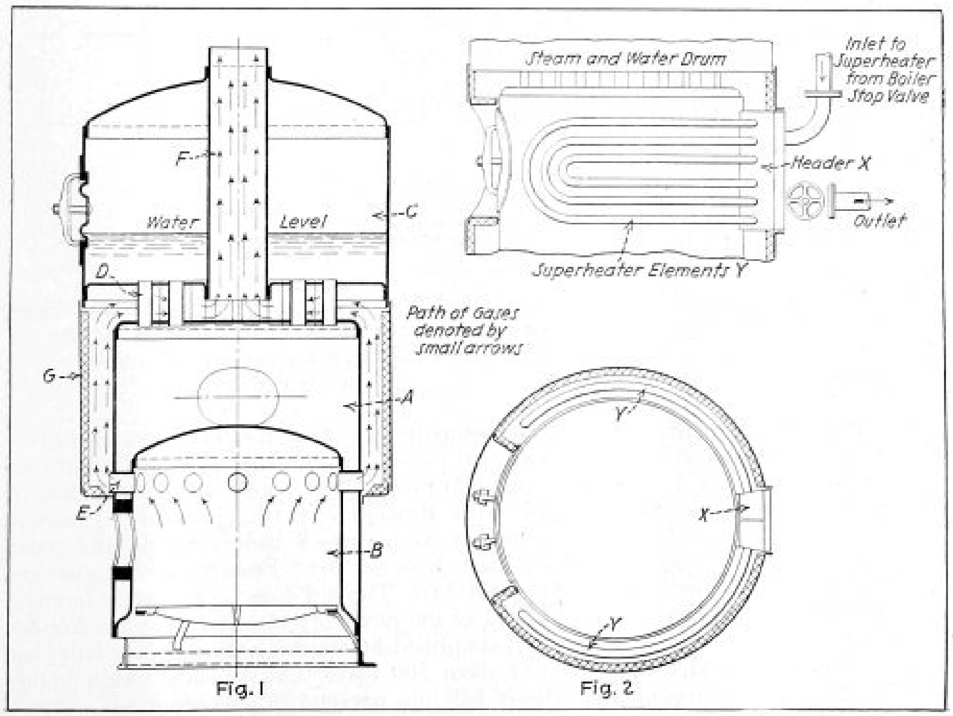
The boiler described in this article was designed to overcome the troubles usually encountered in the types of boilers already mentioned, and it is left to the reader's own opinion as to what extent this has been successful. The general arrangement of the boiler is shown in Fig 1. It will be seen to be composed essentially of three main parts, (1) a lower water drum *A*, in which is located (2) the usual combustion chamber *B*, and (3) an upper steam and water drum *C*, connected to the lower drum by a number of water tubes *D*, expanded into both tube plates. The products of combustion are led from the firebox through short smoke nipples *E* to the outside of the shell, into a smoke chamber enclosed by an insulated casing *G*, secured to the upper and lower drums. Incidentally this chamber can be utilized as a superheater chamber of which more will be said later. From here the gases pass between the upper and lower drums, among the watertubes to the central flue *F*, and thence to the atmosphere.

Ready access can be obtained to the internal parts of the boiler by large manholes in the upper and lower components, the smoke casing round this latter being flanged inwards as illustrated in Fig 2. The smoke casing itself can be made either in two or three parts and entirely removable, or alternatively, in the case of larger boilers, have one or two access doors and removable strips round the bottom of the casing to facilitate cleaning through the smoke nipples. There are of course the usual mudholes round the bottom of the water jacket.

It will be noted that the boiler can be machine riveted throughout during construction. The design allows of a boiler very well proportioned as regards heating surface and grate area. For instance a boiler 9 feet high by 4 feet diameter (quite an average size for vertical cross tubes), has a heating surface of 120 square feet with 7 square feet grate area. It will thus be seen that the design provides about 30 percent more heating surface than the cross tube type, which in a boiler of the same dimensions, gives the same grate area, but only about 90 square feet heating surface.

Novel Superheater Chamber

The provision of a superheater chamber may be regarded as a distinct novelty as regards this class of boiler and yet a most useful addition. Any amount of small vertical boilers are in use where superheated steam is required, but with these, special arrangements have to be provided in addition to the usual design of the boiler. The construction of the superheater is shown in Fig. 2 and will be seen to be a very simple design. A welded header *X* is studded to the shell of the lower water drum. This header is divided into two portions, top and bottom, and the superheater elements *Y*, composed of solid drawn steel *U* tubes, are expanded in and shaped round the circumference of the shell. The steam from the boiler is simply led into the upper chamber of the header, passes through the *U* tubes and out of the lower chamber as superheated steam. It should be noted that the superheater header will have to be halved longitudinally and jointed to enable the superheater to be removed from the boiler when it is desired to do so.



New design vertical boiler

It is not proposed to go into any details of construction here, but perhaps it would be as well to discuss one point which has been queried once or twice (incidentally this is the only part of the design which has been queried) i. e. the effect of the smoke nipples between the firebox and the outer shell when the fire is lighted. In the writer's opinion the expansion will be nothing like what we get in the vertical cross tube boiler owing to the top of the firebox not being fixed rigidly by any central flue. All the firebox is surrounded by water on one side which will tend to keep down expansion and of course the height of the firebox is smaller than that of the cross tube type. Therefore the nipples could be practically regarded as a row of stays, such as we very often get on the firebox of the cross tube boiler. Of course, reasonable care should be exercised in lighting up as in any other type.

Unloading a Steam Boiler

By James F. Hobart

A 6 by 16-foot horizontal return tubular steam boiler had to be unloaded from a flat car which had 18-inch side boards permanently in place. The boiler was to be placed upon a heavy truck which, when placed in position beside the freight car, was found to be three feet below the level of the car side boards.

Only a very few tools were available, a 3-ton screw jack, a two-ton rope hoist and plenty of rope slings, chains and crowbars. The boiler had no skids underneath it, not even plank shoes or bearers. Indeed, the boiler laid so closely upon the car floor that it was impossible to even pass a rope under the boiler without first raising it up.

Some pieces of board 16-inches long were cut and placed side by side until 24-inches in width had been built up. Then, strips of board were placed the other way and nailed securely to the first layer of boards. The first strip was set back nearly twice its thickness from the ends of the lower layer of boards. Other layers of boards were then nailed in place, each layer being "corbelled" back at a distance that would make the corners of the board layers lie at an angle of about 30 degrees with the first or crosswise layer of boards. When about 6 inches of thickness had been nailed up, and the wedge-shaped block thus formed when placed under the screw-jack would tilt that device to an angle of about 30 degrees from the vertical, or, so the jack would stand at an angle of about 60 degrees.

The jack was placed upon the wedge above described, which was so arranged that the jack bore against the boiler at about the middle of the boiler length. Two pieces of board were then placed on the car upon the side opposite to the jack, and near either end of the boiler. The jack was then screwed up, and the boiler rolled upon the boards upon which another board was placed as soon as the boiler had climbed the first one.

When the jack, had been screwed out to its safe-limit, blockings were built at either end of the boiler on the side where the jack was located, after which the jack was moved to the opposite side of the boiler, and made to roll the boiler back again upon other board thicknesses. This movement was continued until the boiler had been raised up level, with the top edges of the car side boards.

Two 8 by 8-inch timbers, each 16 feet long, had been hunted out for skids to reach from the car to the truck. Three 4-inch bolts were also provided, four of them being eye bolts, each 12 inches long. The other two were plain bolts, each long enough to reach through the eyes of two of the long bolts and also through the 8-inch timber.

"Cob-house" blocking was built under each skid timber midway between car and truck, then a couple of blocks were bedded into the railroad ballast alongside the track, and posts or "shores" or 4 by 6-inch timbers were placed one upon each block, and under the car end of each skid-timber.

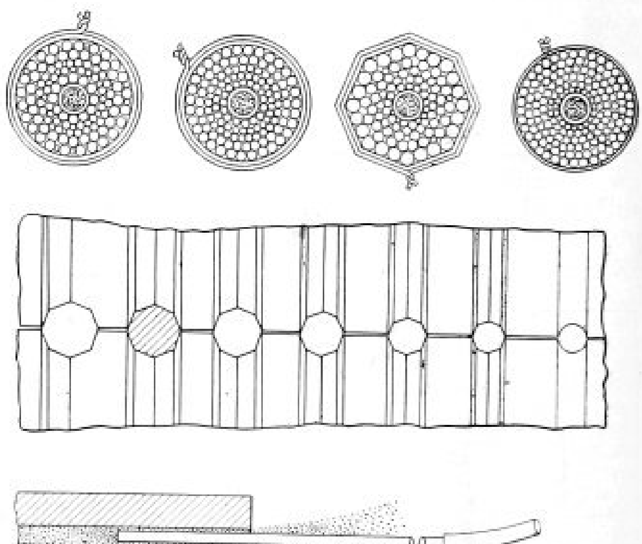
Two holes were bored through the wooden side boards of the railroad car, close beside the skid-timbers. Two of the eye-bolts were pushed through these holes, then a hole was bored through the timber and the plain bolt passed through the bolts and timber, and screwed home. The skid timbers were thus attached to the stout board of the freight car.

Before commencing operations, the freight car had been pinch barred along the track until the middle of the boiler was opposite a tree which chanced to be beside the track. Had there been no tree, or suitable object to which rope tackle could be made fast, a "dead-man" or a post, would have been put into the ground. Two long ropes, $1\frac{1}{2}$ inches in diameter, were each carried from the tree, over the boiler, each wound three times around it, the ends tucked under and the ropes pulled tight.

One of the ropes was "snubbed" around the tree and placed in the hands of a reliable man. The rope tackle was hauled almost "chock-a-block" taut and made fast to the second rope around the boiler. Then the boiler was jacked and pried over, upon the skids until its rolling weight was sustained by the rope tackle, which was slackened cautiously, and the boiler allowed to roll slowly down the skids, which had been carefully located so as to clear the supporting lugs of the boiler. When the rope tackle had been slacked off until most of its rope was between the blocks, the other large rope was snubbed to hold the boiler from rolling, and another hitch made with the rope tackle and these several operations were repeated until the boiler was in place upon the truck. The time required was 3 hours and 15 minutes using 4 men, and not including the time spent in forging the bolts and in getting tools and material upon the spot.

Seamless Hollow Rolled Staybolt Bars

THE Old Dominion Iron & Steel Works, Belle Isle, Richmond, Va., is now using a patented process to manufacture on a production basis hollow staybolt iron. The process consists essentially of building up a hollow fagot by arranging the rods around a hollow metal core, heating the fagot to a welding and rolling temperature, rolling the heated fagot down to the required size, at the same time preserving the desired direction of the hole through the axis of the bar. The core of the fagot is filled



The top view shows four methods of building up the billet—The center view shows a detail of the rolls and the bottom view shows how the bore of the finished bar is cleaned

with a refractory material. After the billet is brought to a welding heat, it is passed through a series of polygonal rolls instead of circular rolls. The reason for this is that by passing the billet through a series of circular passes, a twisting action is set up which badly distorts and sometimes closes the hole in the bar. From 16 to 20 passes are used to finish the bar. The last pass is circular in form.

The removal of the refractory material from the finished bar has been simplified by chucking the bar in a lathe and turning it at about 500 r.p.m. At the same time a hollow metal tube is fed into one end of the cored bar. Air is blown through the metal tube to remove the dust.

Dictionary of Locomotive Boiler Terms

Definitions of boiler parts adopted by Master Boiler Makers Association at annual convention

At the recent annual convention of the Master Boiler Makers Association, W. H. Laughridge, chairman of the committee on "Standard Boiler Terms" proposed that the association adopt such portions of the "Dictionary of Terms" appearing in the *Locomotive Cyclopedia* published by the Simmons-Boardman Publishing Company, New York, as applied to boiler work. The convention passed the motion unanimously and adopted the definitions of terms which for the benefit of members of the association and all others connected with locomotive boiler work appear in part below. The first section appeared on page 171 of the June issue. Further instalments of these terms will be published in later issues.

Definition of Terms

C

Cab. A shelter built of wood or sheet steel, enclosing the back end of the boiler for the protection of the enginemen. On locomotives having broad (Wootten) fireboxes, two cabs are frequently built; one on the waist of the boiler like a saddle; the other, much smaller, to shelter the fireman at the back end. With the latter type, a roof on the forward end of the tender is frequently used, the tender cab roof being slightly lower than that on the engine. See LOCOMOTIVES, INSPECTION and TESTING.

Chain Riveting. A name applied to one method of setting rivets in boiler seams. Two parallel rows of rivets are put in with each rivet of one row exactly opposite a rivet in the other row.

Cinder Cleaning Hole. A circular opening in one side of a smokebox. It is for the insertion of a rod or poker by means of which the cinders are pushed down in the cinder pipe at the bottom of the smokebox. The hole is closed by a cast iron lid, secured in place by a cam and handle. Also called smokebox cleaning hole.

Cinder Hole. A circular opening in the bottom of a smokebox to which the cinder pipe or hopper is attached. Also called spark hole.

Cinder Pipe. A cast iron tube bolted to the under side of the smokebox and passing down between the frames to discharge cinders or sparks into a pit or other receptacle. Also called spark hopper pipe or cinder chute.

Cinder Pipe Bracket. A support for the cinder pipe.

Cinder Pocket. A hopper, beneath a smokebox. Also called spark pocket.

Cinder Pocket Ring. A heavy iron ring, riveted around the cinder pipe opening at the bottom of a smokebox to furnish a means of attachment for the cinder pipe.

Cinder Pocket Slide. SEE CINDER VALVE, HOPPER.

Cinder Valve. Another name for the sliding piece used to open and close a cinder pipe under a smokebox.

Cinder Valve Cap. A cover fitted on the lower end of a cinder pipe.

Cinder Valve Chain. A chain attached at one end to the smokebox and at the other to the cap or cover on the lower end of a cinder pipe, to prevent the cap from being lost.

Cinder Valve Hole. A hole cut in the smokebox shell to which the cinder valve is attached. Usually placed on the bottom center line ahead of the exhaust steam pipes.

Circumferential Riveting. The row or rows of rivets that fasten one section of the shell of a boiler to the adjoining piece on the circumference of the plate.

Cleaning Hole. See CINDER CLEANING HOLE.

Cleaning Hole Cover. A cover or lid secured by a handle and a cam on the inside for closing a cleaning hole in the side of the smokebox. Also called cleaning hole cap or plate.

Cleaning Hole Flange. A casting riveted to the smokebox shell around the cleaning hole, to which the cover is attached.

Cleaning Pipe. See PETTICOAT PIPE.

Columbia Type Locomotive (2-4-2). A locomotive having a two-wheel front truck, two pairs of coupled driving wheels and a two-wheel trailing truck. Now used principally as light engines for logging or switching purposes.

Combustion Chamber. A compartment or space in a locomotive boiler between the firebox and smokebox. Its purpose is to promote combustion and secure additional heat from the gases before they enter the tubes. The space between the firebox and the back tube sheet is called a built-in combustion chamber. The back tube sheet is in this case set from 8 to 72 inches ahead of the throat of the firebox, because with wide, shallow fireboxes the tubes give trouble by leaking unless kept away from the direct heat of the burning coal, where they are subjected to sudden and decided changes of temperature. The combustion chamber is used on many locomotives with long boilers. See FIREBOXES.

A discussion of the value of the combustion chamber will be found in the report of the Locomotive Boiler Committee in the Master Mechanics' Proceedings, 1912, page 114.

Combustion Chamber Brace. A brace in the form of a rod or bar tying the shell of a built-in combustion chamber to the boiler shell.

Combustion Chamber Course. That section of a boiler shell in which the combustion chamber is located. In some designs the dome course and combustion chamber course are identical.

Compound Locomotive. A steam locomotive having two or more cylinders so arranged that the exhaust steam passes from one cylinder into another cylinder or cylinders, where it performs additional work before being discharged from the exhaust nozzle and stack. See MALLET ARTICULATED TRIPLEX COMPOUND LOCOMOTIVE.

Conical Boiler. A boiler having a shell made up of one or more cylindrical courses of uniform diameter next to the firebox, a conical connection or course tapering down to smaller diameter, the taper extending entirely around the boiler, and one or more adjoining cylindrical courses of reduced and uniform diameter next to the smokebox. See BOILERS.

Conical Connection or Course (Boilers). That plate or course of a boiler having a tapering shape, or of larger diameter at one end than at the other. In a wagon top boiler it comes next to the firebox and in an extended wagon top boiler one or more straight courses are put in between it and the firebox. In these types of boilers the taper is placed on the top and sides of the boiler, as distinguished from conical type boilers, where the taper extends entirely around the boiler. Some straight top boilers have a conical course with the taper on the bottom, next to the firebox, to provide more water space between the tubes and shell. See BOILERS.

Consolidation Locomotive (2-8-0). A locomotive having a two-wheel front truck and four pairs of coupled driving wheels, but no trailing truck. Used for slow, heavy freight service.

Corner Grate. A grate bar shaped to fit the corners of the firebox. Usually it is stationary and not connected with the shaking grates.

Corrugated Firebox. See VANDERBILT BOILER, LENTZ BOILER.

Cross Compound Locomotive. A two-cylinder compound locomotive having its high-pressure cylinder on one side and its low-pressure cylinder on the other side of the engine.

Crosstie. A transverse brace for strengthening a locomotive or truck frame. The main frame crossties are designated according to location, as top or bottom crosstie, back or front of cylinder; back of firebox; at back, main intermediate or front pedestal, and under firebox. Usually a steel casting. See EXPANSION CROSSTIE, PEDESTAL CROSSTIE.

Crosstie Shoe. A metal piece attached to the foundation ring of a wide firebox, resting upon a special type of frame crosstie, to allow a slight movement of the firebox due to expansion and contraction.

Crow Foot. A boiler brace foot made in triangular form and riveted to the boiler plate. Usually used to fasten the back head and tube sheet stays to the boiler brace.

Crown Bar. A beam extending across the water space above the crown sheet of wagon top boilers to support the stay bolts holding up the crown sheets where the opening for the steam dome prevents staying the crown sheet to the roof sheet. They are usually supported at the ends by castings resting on the top edges of the side sheets of the firebox and by sling stays from the roof sheet or dome shell. Thimbles on the crown sheet stay bolts maintain the proper spacing between the crown sheet and the crown bars. Not now in general use.

Crown Bar Bolt. A bolt passing through the crown bar and supporting the crown sheet. They are encased in crown bar thimbles to preserve the proper space between the crown sheet and the crown bar.

Crown Bar Foot. That portion of the lower edge of the crown bar that rests upon the side sheets of the firebox.

Crown Bar Link. A short rod or link to connect a crown bar with a brace.

Crown Bar Separator. See CROWN BAR THIMBLE.

Crown Bar Sling. A rod secured to the crown bar and supporting it from above by being bolted at its upper end to a bracket riveted to the roof sheet or dome shell.

Crown Bar Sling Eye Bolt. An eye bolt screwed into a crown bar for attaching it to a crown bar sling.

Crown Bar Sling Pins. The bolts or pins holding the crown bar slings at the top and bottom.

Crown Bar Thimble. A short, hollow bolt or spaces through which a crown bar bolt passes, placed between the crown sheet and the lower side of the crown bar.

Crown Brass. See DRIVING BOX BRASS.

Crown Sheet. A sheet or plate directly over the fire and forming the roof of a firebox. Being exposed to an intense heat on one side and covered with water on the other, there is a violent formation of steam on its surface. Crown sheets are sometimes made flat and sometimes curved. They are also made in one continous sheet with the firebox side sheets. In any case, they must be strongly supported, and this is accomplished either by crown bars, radial stays, or in the case of the Belpaire firebox, straight vertical and horizontal stays.

Crown Stay. A stay bolt connecting the crown sheet of a boiler with the roof sheet. It performs the same functions for the crown sheet as the stay bolt does for the side sheets.

D

Damper. See ASHPAN DAMPER.

Damper Regulator. A lever connected to the dampers of a fire pan on an oil burning locomotive for the purpose of regulating the amount of air to be admitted to the firebox.

Dash Plate. A plate or plates placed across the inside of a boiler above the fire tubes to prevent the water surging when the locomotive is in motion. Also called swash plate.

Dead Grate. A portion of a grate that is made without any openings for the admission of air. Generally placed near the ends or sides of a firebox, as in those places the combustion is less active than in the center, and with open grates the fire cannot be kept hot enough. Also called dead plate. See GRATE.

Dead Plate. See DEAD GRATE.

Decapod Locomotive (2-10-0). A locomotive having a two-wheel front truck and five pairs of coupled driving wheels, but no trailing truck. Used for heavy drag freight service.

Deck. The floor or platform of the cab on which the engine crew stand. Called also foot plate and foot board. It is commonly made of cast iron and serves to tie the back ends of the frames together, and to form a holder or drawhead for the tender drawbar.

Deflector. An iron plate in the smokebox pointing downwards from just above the top rows of tubes to deflect or throw down the sparks and cinders to the bottom of the smokebox. More commonly diaphragm.

Deflector Angle. An angle secured to the inside of a smokebox to hold a deflector in position.

Deflector Plate. See DEFLECTOR.

Diamond Boiler Seam. A type of boiler joint in which the the ends of the plates are welded, and a large diamond-shaped welt is riveted to the inside of the seam, the outside welt being of the usual design.

Diaphragm. A thin wall or partition.
(Smokeboxes.) A deflector or baffle plate, placed just ahead of the tube sheet to deflect sparks to the bottom of the smokebox and to equalize the draft through the tubes.

Diaphragm Apron. A plate projecting downward from the front end of the table plate in a smokebox for the purpose of throwing the sparks downward before they encounter the netting.

Dome. A cylindrical reservoir on top of a boiler and secured to it by riveting through a heavy flanged collar. In recent designs the dome shell has been made in one pressed steel piece and riveted directly to the boiler shell. Its purpose is to collect and hold dry steam. The dry steam passes through the throttle valve, located in the dome, dry pipe and steam pipes to the steam chest from which it is delivered to the cylinders, through the valves and steam ports. See AUXILIARY DOME, BOILERS.

Dome Base. The flange riveted to the boiler shell around the opening for the dome, and to which the dome shell is riveted. Also called DOME FLANGE and DOME COLLAR.

Dome Brace. A brace secured inside the dome at one end and to the crown bars at the other, to support and strengthen the sides of the dome. Used only in wagon top boilers.

Dome Brace Foot. A lug or projection on the lower end of a dome brace for securing it to a crown bar.

Dome Cap. See DOME COVER.

Dome Casing. The outside sheathing or jacket of a dome used to protect the lagging anu to present a finished appearance.

Dome Casing Base. The base fitted to the boiler jacket on which the dome casing rests.

Dome Casing Ring. The cylindrical section of a dome casing between the base and the top.

Dome Casing Top. The sheet steel, hemispherical cover on a steam or sand dome. It is usually fitted flush with the dome casing ring.

Dome Collar. See DOME BASE.

Dome Course. That plate or course of a boiler in which the dome is located. In a wagon top boiler it is identical with the roof sheet and sometimes the conical course, as the case may be. In an extended wagon top, straight top or conical type boiler it may be one of the other courses.

Dome Cover. The lid which is bolted to the dome ring and forms top of dome.

Dome Joint Ring. A flanged ring riveted to an opening in the top of a boiler and to the base of the dome to fasten the dome to the boiler shell. It is usually reinforced by another ring, inside the dome, called a dome stiffening ring.

Dome Liner. A plate riveted to the inside of the boiler shell around the dome opening to strengthen it.

Dome Ring. A heavy cast iron ring riveted to the upper edge of a dome and having a flange to which the dome cover is bolted.

Dome Shell. A plate, either of one pressed steel piece, or several built-up sections which form the dome.

Dome Stiffening Ring. A heavy ring, made of steel boiler plate, riveted to the dome at its base and to the dome joint ring which secures it to the shell of the boiler.

Door. That which closes an opening in a wall or partition. See FIREBOX DOOR, CAB DOOR.

Door Sheet. The back sheet of the firebox which contains the door.

Double-Ender Locomotive. A locomotive adapted to run equally well in either direction. Usually the tender is supported on an extension of the main frames and guiding trucks are placed at both ends of the locomotive. Used for switching, suburban and branch line service where turntables are not available.

Draft Pan. See FIRE PAN.

Draft Pipe. See PETTICOAT PIPE.

Drop Grate. A grate bar of large size which can be dropped independently of the other grate bars for the purpose of dumping the fuel and ashes into the ashpan.

Dry Pipe. A pipe conveying steam from the throttle valve and throttle stand pipe in the dome to the steam pipes in the smokebox. It is usually placed inside the boiler and supported by hangers riveted to the boiler shell, but on some designs it has been placed outside and along the top of the boiler, in which case it is lagged and jacketed.

Dry Pipe Bridle or **Hanger.** An iron band or yoke for holding the dry pipe and throttle pipe firmly in line.

Dry Pipe Elbow. The right-angle bend in the dry pipe at the point where the vertical section of the throttle pipe in the dome joins the horizontal dry pipe running through the boiler to the front flue sheet. In some designs the dry pipe elbow is made in a separate casting and fitted to the dry pipe.

Dry Pipe End. The end of the dry pipe attached to the tee or niggerhead from which the steam pipes lead to the steam chests. Commonly refers to the design in which the dry pipe is secured directly to the tee head without the use of a dry pipe sleeve.

Dry Pipe Sleeve. A cylindrical casting fitted to the dry pipe at the flue sheet end, and passing through the sheet. It connects the dry pipe to the tee or niggerhead by a ground ball joint.

Dummy Locomotive. A term sometimes applied to switching locomotives having the boiler and running gear entirely housed. Used for service in public streets.

Dump Grate. See DROP GRATE.

(To be continued)

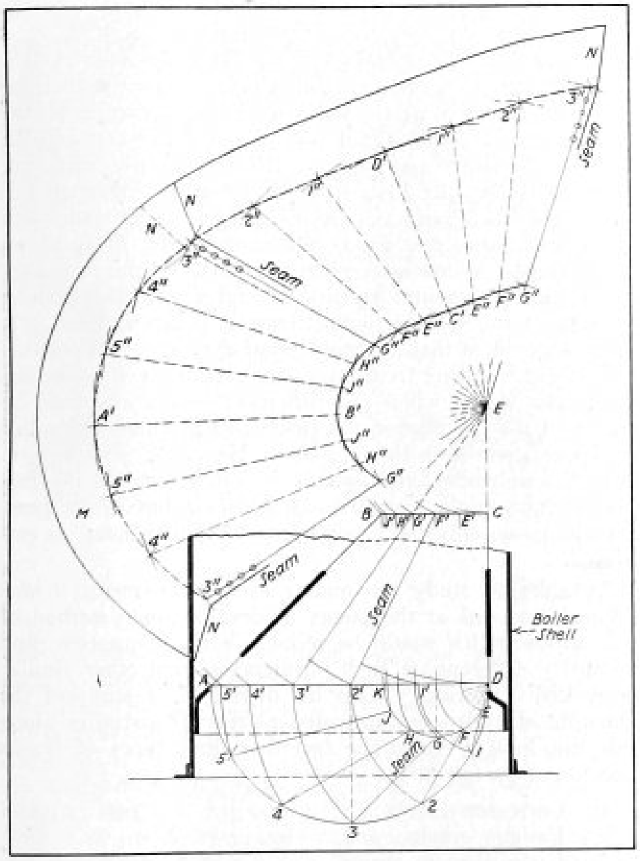
Layout of an Oblique or Scalene Cone

By I. J. Haddon

A B C D is the elevation of a scalene conical firebox, and is fitted to multitubular donkey or upright boilers, such as the Cockran type.

Produce the sides *A-B* and *D-C* until they meet in *E*. Draw the semicircles representing the half plan as shown. From *D* as center and radius *D1*, *D2*, *D3*, etc., draw arcs to the line *A-D* as shown in 1′, 2′, 3′, etc. Draw lines from 1, 2, 3, etc., to *D* cutting the small semicircle in *E*, *F*, *G*, etc.

With *D* as center and radius *D E*, *D F*, *D G*, etc., describe arcs to the line *A-D* and project these to the line *B-C* in *E′*, *F′*, *G′*, etc. Now if *1′ E′*, *2′ F′*, *3′ G′*, etc., were connected they would represent the true lengths of *1E*, *2F*, *3G*, etc., shown in the plan, but it is not necessary to draw them as we only require their respective positions on the lines *A-D* and *B-C* as shown.



Layout for conical course on vertical boiler

The firebox is generally made in two plates, with the seams as shown on the sides, as at *3G* in the plan, therefore:

From *E* as center and radius *E3′*, *E4′*, *E5′*, etc., describe arcs in the development as shown at the bottom, also draw the arcs with *E* as center as *EG′*, *EH′*, *EJ′*, etc.

At any convenient place draw a line cutting the arcs drawn from *3′* and *G′* in *3″* and *G″*. This line will represent the center line through the seam holes as shown. From *3″* step around from arc to arc the distance *D1* shown in the plan, such as *4″*, *5″*, *A′*, etc. Draw lines from *4″*, *5″*, *A′*, etc., towards the point *E* and cutting the arcs already drawn at the top in *H″*, *J″*, *B′*, etc. A fair curve drawn through these points will be the development of the cone as far as *A B C D* is concerned.

Note: The semicircle *A—5—4—3—2—1—D* should be divided into any number of equal parts.

Now measure along the center of the thickness of the iron, the length required to form the joggled part below *A* and *D* and set it out as shown at *M*, allow a little extra material on at the corners of each plate as shown at *N* because when joggling the plates at the fire the parts such as at *5″*, *A′*, *5″* will stretch, where as at *N* there will be only bend and will shorten at the corners. The two corners of the plates that are required to be next to the shell of the boiler, should be thinned at the forge fire before joggling to shape. Both plates should be rolled to their correct curvature and bolted together before joggling the bottom, as it will be found to be more convenient to manipulate and the parts *N* will be both bent at the same time and will be sure to fit together correctly.

The lines shown on the developed plate are rolling lines.

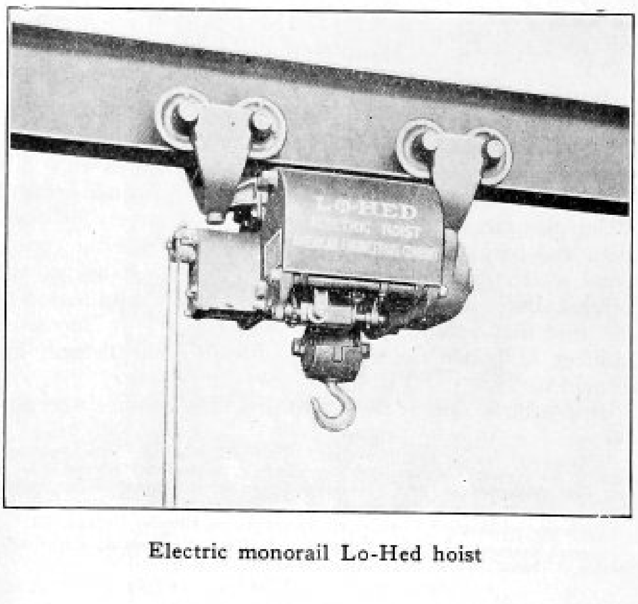
Monorail Hoist Operates with Low Headroom

A MOTOR trolley electric monorail hoist that operates in 15½ inches headroom is announced by the American Engineering Company, of Philadelphia, as an addition to its line of Lo-Hed hoists.

This hoist is built in half ton and ton sizes and is similar in construction to the standard Class A Lo-Hed hoist, except that it is mounted on an 8-wheel trolley that reduces the headroom requirement by more than 5 inches. It is made for operation with alternating current at 20 feet per minute or direct current at 20 to 40 feet per minute and a special high-speed hoist provides for operation at 40 feet per minute with alternating current and 40 to 80 feet per minute with direct current. Standard height of lift is 20 feet but when required a lift of 25 feet can be provided. Four ropes are used. Remote control of both hoist and trolley motors can be provided.

The manufacturer states that this hoist has been designed to meet the need for a means of handling and conveying materials under minimum headroom conditions and for lifting and moving bulky objects over crowded shop or warehouse floors, where clearance is at a minimum. It also permits the stacking of materials to a greater height in warehouse and factory storerooms.

This hoist travels around curves of short radius; shifts easily over switches and is protected from dust and moisture by metal covers. Motors are fully enclosed. The mechanical efficiency is over 80 percent.



Electric monorail Lo-Hed hoist

The Cause and Prevention of Embrittlement of Boiler Plate*

By S. W. Parr† and F. G. Straub‡

THREE types of cracks are recognized: first, those due to direct corrosion of the metal; second, those due to fatigue; and third, those which are caused by caustic solutions. Each is found to be distinctive in type, which makes it possible to recognize the embrittlement cracks when met with. A study of the areas throughout the United States where embrittlement occurs has been made, but instances of embrittlement are noted which are the result of boiler water treatment. Hence, it is more important to know the condition of the water rather than the locality from which it comes, as an index of potential danger.

A method of procedure was devised whereby the embrittlement effect could be produced at will, thus making it possible to study both the conditions under which it occurs and remedies for its prevention. The results indicate that two conditions must be present simultaneously to produce the embrittlement effect: first, the stressing of the metal above the yield point; and second, the concentration of sodium hydroxide to a point which is in excess of 350 grams per liter. Parallel tests omitting the sodium hydroxide show no effect. Tests upon various types of metal from the purest obtainable to those with a high percentage of impurities show that impurities do not modify the conditions.

Inhibition of embrittlement, so far as the experiments have gone, indicate that this might be accomplished by the elimination of localized stresses, which is assumed to be impossible. The modification or control of the chemical condition of the water has been found to be effective. Data on actual plants in use, covering a period of ten years, are consistent with the artificial embrittlement in that by maintaining a ratio of sodium sulphate to sodium hydroxide in excess of 2, no embrittlement is found to occur. Free sodium carbonate in the water is in itself not active in producing embrittlement, but contains a potential danger in that it gradually is hydrolized into the caustic form.

Photographs illustrating the cases of actual embrittlement in widely distributed regions, from Buffalo to Southern California, and from Michigan to Texas, show the wide distribution of the difficulty. Photomicrographs of both the natural and the artificially produced cracks furnish a method of identification as well as illustrate their special characteristics.

Introduction

Within recent years, a phenomenon of more or less frequent occurrence has become recognized, to which the term "the embrittlement of boiler plate" has been applied. Because of the relatively infrequent occurrence of this difficulty and the more or less obscure causes which bring it about, the fact of embrittlement has been largely in question, and both the evidence of its presence and the conditions which promote it are matters of importance at the present time. This is all the more accentuated by reason of the fact that seemingly within recent years an increased number of boiler failure chargeable to embrittlement are in evidence.

It should be said at the outset that these studies were undertaken by the Engineering Experiment Station of the University of Illinois as a continuance of former studies, under conditions which would preclude any possibility of the work being done for any manufacturing or industrial enterprise, but solely for the purpose of developing information of general interest to all, whether concerned in the production of power or the fabrication of boilers. Acknowledgment is here extended with very great appreciation to all of these sources of information.

Development of the Embrittlement Idea

It will not be necessary at this point to review the historical development of the study of the phenomenon of embrittlement. A bibliographic compilation elsewhere will be sufficient to cover that feature. Reference only will here be made to the fact that in the early stages of experience along this line, connection seems to have been made with failures of fabricated metal which was used in processes where caustic solutions were involved, as in the manufacture or use of sodium hydroxide, and under these conditions the term "caustic embrittlement" was employed. It was soon evident that a certain relation existed between embrittlement resulting from the use of actual caustic solutions and boiler waters where embrittlement seemed to occur, by reason of the fact that in the case of such boilers the water used was also shown to be caustic. Hence the general term "caustic embrittlement" which is often applied to this phenomenon might seemed to be justified, but in the present discussion only the general term "embrittlement" is employed.

In order to study the matter of embrittlement, it was deemed essential at the outset to develop some method of recognition which would be reliable without question, and distinctly differentiate such phenomena from other similar or related conditions. This led directly to a study of the cracking of rolled or fabricated plate. The studies along this line have revealed the fact that three types of cracks may occur as follows:

1. Corrosion cracks;
2. Fatigue cracks; and
3. Embrittlement cracks.

Each of these three types is distinctive and can be definitely differentiated from the others by micrographic analysis. Their characteristics may be briefly described as follows:

Corrosion Cracks.—As the name implies, such cracks are due to direct corrosion of the metal. It is well known that where parts of the metal differ in composition or physical properties from other parts due to strains, density or impurities, there exists a difference of electric potential by reason of the fact that one portion of the metal is electropositive to another. This electric potential sets up a galvanic circuit and in the presence of an electrolyte there is started a solution action on the positive side and a corrosion area is thereby developed. These corrosion areas or cracks in the case of metal under strain will follow the lines of stress as we would naturally expect. Also, since the electrolyte for producing the solvent action is accentuated or occurs in the presence of that type of ionization wherein the hydrogen ions predominate, we would expect to find such examples of corrosion in the presence of such electrolytes as nitrates, chlorides, or sulphates, and such

*This paper was presented at the 29th annual meeting of the American Society for Testing Materials. The paper is reproduced herewith as it was also presented in part and formed a special feature of the recent annual meeting of the American Boiler Manufacturers' Association.

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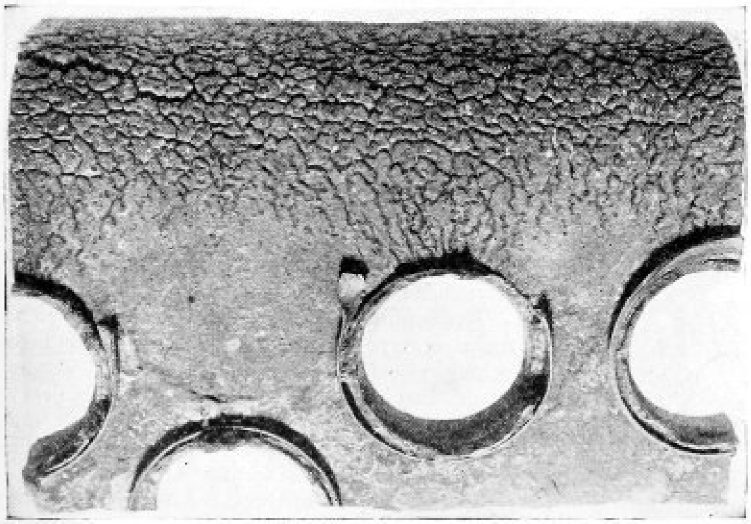
corrosion phenomena would be checked or inhibited by the presence of hydroxyl ions or that condition where an alkaline state exists. This in itself will explain why we would not expect to find corrosion cracks in boiler waters which are alkaline in character. A study of chemical corrosion as above described does not necessarily require a micrographic analysis of the structure of the corroded surface and the accompanying illustrations (Fig. 1) include both the unmagnified and the magnified surfaces of cracks of this character. One specific feature should be noted in the micrograph, namely, the direction of the cracks follows the lines of stress, and this without regard to grain areas, that is, they proceed across the grains and disregard the grain boundaries in their path of development.



(a)

(b) (×50)

Fig. 1.—Corrosion Cracking

Fatigue Cracks.—The development of cracks due to stress alone furnishes interesting illustrative material in the study of metal cracks. Because of the abundance of material available of this type from the investigations of the fatigue of metals laboratory, an illustration is here introduced (Fig. 2) because of its bearing on the general topic of cracking of plate. It seems that in metals placed under reverse strains, as failure is approached, cracks develop which upon micrographic study reveal a positive characteristic which serves as a ready method of identification. By examination of a few type specimens it is obvious that the cracks which have been started as a result of fatigue do not respect the fact of grain structure in the metal, but follow a course quite independent of grain boundaries and are hence described as cross-granular in character as opposed to inter-granular in what is known as directional development.

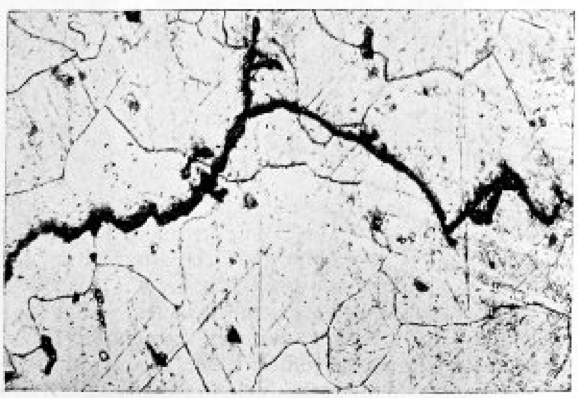


Fig. 2.—Micrograph of cracks in Armco iron (×350). Etched with 2 percent nital solution

Embrittlement Cracks.—We are now able to differentiate those cracks which accompany embrittlement from either of the above types for the reason that a micrographic study shows one distinctive characteristic which in all cases is found to accompany this type. By reference to the micrographs of embrittlement cracks, especially when the surface is etched in such manner as to bring out clearly the grain boundaries, it is very evident that without exception these embrittlement cracks follow grain boundaries. A typical micrograph illustrating the point is shown in Fig. 3.

With this very definite method of identifying any of the cracks that may occur in connection with boiler plate, it has been possible to make an extended survey of the situation geographically, as well as from the standpoint of boiler fabrication and of boiler-water treatment.

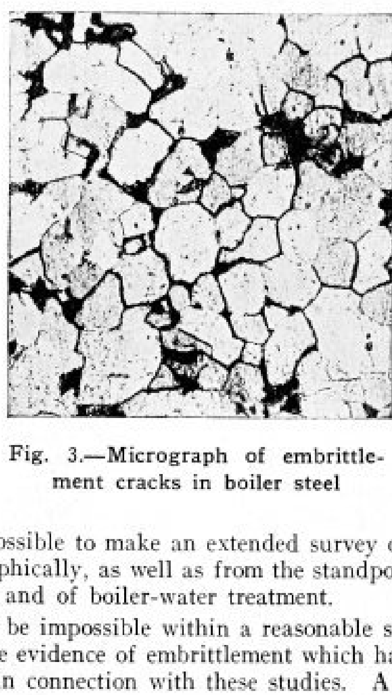


Fig. 3.—Micrograph of embrittlement cracks in boiler steel

It would be impossible within a reasonable space to give in detail the evidence of embrittlement which has thus been assembled in connection with these studies. A few typical samples only are made use of. In general the cases of embrittlement may be discussed under two headings:

1. Regional areas where a specific type of natural water exists;

2. Treated waters resulting from the direct application of a chemical resulting in embrittlement.

Under the first topic it is clearly evident that certain regional areas may be defined in which embrittlement is more evident than in other regions where embrittlement does not exist. The waters of these regions are characterized by the fact of an almost complete absence of sulphates in the water, but this phenomenon accompanies another very marked characteristic and the one which is primarily responsible for the embrittling action, namely, the presence of free sodium bicarbonate. It will thus be seen that these waters have only temporary hardness due to the presence of bicarbonates of lime, magnesium and iron, and that there is a substantial absence of sulphates of these elements. Areas of this type, without attempting to circumscribe such areas, may be in a general way located as shown on the map in Fig. 4. This does not necessarily mean that in the collection of data of this sort we pretend to cover all of the localities where waters of this type are met with. As a matter of fact, since the transition from shallow wells to deeper sources of supplies has progressed, waters from isolated wells without regard to any defined areas may be met with in almost any region.

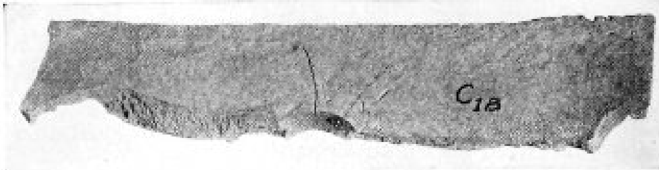


Fig. 5.—Section of cracked plate from boiler using treated water

Fig. 4.—Areas in which boilers using well waters have been embrittled

In the second case, as will be seen later, the causes of embrittlement which can be traced to water treatment are comparatively few in number, but the possibilities of such distress if even remotely present should be thoroughly understood and the knowledge of how to avoid the difficulty should be quite as eagerly sought by water-treating establishments as by the users of such water-treating formulas or apparatus.

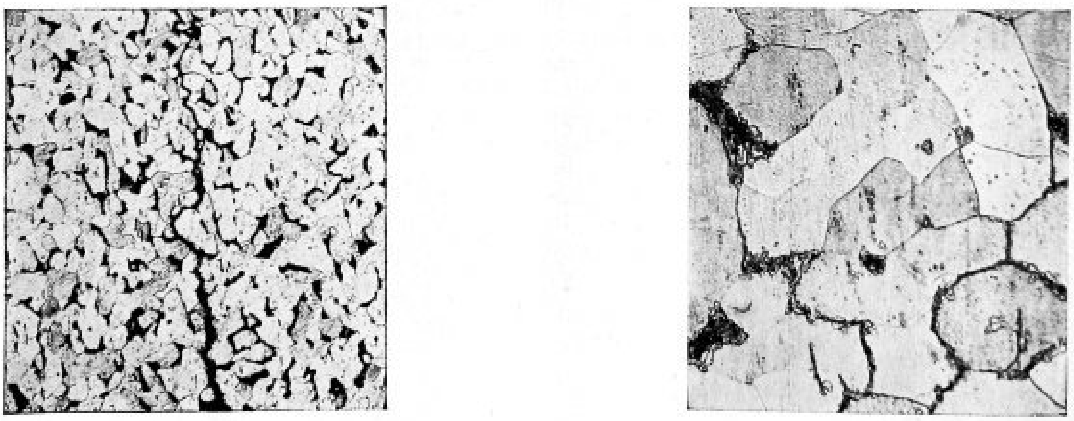
An illustration is given in Fig. 5, but it should be emphasized that it represents only one case of this type.

Two other phases of the problem should receive brief consideration.

The confining of the distress to any particular make or type of boiler is wholly without confirmatory evidence. That is to say, we have found instances of embrittlement in boilers of different makes and designs in sufficient number to warrant the statement that the embrittling effect is not confined to any particular make or type of boiler, all of the standard makes of both fire and watertube boilers having been represented in the investigation.

Embrittlement Occurs in Metals of Highest Quality

Not a little controversy has centered in the question as to whether the embrittling action may not be due to faulty composition of the iron. This question seems to have been decided in our studies to the effect that the embrittling effect occurs without regard to impurities or composition of the plate and that any defence of the embrittling distress attempting to charge it against faulty iron is without basis in fact. By this we mean that embrittlement is not confined to faulty or dirty iron, but quite as consistently occurs in iron of the best grade as otherwise. The micrographs in Fig. 6 will serve to illustrate these facts. Fig 6 (a) is a specimen that has been etched and magnified 100 diameters, while Fig. 6 (b) has been magnified to 500 diameters in order to show a typic...



(a) (×100) (b) (×500)

Fig. 6.—Micrographs of cracks in embrittled boiler plates

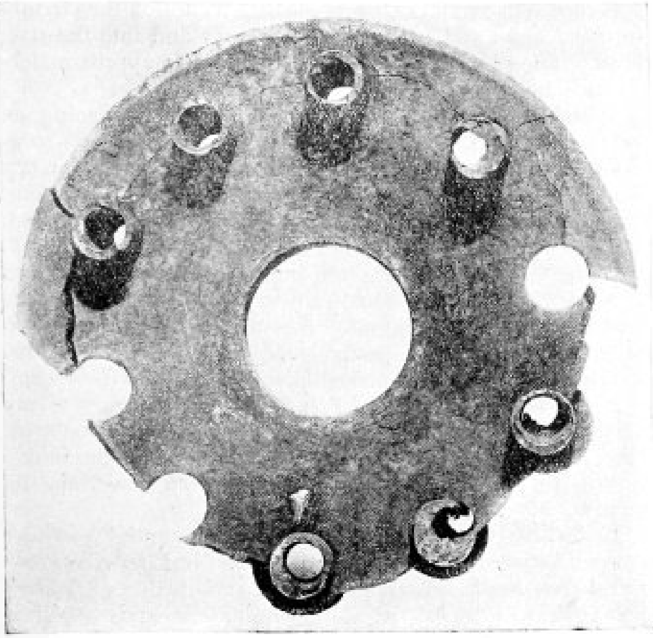


Fig. 7.—Embrittled blow-off flange

SUMMARY OF EMBRITTLEMENT CHARACTERISTICS

The salient features which are characteristics of embrittlement may be more fully understood upon a brief survey of a few typical illustrations taken from the numerous cases.

Fig. 7 for example, is a blow-off flange and it may be inferred, from the frequency with which cases of this sort are met, that the difficulty may be accentuated by the vibratory effect produced by the blowing-off process.

Fig. 8 is the outside of a drum from which twenty-six rivet heads were knocked off by sharp blows from a hammer. Figs. 3 and 6 show micrographic studies of embrittlement cracks in these same or corresponding plates which have failed in service.

The characteristics of these cracks may be summarized as follows:

1. The cracks do not follow what is generally considered the line of maximum stress;
2. They start on what is termed the dry side of the plate;
3. They run, in general, from one rivet hole to another, though they often run past each other, leaving islands of plate;
4. They are irregular in direction;
5. They never extend into the body of the plate beyond the lap of the seam;
6. There is no elongation of the plate;
7. Where extreme action has occurred, rivet heads crack off or are easily dislodged by a slight blow of the hammer.

A summary of conditions relating to the location of the cracks in the boiler may be given as follows:

1. The cracks always occur below the practical water level;
2. All the cracks are in seams under tension;
3. They occur at places where the highest localized stresses might be assumed to occur;

TABLE I—CHEMICAL ANALYSIS OF PLATES FROM EMBRITTLED BOILERS

Location of Boiler	Carbon, Percent	Manganese, Percent	Phosphorus, Percent	Sulphur, Percent
Bloomington, Ill.	0.17	0.26	0.015	0.046
Hartford, Ill.	0.22	0.35	0.017	0.024
Champaign, Ill.	0.20	0.50	0.005	0.024
Los Angeles, Cal.	0.22	0.54	0.013	0.036
Houston, Texas	0.26	0.34	0.014	0.025
Railway	0.14	0.37	0.018	0.018

4. The cracks occur in plates having practically perfect chemical composition and physical properties as well as in plates of inferior make.

Table I gives the chemical analysis of boiler plate in which a few typical cases of embrittlement have occurred. It is of interest to compare these analyses with those of standard samples of high-grade material furnished to us direct from the manufacturers for testing under a later topic, that of "Laboratory Reproduction of Embrittlement."

A summary of the chemical conditions which character-

Fig. 8.—Outside of embrittled drum in 500 horsepower boiler

TABLE II—ANALYSIS IN GRAINS PER U. S. GALLON OF WELL WATERS WHICH HAVE BEEN USED IN EMBRITTLED BOILERS

	Bloomington, Ill.	Urbana and Champaign, Ill.	DeKalb, Ill.	McHenry County, Ill.	Watseka, Ill.	Paxton, Ill.	Sycamore, Ill.	Los Angeles, Cal.	Dallas, Texas	Denver, Colo.	Houston, Texas
Calcium Carbonate	9.27	9.75	8.23	6.27	5.55	9.97	9.22	3.55	1.47	0.60	2.58
Magnesium Carbonate	6.82	6.34	4.72	5.18	2.99	6.64	6.26	0.38	1.01	0.26	0.00
Sodium Carbonate	3.21	4.52	3.93	3.12	8.82	3.96	1.99	7.71	21.70	5.96	7.1
Sodium Sulphate	0.00	0.10	0.08	0.00	0.83	2.36	0.16	5.72	11.92	1.49	0.0
Sodium Chloride	3.85	0.47	0.10	0.39	0.54	0.25	0.24	5.10	4.21	0.70	12.1
Iron Oxide and Aluminum Oxide	0.12	0.10	0.07	0.53	0.09	0.03	0.17	....	....	0.05	0.0
Silica	0.58	0.82	0.40	0.23	0.31	1.82	1.18	0.95	2.51	0.63	....
Total Solids	26.35	23.17	17.92	16.03	20.04	27.80	19.45	.....	48.50	9.69	.....

ize the water used in boilers where embrittlement has occurred is as follows:

1. Sodium carbonate is the one substance which is always present in the feed water;

2. Sulphate hardness is usually absent or of a low ratio with respect to the sodium carbonate present. Sodium sulphate is similarly lower in amount than the sodium carbonate;

3. Boilers encountering this trouble use waters having the characteristics noted under 1 and 2, and as a consequence of chemical reaction within the boiler develop a caustic condition with the sodium hydroxide in material excess over the sodium sulphate present.

Table II gives the anlysis of well waters which have been used in embrittled boilers.

(*To be continued*)

Corroded Drum Shell at Seam and Rivet

By E. N. Treat

SOME years ago while employed by an insurance company as a boiler inspector, and shortly after starting in the business, I was detailed by the chief inspector to visit an electric power station and investigate a leaking drum at the bottom of a girth seam on a large watertube boiler. Armed with my suitcase containing shoes, cap, overalls, calipers, rule, hammer and the every day outfit and with a large amount of correspondence on the defect which had not been observed until it had evidently leaked for some time, I arrived at the plant.

I was shown to the office of the chief engineer who informed me confidentially that he had just been reprimanded by the "big fellow" on account of having another case of leakage similar to this case on which I had been detailed. The remedy that the chief engineer had prescribed was to have a new course installed which had put the boiler out of commission for sveral weeks and cost the company several thousand dollars. The substance of the reprimand had been that if the chief engineer had had his assistants examine the boiler when the leak first started, it could have been calked and made tight, or a new rivet driven, in place of putting the boiler out of commission and expending considerable money for the new course. The chief informed me that the boiler inspector for the insurance company, in his opinion, was not much, and he doubted very much that the inspector had examined that part of the boiler at all, but as that could not be proven the inspector in the mind of the chief was dumb. I was also informed that my company claimed to maintain a staff of experts on boilers and repairs and that he would have the engineer on watch conduct me to the leaking drum and I could make the recommendations for the repairs, and if there was any one to be bawled out it was to be the experts and not he.

This was somewhat of an annoyance to have thrust upon me the responsibility of recommending another new course, although the chief thought it could be patched neatly by an expert boiler maker and suggested that I consider it very carefully before I recommended a new course;—although he admitted that a new course was the best bet, except that it would mean that again the "big fellow" would jump on him for allowing the second boiler to get in such a state. Summoning the engineer of the watch, the chief ordered him to show me the defect, and going to the boiler room we climbed the ladder and went in under the drum where sure enough, was the leak. The rivet had been leaking and this leakage had kept the edge of the plate wet, had corroded the edge of the plate from the rivet hole out and most of the rivet head. At the edge of the plate this corrosion had worn away about 3 inches on the circumferential seam and back toward the rivet and into the rivet head. The plate was reduced at the edge to approximately 3/8 inch and less, at the rivet hole.

It could be seen at once that no patch was going on here as it would burn off in a short time and with its location a tight patch could not be fitted and kept tight for any length of time. A new drum seemed the only way out, but on second thought I said, "All right, I will recommend, and you will be advised within a couple of hours." "Well," said the Chief, "what are you going to recommend?" and I, remembering what he had said to me about the insurance company's experts assuming the responsibility, said, "I report to my chief inspector, not you—I assume all responsibility for the recommendations I will make. A copy will be forwarded to you, I suppose." Returning to my office I told the chief inspector all about my meeting with the chief engineer and the way he had "passed the buck" to me, and went into detail in regard to the defect and its repair. My report was as follows:

Boiler No. .... center drum, circumferential seam at bottom, between first and second courses, leaking rivet, corroded rivet head and corroded drum, shell between the rivet hole and the edge of the plate, original thickness 3/4 inch reduced to approximately 3/8 inch.

Recommendation: This drum should be turned until the defective rivet can be more easily worked upon, the defective rivet removed, corroded part of rivet hole and plate be cleaned, a reliable electric welder be employed to weld up the rivet hole and reinforce the corroded portion; a new rivet hole drilled and new rivet put in; rivet head calked and welded over calking, girth seam welded at calking edges for a distance of .... inches.

That afternoon my report was received by the power company and the following morning work started in getting the drum in position for the welders, who on account of not having to furnish juice, did the job for a fraction of what the new drum cost. When repairs were finished, I was sent back to approve the work and it was a good job. The chief left word that he wanted to see me and that I should wait in his office until he returned if I finished before he returned.

The hydrostatic test was applied and no leakage was found. That noon I had lunch with the chief and smoked a good cigar after the lunch, and he told me several times that he didn't know why he had not thought of having the former drum welded as he had the latter, under recommendations made by an insurance inspector.

Obituary

Bradford McIntyre died suddenly June 8, at Miami, Fla., while there on business. His death was due to pneumonia and he was ill for a period of only twenty-four hours. Funeral services were held at his home in Birmingham, Ala., Saturday afternoon, June 11, 1927, after which the body was taken to Albany, N. Y., for burial. He was 47 years of age and since June, 1925, has been Southeastern Traveling Representative of the Pittsburgh Screw & Bolt Corporation.

B. A. Clements, president of the Rome Iron Mills, Inc., has been elected president of the American Arch Company with headquarters at New York, succeeding H. B. Slaybaugh, who has resigned. Lee Deutsch has been elected president of the Rome Iron Mills, Inc., with headquarters at New York, succeeding Mr. Clements.

The amalgamation of the sales forces of the National Machinery Company, Tiffin, Ohio, with those of the Chambersburg Engineering Company, Chambersburg, Pa., was recently completed.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Header Problem

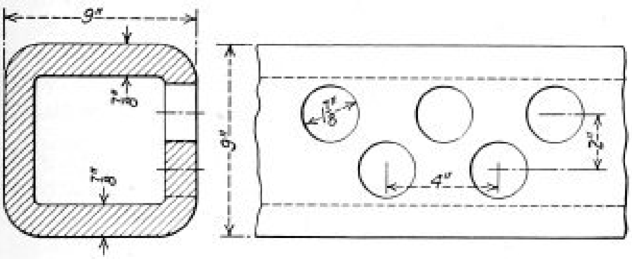
Q.—Would appreciate if you would publish in THE BOILER MAKER an answer to the following question:

How would the factor of safety be obtained on a square header, having thickness of walls, pitch, and back pitch of tube holes, as shown on attached sketch; working pressure being 225 pounds?

Trusting you will find it convenient to give this prompt attention, as I am concerned with a problem of this sort.

Thanking you for this and other considerations.—H. P. G.

A.—The rules covering headers, are given in the A. S. M. E. Boiler code, Par. 245 to 247 inclusive, and in Par. 245-246, they refer to *cast iron* and *malleable iron headers.*



Problem to determine the factor of safety of a square header

In Par. 247, the following is given: "Where no rules are given and it is impossible to calculate with a reasonable degree of accuracy the strength of the boiler structure or any part thereof, a full sized sample shall be built by the manufacturer and tested in a manner prescribed by the Boiler Code Committee and in the presence of one or more representatives appointed to witness the test."

Calculation of Boiler Heating Surface

Q.—Please inform me throgh your valuable journal the proper way to calculate the heating surface of a boiler.—H. S.

A.—To find the number of square feet of heating surface in a boiler, calculate the area of the firebox or furnace sheet, and the area of the tubes or flues in contact with the fire and the heat from the gases.

The A. S. M. E. advocate using the inside diameter of firetubes and the outside diameters of watertubes.

Only the boiler parts in contact with the water and products of combustion are considered. All surface above the brickwork and covered with brick should not be figured. The area of the tube sheet is figured by some engineers and not considered by them.

Plate Thickness and Conduction of Heat

Q.—We are considering, in some of our boilers, reducing the thickness of the firebox wrapper sheet from 3/8 inch to 5/16 inch in order to enable heat from the firebox to pass through the plate to the water in the water leg more readily.

The writer estimates that heat will pass through a 5/16-inch plate from 15 to 20 percent more readily than a 3/8-inch plate. Have you any data bearing on this subject which you could send us at an early date?—G. B. W.

A.—The transfer of heat from the furnace to the boiler is accomplished by radiation, conduction and convection. About one-half of the heat is radiated, and the transfer of heat through the boiler furnace plates takes place by conduction. It has been proved by experiment that the thickness of the plate has little influence on conduction; however thick plates, especially at joints, are liable to overheat and burn.

The practice is to make the furnace plates as light as possible consistent with the required strength of the boiler; we have no data directly bearing on the efficiency of thin plate as compared with thicker plate.

Stays and Diagonal Seams

Q.—Would like to get your interpretation on Par. 203, 1918, Code book. I am not sure about the spacing of the rivets for crow foot braces.

$$135 \times \frac{T^2}{P^2} = C \times \frac{T^2}{P^2} = P$$

8 inches $= P$
$T = \frac{9}{16}$
$C = ?$

$$135 \times \frac{T^2}{P^2} = P \text{ or } 160 \times \frac{T^2}{P^2} = P$$

Also, in April issue of THE BOILER MAKER I could not get the same answer in finding the factor for the diagonal seam.

$$\text{Factor} = \frac{2}{\sqrt{3 \times \text{Sin}^2 A + 1}}$$

Sin. of angle 30° = .5
A = 30°
.5 × .5 = .25 × 3 = .75
.75 = 30 + 1 = 23.50
$\sqrt{23.50} = 4.84$
4.84 ÷ 2 = 2.42

I would like to know where I am wrong, as THE BOILER MAKER shows 1.51.—E. M.

A.—The formula given in Par. 199 A. S. M. E. Code is to be used as explained in Par. 203a.

$$P = C \times \frac{T^2}{p^2} \qquad (1)$$

in which, P = maximum allowable working pressure, pounds per square inch.
C = Constant = 135.
T = thickness of the plate in *sixteenths* of an inch.
p = pitch in inches.

To find, T, or p when the other values are given the above formula is transposed, thus,

$$p = \frac{\sqrt{C \times T^2}}{P} \qquad (2)$$

$$T = \frac{\sqrt{P \times p^2}}{C} \qquad (3)$$

$$C = P \times \frac{p^2}{T^2} \qquad (4)$$

The formula given is not quite clear for the diagonal seam factor, it should read,

$$\text{Factor} = \frac{2}{\sqrt{3 \times (\text{sine of angle of inclination})^2 + 1}}$$

The angle of inclination is the angle the diagonal seam makes with the girth seam.

Then

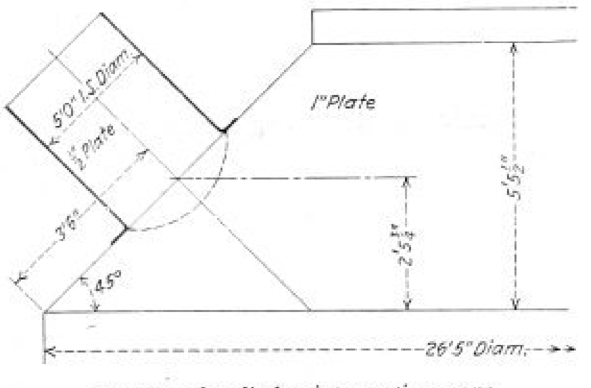
$$\text{Factor} = \frac{2}{\sqrt{3 \times .5^2 + 1}} = 1.51$$

Cylinder Intersecting a Cone at 45 Degrees

Q.—Enclosed you will find a sketch of a cone with a cylinder intersecting it at 45 degrees. Would be pleased to have you develop the complete layout, as this problem has caused much discussion—due to a previous layout in your issue of October, 1925.—T. C. K.

A.—The principles applied in the construction given for the above problem are applicable to the example you give with the following exception for thick plate work:

It is necessary in order to obtain an accurate layout for the development of the pattern for the branch pipe and for the opening in the pattern of the cone to make two sectional developments as follows:



Details of cylinder intersecting cone

First: For the pattern of the branch pipe make a layout taken at the neutral layer of the plate thickness and show the lines of development intersecting the outer surface of the cone.

Second: For the opening in the pattern of the cone, assume that the inner surface of the branch pipe intersects the neutral axis of the plate of the cone.

From these constructions the respective patterns are laid off.

The width of the flange for the branch pipe depends on the size of rivet, making the lap from the center of rivet hole from 1¼ to 1½ times the diameter of rivet hole.

If you have further trouble with this problem, make a development as you understand it and send it to us for examination.

APPRENTICES of the mechanical department of the Atchison, Topeka & Santa Fe have compiled and issued the "Iron Horse," a volume summarizing all apprentice activities for 1926.

Budget Control

The budget in business, as a means through which management achieves co-ordinated effort, conservation of resources, and more rapid turnover of merchandise inventories, is described in a 32-page booklet, "Business Control through Analysis," just issued by Ernst & Ernst, accountants, New York.

The booklet explains that in preparing the budget, an advance estimate of sales is made according to lines of merchandise and the months of the budget period. Buying allowances, production schedules, expense, collections, improvements, financing and profits are planned in the light of the sales estimate. The calculations, it is said, are based on analysis of past operating results, study of markets, trade conditions and business trends.

Any business in the retail, wholesale, manufacturing or any other field, the booklet points out, can be budgeted to some extent and to real advantage regardless of the seasons, weather, crops or other conditions.

Modern Manufacturing with a "Stable-Arc" Welder

Modern Manufacturing with a "Stable-Arc" Welder is the title of a 36-page booklet just issued by The Lincoln Electric Company, Cleveland, Ohio.

This miniature text book outlines briefly the theory of the use of arc welding in production manufacturing and illustrations are reproduced showing recent applications of the arc welding process.

The first part of the book is devoted to the replacing of iron castings by standard rolled steel sections joined by arc welding.

For the purpose of comparing costs the average price of castings is taken as six cents per pound and rolled steel at two cents per pound. A number of typical machine parts are illustrated and detailed cost figures are reproduced tending to show great economy for the arc-welded method of construction.

One section of the book is devoted to arc welding in the tool room. Jigs, fixtures, punches, dies and strippers are illustrated which were made by arc welding at a great saving in weight and cost.

There are numerous products illustrated where severe vibration must be guarded against and where manufacturers have been won over to arc welding after comprehensive tests.

Several types of "Stable-Arc" welding machines are illustrated and described.

BUSINESS NOTES

The Industrial Works, Bay City, Mich., has closed its district office at 823 South Oregon avenue, Tampa, Fla. The district office at Atlanta, Ga., in the Hurt building, will in future handle all the business of Florida, Alabama, Georgia, North Carolina, South Carolina and the eastern portion of Tennessee.

George Thomas, 3rd, has been appointed treasurer of the Lukens Steel Company, Coatesville, Pa. He was born at Whitford, Pa., and after being graduated from Haverford College, became affiliated with the Pennsylvania Steel Company at Steelton, in the open hearth department. He then served with the Standard Steel Works, Burnham, Pa., and subsequently was treasurer of the Parkesburg Iron Company, Parkesburg, Pa. He later was consecutively with the Diamond State Steel Company, Wilmington, Del., and the E. B. Leaf Company, Philadelphia, until 1908, and then returned to the Parkesburg Iron Company, as treasurer and general manager of sales.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—C. D. Thomas, Salem, Oregon.
Statistician—E. W. Farmer, Rhode Island.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.

William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.

H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.

International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Avenue, Columbus, Ohio.

Master Boiler Makers' Association

President—W. J. Murphy, division boiler foreman, Pennsylvania Railroad, Olean, N. Y.

First Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line, Waycross, Ga.

Second Vice President—George B. Usherwood, supervisor of boilers, New York Central Railroad, Syracuse, N. Y.

Third Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy Railroad, Lincoln, Neb.

Fourth Vice President—Franklin T. Litz, general boiler foreman, Chicago, Milwaukee & St. Paul Railroad, Milwaukee, Wis.

Fifth Vice President—Henry J. Raps, general boiler foreman, Illinois Central Railroad, Chicago, Ill.

Secretary—Harry D. Vought, 26 Cortlandt Street, New York.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.

Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman.

Boiler Makers' Supply Men's Association

President—A. W. Clokey, American Arch Company, Chicago, Ill.

Vice President—J. C. Kuhns, Burden Iron Company, Troy, N. Y.

Treasurer—George R. Boyce, A. M. Castle & Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—Starr H. Barnum, the Bigelow Company, New Haven, Conn.

Vice President—M. F. Moore, Kewanee Boiler Company, Kewanee, Ill.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.

Executive Committee—Joseph H. Broderick, the Broderick Company, Muncie, Ind.; George W. Bach, Union Iron Works, Erie, Pa.; A. C. Weigel, Walsh & Weidner Company, Chattanooga, Tenn.; H. E. Aldrich, Wickes Boiler Company, Saginaw, Mich.; A. G. Pratt, Babcock & Wilcox Company, New York; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; E. R. Fish, Heine Boiler Company, St. Louis, Mo.; J. F. Johnston, Johnston Bros., Ferrysburg, Mich.; J. R. Collette, Pacific Steel Boiler Corporation, Waukegan, Ill.

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

States

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

Cities

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

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

States

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

Cities

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

SELECTED BOILER PATENTS

Compiled by

DWIGHT B. GALT, Patent Attorney,

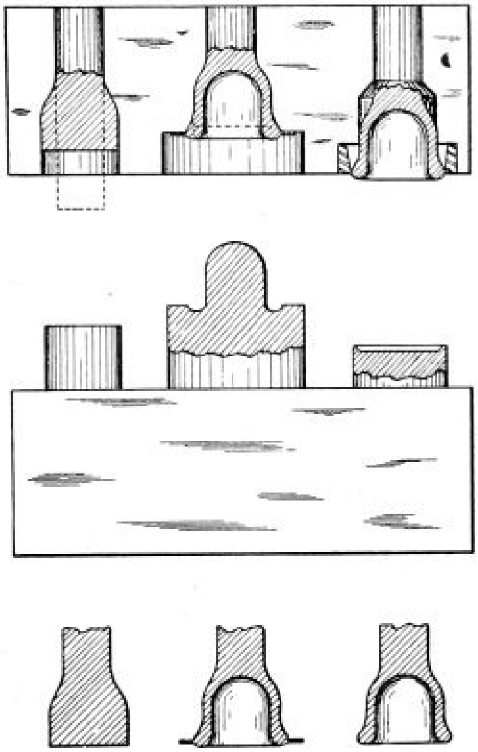
Washington Loan and Trust Building,

Washington, D. C.

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

1,628,063. ARTHUR F. PITKIN, OF SCHENECTADY, NEW YORK. MANUFACTURE OF STEAM-BOILER STAY BOLTS.

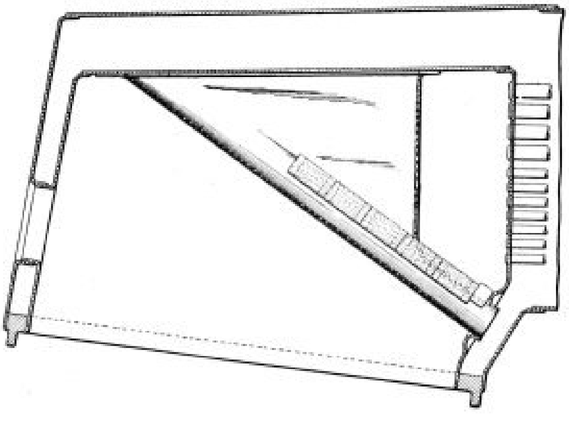
Claim—The method of forming stay bolts, having a socket at one end for the reception of the rounded head of a companion member, which comprises the following steps: heating a rod to forging temperature; confining the rod in a die cavity, having a constricted portion and an en-



larged portion; expanding one end of the rod in the enlarged portion by the pressure of a plunger; confining the rod in a second die cavity; applying pressure to the expanded end of the rod to form a socket therein, with the mouth of said socket thicker than the rest of the wall and curved in cross section; confining the rod in a third die cavity, and cutting off any fin formed around the thickened mouth of the socket.

1,628,180. JOHN L. NICHOLSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE. FIRE-ARCH CONSTRUCTION.

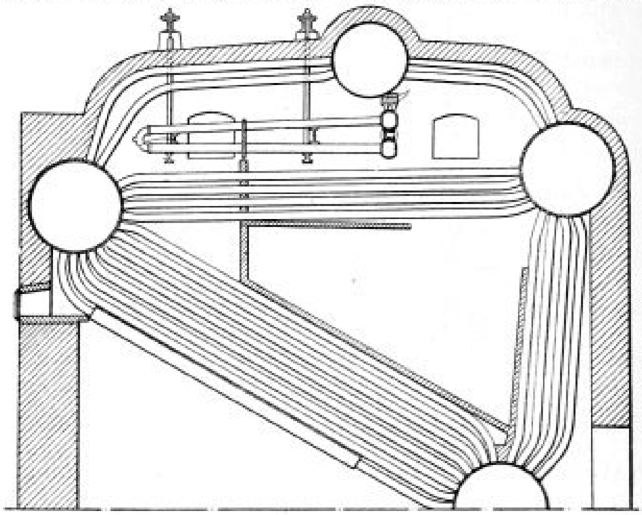
Claim—The combination with a fire box and an internal waterleg



therein of a refractory arch across the fire box comprising fire brick resting on said waterleg and recessed adjacent the same to afford passage for gases through the arch in contact with the water leg. Four claims.

1,627,918. FRANCIS MILLER MacDOWELL, OF FANWOOD, NEW JERSEY, ASSIGNOR TO POWER SPECIALTY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK. SUPERHEATER BOILER.

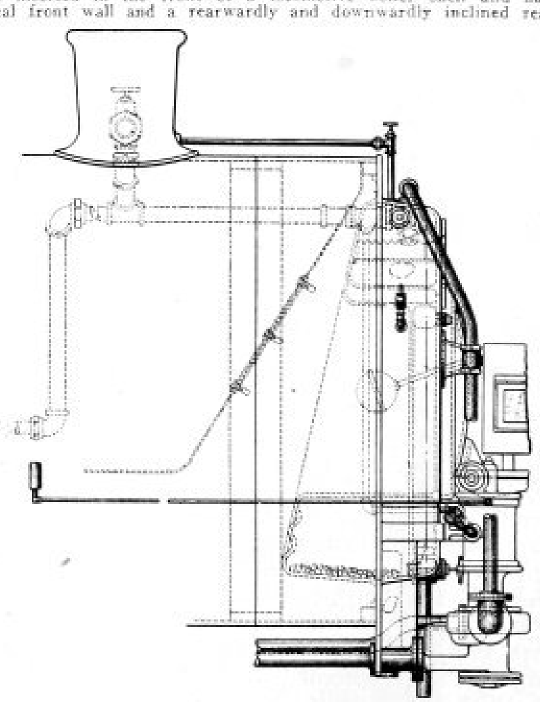
Claim—The combination with a water tube boiler comprising a steam and water drum and a water drum adjacent one end of the boiler, a second steam and water drum adjacent the opposite end of the boiler, banks of tubes connecting the water drum to each of the steam and water drums, a third bank of tubes connecting the two steam and water drums, a steam drum parallel to the other drums and located intermediate the ends of the boiler and sufficiently above said third bank of tubes to provide space between said drum and last mentioned tubes for the hereinafter mentioned superheater headers and having a heating gas outlet adjacent said water drum, and tubes connecting said steam drum to each



of said steam and water drums, of a superheater located in the space between the steam drum and said third bank of tubes and comprising headers parallel to and beneath the steam drum and tubular superheater elements secured to said headers and extending from the latter toward said opposite end of the boiler in the space between said third bank of tubes and the steam tubes connecting the steam drum to said second steam and water drum, and baffle means including a baffle extending upwardly between the tubes connecting the water drum to the two steam and water drums and across said third bank of tubes, and a baffle formed in part by said headers for causing the heating gases to flow upward toward the last mentioned steam and water drum along the tubes connecting it to the water drum and thence upwardly across an adjacent portion of said third bank of tubes and portions of the superheater elements, and thence downward across the remaining portions of the superheater tubes into said third bank of tubes and thence downward to said outlet through the bank of tubes connecting the first mentioned steam and water drum to the water drum.

1,627,595. MILLARD F. COX, OF LOUISVILLE, KENTUCKY. FEED-WATER HEATER.

Claim—In a locomotive feed water heater, an annular body adapted to be inserted in the front of a locomotive boiler shell and having a vertical front wall and a rearwardly and downwardly inclined rear wall



whereby the lower portion of the body extends rearwardly of the smoke box beyond the upper portion of the body, and feedwater pumps carried by said heater on the lower portion of said front wall and connected to the interior of said heater. Twenty-three claims.

The Boiler Maker

Volume XXVII | August, 1927 | Number 8

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
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Washington: 17th and H. Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St.
Westminster, S. W. 1.

Cable address: Urasigmec, London.

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

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

CONTENTS

Apprentice Training

THE turbine casing built at the Newport News Shipbuilding and Dry Dock Company yard, which is described elsewhere in this issue, represents a distinctive field of steel plate construction which seldom is given the prominence that it deserves. The notable fact in this particular case is that the entire layout was made by an apprentice who had had three years training in the yard. Of course more complicated and more difficult forms of construction are sometimes handled here, as well as in other large shops devoted to steel plate work, but the fact that an apprentice was considered competent to handle this particular piece of work to completion should serve as an incentive to other young men undergoing similar courses of training.

Whether in the shipyard or in the contract or locomotive boiler shop or steel plate works, the need for competent new blood to fill the vacancies that time brings is always present. Young men thoroughly trained in the processes of the industry answer the problem satisfactorily, but an ever increasing effort on the part of the mechanical officers and executives is necessary to induce boys to study the trade. In the railroad field, the Baltimore & Ohio and the Missouri-Pacific roads are now carrying on experiments in apprentice training which, while they are unusual, offer every possibility of being extremely effective.

The two methods of training are in general similar in character. Briefly described, a progressive series of lessons prepared by an apprentice bureau is sent out to each apprentice at his home address. The instructions are planned to cover a four-year period on a basis of two lessons a month. The answers are returned to bureau headquarters where they are examined and corrected. Within a few days, the corrected papers with penciled explanations of points in question are returned to the pupil. Boys who fail to send in papers regularly or show a grading of less than 75 percent, or otherwise give evidence of unusual difficulty with their work, are given individual assistance by traveling instructors to whom their names are supplied as occasion requires. During the first year, most work is the same for all classes of apprentices. Special craft instruction for each trade is scheduled to begin as soon as the fundamentals have been properly mastered. This elementary preparation includes in one division of the work, mechanical and geometrical drawing, shop sketching and blue print reading; in the other, general instruction including the history of transportation, elementary mathematics, shop measurements, something about railroad shop expenses, cost of equipment, cost of delays and practical suggestions on accuracy in seeing, hearing and thinking. In the second year, the boy is given training in projection drawing and more specialized mechanical drawing; the general course carries him further in mathematics. From this point on his work is almost wholly related to his particular trade.

Although these training courses have been in operation for only eight months, the results so far have been highly satisfactory. It will be some little time before direct proof of the value of this system of apprentice training can be determined but it is certain that organized efforts of this kind are bound to bring forth better results than half-hearted attempts that are usually made to accomplish the same end. The progress made in the case of each railroad will be watched with keen interest throughout the entire field.

National Board Convention

THE annual meeting of The National Board of Boiler and Pressure Vessel Inspectors, which is reported in this issue of The Boiler Maker, brings the convention season of the year 1927 to a close insofar as the boiler manufacturing industry is concerned. The body of membership which constitutes this organization is the one administrative branch of the industry, outside the Federal Inspection Bureau, which covers the operation of boilers in this country. Because of this fact, the activities of the National Board have a far-reaching effect. Fortunately The Boiler Maker, through the courtesy of the Board is permitted to publish a complete report of the proceedings at the annual convention, and this is the only form in which an account of the transactions of the body is made available to the industry at large. Every member of the boiler making fraternity should read this report carefully since from it may be gained an idea of the procedure which will be followed by boiler supervisors and inspectors during the coming months.

This year's meeting was highly successful and many decisions were reached on specific applications of the American Society of Mechanical Engineers' Boiler Code as well as on the use of devices that have been pending the approval of this organization.

The only point on which support of the members of the Board must be improved is that of supplying statistics when requested covering the installation, inspection and operation of boilers in the several states and cities coming under their jurisdiction. The statistics, as will be noted in the report this year, cover the number of accidents, injuries and deaths caused by boiler failures, as well as the number of boilers installed and similar data. These figures and those of the United States Department of Commerce are the only sources of boiler records in the country, and in order that the work of the Board in this matter may be accurate and complete it is essential that every member promptly supply the statistician with all figures requested when the year's report is being compiled. The discussion of this question after the reading of the statistical report brought out the fact that in some states conditions are such that the collecting of boiler data can only be done at great sacrifice of time due to lack of assistance and then it can only be done in an incomplete way. Such conditions, however, do not exist in all departments which were negligent this year in making returns and it is doubtful but that everyone can in some form supply the necessary information if the proper effort is made. The beneficial results of the meeting this year to the members and the direct appeal to correct any lack of cooperation in the few isolated cases, will undoubtedly be heeded so that next year the statistician will be able to report the status of the industry for all Code states and cities.

Where lack of space in this issue precluded the publication of papers read at the convention and their subsequent discussion, abstracts of such addresses will appear in later issues of the magazine.

At a meeting of the executive board of the Master Boiler Makers' Association held recently, it was decided to hold the nineteenth annual convention of the Association at the Hotel Hollenden, Cleveland, Ohio, on May 22 to 25, 1928.

LETTERS TO THE EDITOR

Boiler Shop Kinks

To the Editor:

"More taps, reamers and drills are worn out by hard misuse than by actual hard work," said the superintendent of a large boiler shop, and then the gentleman went on to tell how expensive reamers and staybolt taps were worn and dulled by being thrown into nail kegs or tool boxes with hammers, wrenches, cold chisels and other tools which do more damage to other tools than they receive in return.

In a certain mid-West boiler shop, reamers and taps are never seen thrown promiscuously around with other tools. Instead, the taps and reamers may be found on a job, awaiting use in a strong box or case made purposely for them of hard wood or sheet metal and, if the latter, lined with strong leather or sheet packing in such a manner that each tap or reamer lies in its own little compartment so that two of the tools can never strike or rub together or be smashed by having other tools thrown upon them. Indeed, in a Missouri shop the writer has seen staybolt reamers waiting to be used upon a job, each one in a little brass tube, four of which are screwed vertically to a base which keeps the tubes upright and permits them to be filled with oil in which the tools are kept, each in a compartment of its own.

A Quench Fountain

One boiler shop smith of considerable experience in working steel for tools as well as for parts of boilers, claimed that he could do exactly as good work repairing steel with clean, pure water as with any of the numerous "compounds" with which he said many smiths were "afflicted." "The value of any hardening compound, if there is any extra value above that of clean water," said this veteran smith, "lies in the fact that water loaded with salt or similar chemicals has a slightly higher boiling temperature than pure water and is able, therefore, to carry away a little more heat before being boiled away than pure water can take up under the same conditions." The smith further said that quenching carbon steel in the ordinary slack tub as found at most forges, could not be depended upon to harden steel well. He said, "You can't expect to harden steel well in the 'soup' usually found in a slack tub. The water may contain almost anything in solution, also a vast amount of insoluble material which forms a mud or slime, preventing more or less, the quenching water from reaching the hot steel readily, thus preventing the quick removal of some of the heat, thereby doing damage to the operation of hardening the piece of steel.

"A slack tub should be kept as clean as your wash bucket—and that may not be saying much, perhaps. Clean out the slack tub once a week at least and do better work for the effort.

"I have had two 'fountain' quenches which are the best ever, not only for ordinary hardening of carbon steel, but also for the necessary cooling when 'heat treating' some of the modern steels. In one shop, where there was plenty of overhead tank water available, I had a 4-inch pipe brought up vertically through the bottom of the slack tub at least 2 feet above the bottom of the tub."

A quick acting stop valve was placed in the 4-inch water pipe and arranged to be operated by the foot and furthermore arranged so it could be opened only enough to give a strong, smooth and steady flow of water from the vertical pipe with no sign of squirting or spattering of water. An overflow was rigged to the slack tub to prevent its running over. When a long and necessarily slender staybolt tap was to be quenched, either for hardening or for heat treating, as soon as the proper degree of heat had been reached, the smith would grasp the tap by its wrench-squared end and, holding the hot tool at right angles with the tongs, he would start the water going with his foot and then plunge the long tap quickly and evenly down into the bubbling-up water—only. There were no air bubbles in the water, and none were required.

The tap was held as nearly vertical as possible and evenly and quickly lowered into the water until the tongs rested upon the open end of the water pipe. The smith claimed that inserting a long tap in this manner, ensured its being straight after the hardening was completed. Owing to the quick removal of all steam bubbles by the upward flowing water and the steam bubbles being carried away quickly, the steel was quenched more quickly and therefore made harder than is possible when steel is simply plunged into a vessel of still water. The smith pointed out that were the tap to be lowered into the running water at as great a tilted angle as the 4-inch pipe would permit, there would be danger of the tap being made crooked during the hardening process by the adhering of steam bubbles upon the uppermost tilted side from which the running water could not reach and remove the steam bubbles, which remained upon the steel and kept a portion from cooling as quickly as did the opposite side of the tap. As a consequence, the tap was curved, being convex on the side where the steam bubbles adhered.

The smith also claimed the "bubble" quench to be just the thing for quenching hammer faces which often give trouble by coming out of the water hard around the edges, but all too soft in the middle of the hammer face. Running water carried all the steam bubbles away as soon as formed and allowed the clean, cold water to do the work of quenching and hardening, evenly, all over the entire hammer face.

As previously mentioned, the smith remarked that he had two ways of constructing his "bubble" quench. One way—using water under pressure has been described above. The other method, which is to be used when pump and bucket comprises the shop water service. In this case the slack tub is to be fitted with 4-inch vertical bubble pipe precisely as described. The overflow pipe is also to be connected to the slack tub, but from this point there is a difference. Instead of being connected respectively to a water supply pipe and to the sewer, the two pipes are to be connected to a motor or belt-driven centrifugal pump, the starting and stopping of which should be controlled by a foot-operated lever or treadle.

Quenching with the pump-driven water supply is effected in exactly the same manner as when the tank water service is used. The smith, however, cynically observes that "You can't do as good a job of hardening with 'slack tub soup' as you can with fresh water which is cold and clear, so don't expect it."

Indianapolis, Ind. James Hobart.

Coated Electrodes Versus Bare Wire Rods for Welding

To the Editor:

Since the advent of electric welding, much has been written and said of its merits and demerits. We cannot consider acetylene, carbon arc or electric welding to be in the same class as a fire weld. It is impracticable to fire weld the larger sizes of boilers, tanks, receivers, etc., therefore we are compelled to resort to the more portable methods available.

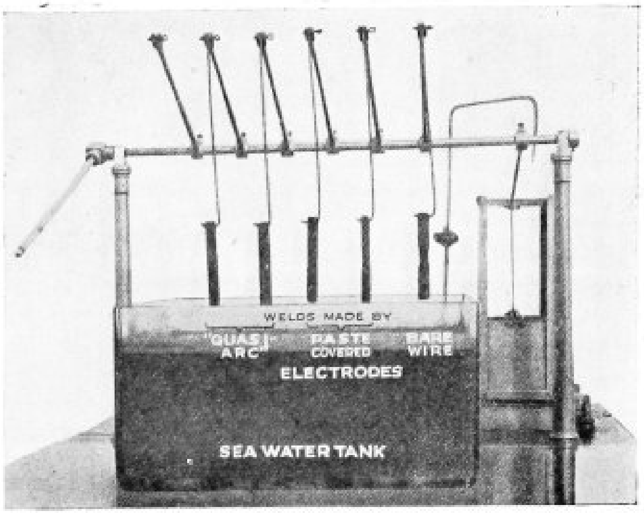


Fig. 1.—Machine for testing corrosion of welded metal

Confining ourselves to the electric method, we have at least three methods or practice, viz.:—bare wire welding, paste covered electrodes and flux coated electrodes. I understand that the bare wire is very much in use in America which probably accounts for the amount of criticism that the results of electric welding receive. Far superior results are obtained from the coated electrode as I hope to show you in a moment.

I had the pleasure of being conducted through the laboratories of the Quasi-Arc Company in London where a number of tests were carried out for my information and guidance. They have there a specially designed machine which will test pieces of welded metal as nearly as possible to the actual working conditions to which a welded job would be subjected. The piece of welded metal when placed in the jaws of the machine receives alternating blows and bends at the rate of 600 per minute. A job would not receive this violent treatment under working conditions in a minute but it is quite probable that in the course of 12 months it would receive an aggregate number of blows and bends equal to the test that is carried out in a minute. I wanted to see something to show the difference between bare wire welds and welds made with the Quasi-Arc electrodes and I did. The test piece which had been made with bare wire was put in the machine and after receiving 202 blows and bends (the number of blows are automatically shown on the ma-

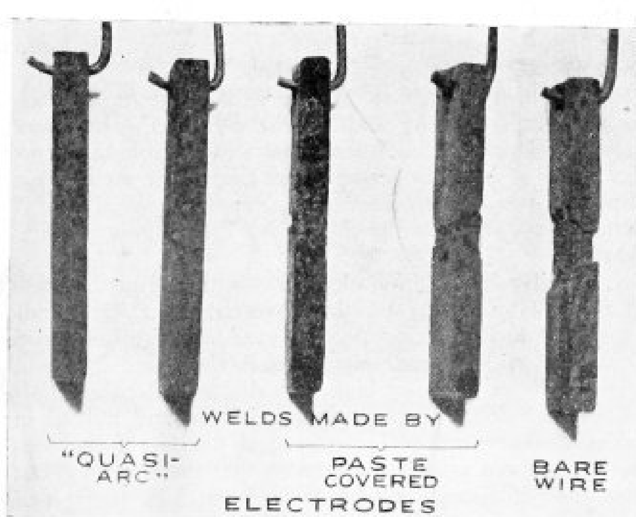


Fig. 2.—Results of corrosion tests

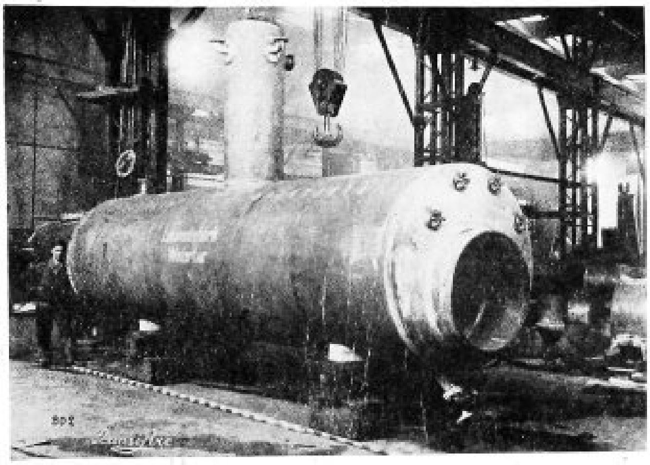


Fig. 3.—Cornish type welded boiler designed for 196 pounds working pressure

chine) it snapped through the weld. A Quasi-Arc test piece was then inserted and it failed after receiving 7,800 blows. In other words the coated electrode was 38 times superior or stronger than the bare wire weld. The single test favored the Quasi-Arc electrode too much, so after a series of tests the averages were:

Bare wire 306 blows, coated electrodes 3,080 blows. Suppose for the moment that we put down a mild steel welded underground pipe line for water or gas in a big city where heavy traffic on the roads and automatic stresses in the pipe line are common tests, then we must prefer the coated electrode to the bare wire welded job.

Another interesting point was the resistance to corrosion of welded metal. I enclose two photographs which may help the explanation. For seams of tanks exposed to dampness, welds on stern parts and shell plating of ships and other cases where corrosion would mean considerable loss, the Quasi-Arc have made study of producing a weld free from oxide defects and electro-negative to the surrounding metal and therefore practically impervious to corrosion. The ingenious apparatus shown on Fig. 1 was specially designed for the purpose of research. The illustration shows the welded specimens in the course of a corrosion test. The specimens are automatically and alternately immersed in sea water and lifted into the air. These have been under this continuous test for 20 months which represents over 200,000 air and water exposures and immersions respectively.

Fig. 2 shows an enlargement of the specimens. It will be observed how the bare wire piece is practically wasted away, the paste covered specimens are not much better and the Quasi-Arc specimen is quite whole.

Readers of THE BOILER MAKER will remember the articles which appeared for and against welding, in the issues of June to December last year. One writer wanted to know what kind of boiler a certain firm electrically welded for 60 pounds per square inch working pressure. Well here is a photograph of a Cornish Boiler for 190 pounds working pressure.

A. J. Riley & Son, of Batley, Yorkshire, are at the present moment building 50 tanks or receivers for 75 pounds per square inch working pressure and electrically welded throughout with covered electrodes. These are 5 feet 6 inches diameter by 8 feet high with dished ends; the longitudinal and circular seams are lap jointed and welded in and out. There are several thousand pounds in the contract so you can take it for granted that there is no doubt about their efficiency. I hope to send you a photograph of these at some future date.

Batley, Yorks, England. JOHN GORDON KIRKLAND.

Lap-Joint Failures in British Navy Boilers

TO THE EDITOR:

After a boiler of a type installed in many vessels of the British Navy before the war had burst in 1915, a careful examination of others was made, with alarming results. In many cases it was found that almost invisible cracks had developed at places in the lower or "wrapper" plates close to the edges of the tube-plates to which they were connected by lap-joints. Experiments were made, and it appeared that owing to the departure from a circular form adopted in the design of the water pockets the induced stresses at these places were at least twice, and possibly four or five times as great as the direct stress due to tension alone.

These hair-line cracks were found to occur most frequently close to the inner edges of the lap-joints farthest from the fire. Owing to the higher temperature near the furnace the steel there is about 10 percent stronger than in the outer joints.

Some trouble was experienced in renewing the wrapper plates in the boilers of the Australian warship *Brisbane*. Several methods were tried and rejected in turn, and finally the old half-inch plates were replaced by 5/8-inch plates which were 10 feet long and weighed about 1/2-ton each. The boilers were arranged in pairs, too close together to admit of access to the joints, and they had to be moved farther apart, plates being cut out of bunkers by oxy-acetylene burners to allow of this. Templates of thin plate were made to fit the old wrapper-plates, and were used to mark off rivet-holes in the new plates, with very successful results. As the boilers had been placed in position before constructing three decks above them, the wrapper plates were passed up and down the uptakes of some of the boilers, the funnels being removed to permit of this. Final adjustments were made by bending a width of about 4 inches of the edges of the new plates by hammers and swages, and then planing them to the right depth and angle. They were not subsequently annealed.

BRITISH ALTER BOILER TUBE STANDARD SPECIFICATIONS

The British Engineering Standards Association has just issued revised editions of the British Standard Specifications for charcoal iron lapwelded boiler tubes and for cold drawn weldless steel tubes for locomotive boilers.

The principal difference between the old and the new issues of both specifications is the inclusion of standard sizes and thicknesses for boiler tubes, and tolerances on their thickness and external diameter, but while the specification for cold drawn weldless steel tubes has been drawn up so as to cover testing requirements for superheater smoke and element tubes, standard sizes for these tubes are not included.

The tensile strength for steel tubes, whether the test is made on pieces of tube, has been raised to 26 tons per square inch, and a minimum of 20 is now specified. The minimum elongation required on pieces of the tube remains the same as before, namely, 28 tons per square inch, but in the case of strips cut from the tubes the minimum has been reduced to 22 tons per square inch.

London, England. G. P. BLACKALL.

The Lincoln Electric Company announces that the Missouri district office has been moved from 1808 Railway Exchange Building, St. Louis, to 1003 Davidson Building, Kansas City. Robert Notvest is in charge. A branch office has also been established at 220 Nicholas Building, Toledo, Ohio, A. H. Homrighaus, formerly in charge of the Missouri district having been transferred to Toledo in charge of the district.

Cooling Boilers for Cleaning, Repairs, or Inspection

By J. A. Snyder*

ALL steam boilers should be periodically cleaned and inspected, the frequency depending upon the condition of the feedwater and the usage of the boiler. Owing to changes in personnel from time to time, with new engineers and firemen taking charge of the steam boilers, some instructions regarding the best methods of cooling and otherwise preparing a boiler should be of value.

The ideal method of cooling any type of boiler, especially those with brick settings, is to close all openings to the setting and allow the boiler to stand several days after drawing the fires without emptying it. By thus giving ample time, the cooling is very slow and uniform, the material contracts uniformly, and the riveted joints and tube ends accommodate themselves to the change without distress. Unfortunately, industrial conditions seldom permit of sufficient time for this ideal way of cooling, and so some modification of it must be adopted. But it should be remembered that boilers are abused when emptied immediately after having the fires drawn, especially when under steam pressure. The heat of the setting is quite likely to burn the boiler, but even if this should not occur, the sudden, unequal cooling of different parts, and consequent non-uniform contraction, causes a decided shock to the structure, particularly the joints and tube ends.

When the fires have been burned out and drawn or dumped, all hot ashes should be removed from the grate, ash pit, and combustion chamber. Hot ashes in the ash pit and hot soot in the combustion chamber cause the boiler to hold its heat for a longer time. Furthermore, supposedly cool soot in combustion chambers has been known to cause severe, and even fatal, burns to workmen. The soot should also be cleaned from the tubes and plates while the boiler is being cooled. This cleaning is essential if the boiler is being shut down for inspection or repairs, and it is advisable to perform it immediately upon shutting down because the soot delays cooling by acting as heat insulation between the tubes and the cool air which later may be drawn through the gas passages. After removal of the fire, the steam valve may be closed, and the boiler should then be blown down several times for the purpose of clearing the blow-off passages to avoid difficulty in emptying the boiler by gravity when cold and not under pressure. If it becomes necessary to add any water to the boiler while it is still hot, this should not be cold water. Cold water in a hot boiler is never helpful, although moderate amounts likewise may not be very harmful, but in shutting down a boiler there is always the possibility of becoming too enthusiastic in this respect in an endeavor to expedite cooling.

Special care should be taken to see that cold water is not thrown or splashed on hot furnace brickwork, as it will cause the refractory to crack and spall.

Draft Effects Rapid Cooling

When the temperature of the boiler and setting becomes fairly low, cooling may be safely expedited by letting air pass through the gas passages. In order to do this, the damper is opened and all openings to the setting closed except the ashpit doors. Cool air thus takes the place of hot gases and further safely reduces the temperature of boiler and furnace. The mistake is frequently made of opening the door at the base of the stack, but this kills the draft through the boiler and, therefore, has a reverse effect from that desired. It is during this period of cooling that a coating of dust or soot on the boiler surfaces will have a retarding effect, as mentioned previously.

In opening a boiler, the top manhole cover should be removed first and then a lower manhole or handhole cover. If this order is reversed, the moment the top opening is cracked there will be a current of air set up from the lower opening to the upper, and this will carry hot vapor about the hands and face of the person removing the top manhole cover, thus seriously handicapping him in the work. Attention to this detail will lighten an otherwise disagreeable task.

Before entering a boiler for any purpose, one should make sure that the vessel is well ventilated so that the air will be fit to breathe. Working in an atmosphere deficient in oxygen may, in extreme cases, be dangerous, but it is always uncomfortable and distressing and greatly reduces the efficiency of the workman. A boiler can readily be ventilated by taking off manhole or handhold covers, such that there will be openings inside and outside of the setting, and then closing all doors or openings to the setting. In horizontal tubular boilers, for instance, there is usually a manhole above the tubes in the shell plate and one below the tubes in the front head. The upper one is accessible from outside of the setting and the lower one must be reached from inside the setting. There are certain types of watertube boilers that can be ventilated by having the manhole plate removed from the steam drum and also several of the lower tube-hole plates or caps at the rear end. With the damper open, the stack will draw air into the setting by way of the boiler, thus introducing a continuous current of fresh air into that vessel.

Often it is necessary to work in a boiler before it can be brought to a comfortable temperature. Under such conditions a workman can never do his best work, but electric fans and air hose can be used to good advantage to make conditions more endurable.

Suggestions Apply to All Types

Locomotive, firebox, and vertical tubular boilers, large or small, should have approximately the same treatment as far as may be applicable. The soot should be blown from the tubes and all ashes and dust removed from the grate and ashpit. When the boiler has sufficiently cooled for safety, it may be further cooled to a comfortable working temperature by opening the damper and the ashpit door and allowing cool air to be drawn through the tubes.

When boilers are emptied they should be immediately washed out with a hose under strong pressure for the purpose of removing sludge and soft scale before it hardens on the boiler surface. Incidentally it may be pointed out that when boilers are emptied while still hot, much of the scale is baked onto the surfaces so that it is much more difficult to remove than it would have been had the boiler cooled before being emptied.

Briefly, regardless of the type of boiler, take as much time as possible in cooling it, and expedite cooling only by drawing air through the gas passages from the ashpit. All other openings to setting or stack should be closed.

*From an article in *The Locomotive* by the chief inspector, Pittsburgh Department, Hartford Steam Boiler Inspection and Insurance Company.

William J. Rice, deputy state boiler inspector, Colorado, died suddenly July 11 while inspecting the boiler of the Great Western Sugar Company at Brush Colorado.

John J. Kelly of Denver, Colorado, was appointed deputy state boiler inspector, July 22, by governor Adams. He succeeds W. J. Rice who died a short time ago.

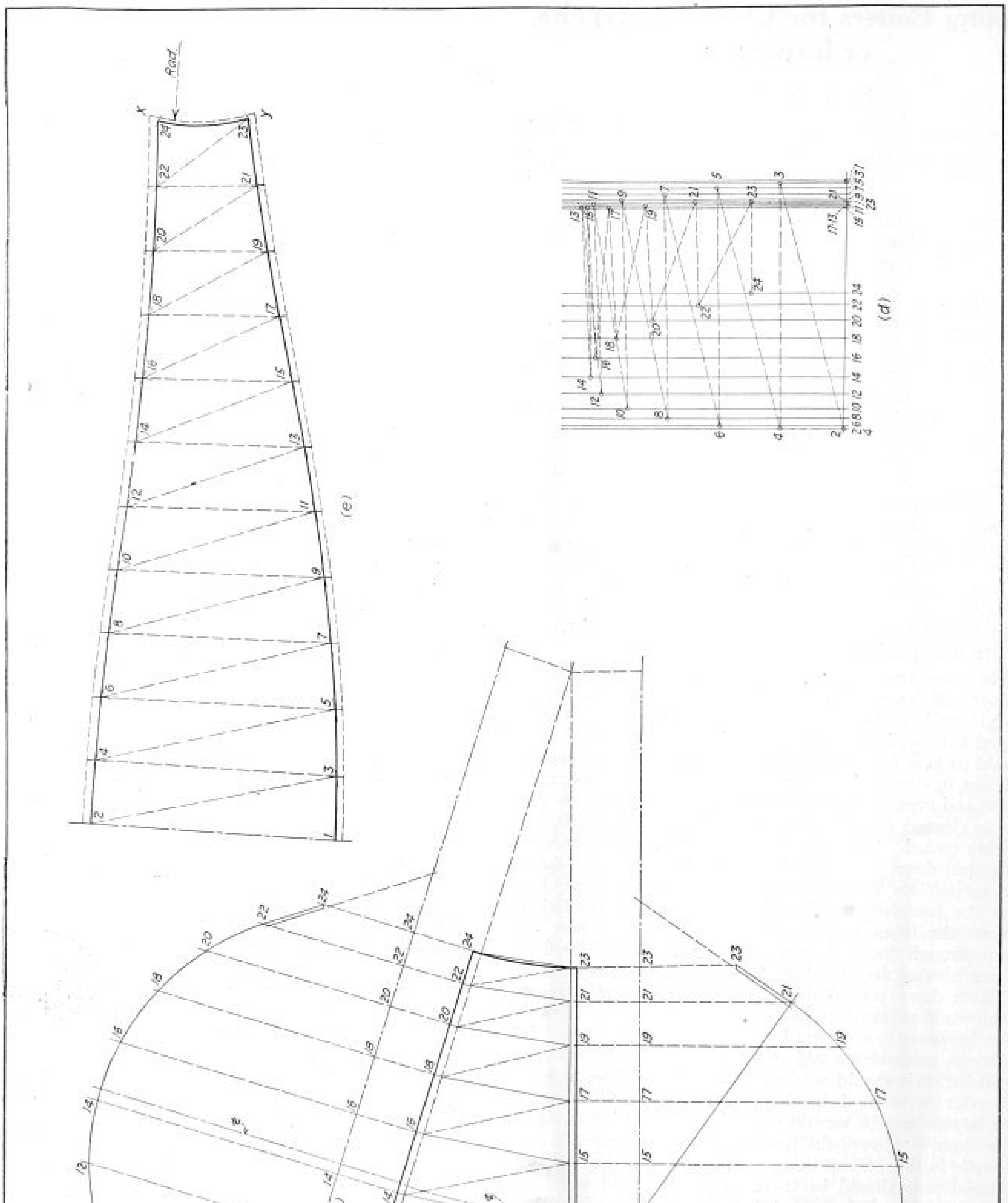


Fig. 1.—Development of one section of spiral casing

Building a Spiral Water Turbine Casing

Methods employed at Newport News Shipyard for the construction of a complicated plate layout and assembly job

By C. E. Lester

In recent years the Newport News Shipbuilding and Dry Dock Company of Newport News, Va., has carried out a great many jobs of heavy and complicated plate work that do not often come within the scope of the average workman. The most recent work of this nature at the yard is the construction of a plate steel spiral casing for a water turbine to be used by the United States Department of the Interior, Bureau of Reclamation, on the Minidoka project, Idaho. The turbine in question generates 3,500 brake horsepower with a 47-foot static head and operates at 200 revolutions per minute.

The casing for this turbine is a rolled steel plate ½-inch thick at the large end and graduated to ⅜-inch at the small end. The general layout of the spiral casing is shown in Fig. 3.

General Details

The plates are bumped to eliminate flat surface sections. The casing is lap riveted throughout and is designed to prevent deformation and to stand a 35-pound per square inch internal pressure. The draft tube liner of ¼-inch riveted steel plate reinforced at the top and bottom with angle iron stiffener rings, was also built to go with the turbine.

The specifications require a clear width of water passage at the discharge end of the draft tube of 14 feet and a distance from the center line of the turbine distributor to the bottom of the tail race of 25 feet. This turbine is one of many of various sizes and character built by the Newport News yard and is of peculiar interest in that the casing and draft tube were entirely laid out by a third-year apprentice. The development of each course of the casing is similar to every other but, due to the change in size and camber, a separate development was required for each sheet and section. The slightest error in camber made in carrying out the work would cause considerable difficulty when the various sheets were assembled on the speed ring so that accuracy of the highest order was necessary at every stage of the layout and construction.

Development of the Spiral Casing

The development now to be taken up deals with the intersections of the surfaces of the spiral casing and the methods of obtaining the miter line, as it is commonly

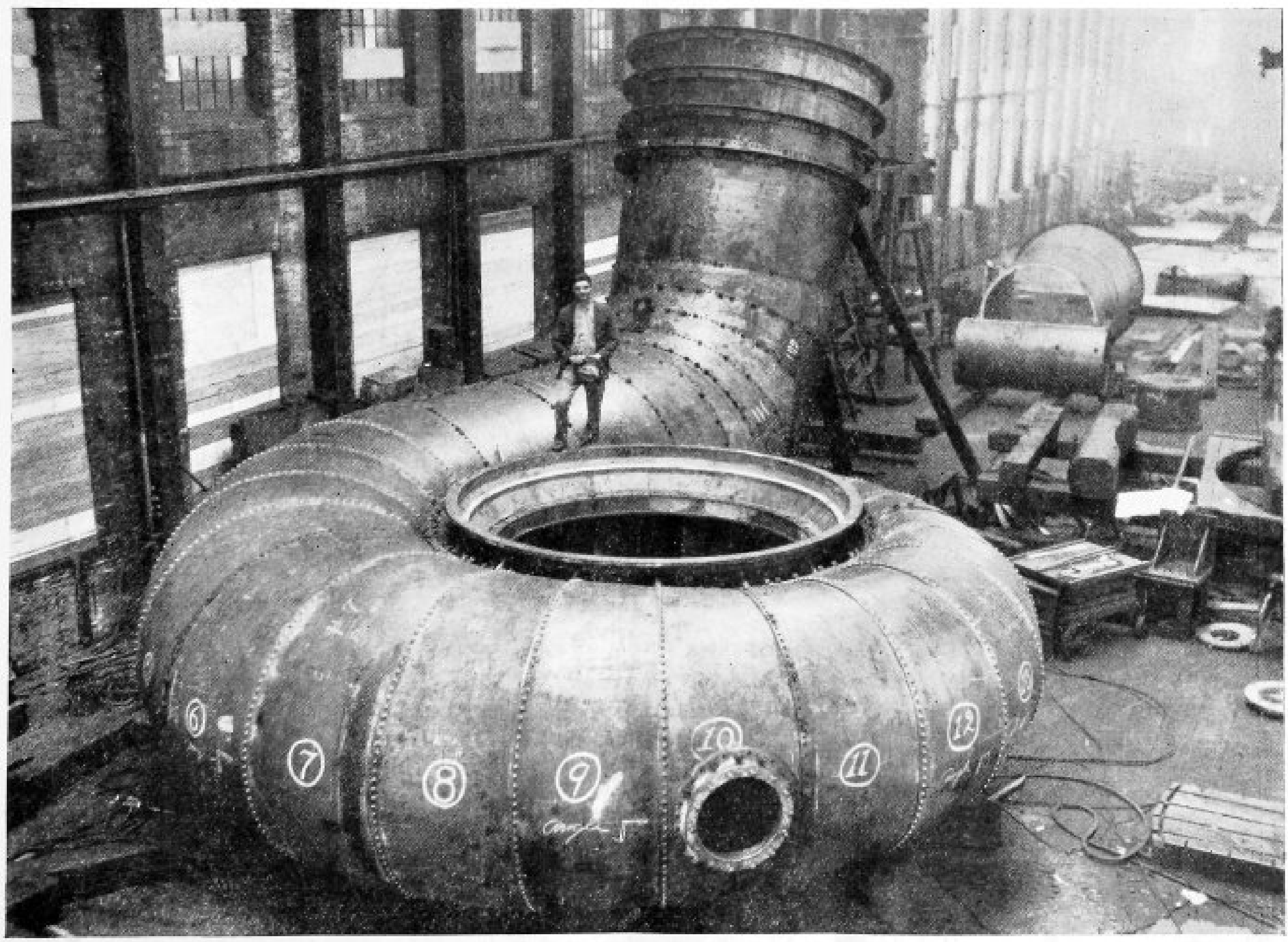


Fig. 2.—Spiral casing as it appeared when erected in the shop

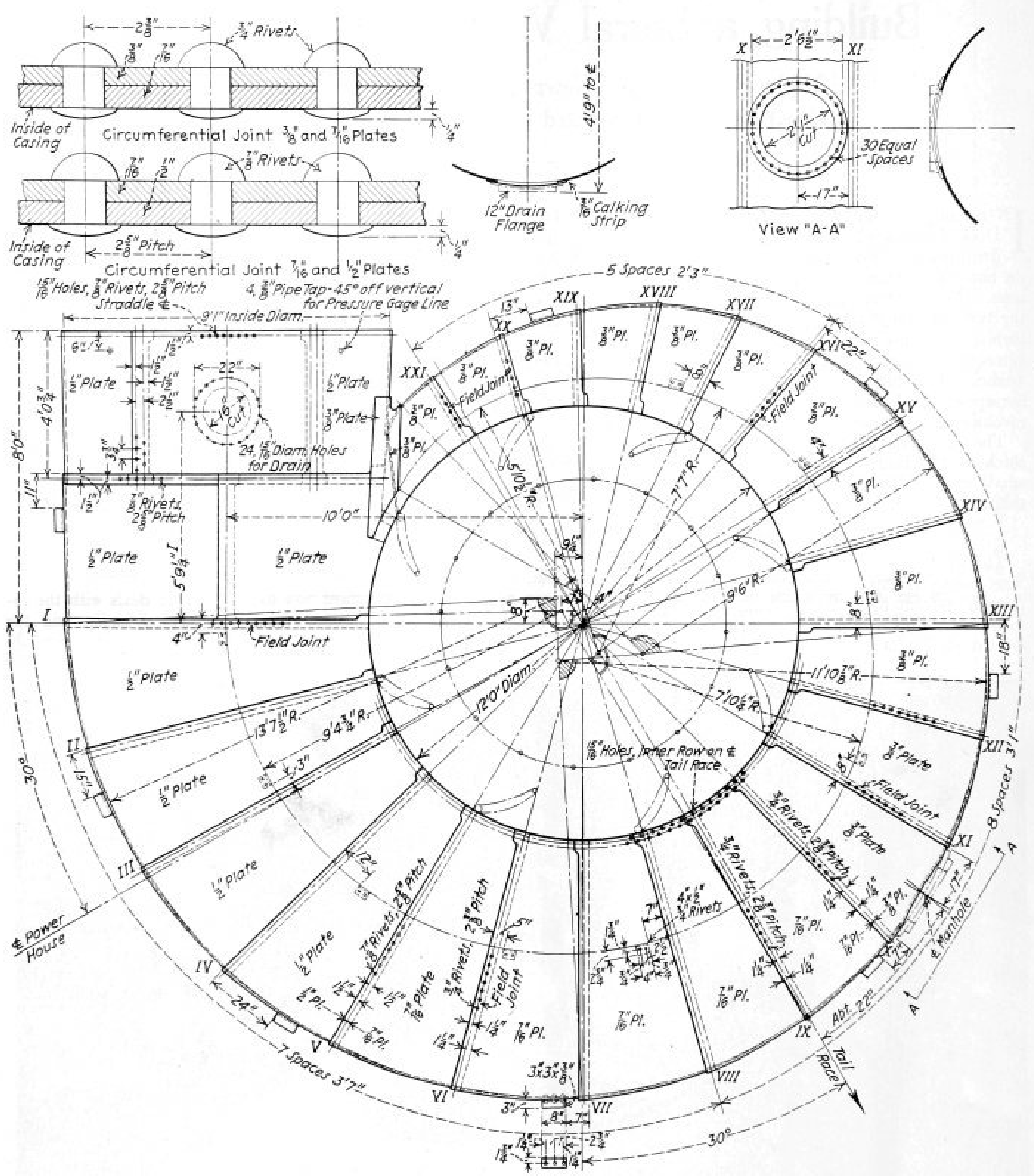


Fig. 3.—Working details of spiral casing

called. By the methods explained in connection with this plate the patterns of the intersected surfaces are developed. One of the important requirements in the construction of these figures is to locate with accuracy the points lying in the lines of intersection.

Fig. 1 (*b*) shows the plan view of section 5 of the spiral casing. Fig. 1(*c*) shows the half shape of the right end view of section 5. Fig. 1(*a*) shows the half-shape of the left end view of section 5.

The semi-circles 1, 13, 23 and 2, 16, 24 of Figs. 1 (*a*) and (*c*) are divided into any number of equal parts; the greater number of these divisions, the more accurate will be the results. The points of 3 and 3, 5 and 5, 2 and 2, 4 and 4 are joined with lines as shown in Figs. 1 (*a*) and (*c*). In Fig. 1(*b*) the points 1, 2, 3, 4, 5, etc., are joined together with lines as shown. Fig. 1(*d*) is then drawn. A base line 1-2 is next drawn. The length of the line, 1-2 is made to equal length of 1-2 in Fig. 1 (*b*) and 2-3 and 3-4 and 4-5, etc., equal 2-3 and 3-4 and 4-5, etc., in Fig. 1 (*b*). From lines 1-2 in Fig. 1 (*d*) perpendicular lines are projected up to suit length of lines in Figs. 1 (*a*) and (*c*) as shown. For length of lines 1, 3, 5, etc., the length from

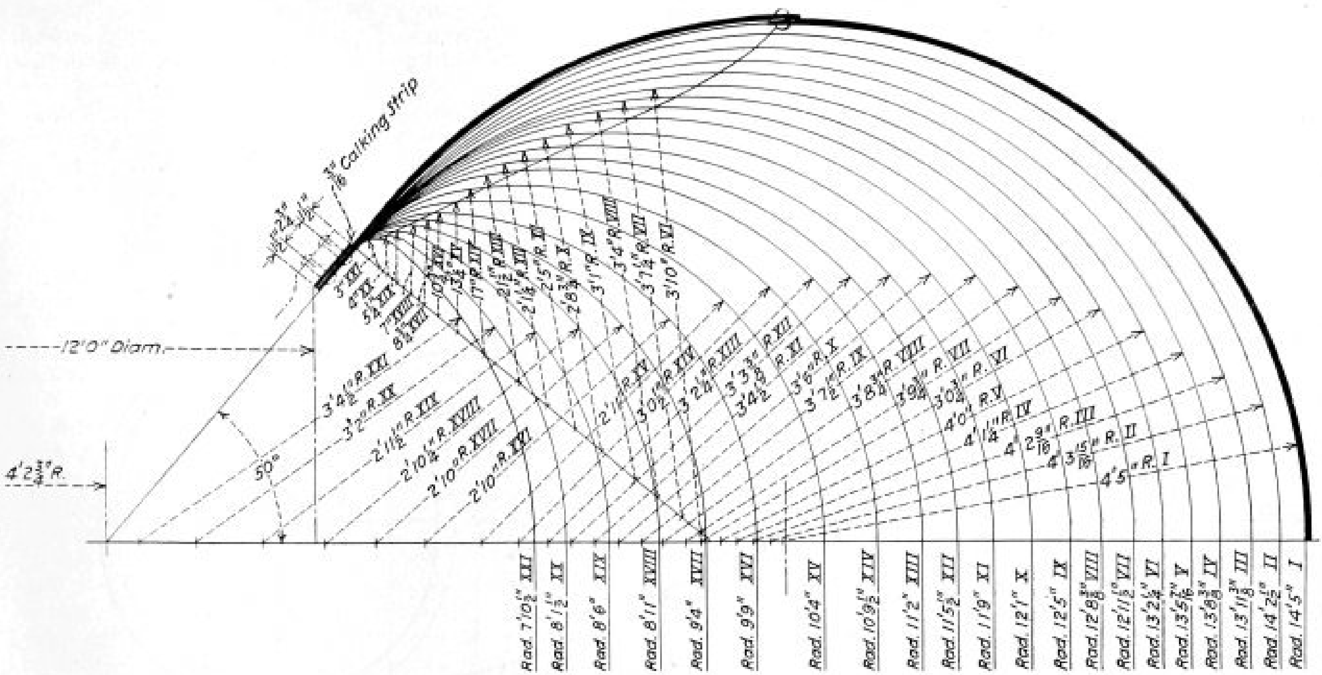


Fig. 4.—Arcs according to which casing was developed

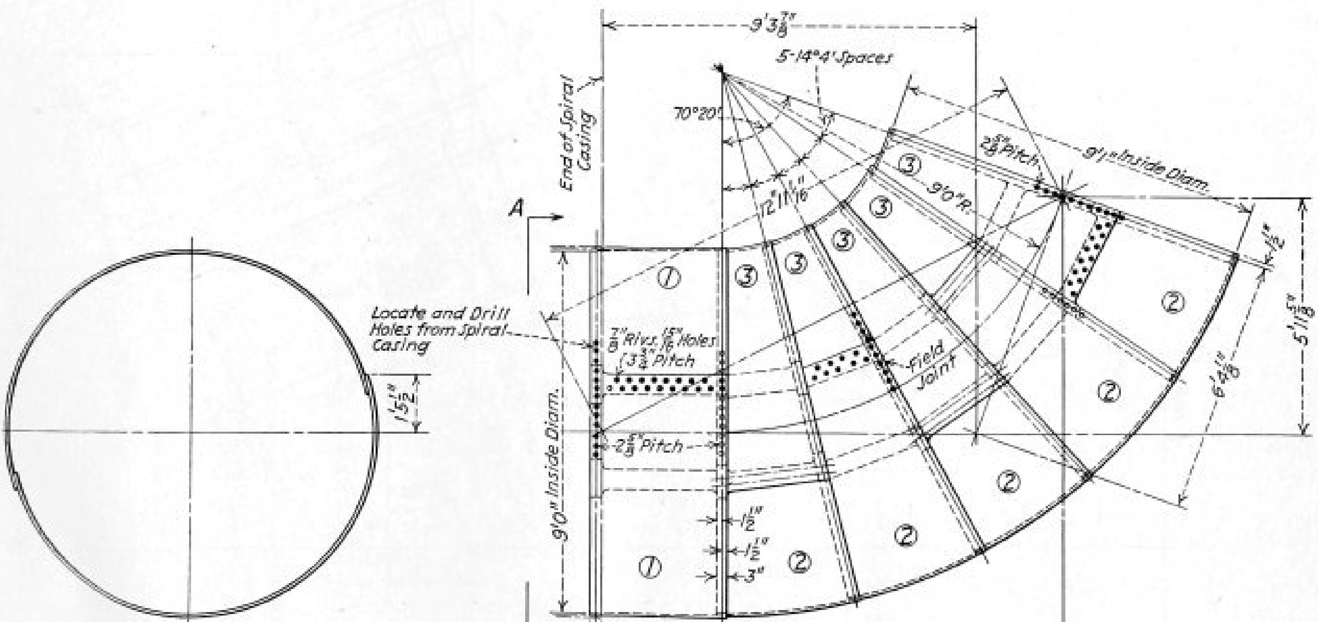


Fig. 5.—Inlet section of turbine penstock (Elevation)

line 1 and 1, 2 and 2, 3 and 3 in Fig. 1 (*a*) are taken. For length of lines 2, 4, 6, etc., the length from lines 2, 4 and 4, 6 and 6 in Fig. 1 (*c*) is taken. The points 1, 2, 3, 4, 5, etc., are connected together with lines as shown.

The template lines are now ready to be drawn. Instead of drawing the whole template, only one half of it is drawn, as shown in Fig. 1(*e*) since the other half is exactly the same. The line 1-2 which is the center line of the plate is drawn, and made to equal in length the distance 1 to 2 in Fig. 1(*d*). The division lengths of lines 1 and 23, and 2 and 24, equal the lengths of arc 1 and 23 of Fig. 1(*a*), 2 and 24 of Fig. 1(*c*).

The construction of the remaining portion of the half template is continued in a similar manner, taking the length of line 2 to 3, 3 to 4, 4 to 5, and 5 to 6, etc., from Fig. 1(*d*). Through the points 1, 3, 5, 7, etc., the curved line shown is drawn.

Since this is the development of the section at the seam, the laps for riveting must be allowed as shown in dotted lines. Line X-Y on the template shows allowances made to insure fitting on the casting.

This procedure is necessarily followed throughout the layout of the several sections of the spiral casing. The draft tube liners, and taper inlet section are simple taper

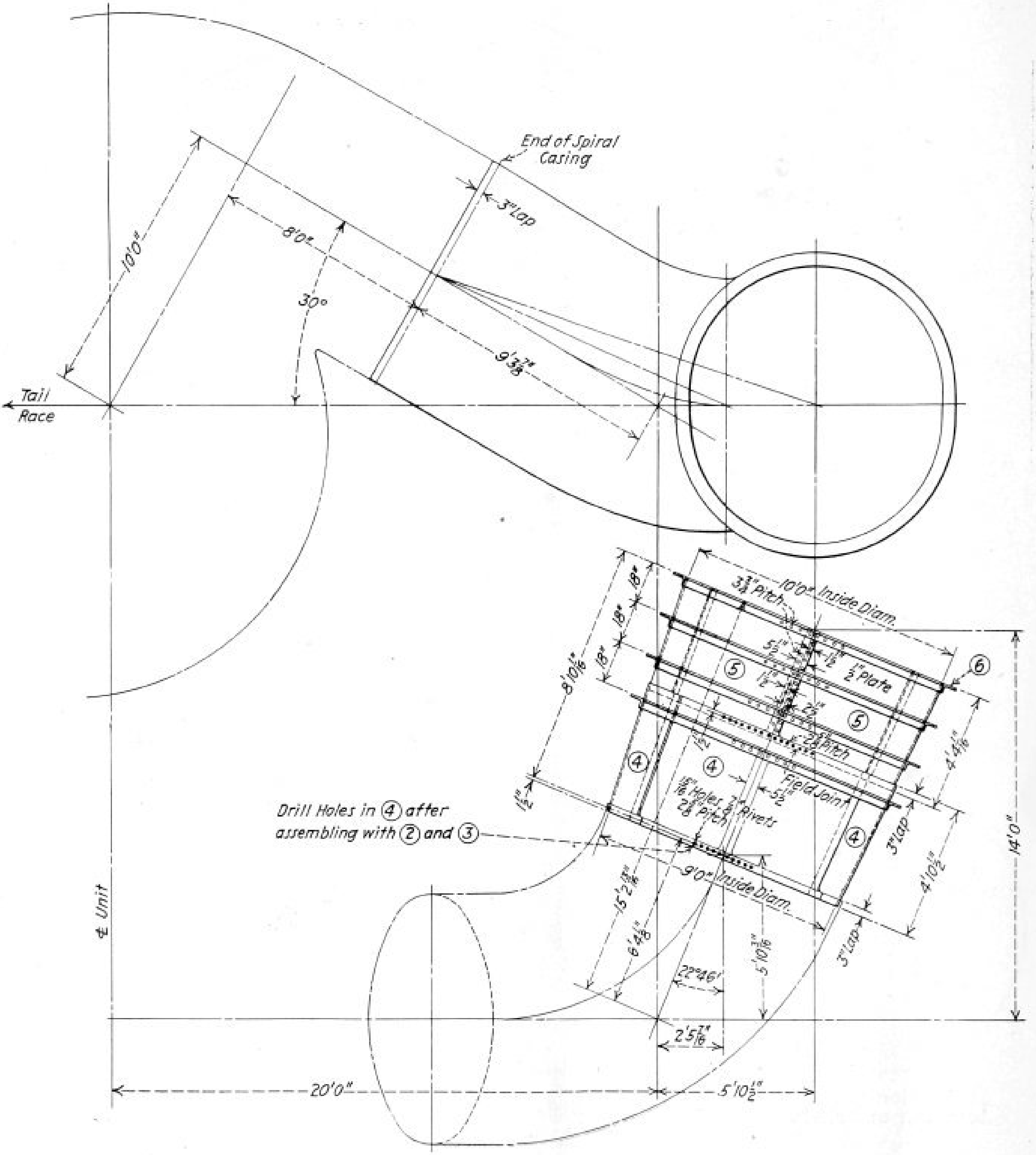


Fig. 6.—Inlet section of turbine penstock (Plan)

courses, and entail no particular difficulties of layout. The difficulties which might have been encountered in the elbow section are more or less eliminated by the completeness of the drawing, and the usual elbow development with its various phases suffices.

Layouts for manholes, flanges, etc., were made after the assembly of the several parts.

Fabricating and Assembling the Casing

In the development, to minimize the possibility of error, holes were all laid out but in one plate and tack holes in the connecting plate. No holes were laid out in the plates where they connected to the speed ring.

In carrying through a job of this character fabrication really begins when the plates are sheared on the rotary shears in nearly all cases. However, some of the quick bends are cut with the oxyacetylene torch.

From the shears the plates go to the smith fire for scarfing the laps where they intersect and lap over one another at the speed ring joint. This operation is followed by rolling the plates to the proper contours on a 14-inch power roll with a drop head or housing. That this operation be well done is of the greatest importance, as faulty rolling of plates of irregular shape seriously interferes with rapid fit-up and causes a great deal of useless pulling, heating and sledging as well as the occasional re-rolling of plates to get them more nearly to the correct shape To expedite this work batten molds are made in the mold loft which conform to the contours of each section and the roller uses them in the forming of the sections. The rolling process is exceedingly difficult in that each plate being of different size, the rolls operator gains no particular knowledge of the action of the rolls on the succeeding plate from the action on the preceding one.

Curving Plates on Press

The next operation is the spherical bumping with curved dies on the hydraulic bull which eliminates the flat section of the plate, making the curves more continuous and permits of a more uninterrupted and smooth-flow of water.

As will be observed the sections are laid out telescopic in form and in the assembly the work is started at the large end next to the penstock inlet section. The casing is assembled without the speed ring. Lines are drawn on the floor indicating the general contour of the circumferences and the casing is assembled section after section and made to conform in general to the rough finished dimensions and size. No great attempt is made for exactness which is not essential until after the speed ring assembly. The draft tube liner, the spiral casing and the inlet section are assembled complete but independent of one another.

Of the spiral casing all parts are assembled except the intersecting piece, this piece is not laid out.

Dissembling the Casing

After the general assembly (the speed ring processing is taking place in the machine shop during this period) the casing is checked for size and errors corrected and then disassembled, in this case in three pieces. The speed ring is then placed horizontally on the floor with plenty of room surrounding it and the casing reassembled around it. The sections are fitted consecutively, tapering down from the large end and as now accurateness and a close fit are necessary, a considerable amount of heating and trimming at the speed ring and adjustments are required to make the proper fit. It may be said in passing that this assembly is a most difficult and arduous task with nothing but hard work from beginning to end.

The drillers follow the fitters at a reasonable interval and the final drilling follows closely on the final line up and check of dimensions. The drillers are frequently required to precede the fitters in order to get tack holes drilled to apply temporary bolts.

At this time the intersecting piece is roughly formed and applied by the "fit and try" method. This is a tortuous job and entails a great deal of labor. All holes are then countersunk on the inside for oval head rivets and the plates securely bolted up for riveting.

Due to the necessity for partial dissembly the casing is riveted up in sections and the field joints are left for the final assembly at its destination.

It is doubtless possible that all assembly might be deferred until the speed ring be received and but one assembly made necessary—this however would seriously delay the work and is of doubtful utility.

The oxy-acetylene heating torch has been of inestimable value in this work in getting quick small heats in areas closely confined and where oil heaters would make the heat continuous and intense and make a hot hard job much harder and hotter.

The inlet section after having been assembled and banded separately is finally joined to the casing, fitted and a final check of dimensions made, then reamed and disassembled. The draft tube liner is assembled separately, reamed and riveted and not joined up until it reaches the field.

Fall Meeting of the American Welding Society

THE tentative program for the fall meeting of the American Welding Society to be held in Detroit, Mich., September 19, 20, 21, 22 and 23, at the Book-Cadillac hotel, is as follows:

Monday, September 19

2 p. m.

Meeting of board of directors

7:30 p. m.

Meeting of American Bureau of Welding

Tuesday, September 20

10 a. m.

Airplane welding, by J. B. Johnson, chief of material branch, War Department, Air Corps, McCook Field.

Welding on the long distance aircraft by the Atlantic Aircraft Corporation.

2 p. m.

Report of San Francisco Section's investigation on "Study of welds subjected to high temperatures."

Heat treatment by the oxy-acetylene flame, by E. E. Thum, associate editor, *Iron Age*.

A metallurgical study of welds, by G. R. Brophy, Research laboratory, General Electric Company.

Wednesday, September 21

10 a. m.

Car welding, by Victor Willoughby, general mechanical engineer, American Car & Foundry Company.

Automobile welding, by W. C. Happ, chief engineer, Department of Methods and Standards, Studebaker Corporation.

2 p. m.

Inspection tour to the River Rouge plant of the Ford Motor Company and to the plant of the Fisher Body Corporation.

7:30 p. m.

Meeting of Structural Steel Welding Committee.

Thursday, September 22

10 a. m.

Production welding of water heaters, by H. J. Grow, Air Reduction Sales Company.

Welding in the plant of the Combustion Engineering Corporation, by C. S. Reed, vice-president and general manager.

2 p. m.

Welding of structural steel, by Joseph Matte, Jr., of Albert Kahn, Inc.

Welding in the design of steel plate work, by L. J. Sforzini, Engineering and maintenance department, Eastman Kodak Company.

6:30 p. m.

Annual fall dinner dance of the American Welding Society.

An interesting program has been worked out for the entertainment of the ladies.

The welding and cutting exposition held under the auspices of the American Welding Society and in cooperation with the National Steel and Machine Tool Exposition in Detroit, the week of September 19, will be the largest exhibit of its kind ever held. A special section of the convention hall of over 10,000 square feet has been set aside for the welding exhibit.

Ernest B. Perry, president of the Industrial Works, Bay City, Michigan, nationally known manufacturer of cranes, died recently at his home in that city. He first became connected with the company in 1889 as a draftsman. In 1891 he was made superintendent and mechanical engineer, and, later, vice-president and general manager. In 1924 he became president of the Industrial Works and served in that capacity until his death.

Marketing Products of the Boiler Shop*

Analysis of the problems of the industry and sales methods that can be used to develop new business

By E. St. Elmo Lewis

IN the last thirty-five years of a rather active life, I have been thrown more or less in contact, both as a manufacturer and as part of organizations in which you have been required to function, with many of the problems that confront you. The consequence is that I am going to talk more particularly from the standpoint of a man who has made an intensive study for thirty-five years of the whole problem of merchandising commodities and specialties, etc.

It happens that my own particular work in business for a number of years has been on the sales side. Sales work can be divided up into four or five different subjects. First, we have the broad subject of marketing, which is the whole distribution side of business. That calls for a concept or a line of thinking that is entirely different from the line of thinking which is most valuable in production, for instance. It calls for an entirely different line of thinking than distinguishes the financial man. The great problem before you gentlemen in your industry at this time is markets. Now you may not like that, but while you can apply the same principles of rigorous thinking to the problem of markets that you can apply to the construction of a boiler, it is not always an easy thing to do, to step over from one line of activity to another. Under the marketing conditions of today and the highly competitive conditions that confront not only your industry, but every other industry in the United States that has a history of fifty years, you have to carry over into the new problems the same rigorous thinking, but you have an entirely different set of facts to think about, and it is not always easy for those who have been thinking in quantitative and qualitative terms of very definite proportions and very definite limitations, to go over into purely human relationships which are the fundamentals of selling, and think in terms quite as accurately or arrive at so definite, conclusive ends, as they can, for instance, in engineering. I would recall to your mind one of the patron saints of your profession, engineering, Stevenson, who said, after a rather busy life, and after delving rather deeply into the definitions and into the science of engineering, that he had come to the conclusion, after it was all through, that as far as living was concerned, that after all, we have these sciences for the contribution they make to living. He came to the conclusion that the greatest engineering was the engineering of men. And, after all, that is the foundation and the root of your industry and every other that is over fifty years of age. Why do I say that? For the simple reason that it gives me a latitude to make the statement I desire to make; industries that are less than that time are pretty much sales-minded, and I shall presently dwell upon the difference between the technically minded, the production minded industries, the industries that give all their talents and rewards to those who can solve production problems, and those industries that give their talents, their rewards, and honors, if you please, to those who can create and develop markets for the industries.

From 1880 to 1900, you older men will remember that we went through quite a hectic period of trusts and combination development. During that time, when the problem of finance was the outstanding problem, we developed what is known today as cost finding; and it was during that time that we developed the laws relative to certified public accountants, and we used to say in the old days that an expert accountant was a bookkeeper out of a job. We found very quickly that in order to get the proper background, the proper accounting background, and get proper and active reports, that we had to have men who were certificated as competent, and that brought on the C. P. A. laws. Now that was the accent given by the financial men who wanted to find out what it cost to do these things. They found chaotic conditions, they found books that did not account, and they wanted to find out really what the basis was. Then we came around, we found out what it cost to do these things in production, and during the past ten or twelve years there has been a gradual and very definite increase in production efficiency. The war gave a tremendous advance to what had been done previously. Paroe brought many things, Gantt brought many others, Emerson and the rest of the production engineers, and many of the so-called efficiency, management engineers, etc., and my observation is this, that wherever scientific management has been put in with intelligence, it has always made a distinct contribution.

Marketing Products Now a Problem

We are now confronted with a problem of distribution, by which I mean marketing, sales, advertising, merchandising. We are confronted by the problem of sales, just as much as previous generations were confronted with the question of cost and production. We will have to bring to the subject of distribution the same activity of thinking, the same recognition of fundamental problems, and the same hospitality, if you please, to entirely new ideas, as the men of an older generation had to bring to the subject of putting a cost keeper into a plant.

I was interested last night in what Mr. Rastall* had to say about the foreign markets. I find very little difference between the domestic situation and what he told you with respect to the solution of the foreign situation, and what you must bring to the solution of the domestic situation. In other words, if you are going into the foreign markets, you must study it—study it in relation to yourself, true, but study yourself more in relation to the foreign markets. Industry is here for the purpose of doing something for society and getting paid for it and making a profit in the process, and that problem of profit is the outstanding problem that is before all of us at this present moment. Now unless society knows what this service is and thoroughly understands it, it is not surprising that we should receive little cooperation from society at large in the process of trying to do the thing that we are organized to do, that is, to give it service. I think there is something that has distinctly been overlooked in a great deal of our talk about selling.

There are in the United States probably twelve or fifteen organizations interested primarily in the very self-same problems in which you are interested. There is a unit in the factory or industrial plant where a great many different

* Abstract of address delivered at annual meeting of the American Boiler Manufacturers' Association, held at French Lick Springs, Ind.

* W. H. Rastall's address appeared on page 195 of the July issue.

industries meet, the boiler, the stoker, the engine, the valve, the pump, the feedwater heater, and everything else of that kind; they all meet at that one point and they are all interested in that self-same power plant. They are interested in the problem of maintaining that power plant as an individual unit. Let us say, for the sake of argument, that we want to maintain all that is right and just and scientifically productive in the individual power plant; let us assume that for the purpose of this idea, we want to find the real truth about the economy of the individual power plant as against the public service power; we want to find out where and under what circumstances the individual power plant is the clearly indicated and the economical power to use.

We know that under certain circumstances it is the best kind of a power plant; we know there is a twilight zone where it is a question; and we know in the third place, that there are some cases where it is not as efficient as the public service power. All right, but where are they, and who says so? It is not sufficient that the man who is going to try to sell me something shall always be permitted to advise me. Now it is very truth that some organizations can, in process of time, acquire a reputation for fairness, for disinterestedness of counsel and advice, but just the same, if I were going to buy something, particularly where it affected so vitally so many other things than merely the amount of the investment in that particular thing, as a power plant does, I should want, if it were possible, to have the advice of purely disinterested people, and it is for that reason that the consulting engineer has risen in the last twenty-five years to play a very important part in the industry.

On the other hand we find in the past ten years, a large growth on the part of various industries, of the tendency to pool in organizations that shall be representative of the entire industry, the combined intelligence, all the scientific data and a great deal of the results of scientific research of the industry. To pool it so that it may do two things, that it may benefit the individual units in the industry, in the first place, and in the second place that it may meet the competition that is going on between industry and industry. I venture to say, and I make this prophecy—whether it shall be immediate or remote, I do not know, because it is very largely a matter of the growth of your attitude toward this problem, but I make the prophecy that within the next few years you will have a power house institute or a power institute or something of that kind in these United States that shall represent the pooled experience of all of the people interested in the subject of power. You will have there also besides merely the scientific data with respect to the technical operation of these interests, and the association and the industries, an organization that will be charged with the market study of foreign and domestic commerce and the use of such domestic and foreign agencies as Mr. Rastall spoke about last night. You will have the subject of standardization worked out, you will have the subject of cost finding experience, you will have the technical study, of course, of power house problems; you will make a study of foreign markets and you will have that important thing Mr. Rastall spoke about last night, propaganda.

The technical trade press of the United States is hungry for accurate scientific information with respect to performances, and your organization could make contributions to that technical press with respect to the performance of your own products, its utility, etc., in a way that would get it space in any editorial column in the United States. I would suggest to you that it be written by men who in themselves are authorities and that it be written around definite installations and definite experiences and not merely the discussion of theoretical ideas. The same thing applies to the foreign trade press. The process of education has to be coordinated by your organization and has to be fortified by some very definite standards of operation. I was very much interested in what Mr. Rastall said last night about obsolescence, about depreciation and scrapping. I have been informed that if a proper educational campaign on those subjects could induce proper thinking and I do not know any other way to induce it upon the part of industrial managers, that probably 50 percent of present boiler equipment would be scrapped, and if that were done within the next few years there would hardly be any problem of overproduction to be considered by this organization.

I do not think there is as much difficulty with competitors as I think there is with the market and the approach of the whole industry toward the problem of furnishing or supplying the number of boilers to be made. A purchasing agent said to me the other day that they did not have to cut the prices the way they did, but the suckers just cut them, and he said, "why shouldn't I sit there and take all I can get? But now I am commencing to realize that I may have to do something to prevent these people from cutting themselves out of business entirely and destroying my source of supply." Is not that a very sad case when an industry—it was not your industry, but is it not a sad case when a whole army of men in an industry get so far bad that even the buyers recognize it and fear they will ruin themselves and prevent the buyer having a source of supply? I do not know, I am a common ordinary layman, you may have some answer to this problem that is much more scientific, but it just occurs to me that it is just a fundamental thing after all. Now, how are you going to stop it? I do not know. I think that the only place to stop it is first inside your own office. I have here an editorial from the *Iron Trade Review* of April 28, 1927, and my good friend, Mr. Shaner, gets quite excited about the sheet steel people. The sheet steel people are making sheets and selling them at a loss of $7 or $8 a ton and they do not seem to be able to get together and fix it up. One mill they told me about lost $18,000 last month, and if they had shut down and had not made anything they would have lost only $10,000. To an engineer it may be a perfectly legitimate and excellent scientific method of operating a business, but if we all did that well, there would be troubles in the country. Here is the fertilizer industry, probably some of you heard about it depending upon the farm market. They are out making fertilizers, very busy and competing with each other—they call it competition. They have got 10,000,000 tons capacity and a 7,000,000 ton market, so it is always somewhat difficult to distribute the product. In 1923 one of the largest units in the industry had a surplus of $17,000,000, and in 1926 they had a deficit of $14,000,000; that is efficiency in the reverse English. They have a problem and their problem is one of control, the same thing as you men have, though it is not quite so bad in your case, from the standpoint of figures, but at the same time it all clearly indicates this one thing: that you have got to get together and go into this question of distribution and marketing, with a consciousness that there is a way to handle the marketing side of this proposition, the same as there is a way of handling the technical side.

Revision of the Sherman Law

There is no doubt in my mind at all but what this whole situation in the country is induced by the oil situation you have been reading about in the papers, where the oil conservation board, which is only an advisory body, has before it the question of control. I haven't a bit of doubt in my mind but what this question of revision of the Sherman Law, together with tax reduction and railroad regulation, will be the outstanding features of the next

Congress. What are you going to do about it? Are you going to be represented in the demand on Congress that something shall be done toward the revision of the Sherman Law? Are you going to take a constructive attitude toward the problem and enter into the fight with the different organizations of your kind, prepared to present the views of your organization? That is not illegal yet, because the Tax Board and the Supreme Court permit you to pay for that sort of thing and deduct it from your income statement, but that is one of the things that your industry ought to contribute to. The Sherman Law has been entirely outgrown; there is a sane line of legislation that can protect the public and protect good business, but you have to make your contribution to the fight, not only in money, but in brains, which is more important. The bituminous coal people have had the same problem; the oil people have it; the fertilizer people have it; there are three hundred organizations in the United States that are going to make a more or less effective drive on this question of the Sherman Law at the next Congress. Are you going to take your part in it? Now, let me sum up what I have had to say to you.

I do not care very much whether it comes through the government or private initiative, but there is no law ever recognized by man since commerce began that compels an industry or a business to lose money, and I think that the government at Washington wishes to help business to make money.

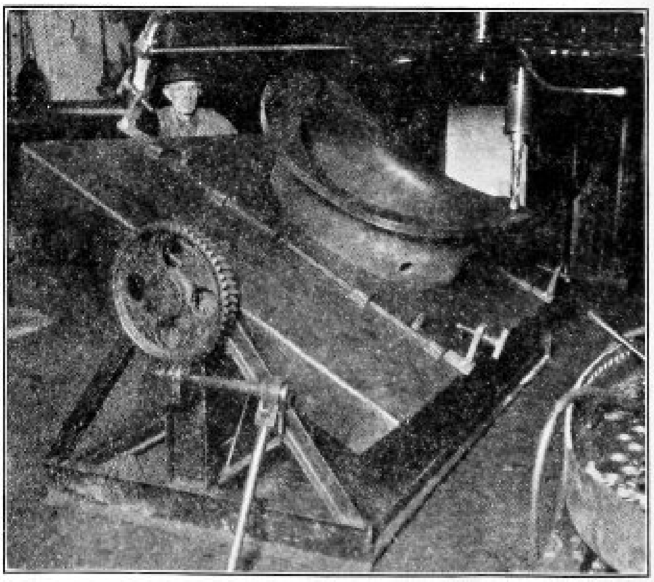
I would first urge that this power house group be formed. I think that that is a very distinct step in the right direction. You have a common problem with ten or twelve of the biggest groups in the country in the power house industry. This calls for scientific work, it calls for marketing analysis. Such a group does not have to interfere with your present association at all; it can be an institute that is controlled by the representatives of the individual constituent associations representing constituent groups; it has for its primary purpose the financing of scientific investigations with respect to the utilization of its combined product. In the second place, it has market research to be done to find out under what conditions any particular grouping is the most efficient for handling the problem of power in any particular manufacturing plant. In other words, this institute is for the purpose of educating inside the industry indicated, as well as outside the industries indicated. It does not interfere with your present organizations, I want to repeat, in any manner, shape or form, except to make them more effective. In the third place, it develops sales power because it finds out what the problem is and puts it in the hands of the individual sales organizations in the groups, accurate facts with respect to what must be done in order to sell the product. Fourth, it finds out what the market wants and what it needs, sometimes two entirely different things. Fifth, it educates the whole power house group to a proper coordination of its efforts. Sixth, it investigates foreign markets in the same way. Seventh, it ought to go on a five-year program, no more and no less. Eighth, it needs proper financing and budgeting. Ninth, it adopts the proper attitude, a constructive attitude, toward the question of legislation and legislative development.

Now, in closing, I want to say to you that there is only one thing that I have observed over ten or fifteen years of pretty careful analysis of trade groups, pretty careful co-operation. I organized five different national organizations myself, and I will say to you that there is just as much benefit to be obtained by proper coordination with respect to your marketing work and the distribution side of your activities, as there is with respect to the scientific or technical side of your activities. I am reminded constantly in meetings such as this of old Ben Franklin's remark to his fellow signers of the Declaration of Independence to the effect that "If you don't all hang together, you will hang separately, but there is going to be a hanging party somewhere."

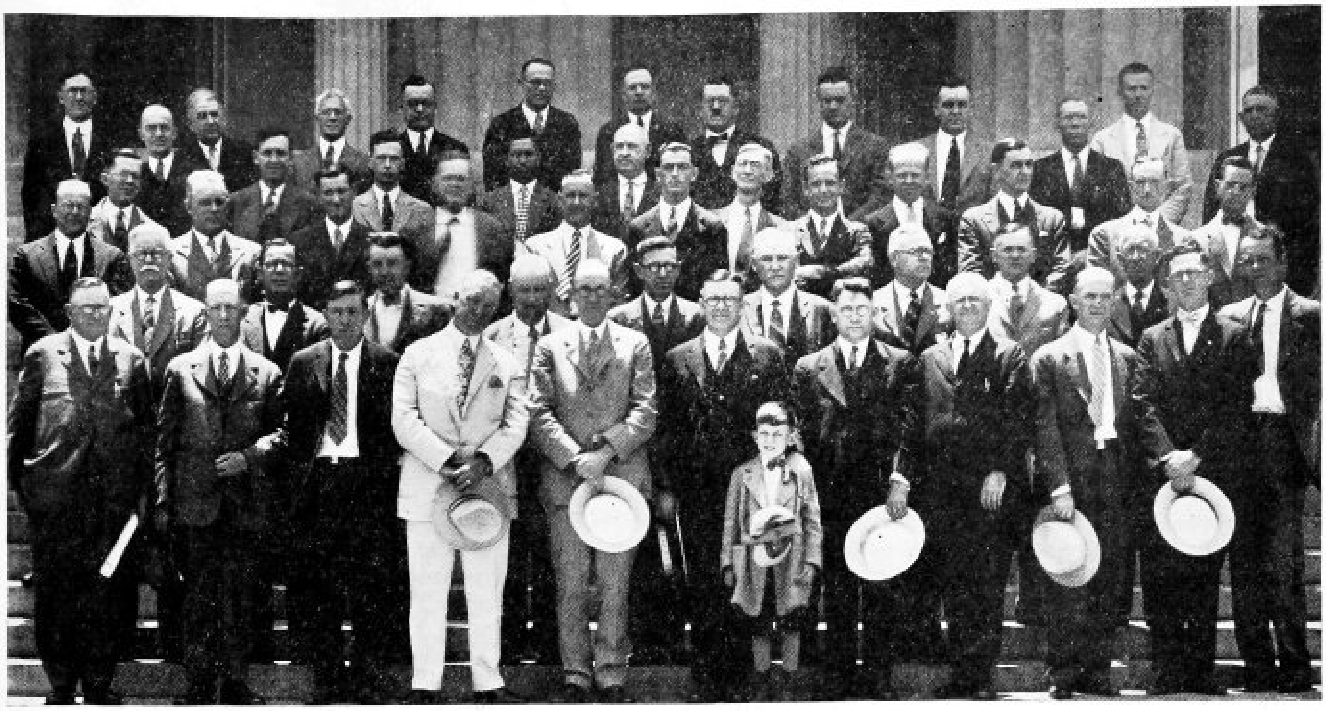
You have but four alternatives in any declining market: in the first place, you can find new markets for your present products—Mr. Rastall suggested possibilities in the foreign fields last night. Second, you can find new products for your plants, with the new markets involved. Third, you can absorb those concerns which have nothing but a nuisance value, the ones that cut prices. I have been in associations where we have absorbed such units. I know of one association that got rid of three plants whose nuisance value was considerable. In the fourth place, you can kill them by letting them have all the unprofitable business. Those are all the alternatives you have, with respect to the whole question of making money and succeeding. When it all comes down to the final analysis, there is only one answer; just as long as a man, through ignorance, prejudice, cantankerousness, or malice aforethought, is willing to take business at a loss, he is a trouble maker in the industry, and as long as the industry is impregnated with that kind of thought, the industry is not going to make money as an industry.

Tilting Table for Radial Drill Presses

THE tilting table, shown in the illustration, is used in the boiler shop of a large railroad located in the middle west, for drilling holes with a large radial drill in the flanges of sand boxes, domes and other boiler accessories of irregular shape. The table was built in the company shops and is made of heavy boiler plate, suitably braced underneath to provide a stable support. The base is built up of angle and channel irons. The worm gear is operated by means of a ratchet lever secured to the end of the worm shaft. It is of substantial construction to withstand any pressure that may be exerted by the drill at the extreme edge of the table. The table is provided with clamps and also has holes drilled in the top, for the purpose of securing the work either by using the clamps or by bolting direct to the table. It is altogether a convenient and easily made device for any shop.



A tilting table for the boiler shop radial drill



Members and guests of the National Board at the Nashville convention

Fifth Annual Meeting of the National Board of Boiler and Pressure Vessel Inspectors

THE fifth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors was held at the Hotel Hermitage, Nashville, Tenn., June 14, 15 and 16. About 60 members and guests from all parts of the United States and from Canada were in attendance. The chairman of the National Board, Joseph F. Scott, chief boiler inspector of the state of New Jersey, was unable to be at the meeting and so the sessions were conducted by C. D. Thomas as acting chairman.

The opening meeting was featured by an interesting address by Mayor Rouse of Nashville. The absence of Mr. Scott made it necessary for C. O. Myers, secretary-treasurer of the organization to read the address prepared by Mr. Scott for the occasion.

Address of Joseph F. Scott

Members of the National Board of Boiler and Pressure Vessel Inspectors, associate members, and visitors: This is the fifth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors since its birth in Detroit, Michigan, in 1919. Its preamble follows:

"The National Board of Boiler and Pressure Vessel Inspectors is organized for the purpose of promoting greater safety to life and property by securing concerted action and maintaining uniformity in the construction, installation, and inspection of steam boilers and other pressure vessels and their appurtenances, and to secure interchangeability between political sub-divisions of the United States." This preamble expresses in a few words the reason for the existence of this body.

For the last several years we have endeavored to meet annually in order to check up on ourselves and make notes relative to our mutual activities, and when we meet it is for the purpose, primarily, to discuss and better assist in coordinating our activities with the viewpoint of further improving and simplifying our work, in order to attain to the highest standard in uniformity of functioning, pertaining to the construction, installation, and inspection of steam boilers, and not to criticize or act in any way that would tend to discourage the cooperation of the steam boiler industry as a whole. Therefore, when we meet annually our meeting should act as a clearing house by all interested in our work, whether they are or are not members of this body. This should be the time when objections, criticisms, and constructive suggestions should be presented with a feeling of an obligation of duty.

The members of this National Board are members of the Conference Committee of the Boiler Code Committee of the American Society of Mechanical Engineers. The problems of the Boiler Code Committee of the A. S. M. E. are our problems and therefore, the Boiler Code Committee looks to us and rightly expects us to assist them in revision, interpretation, and adoption of every paragraph in the A. S. M. E. Boiler Code that comes under discussion, and therefore, a uniformity of opinions is vitally necessary in a board of this kind in order to eliminate a multiplicity of opinions presented to the Boiler Code Committee, creating what heretofore might be termed "confusion compounded," and to overcome this condition this is one of the reasons why the National Board is organized.

With the excellent, able, and efficient engineering consultants which we have as associates, and always are at our service on the Boiler Code Committee of the A. S. M. E., there is no reason why the Boiler Code, with its guidance and interpretations, and the boiler inspection service, should not be one of the most efficient in the engineering field in the world, and with a feeling of such unbiased assistance ever ready to serve, we, as inspectors, ought to be grateful and do our part, to the best of our ability, whenever necessary and required.

By our actions we shall be known and we shall likewise be gaged. It is therefore obvious that every subject that comes before us, individually or collectively, should be given much care and thought before arriving at a conclusion regardless of its simplicity or complexity, for by these conclusions, even though they are of the smallest, shall you receive the rating of your ability. Some men are able in their line and equally as careless in their decisions; also some men are less able but more careful in their decisions. It is therefore pertinent to feel that the man most careful in arriving at a conclusion would be a greater asset to his associates, because he would be confident in his decisions and therefore dependable.

Seventeen states and fourteen cities have representation in this National Board, which represents the number of states and cities operating under and in conformance with the A. S. M. E. Boiler Code. I hope to see the time when every state and city will be listed the same way. This undoubtedly will eventually be realized and when that realization is a fact it will then be a comforting thought to know that no boilers of any type or for any purpose are built that do not conform with the A. S. M. E. Boiler Code. No body of men could appreciate what this would mean more than steam boiler inspectors. A feeling of doubt of the inspectors in the field, pertaining to the construction of the steam boiler, is eliminated when we know the boiler is of A. S. M. E. Code construction, and with a feeling of security he can go ahead and conduct his inspection when he finds a National Board stamp thereon. I do not know of any greater safeguard that could be built around a steam boiler than to have such trademarks stamped on every boiler built.

Before the National Board was organized, I feel it unnecessary to mention the multiplicity of stamping that was then considered in style, but if you stop to think and look back at such practice, you can readily realize the confusing methods that were followed out before we obtained uniformity of stamping. It was a reflection on engineering ability, and was discussed more than any other subject that the boiler manufacturers, insurance companies, and inspectors had to deal with, and while it is evident still in a few isolated cases, we are confident through the instrumentality of the National Board such inefficient methods will be entirely obliterated.

After completing the chairman's address Mr. Myers continued with the reading of his own report for the past year as secretary and treasurer of the National Board. This report appears below.

Report of Secretary-Treasurer C. O. Myers

I am pleased to report that the National Board of Boiler and Pressure Vessel Inspectors has gradually accomplished the results which it set out to do in 1921. Every year since our first meeting we have progressed, which is true of the past year, and in order to give you an idea of the progress as briefly as possible, I believe it can best be done by a comparative statement of the number of boilers which have been registered in the past several years at the office of the secretary-treasurer. In the year of 1923 there were registered 12,820 boilers; 1924, 13,145; 1925, 16,170 and in 1926, 20,745. Mr. Farmer, our statistician, will give you in his report an analysis of the size of the boilers which were registered in 1926.

The question of statistics on boiler accidents, causes, and the types of boilers and whether or not they are code or non-code boilers, is the greatest problem which we have before us today. There is no means of collecting authentic statistics other than through an organization of this kind. The information obtained from such statistics should be valuable in the guidance for preparation of rules for construction and installation of boilers and to the boiler industry as a whole. Our statistician, Mr. Farmer, deserves a great deal of credit for the effort he has put forth to secure a picture of what is happening to the various types of boilers in this country, but he has been handicapped a great deal by not securing the information he desires from the various state and municipal departments. I would suggest that before this meeting adjourns, that a standard form of questionnaire be prepared upon statistics, and that each and every member of this organization, when he returns to his office, govern the preparation of his records so that this questionnaire can be intelligently filled out.

At our last meeting attention was called to the importance of securing a uniform examination for boiler inspectors and a uniform date for conducting such examinations and I am pleased to report that since this meeting the state of Ohio has changed its examination dates to correspond with the examination dates of New York and Pennsylvania, which is in March, June, September and December. I understand that the chairman of the examination committee, Mr. Thomas, has a complete report on rules governing such examinations to submit to the members at this time, and I sincerely trust that all of you will express your views freely upon this subject in order that we may get it started within the next year.

The next order of business was the reading of the statistician's report by E. W. Farmer, chief inspector of the state of Rhode Island.

Report of Statistician

In presenting the third annual report of statistics in regard to accidents to boilers and pressure vessels and casualties attended thereby, I deplore the fact that I have been unable to obtain figures as to the actual number of accidents in code states from members of the Board. If the same will not cooperate with your statistician and give him all the required information with such figures as they have at hand, he cannot give the Board a statistical record that is worth while, but merely an approximate estimate. With this no comparison can be made between boilers constructed to standard regulations and those that are not, also the less incentive in creating a bureau interested in safeguarding the public from possible injury by defective boilers and pressure vessels, keeping no record of same.

Several of the members, with the exception of several of the old standbys who are interested in the success of the organization, have not responded to the appeal of the statistician for such figures as they may have at hand. Surely they know how many boilers they have inspected and recorded, and they most surely inspect all boilers that require inspection. It is not a very hard job for any man to get an estimate as to the number of boilers in his jurisdiction with the postal facilities of today and the newspapers print all the explosions and accidents of boilers, the account of which can be easily obtained from any part of the territory over which a member of the National Board has jurisdiction. In most states having boiler regulations, my own included, the inspector is required to keep a record of the boilers and their condition and these can be obtained at any time, also to inquire into any accidents that occur.

I am very much pleased to report that as far as learned from the members sending in reports, the accidents that have occurred this year have all been on boilers and pressure vessels which were non-code boilers, that is, on industrial boilers.

As in last year's report, the statistician has classified the boilers separately, first, including boilers for industrial use mostly under state supervision, second, including boilers on steamers under the Department of Commerce and under steamboat inspection, third, including boilers on locomotives on railroads and under Interstate Commerce Commission and the Locomotive Inspection Bureau.

The number of accidents to industrial boilers which occurred during the year of 1925 as reported from all sources available:

Total number of accidents and casualties including explosions of stationary boilers, pressure vessels and appurtenances are as follows:

			Code	Non-code
Explosions to boilers	57	..	11	46
Casualties: Killed	..	41	3	38
Injured	..	80	12	68
Accidents to boilers	151	..	75	76
	208	121	101	228
Explosions of low pressure boilers			16	..
Casualties: Killed			..	2
Injured			..	9
			16	11
Explosion to pressure vessels			28	..
Accidents to pressure vessels			12	..
Casualties: Killed			..	15
Injured			..	51
Accidents to boiler appurtenances			57	..
Casualties: Killed			..	1
Injured			..	5
Explosions to boilers on oil wells, etc.			14	..
Casualties: Killed			..	6
Injured			..	18
			335	228

The statistics of boilers as reported by the members of the National Board is very incomplete as I received no answers from three of the states and six cities, also did not receive answers from two other states until after the figures had been tabulated.

From the members that have cooperated with us, however, we make the following report:

Number of boilers	204,518	
Number of boilers insured	52,931	
Number of boilers defective	5,210	
Number of boilers unsafe	877	
Number of boilers exploded	20	plus 2 on railroads
Number of boilers accidents	38	
Number of lives lost	16	
Number of persons injured	29	
Number of pressure vessel explosions	4	
Number of lives lost	2	

Number of boilers constructed in accordance with the power section, A. S. M. E. Boiler Code and stamped with National Board Stamp and registered with the Secretary of the Board are:

1 to 5 Hp.	13,272
6 to 50 Hp.	4,299
51 to 200 Hp.	2,007
201 to 500 Hp.	668
501 Hp. and upward	499
	20,745

The number of accidents to industrial boilers which occurred during the year of 1926 as reported from all sources available are as follows:

			Code	Non-code
Explosions	42	..	20 2 (RR)	22
Accidents	75	..	40	35
Killed	..	26	..	..
Injured	..	30	..	..
Low pressure boiler explosions	10	..	..	..
Killed	..	0	..	..
Injured	..	3	..	..
Pressure vessel explosions	9	..	..	..
Pressure vessel accidents	2	..	..	..
Killed	..	1	..	..
Injured	..	2	..	..
Accidents to appurtenances	34	..	..	..
Killed	..	3	..	..
Injured	..	11	..	..
Misc. explosions	15	..	..	..
Killed	..	17	..	..
Injured	..	19	..	..
	187	112		

Miscellaneous boilers include boilers used for oil wells, agriculture and portable saw mills.

The number of accidents to boilers by explosions on railroads for fiscal year 1926 are as follows:

Explosions	37
Killed	17
Injured	63

The number of accidents to boilers by explosions, etc., in the merchant marine is one explosion of ruptured plate (on Str. Mackinac) and 20 explosions of boilers other than ruptured boiler plates, total 21; there were 58 lives lost—53 on Str. Mackinac and 119 persons injured—100 on Str. Mackinac.

The number of fly wheel explosions for 1925:

Explosions	25	..
Explosions gas engines	16	..
Killed	..	9
Injured	..	12
Turbine explosions	3	..
Centrifugal dryer explosion	1	..
Killed	..	2
Injured	..	1

Last year the report included the latest statistics of power and industries of the states and not caring to repeat the same, I have obtained a short resumé of such changes as have come to my attention, also a survey of the industrial activities and other sources of power in the smallest state in the union, i.e., Rhode Island. If these figures are of interest to those interested in power development, how much more interesting it would be if we could get the same information from some of the larger states, say for instance, the largest state.

The statistician wishes to thank the members who have cooperated with him and hope they will continue to show the same interest in this part of the Board's activities in the future as in the past.

One of the many evidences to show the growth of industry in the United States and the manner in which mechanical contrivances are replacing man power is found in the report, just issued by the Geological Survey, giving the figures on the production of electric power by public utility power plants in the United States in 1926.

It reveals that this production almost has doubled since 1919 and, contrary to popular belief, it shows also that not water power but fuels are used in increasing quantities to produce this electricity.

The figures used in the report refer only to the production of central stations and electric railway plants.

Where in 1919 these plants produced 38,921,000,000 kilowatt hours, in 1925 they produced 65,875,000,000, which rose in 1926 to 73,791,000,000 kilowatt hours.

In 1919, 37.5 percent of all this electricity was generated by water power; but in 1926 this percentage had fallen to 35.5 percent, while the amount derived from fuel power had increased accordingly.

There are three major classifications of fuels—coal, oil and natural gas. The use of oil, however, is decreasing, while that of coal and gas is increasing. Gas is not used in the New England electric plants.

In 1919, 35,100,000 short tons of coal, 11,050,000 barrels of oil and 21,406,000 thousand cubic feet of gas were consumed in the fuel-operated electric plants of the country. In 1926, 41,311,000 short tons of coal, the largest amount on record, and 53,207,000 thousand cubic feet of gas, likewise a new record, were consumed, but the consumption of oil had fallen to 9,399,000 barrels, the lowest in the eight years.

During 1926, the production of electric power in New England was 5,165,955,000 kilowatt hours, or 7 percent of the total production of the United States. Of this 1,684,790,000, or 32.6 percent was derived from water power and 3,481,165,000 or 67.4 percent from fuel power.

Rhode Island's total production was 476,239,000 kilowatt hours, or 0.64 percent of the total for the United States. Of this only 5,524,000 kilowatt hours, or 1.2 percent was derived from water power, while 470,715,000 came from fuel.

In New England the fuel produced electricity in 1926 consumed 2,786,960 short tons of coal and 929,703 barrels of oil. Rhode Island's share of this was 348,459 short tons of coal and 181,975 barrels of oil.

Discussion

Chairman Thomas: I am sure we all appreciate the report, but I wish to call your attention to the incompleteness of the report owing to the failure of the various officials of the states interested to furnish the proper statistics. Our statistician is doing all he can to bring the information before us, regarding explosions and accidents of various kinds, but it is impossible for him alone to furnish the entire statistics of the country, unless he has the full cooperaton of all the states that are operated under the Code. In Oregon we have to make out our reports to the higher authorities something along the lines required of the statistician, and it is no small job, so far as that is concerned, when it devolves upon one man, to do that, and at the same time it does not take so much extra time to make one out to comply with the requirements of this organization, and I believe all the other states and cities could do a lot better than they are doing at the present time. This report will become valuable insofar as it is complete, and no further, so if you are interested in knowing the reresults of boiler inspection as a whole, it is necessary that this information be furnished our statistician. All these reports will be printed in the records of our meeting, and you will receive a copy of the same.

L. R. Land: The legislature of the State of Oklahoma only provided for one inspector for the entire state, except the two cities Tulsa and Oklahoma City, and it is a physical impossibility for one man to visit all the plants in the state. Therefore it is impossible for an inspector to report the actual count of the boilers, and a true report, as the law requires. The law requires the inspector in that state to supervise the installation of new boilers, and make a personal investigation of all accidents. So you can see one inspector's time is pretty well taken up along this line. That is the reason, when I received the statistician's blank to be filled out, I immediately turned it over to the statistician in our office, and when I received the second one, I called his attention to it, he had never done anything. So I hope that my report or summary of the number of boilers wasn't too late to go in that report, but it would be impossible for the State of Oklahoma to report on the actual number of accidents caused from burning oil.

Chairman Thomas: In regard to the suggestion of Mr. Land of Oklahoma, gas furnace explosion by means of gas generated by oil burners, etc., those interested in that question should furnish the information to the statistician regarding such explosions, no matter from what cause. Of course it is not a boiler explosion, it is really a furnace explosion, but it may result in the death of a man, or the complete destruction of the boiler plant, so far as that is concerned.

Chairman Thomas: I think there is one very important part of Mr. Myer's report that has been overlooked, that is, his suggestion of a uniform questionnaire for statistics. Now I believe in revising it so it will meet the requirements of various states, I believe we should have something of that nature. I would like to hear some remarks along that line, with a view of appointing a committee to get up a form of blank required to furnish the certificate.

L. R. Land (State of Oklahoma): I think that is a very good suggestion. If the statistician has any of his blanks with him here, a committee should be appointed to meet with him and work this out. I think there are some questions that could be eliminated, and some could be added. For my state there are questions which it is impossible for me to answer. I might make a suggestion where it would be possible to put another one or two in that would meet the conditions. I think that could be worked out with the committee very easily.

Chairman Thomas: The meeting is open for the general discussion of any question you wish to bring up at the present time. It looks to me that all the difficulties of the boiler inspectors are not imaginary, or anything of that kind, that in the course of the year there should be some question on the inspectors' minds that should be brought before this organization. One I have in mind is this: The various manufacturers throughout the country are manufacturing unfired pressure vessels, they are manufacturing low pressure heating boilers, they are manufacturing other things in accordance with the requirements of the A. S. M. E. Code, yet these manufacturers are not registered manufacturers. It seems to me that before a manufacturer should be allowed to mark his boiler or product A. S. M. E. he should be registered with the A. S. M. E. Society. At the present time the only requirement, as I understand it, is when you are making power boilers then you must register. Now it is rather hard at times in our state, as our friend from Oklahoma stated a year ago, these cross-roads manufacturers, junkshops, or whatever you call them, want to make all of these products, and we have a hard time keeping them from doing it. They comply with the regulations as laid down in the Code, and they want them inspected in the shop, and material inspected, and all of that. Probably their welder is a good welder, and maybe he is not a good welder. We don't know, we can't tell. There is no way that we have of going in there and testing that man's welding. The only thing we can do is to apply the Code test to unfired pressure vessels that are of welded construction. Sometimes I am not absolutely satisfied with that test. It puts me in mind of the time that I tested a boiler that had been welded as repairs, before the Code went into effect in our state. I put 1½ times the working pressure on that boiler, and took a four pound hammer and hammered that as hard as I could when the working pressure was on it, and I must have kept that up for at least ten minutes. Yet I wasn't satisfied, I felt as if I ought to hit it just one more lick. I walked away and accepted it. I caught that boiler six months later when it was broken out at both ends of the weld. That may happen with your unfired pressure vessel, it may stand your tests, and then go to pieces because not properly welded. I don't know whether I am voicing any ideas you fellows may have had in your states, or not. It does seem to me that the manufacturer who is putting even the letters A. S. M. E. on his product should be compelled to register with the A. S. M. E. Society.

F. A. Page (State of California): We have had a lot of experience along that line in California. A lot of you have probably read about a gas explosion in which five men were shriveled up, you might say, in the Ventura Refinery. The cause was a welded head blowing out of a gasoline receiver 16 inches in diameter. After this experience the Gulf Petroleum Company went ahead and built a tank in their shop by the same method, using the same method of construction. They then applied a test of from 1 to 30 pounds. What I mean is they put a pump on there, with the stroke set so that every revolution of the pump would raise the pressure from 1 to 30, and continued on the 1 to 30, that was done for 1,000 applications, and after that the container was examined and found in good condition. The chief engineer says, "Well, let's put on 500 more." At the 1,201 application the shell broke just about ¾ inch below the weld, which goes to show that it is not always just the strength of the weld at that time, but it is the demarcation line of the heat in the plate, and the number of applications of vibration that the container may be subjected to, and although passing the test the inspector may for any reason put on it, it may be that later on, after a number of years of service, the vessel is liable to go any time, when, nobody knows.

Chairman Thomas: The welding proposition is something that is here to stay, and it is going to be improved, so far as that is concerned. Eventually it will be accepted, there is no question in my mind but that it is only a question of our getting down to a system where we know welding is reliable, and I would like to hear an expression from the various members as to whether they think that a man who stamps a vessel A. S. M. E. should be a registered man, or not. It looks to me like that question ought to be taken up, and if we in this organization would take action on it, and approve, or if not approve then demand in a way that the A. S. M. E. Society make that one of their requirements, they might probably take some action on it. As long as we do nothing, things will probably go along just as they are now.

F. A. Page (State of California): I think you are right. I do not see why anyone should put the four letters A. S. M. E. on a product unless he has permission to do so from the A. S. M. E. Society. No one has the right to use anyone's copyrighted symbol, mark, or anything of that kind, without having their permission to do so. To have the permission would of course mean they would have to agree to all of their rules and regulations, in order to legally be allowed to use that symbol.

P. M. Medcalf (Province of Ontario): I understood that for any person to use the A. S. M. E. symbol it was necessary to submit their designs for the A. S. M. E. approval, that is, showing the detailed construction, the methods under which it is built, strength of plate, etc. I think the A. S. M. E. is altogether right. I was of the opinion they had to submit their designs for approval in the same way they do in the Province of Ontario.

C. W. Obert (A. S. M. E. Boiler Code Committee): The American Society of Mechanical Engineers is a strictly non-commercial organization. It has no power. It is not permitted by its character to enter into anything of the duties that you men have for your work. Therefore, when the Society permitted the Boiler Code Committee to go into the matter as far as it has gone, it has always been with the definite instruction that the administrative, or, as you might call it, political phase of the work should be left entirely out. Therefore, when we came to consider this matter of the code symbol, there was a great deal of discussion on just how far the Boiler Code Committee could go, and it was with some fears and trembling of the officers of the A. S. M. E. that it was allowed to go as far as to have this symbol, this clover leaf symbol surrounding the letters, used, and the stamp given out by the Society, but that was influenced by the concern of the boiler manufacturers. They realized that if there wasn't something to which the industry could tie in a national way at the beginning of the work in 1914, there, that it would probably never get anywhere, so they started off with this process of the Society, using the stamp, and a little later on there was added to that the idea of registering the boiler manufacturers, so the boiler manufacturers have a number, the number assigned to every particular manufacturer that number to appear over the symbol; and the Society felt that it was reasonable to go to that extent of using this number, using the stamp, and showing the number, when the stamp is obtained and they have the inspectors, the people that constitute your organization, to back up the enforcement phase of it.

If the Boiler Code Committee were in the position Mr. Medcalf is in in Toronto, so that they not only issue the authorization but check up on the designs, it would be a very nice proposition, but we are in a position where we cannot, as a Society, pass upon any specific design. The constitution of the A. S. M. E. strictly prohibits that. Therefore we had to, at the time this work was started, in 1914, take that initial step, which if that were now to be taken would probably be turned entirely around in the line of the suggestion that your National Board take that stand, but it was then expedient to get the work started, when this boiler code condition was chaotic, and there were about fifteen different standards in the United States. It was an effort then to take the step that was taken, in just the way it was taken, in order to bring uniformity, get the thing on that basis, and there wasn't any attempt, as it might seem to some of you, for the Boiler Code Committee to go into it to a certain extent, and then pass the buck on other things that were irksome and troublesome. The society lent itself and its facilities to getting these things started, and now that they are started there are a great many questions coming up in the Society as to whether it should continue, or not. I think perhaps that had something to do with avoiding the responsibilities, if you might call it that, when the unfired pressure vessel code came out, and of not making any provision for registrations in that particular matter. Our chairman just referred to the matter of a registration system for unfired pressure vessels. It wasn't provided, because I do not believe the Code Committee has ever had a very fundamental or serious understanding as to just how far it should go. There is a feeling in the Boiler Code Committee, at least some members have the feeling that in some of these things we are perhaps getting over into the field, taking your prerogative, and that you people should do more of this assuming of such responsibility.

If you gentlemen will take up that matter, and have a pretty thorough discussion of it, you will help the Boiler Code Committee tremendously. If this registration is a good thing, of course I can see from the practical application of the Code, as your charman says, that there ought to be a registration for unfired pressure vessels, but in the first place, do you gentlemen want this registration to go on as it is now going on? Is it helping you? Is it working out properly? And if so, what suggestions have you to offer along that line?

The Boiler Code Committee stands in the position of wishing to support you men, and give your members all the advice and assistance it can, but it has always been very far from desiring to take any of your responsibilities, or assuming anything of your prerogatives. They feel that you have your sphere and your work to do, and they do not want to go into that any further than it can be of assistance to you. So it is up to you gentlemen to discuss this matter, and tell the Boiler Code Committee what they want.

E. W. Farmer (State of Rhode Island): When the A. S. M. E. issues a symbol to any manufacturer do they not have to register with the American Society of Mechanical Engineers? I always understood it that way.

C. W. Obert: I shall be glad to explain just how that symbol matter is handled all the way through. In the first place, it says, in Paragraph P-332 of the Code, that a manufacturer undertaking to build an A. S. M. E. boiler and stamp it A. S. M. E. must obtain a stamp and must obtain a registration number. So the start on this proposition was to arrange with the boiler manufacturers so that they would sign an affidavit to observe the proper use of this stamp. That affidavit is signed by the official of the organization that is manufacturing boilers, and the signature is witnessed by a notary, so as to give it some official standing, and the purport of the thing is that they promise to use the stamp in accordance with the requirements of the boiler code, and to surrender it at any time upon request. Nothing was said in the affidavit as to why it should be surrendered, but "upon request" this stamp should be surrendered. That, as I said, got the desired result, and, to digress just a moment, I will say that there have been only two cases that I can think of where there has been a definite violation of the affidavit. One was the case of a concern a boiler manufacturer that was just going out of business, there was a violation made, but we never got the officials, they were out of business and disappeared, and we never could trace the reason, just that single case. Another case which happened quite recently was very definitely a misunderstanding, lack of knowledge of the Code work. They used the stamp not in accordance with the Code requirements, but probably ignorantly so, and that, I believe, has been straightened out.

Now this registration requirement came later than the original affidavit feature worked out in 1914. The registration number was recommended to the Committee at the time the 1924 revision was made, and it now stands in the Code, the latter part of paragraph 332, that every boiler manufacturer must, before building these boilers and stamping them in this procedure, obtain from the society a registration number. We now send an affidavit to fill out; they fill out the affidavit, sign it, have the signature acknowledged, then we send him the stamp, and also a questionnaire, which asks, in that questionnaire, if he understands that this Code symbol shall be used only on certain kinds of boilers. It is prohibited on heating boilers. Upon receipt of that questionnaire, which goes immediately on record, as to his understanding of the procedure, we assign him a registration number, and also furnish him a certificate. Now it is specified in the Code that this registration number shall appear not more than half an inch above the code symbol stamp.

There was considerable indefiniteness about the unfired pressure vessel code, but after a great deal of discussion that particular requirement was not extended to the entire pressure code. Understand, however, it is prohibited for heating boilers, so we felt there should be no registration provision, and no use of the Code symbol on heating boilers. It is considered unnecessary to have a miniature boiler stamped. Although it is not absolutely essential, it is possible for the miniature boiler manufacturer to build by the code and stamp it, if he desires, but that Code was gotten up primarily to render it unnecessary to go to such extremes as power boilers.

On the unfired pressure end of the matter there was a good deal of uncertainty as to how far they should go, and at various times there has been a great deal of uncertainty as to whether it would go at all, on account of the restrictions on welding, and some of these other problems. We did not impose the registration requirement in that section of the Code, and it will not be imposed, I am very certain, unless you gentlemen request it.

Tuesday Afternoon Session

The meeting convened Tuesday afternoon at 2 p. m., the first paper at that time being read by S. B. Applebaum of the Permutit Company, New York. The subject of Mr. Applebaum's paper was "Recent Investigations of Riveted Seams that Failed by Cracking." The subject is one that at the present time is being given considerable attention by the technical branch of the industry as well as being one that from the boiler manufacturers' and users' standpoint must be corrected. The article in this and in the July issue of The Boiler Maker by Professor Parr and F. G. Straub of the University of Illinois on "The Cause and Prevention of Embrittlement of Boiler Plate" discusses certain phases of the problem of cracks in boiler plate that are referred to by Mr. Applebaum. Mr. Applebaum's paper will probably appear in an early issue of the magazine.

The next topic of the convention was on "Corrosion—Its Causes and Prevention," read by C. R. Texter of the Metallurgical Department of the National Tube Company, Pittsburgh, Pa. In this paper Mr. Texter explained the theory of corrosion as generally accepted and the various factors that occur which tend to make the condition worse. Increased pressures with the consequent increases in temperature greatly speed up the process of corrosion, but since industrial progress must continue the solution must come in the way of better water treatment and the removal of oxygen from feedwater as well as a careful selection of materials and their proper handling. A considerable portion of the paper was devoted to the subject of water treatment and oxygen removal or de-aëration. A number of leading technical societies in the country have organized a joint research committee on boiler feedwater to carry out the most comprehensive investigation of the problem of boiler corrosion that has ever been attempted. The paper concludes with the following suggestions to the members of the National Board:

"If the National Board of Boiler and Pressure Vessel Inspectors is not already cooperating with other groups in their efforts to conquer the corrosion evil, it is to be hoped that they will do so in the future. The problem is too broad and complicated to be handled by any one group and therefore it is only by close cooperation and avoidance of duplicated effort that the most good can be accomplished. If as great strides are made in the next ten years as have been made in the past ten years, little trouble from corrosion should be experienced a decade hence."

A third paper on much the same problem but attacked from the angle of superheated steam was read by Anderson MacPhee of the Foremost Superheater Company, New York. His subject was "Destructive Effects of Free Oxygen in Steam Due to Decomposition During Superheating."

Wednesday Session

Chairman Thomas brought the meeting to order Wednesday at 9 a. m. by introducing S. W. Miller of the Union Carbon and Carbide Research Laboratories, Long Island City, N. Y. Mr. Miller delivered a paper on "Fusion Welding in Boilers and Pressure Vessels," which will be published in a later issue of the magazine.

Following the interesting discussion in connection with Mr. Miller's paper, the second one on welding, entitled, "The Application of Welding to the Construction of Large Pressure Vessels," was read by Professor T. McLean Jasper, director of research of the A. O. Smith Corporation, Milwaukee, Wis. This paper will appear in a later issue.

A. F. Jansen, president of the Hanna Engineering Works, Chicago, came next on the program of the meeting and after being introduced by Chairman Thomas delivered an address on the subject of "The Dependability of the Riveting Arc." Mr. Jansen's paper will be published in a later issue of The Boiler Maker.

The Thursday session of the meeting was devoted to the discussion of business of the National Board during which the election of officers for the coming year was held.

Executive Session Thursday

Thursday morning, June 16, the meeting was called to order by vice-chairman Thomas.

James H. Herron of the James H. Herron Company, engineers, Cleveland, Ohio, representing the James C. Heintz Company, Cleveland, Ohio, appeared before the Board in reference to an electrically heated steam vulcanizing device, and submitted a booklet for each member of the Board containing a full description in detail of the device including photographs and laboratory tests. This matter was discussed later in the meeting in executive session, and on motion of Mr. Land, seconded by Mr. Eales, it was unanimously ruled:

That this is a miniature boiler, and must be built in accordance with the requirements of the miniature code.

The attention of the Board was directed to the fact that the A. S. M. E. code is not definite as to the number of code stamps required on multiple drum boilers. After some discussion of the matter, on motion of Mr. Page, seconded by Mr. Furman, it was unanimously ruled:

That each and every steam and water drum of a boiler comprising one boiler unit shall be stamped by the manufacturer with the same serial number in accordance with paragraph P-332 of the A. S. M. E. code.

Referring to shop data reports, the Board was asked to make a ruling as to who shall sign data reports for final inspection of boilers when they are assembled in a boiler shop other than where built, or in a steam plant where they are to be used. After some discussion of the matter, on motion of Mr. Eales, seconded by Mr. Lukens, it was unanimously agreed that the chairman appoint a committee to formulate resolutions covering this subject to be submitted for approval. The chairman then appointed the following committee, Mr. Speed, Mr. Furman and Mr. Page.

The committee retired from the meeting, and later submitted a report covering this subject in detail. This report was thoroughly discussed, and did not meet the approval of the Board. It was regularly moved and seconded, that the report be not accepted. It was regularly moved and seconded that the executive board give their attention to this question and work out a practical solution.

Referring to paragraph P-328, relating to latches on fire doors, upon which a ruling was requested as to the proper application of this rule, after some discussion of the matter the chairman appointed Mr. Eales and Mr. Obert as a commission to draft the wording of the proposed amendment to paragraph P-328. Mr. Eales read the report of the committee as follows:

Recommend to the Boiler Code Committee of A. S. M. E. that they add to paragraph P-328 the following:

These latches or fastenings shall be of the automatic positive locking type, having a latch or bolt in a fixed bracket on the door frame or furnace front. The latch or bolt shall be dependent upon gravity or counterweighted. Friction contacts, latches or bolts actuated by springs shall not be used. The material and construction of the device shall be durable and substantial. The foregoing requirements for latches or fastenings shall not apply to coal openings of down draft or similar furnaces.

Soot and cinder doors, not used in the firing of the boiler, may be provided with bolts or fastenings in lieu of automatic latching devices.

Explosion doors necessarily provided to relieve furnace pressure, if located in the setting walls, within seven feet of the firing floor or operating platform, shall be provided with substantial deflectors to direct the force of the blast and permit the safe exit of the boiler operators in an emergency.

On motion of Mr. Furman, seconded by Mr. Peal, the report of the committee on fire doors was unanimously adopted.

A communication dated April 1, 1927, from Mr. Furman, addressed to the secretary of the National Board, calling attention to the code stamp being placed below hand hole openings where they became corroded to such an extent as to disappear altogether was referred to the Board. After some discussion of the matter it was unanimously agreed that the secretary be instructed to send a letter to all National Board inspectors instructing them to see that such stamps be placed above hand hole or other openings.

Mr. Farmer read the report of the committee appointed to prepare statistical data form, and submitted copy of same, and recommended adoption of the report. Action on this matter was deferred.

The question of requiring fusible plugs in low pressure heating boilers was submitted to the Board, and after some discussion of the matter, on motion of Mr. Speed, seconded by Mr. Page, a roll call vote was requested on the following ruling.

That we recommend to the Boiler Code Committee of the A. S. M. E. that fusible plugs be not required in low pressure heating boilers.

Mr. Peal offered the following resolution:

That the National Board of Boiler and Pressure Vessel Inspectors go on record as favoring and recommending that states and cities having boiler inspection laws incorporate in their present laws, rules and regulations covering the construction and operation of unfired pressure vessels.

On motion of Mr. Lukens, seconded by Mr. Speed, this resolution was adopted unanimously.

Chairman Thomas called on Secretary Myers to read a report of the committee on uniform examinations which was appointed at Chicago last year. Mr. Myers read this report. On motion of Mr. Peal, seconded by Mr. Wilcox, it was unanimously agreed that the report be adopted in its entirety.

Mr. Edgar suggested that the representation of this Board on the A. S. M. E. Boiler Code Committee be increased to three members, and that the expenses of these members be paid out of the funds of the National Board. Mr. Myers explained that in addition to himself Mr. Scott, Mr. Eales, Mr. Furman and Mr. Farmer attended the Code committee meetings quite frequently. On motion of Mr. Speed, seconded by Mr. Wilcox, it was unanimously agreed that the chairman of this Board make a request to the A. S. M. E. Boiler Code Committee for permission to have the National Board chairman, vice chairman, as well as secretary, to act as members of the A. S. M. E. Boiler Code Committee.

Mr. Speed submitted a communication dated June 13, 1927, from the Erie City Iron Works, Erie, Pa., together with six photostat copies of a new designed safety latch for fire doors, for the approval of this Board. It was unanimously agreed that this matter be submitted to the members of this Board by mail.

Election of Officers

The next order of business being the election of officers, C. D. Thomas of the state of Oregon was elected chairman; William H. Furman of New York, vice chairman; I. C. Peal of Nashville, Tenn., statistician; C. O. Myers of Ohio, secretary-treasurer.

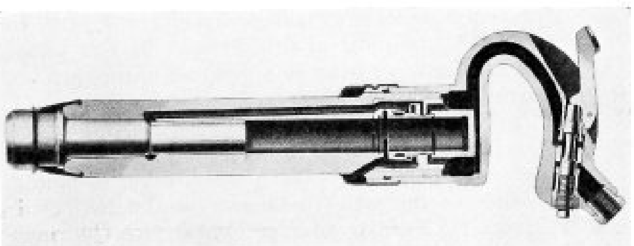
Attendance at National Board Meeting

S. B. Applebaum, The Permutit Company, New York, N. Y.
Thos. R. Archer, Chief Boiler Insp. State of Delaware, Wilmington, Del.
L. M. Barringer, City Boiler Inspector, Seattle, Wash.
R. C. Borchert, A. O. Smith Corporation, Milwaukee, Wisc.
H. L. Bosworth, New York Indemnity Company, Atlanta, Ga.
J. D. Brenen, Tennessee Central Ry. Co., Nashville, Tenn.
Wm. F. Brennan, Chief Inspector, New York Indemnity Co., New York, N. Y.
G. L. Brock, Hartford Steam Boiler Insp. & Ins. Co., Nashville, Tenn.
R. W. Clark, N. C. & St. L. R. R. Co., Nashville, Tenn.
Joseph H. Cole, Maryland Casualty Co., Nashville, Tenn.
L. J. Coulson, Travelers Indemnity Co., Nashville, Tenn.
Thomas J. Coyle, Travelers Indemnity Co., Nashville, Tenn.
John C. W. Daly, Townsend Company, Chicago, Ill.
A. L. Daniels, City Boiler Insp., Parkersburg, W. Va.
Wm. P. Eales, Asst. Supt., Travelers Insurance Company, Hartford, Conn.
M. A. Edgar, Chief Boiler Insp. State of Wisconsin, Madison, Wisc.
Joseph Ernst, City Boiler Insp., Buffalo, N. Y.
E. W. Farmer, Chief Boiler Insp. State of Rhode Island, Providence, R. I.
Geo. C. Fisher, Smoke Inspector, Nashville, Tenn.
Wm. H. Furman, Chief Boiler Insp. State of New York, Albany, N. Y.
Ed. M. Gillenwater, Commissioner of Labor, State of Tennessee, Nashville, Tenn.
A. C. Grist, Lookout Boiler & Mfg. Co., Chattanooga, Tenn.
J. C. Heintz, James C. Heintz & Co., Cleveland, Ohio.
T. A. Heringer, Chief Boiler Insp. State of Utah, Salt Lake City, Utah.
Jas. H. Herrin, J. C. Heintz & Co., Cleveland, Ohio.
John Hunter, Nashville, Tenn.
T. McLean Jasper, A. O. Smith Corporation, Milwaukee, Wisc.
B. S. Jennings, Royal Indemnity Co., Birmingham, Ala.
A. F. Jensen, Hanna Engineering Works, Chicago, Ill.
T. J. McKerihan, Pennsylvania Railroad Co., Altoona, Pa.
L. R. Land, Chief Boiler Insp. State of Oklahoma, Oklahoma City, Okla.
John M. Lukens, City Boiler Insp., Philadelphia, Pa.
Anderson MacPhee, Foremost Engineering Co., of New York, Meadowbrook, Pa.
Chas. J. Manney, Ohio Boiler Inspection Dept., Columbus, Ohio.
C. O. Myers, Chief Boiler Insp. State of Ohio and Secretary-Treasurer National Board, Columbus, Ohio.
D. M. Medcalf, Chief Insp. Steam Boilers Province of Ontario, Toronto, Ont.

S. W. Miller, Union Carbide & Carbon Research Laboratories, Long Island City, N. Y.
Halstead H. Mills, Chief Safety Engr. City of Detroit, Detroit, Mich.
Wm. A. Nevin, Heggie Simplex Boiler Company, Joliet, Ill.
J. D. Newcomb, Jr., Chief Boiler Insp. State of Arkansas, Little Rock, Ark.
M. F. Nicholson, Nashville, Tenn.
C. W. Obert, Secretary Boiler Code Committee A. S. M. E., New York, N. Y.
F. A. Page, Chief Boiler Insp. State of California, San Francisco, Cal.
L. C. Peal, City Boiler Insp., Nashville, Tenn.
R. Peyinghaus, City Boiler Insp., Tampa, Fla.
W. N. Porter, Chamber of Commerce, Nashville, Tenn.
Dan L. Royer, Chief Inspector, Ocean Accident & Guarantee Corp., and Columbia Cas. Co., New York, N. Y.
R. A. Snively, Ocean Accident & Guarantee Corp., and Columbia Casualty Co., Kansas City, Mo.
E. O. Sorensen, London Guarantee & Accident Co., Little Rock, Ark.
James E. Speed, City Boiler Insp., Erie, Penna.
C. R. Texter, National Tube Co., Pittsburgh, Pa.
C. D. Thomas, Chief Boiler Insp. State of Oregon, Salem, Oregon.
E. J. Thornton, Hartford Steam Boiler Insp. & Ins. Co., St. Louis, Mo.
J. W. Turner, Pacific Steel Boiler Corp., Waukegan, Ill.
Eugene Webb, Hartford Steam Boiler Insp. & Ins. Co., St. Louis, Mo.
John G. Wheatley, Ocean Accident & Guarantee Corp. and Columbia Casualty Co., Detroit, Mich.
Geo. Wilcox, Chief Boiler Insp. State of Minnesota, St. Paul, Minn.
J. M. Wood, Chief Boiler Insp. State of Indiana, Indianapolis, Ind.

Tubular Valve Features New Cleco Riveting Hammer

THE new Cleco riveting hammer illustrated is the latest product of the Cleveland Pneumantic Tool Company, Cleveland, Ohio. The chief feature of this riveting hammer is the main valve which is tubular in form and through which the piston passes at each stroke. It is actuated by live air in both directions which insures a uniform and steady action. It is short, light in weight, has solid walls free from port holes and is reinforced at the lower end as a protection against injury from piston slap.



Cleco riveting hammer

Pistons of different lengths may be used without detriment to the tubular valve—the valve being short allows use of short pistons without danger as the piston always has a reasonable bearing in both cylinder and cushion chamber. A cushion chamber is provided in the rear end of the valve block integral with the block and in alinement with the valve and cylinder bore which insures a constant cushion for the piston on its return stroke, absorbing all shock or recoil.

An air reservoir is provided between the outer walls of the valve block and the inner bore of the handle termed "power pocket" in which air is stored up and discharged in volume on the piston at the beginning of each stroke, giving added impulse to the piston and increasing the speed and force of the blow.

The safety handle lock is a new design to safely lock the handle onto the cylinder and so constructed that easy and close adjustments may be made as the hammer becomes worn in service. It consists of a locking ring with teeth milled in the upper side to engage similar teeth milled in the lower edge of the handle and keyways are cut on the inner side to engage similar keyways cut on the cylinder. A spring clip holds the ring and cylinder together and further provides an outlet for exhaust air—the clip can be turned to deflect the exhaust air away from the operator.

The balanced throttle valve is operated by a throttle lever so controlled that it allows a reasonably free action before engaging the throttle valve. The throttle valve operates within a steel sleeve seated in a recess provided in the handle both of which are hardened and ground in position. The valve action is even and smooth and regulates and graduates the air supply.

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

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

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

Below are given records of the interpretations of the committe in Cases Nos. 548 to 552, inclusive, as formulated at the meeting of May 20, 1927, all having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 548. Inquiry: Is it permissible to insert a tee connection between a superheater and its safety valve to permit withdrawal of steam for soot blowers, provided the boiler proper is equipped with its full complement of safety valves according to Code requirements? It is pointed out that Pars. P-277 and P-290 refer to boiler and not to superheater outlets.

Reply: It is the opinion of the committee that Par. P-277, with the exception of the last sentence, and Par. P-290 apply only to the main safety valves on the boiler proper, and therefore the insertion of a tee connection between the superheater and its safety valve to permit of withdrawal of steam, as outlined, does not conflict with the Code requirements.

CASE No. 549. Inquiry: Is it the intent of Par. P-260 and Fig. P-16 of the Code that elliptical manholes must be inserted in the shells of boilers or drums always with the long axis thereof at right angles to the longitudinal center line of the shell? Will it not be permissible on boiler shells and drums not exceeding 48 inches in diameter to insert an elliptical manhole with the long axis parallel to the longitudinal center line of the shell, so that less depth of flange is required at the center?

Reply: There is nothing in the Code to specify the direction of the long axis of elliptical manholes. It is the opinion of the committee that such manholes, when inserted in the shells of boilers or drums, may be placed in either direction provided the opening is properly reinforced with reference to the long axis of the manhole.

CASE No. 550. Inquiry: Is it necessary under the requirements of Par. P.-333 that portable boilers of any type must be fitted with the additional or duplicate stamping on a non-ferrous plate 3 inches by 4 inches in size, as specified in section *c* of that paragraph? It is pointed out that often other types of boilers are fitted out for portable use, such as those covered by items *d* and *h* of Par. P-333.

Reply: It is the opinion of the committee that the provision in the last sentence of Par. P-333c was intended to cover portable boilers of any type, whether of locomotive, vertical-tubular, Scotch marine, or other types that may be adaptable for portable use. If such a boiler is built for stationary use and is subsequently placed in portable service, it is incumbent upon those responsible for the change to see that the requirement for additional or duplicate stamping on the non-ferrous plate is complied with.

Case No. 551. (In the hands of the committee.)

Case No. 552. Inquiry: Is it necessary in purchasing base metal plate for welded steel low pressure heating boilers, to specify firebox quality for plates that are to be exposed to the products of combustion, or is any good soft grade of steel acceptable for this purpose?

Reply: Pars. H-74 to H-77 are intended to cover steel plate of either flange or firebox quality, the chemical and physical requirements to be in accordance with Pars. H-74 and H-76. In all other respects the steel should conform to the Specifications for Steel Boiler Plate, Pars. S-5 to S-17 of Section II of the Code. Such material is practically the same as that covered by the Specifications for Steel Plate of Flange Quality for Forge Welding, Pars. U-110 to U-125 of Section VIII of the Code, and it is the intention of the committee to revise Par. H-74 to conform to Par. U-70 of Section VIII of the Code. Pars. U-112 and U-115 have already been revised to permit the use of two grades of material, Grade A being the same as before and Grade B permitting a maximum carbon content of 0.20 percent and a corresponding minimum tensile strength of 50,000 pounds per square inch.

Redesigned Draper Flue Cleaner

The illustration shows a redesigned flue cleaner manufactured by the Draper Manufacturing Company, Port Huron, Mich., and sold by the Scully Steel & Iron Company, Twenty-fourth Street and Ashland avenue, Chicago. The cleaner is mounted on a heavy, suitably arranged concrete foundation with curbed sides which form a well that is connected with a sewer or other outlet. The overflow of the cleanest water from the top of the well passes into an auxiliary well. This water, by means of a circulating pump, is used over and over through the flue cleaner. In cold weather the water can be heated in the auxiliary well by a pipe coil. A power pump with ball valves can be connected with one of the main shafts.

All the bearings of the shaft, motor and gearing are securely bolted to heavy iron foundation plates, and these, in turn, are bolted to the concrete foundation, thus holding all the shafts and gears in rigid alinement. All the gears are cut and the small gears are made of steel. The main drum bearings and the main shaft bearings are securely bolted to the same foundation plate.

The main drum with the reinforced double plate in the center is securely riveted to the end plates. The heavy drumheads overlap the ends of the steel drum, to which they are securely double riveted. The water is forced in through a hollow shaft at one end and through the cored drum head and a series of pipes and then distributed by 30 nozzles over the entire length of the cleaner. The water supply pipe is connected by a revolving connection. Oblong holes, 4 inches by 4 inches, are cut in the steel drum through which the dirty water and mud drains to the settling tanks. The distributing pipes are securely fastened to the body of the drum and revolve with it.

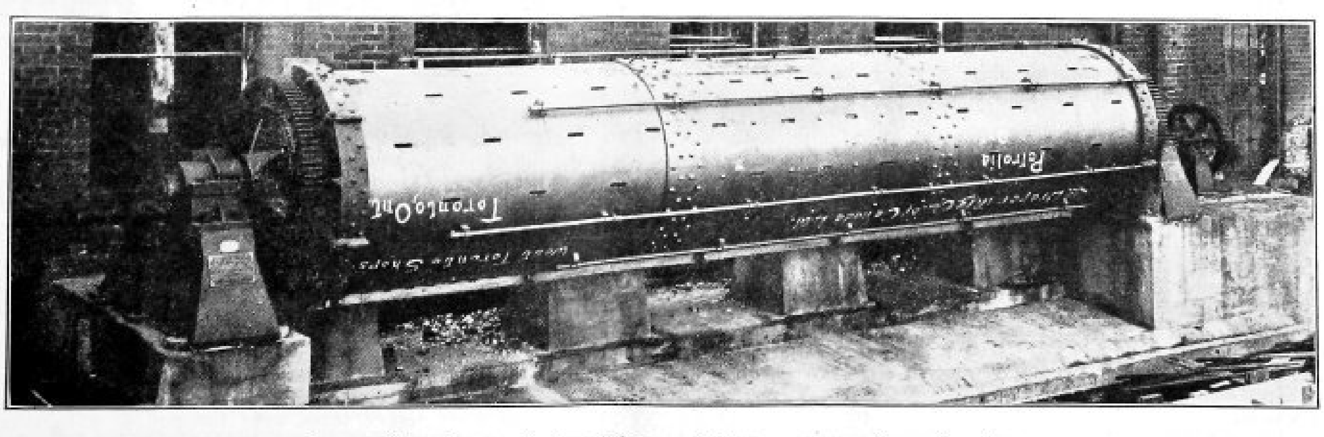
Under some scale conditions, flues may clean better when rumbled dry and in this case all that is necessary is to shut off the water supply, thus having all the advantages of a dry cleaner.

The sides of the drum door fit into a bevel in the steel drum and are held securely in place by forged bolts. The flues are loaded with slings or other loading devices through the door at the top of the drum. For unloading, the open door space, when turned to the bottom, allows the cleaned flues to roll out into a rack located near the cutting-off machine.

Chicago Pneumatic Tool Company, 6 East 44th Street, New York, N. Y., announces the removal of its Seattle branch office, service department and warehouse effective August 1, 1927, from 119 Jackson Street to 1743-47 First Ave., South, Seattle, Washington.

John A. Toleik has served a 17-year connection with the American Can Company to accept the position of chief engineer of the Gibb Welding Machines Company, Bay City, Michigan. Mr. Toleik has been in charge of all welding developments with the American Can Company and was personally responsible for the high production turned out in their many welding operations. Mr. Toleik's chief interest with the Gibb Welding Machines Company will be in the further development of the research department.

Air Reduction Company, Inc., 342 Madison Avenue, New York, has purchased the business, insofar as the manufacture and sale of oxygen, acetylene, and kindred products are concerned, of the United Gas Improvement Contracting Company, a subsidiary of the United Gas Improvement Company, and the United Oxygen Company, Philadelphia. The purchase includes oxygen plants at Philadelphia, Chester, Milton, Enola and Reading, Pa., and an acetylene plant at Bridgeport, Pa.



Draper flue cleaner designed for a minimum consumption of water

Dictionary of Locomotive Boiler Terms

Definitions of boiler parts adopted by Master Boiler Makers Association at annual convention

At the recent annual convention of the Master Boiler Makers Association, W. H. Laughridge, chairman of the committee on "Standard Boiler Terms" proposed that the association adopt such portions of the "Dictionary of Terms" appearing in the *Locomotive Cyclopedia* published by the Simmons-Boardman Publishing Company, New York, as applied to boiler work. The convention passed the motion unanimously and adopted the definitions of terms which for the benefit of members of the association and all others connected with locomotive boiler work appear in part below. The first section appeared on page 171 of the June issue, the second on page 201 of the July issue. Further instalments of these terms will be published in later issues.

Definition of Terms

E

Eight-Coupled Locomotive. A locomotive having four pairs of coupled driving wheels. Built with or without engine or trailing truck, or both.

Eight-Wheel Locomotive (4-4-0). See American Locomotive.

Eight-Wheel Switcher (0-8-0). A locomotive having four pairs of coupled driving wheels, but no front or trailing truck. Used for heavy switching service.

Exhaust Muffler. A device applied to the top of the exhaust pipe in the smokebox. It consists of a deep circular casting with radial apertures through which the steam discharged from the exhaust nozzle must pass. Being divided into many small discharges, the pressure of the exhaust steam is much diminished, the noise softened, and the draft on the fire reduced. A hinged flap or cover, operated by an arm and rod to the cab, enables the engineman to vary the degree of muffling or dampening as desired. Not in general use.

Exhaust Nozzle. A tip or end piece fitted on the end of exhaust pipe or pipes, so proportioned to the size of the cylinders, front end arrangements, etc., as to cause the steam passing out of it to produce the desired draft on the fire. In Europe, and to some extent in this country, a nozzle of variable size is used, so as to adjust the force of the blast to the work the engine is doing. Sometimes called Exhaust Tip.

Exhaust Nozzle Damper. A device to increase or decrease the aperture of the exhaust nozzle.

Exhaust Passage (Cylinders). Cored openings in a cylinder saddle casting leading from the steam chest to the base of the exhaust pipe.

Exhaust Pipe. A vertical cast-iron pipe, bolted at its base to the cylinder castings or saddles inside the smokebox, for conducting the steam exhausted from the steam chests to the upper part of the petticoat pipe and stack. British, blast pipe. See Low Pressure Exhaust Pipe.

Exhaust Pipe Base. A casting attached to the bottom of the smokebox, forming a base for the exhaust pipe and a means of connecting the exhaust pipe to the exhaust pipe of the low pressure cylinders, which is attached by means of a ball joint. The exhaust pipe base forms a stuffing box for the ball joint and allows considerable flexibility between the two pipes, at the same time making a steam tight connection. Used on articulated locomotives.

Exhaust Pipe Blower Connection. An opening in the side of the exhaust pipe or nozzle to which the blower pipe is attached.

Exhaust Pipe Blower Nozzle. Small nozzles set around the edge of the exhaust nozzle and connected to the blower pipe so that steam can be admitted directly from the boiler for the purpose of creating a draft when the locomotive is standing or working slowly.

Exhaust Pipe Bolt. One of the bolts used to secure the exhaust pipe to the cylinder castings.

Exhaust Pipe Combination. An exhaust pipe by which the high and low pressure cylinder exhaust steam is combined. The low pressure exhaust pipe is made in the usual form with a nozzle at the top and the high pressure exhaust pipe is combined by making a chamber around the usual exhaust pipe causing the steam to pass around the outside of the low pressure exhaust pipe and out at the top through nozzles set around the low pressure exhaust nozzle. Used on Mallet compound locomotives.

Exhaust Steam Injector. A form of injector operated by exhaust steam. It also acts as a feedwater heater.

Expansion Knee. A light vertical steel plate, fastened transversely to the frames at some point between the cylinder saddles and firebox to support the boiler, and possessing sufficient elasticity, by reason of its thinness, to allow the boiler to move longitudinally when expanding and contracting by reason of change of temperature. It is usual to put one knee at the guide yoke and one or two back of this, near the firebox. Also called expansion sheet, buckle plate and waist sheet.

Expansion Knee Plate. See Expansion Knee.

Expansion Link. An eye bar secured to a bracket on the frame and to a thick plate or casting fastened to the outside firebox sheet. It is for the purpose of holding the back end of the boiler in such a way to the frames as to allow the boiler a little freedom to move longitudinally when expanding and contracting.

Expansion Link Pin. A pin or pivot holding an expansion link to the frame or firebox sheet.

Expansion Link Pin Plate. A plate or casting fastened to the outside firebox sheet to hold an expansion link pin.

Expansion Pad. A plate or casting bolted to the frames, and holding a corresponding plate or pad which is riveted to the outside firebox sheet or mud ring. These two pads are connected by bolts loosely fitted so as to allow the boiler to expand and contract with changes of temperature. In other forms the piece riveted to the firebox has a narrow projecting flange or lip on which rests another flange on the piece fastened to the frame. The boiler is thus perfectly free to expand longitudinally and to contract, while being held securely to the frames and allowed little movement in a vertical or lateral direction

Expansion Pad Cap. A bent piece of metal fastened to a locomotive frame and resting on the piece secured to the firebox, these two pieces comprising an expansion pad.

Expansion Pad Liner. An iron plate interposed between an expansion pad and the outside firebox sheet.

Expansion Sheet. See Expansion Knee.

Expansion Stay Bolt. See Flexible Stay Bolt.

Extended Smokebox. A smokebox, which extends out beyond the cylinder saddle and which has a large volume. It provides a space for the accumulation of sparks. Within certain limits extending the length of the smokebox improves the draft.

Extended Wagon Top Boiler. A locomotive boiler having a shell made up of one or more cylindrical courses of plates next to the firebox, a conical course tapering down to a smaller diameter, the taper being confined to the top and sides, and one or more adjoining cylindrical courses of reduced diameter next to the smokebox. The purpose of putting in the cylindrical course next to the firebox is to provide a place for the steam dome in front of the firebox, and thus do away with crown bar staying over the crown sheet.

F

Fan Draft. The method of drafting a locomotive by means of a fan in the smokebox operated by an electric motor.

Feedwater Heater. A device by means of which the heat in the waste gases from the firebox or exhaust steam can be imparted to the boiler feedwater before it is delivered to the boiler for evaporation.

Feedwater Treatment. The neutralization, or removal from water to be used in boilers, of injurious acids or incrustants which, if left in, decompose the metal or form scale on the tubes and plates of the boiler.

Feedwater Valve Rigging. The arrangement of a cock with a shaft, rod, handle and bracket for turning on or off the supply of water in the injector supply pipe.

Ferrule. A copper sleeve fitted over the end of a tube or flue to secure a water-tight joint between the ends of the flue and the hole in the flue sheet.

Finger Grate. A grate made up of grate bars cast with projections or fingers on each side which interlay with the fingers on adjacent bars. When the grate bars are rocked or turned in their trunnion bearings the fingers disengage and allow the ashes to fall through to the ash pan below. See Rocking Grate.

Firebox. The furnace, or box in which the fuel is burned. The sides and top or crown of a firebox of a locomotive boiler transmit the heat of the fire to the water, and there is an excessively active generation of steam near these parts. The front or forward sheet of the firebox has a large number of holes in which the ends of the flues or tubes are inserted. These tubes carry the products of combustion to the smokebox, and as they are surrounded by water, give up a large amount of heat to the water, from the waste gases passing through them. Fireboxes are built of steel plate in this country although copper is employed in some countries. See Brotan Firebox, McClellan Firebox, Narrow Firebox, Oil Burning Firebox, Wide Firebox, Wootten Firebox, Belpaire Firebox, Sectional Firebox, Water Tube Firebox.

Firebox Back Sheet. The sheet or plate at the back end of a firebox inside, in which the door or doors are located. Also called door sheet.

Firebox Crosstie. A heavy casting secured across the frames to bind them together and at the same time support the mud ring or foundation ring at the front or back of the firebox.

Firebox Crown Sheet. The plate that forms the top of a firebox. See Crown Sheet.

Firebox Door Sheet. See Firebox Back Sheet.

Firebox Heating Surface. The heating surface of the inside of the locomotive firebox sheets. The heating surface of the combustion chamber and arch tubes is usually included in the firebox surface. It is the area calculated from measurements of the firebox sheets, above the level of the grate, less the total fire area of the tubes, the area of fire doors, and the area of air inlets through the firebox sheets.

Firebox Jacket. The covering or jacket put on outside the lagging on the firebox to hold the lagging in place.

Firebox Outside Sheet. See Outside Firebox Sheet.

Firebox Ring. A steel casting or an iron or steel bar, shaped to correspond to the ground plan of a firebox, rounded at the corners, separating the inside and outside sheets of the firebox, and to which these sheets are riveted. Also called Foundation Ring, Mud Ring.

Firebox Side Sheet. Either of the sheets forming the sides of a firebox, but generally refers to the inside sheet as distinguished from the Outside Firebox Sheet.

Firebox Steel. See Steel (Specifications for).

Firebox Throat Sheet. A boiler plate flanged to connect the back tube sheet, and in the case of a combustion chamber to connect the bottom plate with the mud ring and firebox side sheets. Also called inside throat sheet.

Firebox Tube Sheet. See Tube Sheet.

Firebox Wrapper Plate (British). See Roof Sheet.

Fire Brick. A kind of brick made of refractory material to resist a high degree of heat, used in a firebox arch to promote uniform combustion and diminish black smoke. Also used in oil burning fireboxes to form a surface against which the burning oil may impinge. See Brick Arch.

Fire Brick Shelf. A shelf made of fire brick and placed at the front end, below the tubes, of a firebox for burning oil. The oil burner is usually placed just below this shelf.

Firedoor. A door usually hinged at the side to close an opening through which coal is thrown on the fire. Some types of door are made to slide and are moved by a lever or handle. Swinging doors are made with a handle and a chain fastened to the boiler head for convenience in opening and closing. A catch or notched rod is provided, on various points of which the handle of the door may be set so as to regulate the amount of air admitted above the fire. Some doors are arranged to be operated by a rod moved by the piston of a small air cylinder, whose valve is fitted with a lever, on the end of which the fireman presses his foot and thus opens and closes the door. See Pneumatic Firedoor.

Firedoor Catch. A catch or hook-shaped projection on the back head on which the firedoor handle fastens or latches.

Firedoor Chain Hook. A hook on the firedoor to which a chain attached to the back head is secured.

Firedoor Damper. An adjustable plate fitted in a firedoor for the purpose of admitting air above the grate through the fire door.

Firedoor Deflector. A cast iron plate above a firedoor and projecting into the firebox for the purpose of deflecting the cold air away from the tubes and downward toward the fire. Usually used on oil burning locomotives, but occasionally used on coal burning locomotives having a low brick arch to prevent coal being thrown over it.

Firedoor Diaphragm. A firedoor frame.

Firedoor Frame. A frame fastened to the back head around the firedoor hole to which the firedoor and liner are secured.

Firedoor Guide. Part of the door frame of a sliding firedoor, in which the firedoors slide.

Firedoor Handle. A bar fastened to the firedoor with a handle at one end for the purpose of opening the door.

Firedoor Handle Connecting Rod. A bar or rod connecting the door handle of one sliding door with the other door, thus opening both doors simultaneously.

Firedoor Handle Guide. A guide to keep the firedoor handle or latch in position.

Firedoor Hinge. The hinge or pivot secured to the back head and on which the firedoor turns to open and close.

Firedoor Hinge Bracket. A bracket secured to the back head to hold the door hinge.

Firedoor Hinge Pin. A rod or pin about which the firedoor turns in opening. Part of the door hinge.

Firedoor Hole. The opening in the boiler back head and firebox door sheet through which the fuel is placed in the firebox. Made in various shapes. Two firedoor holes are commonly used with wide fireboxes.

Firebox Hole Ring. A ring of steel plate conforming to the size and shape of the firedoor hole to which the firebox door sheet and boiler back head are riveted, thus providing a means of joining these two sheets and forming the firedoor hole. In some designs the ring is made of a steel or iron bar of sufficient thickness to fill the water space between the back head and firebox door sheet to which it is riveted.

Firedoor Hood. A curved piece fitted around the upper half of a firedoor opening and projecting a few inches from the boiler back head, to protect the eyes of engineer and fireman from the intense glare and heat of the fire. Also frequently used as a stand for oil cans.

Firedoor Latch. A bar on the firedoor to hold it in a closed position.

Firedoor Latch Guard. See Firedoor Handle Guide.

Firedoor Liner. See Firedoor Shield.

Firedoor Peek Hole. A hole in a firedoor through which the fireman can see the fire without opening the door. Commonly used on oil burning locomotives.

Firedoor Peek Hole Cover. The cover for a firedoor peek hole.

Firedoor Register. A plate on the firedoor with radial openings that can be partially or wholly covered by a sliding or rotating piece, to vary the quantity of air admitted over the fire.

Firedoor Roller. A small roller supporting a sliding fire door.

Firedoor Shield. A plate fastened to the fire side of a firedoor to protect the door from the intense heat, and easily replaced when burnt out.

Firedoor Shield Bracket. A bracket secured to the back head to hold the firedoor shield.

Fire Extinguisher. A device frequently attached to a locomotive for the purpose of forcing water from the tender through a line of hose, for the purpose of extinguishing fires in yards and along the track.

Firepan. A pan made of sheet iron or steel, lined with fire brick and fitted to the bottom of the firebox of an oil burning locomotive, and corresponding to the ashpan on a coal burning engine.

Firepan Air Inlets. Small openings in the front and sides of a firepan, through which air is admitted to aid combustion.

Firepan Damper. A door arranged to regulate the amount of air admitted to a firepan or firebox on an oil burning locomotive.

First Course (Boiler Shell). That section of a boiler next to the smokebox. It is made either cylindrical in straight top and wagon top boilers, or shaped like the frustum of a cone in extended wagon top or conical type boilers.

Flexible Boiler. A locomotive boiler made in two parts connected by means of a flexible joint. Used on some articulated locomotives. The rear part contains the firebox, tubes and a combustion chamber. The front part contains a superheater, feedwater heater and the smokebox. Not in general use.

Flexible Boiler Joint. A connection between the two units of a flexible boiler, and allowing the forward end of the boiler to swivel when the locomotive is on a curved track. Made in several different designs, namely, double ball joint connection, bellows type connection and single ball joint connection.

Flexible Staybolt. A staybolt designed to permit of slight relative movements due to expansion and contraction of the two plates which it secures, thus preventing bending or shearing stresses in the bolt which would cause it to break.

Flue. The fire tubes of locomotive boilers are often designated as flues, but since the introduction of the superheater the ordinary small fire tubes are called Tubes, and the large ones containing the superheater units, Flues. The small tubes making up the superheater units are called superheater pipes.

Flue Blower. A steam jet device for cleaning out soot from flues and tubes.

Flue Plug. See Tube Plug.

Flue Sheet. See Tube Sheet.

Flush Staybolt. A staybolt, the head of which is held below the outside surface of the boiler plate; the cap holding this being flush with the outer surface of the plate.

Flush-top Boiler. British for Straight-top Boiler.

Four-Coupled Locomotive. A locomotive having two pairs of coupled driving wheels and either a two-wheel swiveling engine or trailing truck, or both. Frequently built with either side or saddle tanks and without the usual tender.

Front End. A common name for the smokebox, and its contained parts.

Front End Door. See Smokebox Door.

Front Tube Sheet. See Tube Sheet.

Front Tube Sheet Brace. See Tube Sheet Brace.

Front Water Space. The space formed by the throat sheet, mud ring and inside throat sheet or back tube sheet. See Water Space.

Fuel Economizer. An arrangement installed in conjunction with the firebox of a steam locomotive; designed to promote combustion and thus to conserve—economize—fuel. See also Fuel Economy on Locomotives.

Funnel. A conical receptacle with the broad part uppermost, secured to the boiler just below the gage cocks, to receive the drip from them. Called also gage cock-dripper.

The filling hole of the tender tank is sometimes called a funnel.

G

Gage Cock. A faucet or cock screwed into the back head of a boiler for ascertaining the height of the water in it. Three are commonly used. See Boiler Inspection.

Gage Cock Dripper. A receptacle or funnel placed under the gage cocks to catch the water from them and conduct it into a waste pipe.

Gage Cock Hole. The hole into which a gage cock is screwed. Usually placed in the boiler back head and located with respect to the crown sheet and water level, according to local requirements.

Globe Valve. A valve the body of which is spherical or globular in shape, usually having a disk with a conical edge seating in a ring similarly ground to fit the disk. The spindle or stem that raises and lowers the disk has a thread on it working in a nut; and at the end is fitted with a handle, usually disk shaped. A number of globe valves are used on a locomotive. See Angle Globe Valve.

Grate. A set of parallel bars, commonly cast iron, at the bottom of a firebox to hold the fuel. It is usually made of a number of sections, each section comprising three or four bars resting at their ends on frames or bearers, and connected by short levers to a rod that can be moved back and forth to rock the bars and shake ashes out of the fire. For anthracite coal the grate consists of water tubes and pull bars. See Corner Grate, Dead Grate, Drop Grate, Finger Grate, Rocking Grate, Shaking Grate.

Grate Area. The product obtained by multiplying the length by the width of a locomotive grate. Usually expressed in square feet.

Grate Bar. A cast iron bar, usually rectangular in section and thinner at the bottom, a number of which go to make up a grate. British, fire bar.

Grate Bar Thimble. A cylindrical cap or ferrule on the end of a grate bar where it rests on the side frame or bearer.

A piece of tube placed above the mud ring in the boiler back head and firebox door sheet, and in the back tube sheet and throat sheet, through which the shaking grate rod pull bar passes. Usually used in connection with a water tube grate on hard coal burning locomotives.

Grate Bearer. See Grate Side Frame.

Grate Center Frame. A casting placed lengthwise of the firebox and half way between the sides to support the grates. It has bearings on each side for the grate bars. Also called grate center bearer and grate center support.

Grate Connecting Pins. Pins or pivots for attaching shaking grate bars to the grate connecting rod.

Grate Connecting Rod. A rod connecting the bars of a rocking or shaking grate, with a handle or lever for shaking or rocking them.

A rod for tipping a dump grate.

Grate Crank. A crank attached to a locomotive dump grate and operated by the grate lever. Also called drop grate arm.

Grate Crank Bracket. An attachment to the frame or the side of the firebox for holding the grate crank.

Grate End Frame. A casting at either end of a firebox to hold the end portions of a grate.

Grate Frame. The rectangular ring inside a firebox and fastened to the side sheets, in which the grate bars are carried.

Grate Frame Bearer. A bracket riveted or bolted to the bottom of the firebox sheets for holding the frame in which the grate bars are carried. Also called grate bearer support.

Grate Frame Studs. Stud bolts for securing the grate frame to the sides and ends of a firebox.

Grate Frame Support. A transverse casting, of which two are commonly used, to support the frame holding the grate bars.

Grate Lever. A bar pivoted to a bracket and connected to a rod that operates the shaking grates. The upper end of the lever projects slightly above the cab deck and is generally moved by a bar having in its end a socket that fits over the upper end of the grate lever. For dump grates the lever is connected to the grate crank.

Grate Lever Catch. A fastener to restrain the lever that operates the dump grate.

Grate Lever Fulcrum. The bracket on which the grate lever is pivoted.

Grate Lever Hanger. A bracket or suspender on which the grate lever of a rocking grate is pivoted.

Grate Lever Pin. A pin or pivot by which the grate lever of a rocking grate is supported and upon which it turns.

Grate Rocker Key. A key inserted in the arm moving the rocking grates to secure the arm to the rod by which it is moved.

Grate Rocker Trunnion. The pivot cast on either end of a rocking grate bar.

Grate Shaft. The shaft or trunnion usually cast in one piece with the grate, and which turns with it on the supports or bearings.

The short bar to which a rocking grate lever is secured.

Grate Shaft Arm. A lever fastened to the shaft that operates a dump grate.

A lever fastened to a section of a rocking grate, and connected to the grate lever by a rod or pins.

Grate Shaft Bearing. A rest for either end of a dump grate shaft. Usually bolted to the under side of the grate frame. Also called grate shaft bracket.

Grate Shaft Bracket. A hanger affording a bearing for the shaft of any section of a rocking grate.

Grate Shaft Collar. A flange or enlargement formed on a rocking grate shaft to keep it in position between the bearings.

Grate Shaft Locking Pin. A key to make fast a grate shaft and prevent its moving.

Grate Shaker. The apparatus for rocking the grate bars and operated either by hand, air or steam.

Grate Shaker Cylinder. The cylinder of the grate shaking apparatus in which steam or air is used for rocking the grate bars.

Grate Shaker Operating Valve. A valve for controlling the steam in the grate shaker cylinders.

Grate Side Frame. A cast-iron bar on the sides of a firebox with bearings or recesses to hold the trunnions of the grate bars. Also called a grate bearer.

Grate Water Tube. A tube placed longitudinally in the bottom of the firebox and communicating with the front and back water spaces. It forms one of the grate bars of a water grate used on hard coal burning locomotives.

Gusset Course (of a Boiler). See Conical Connection or Course.

Gusset Plate. A flat plate used to hold two parts of a metal underframe together by riveting through each member and the plate or to stiffen a joint between two pieces which are riveted together by angle plates, in which case the gusset plate is riveted to the flanges of the adjoining pieces.

Gusset Stay. A boiler brace made of steel plate cut to a form suitable for bracing and supporting two sheets of the boiler. Usually used to secure the back head to the roof sheet, or the front tube sheet to the first course. See Back Head Brace.

(To be continued)

A Simple Method of Figuring Boiler Patches

By Edward Hall

THE New York State Boiler Code, which is similar to the A. S. M. E. Code, requires that where patches over 24 inches long are fitted to the shell or drum of a boiler, the working pressure shall be determined from the efficiency of the patch seam, providing that the patch seam efficiency is less than the efficiency of either the longitudinal seam or the ligaments between the tube holes in the shell or drum.

Since in most cases the patch seam has the lowest efficiency, provision is made for increasing the patch seam efficiency by noting the angle which the patch seam makes

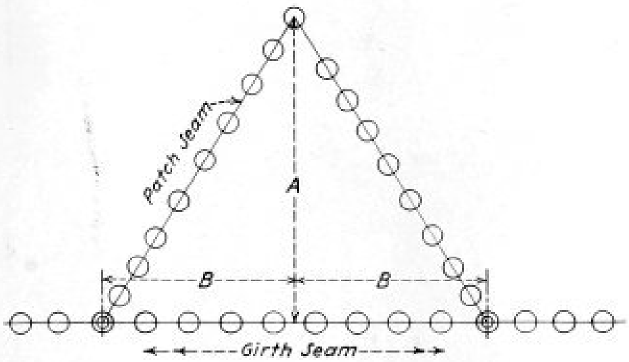


Diagram for use in calculating boiler patches

with the girth seam, and multiplying the patch seam efficiency by a factor corresponding to this angle.

A diagram giving the values of the factors for various angles forms a part of the New York State Boiler Code.

The purpose of this article is to show how these various factors may be found without determining the corresponding angles or using trigonometry, in other words, by ordinary arithmetic.

The above sketch and notation will be used to demonstrate the method:

In general there are two cases where this problem arises.

The first is where a patch is on a boiler and it becomes necessary to determine the factor to use in multiplying the patch seam efficiency.

The second case is where a patch is to be fitted and it is required to determine the roundabout length of the patch in order to secure an angularity with the girth seam sufficient to give the factor required.

Considering the first case where the patch is on the boiler. The problem is to find the factor to be used.

The distance A is measured from the center of the extreme rivet holes and perpendicular to the girth seam. Then the distance B around the girth seam is noted.

With these two measurements it is a simple matter to find the factor to be used.

The distance A is measured from the center of the extreme rivet holes and perpendicular to the girth seam. Then the distance B around the girth seam is noted.

With these two measurements it is a simple matter to find the required factor by means of the following formula:

$$\text{Factor} = 2\sqrt{\frac{A^2 + B^2}{4A^2 + B^2}}$$

In the second case the factor is found by dividing the longitudinal seam efficiency by the patch seam efficiency.

Since the distance A is readily found when the job is examined so that it is known how far back the patch will extend, it then becomes necessary to determine the roundabout length of the patch and the distance B equals ½ of this roundabout length.

The following formula will give the value of B.

In this formula F = the factor

$$B = 2A\sqrt{\frac{(F+1)\ (F-1)}{(2+F)\ (2-F)}}$$

If the distance B and the factor F are known this last formula may be transposed to give the value of A as follows:

$$A = \frac{B}{2}\sqrt{\frac{(2+F)\ (2-F)}{(F+1)\ (F-1)}}$$

For example consider that a patch is on a boiler and the distance A equals 24 inches and dimension B equals 28½ inches. These measurements are the same as those given in the diagram of the New York State Code so one may be checked against the other.

Using the first formula and substituting the value of the letters we have

$$\text{Factor} = 2\sqrt{\frac{24^2 + 28.5^2}{4(24)^2 + 28.5^2}}$$

For these values the factor = 1.338 which is practically the same as 1.34 found by the diagram.

Next consider a case where a patch is to be fitted to a boiler.

Let us assume that the factor, found by dividing the longitudinal seam efficiency by the patch seam efficiency, is 1.338.

Assume also that the distance A = 24 inches.

The problem then is to determine the roundabout length of the patch in order that the given factor 1.338 may be obtained.

Substituting the values given for the letters in the second formula gives the value of B, remembering that B equals one-half of the total roundabout length.

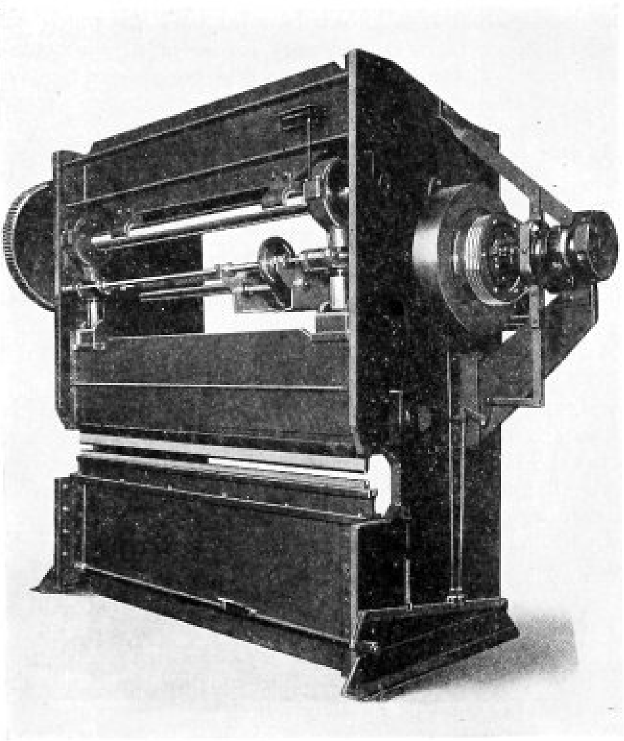
$$B = 2 \times 24\sqrt{\frac{(1.338+1)\ (1.338-1)}{(2+1.338)\ (2-1.338)}}$$

In order that the number of figures used may be as small as possible, all measurements may be taken in feet and fractional parts of feet up to one decimal place.

Forming Presses of All-Steel Construction

THE Dreis and Krump Manufacturing Company, Chicago, Ill., manufacturers of Chicago steel bending brakes, announces the addition to its line of a series of all-steel forming presses of the single housing type. These machines have been designed to replace heavy and cumbersome machinery in the production of light work. The presses are rigidly constructed, with housings, ram and bed of steel plate, which is insurance against breakage. Gears are also made of steel, the eccentric strap, knuckle bearings and gibs for slides are semi-steel castings. Eccentrics are forged steel, keyed to a high carbon steel. Connecting screws are of carbon steel forgings.

These presses require no foundation or pit, but set level on the floor and are shipped set up in one piece. All bearings are of ample size, accurately fitted and grooved for piling. The flywheel has a clutch attached and runs on Timken roller bearings. The outboard flywheel shaft bearing is of the Timken self-alining type. The clutch is of the multiple disk type having asbestos friction blocks and is engaged by a foot treadle, adjustable to any point the



Dreis and Krump all-steel forming press

full length of the machine, which also operates a friction brake simultaneously, stopping the ram instantly at any position desired when the treadle is released. Sight force feed oilers provide automatic lubrication to eccentrics, bearings and slides. Adjustment of the ram is obtainable by an independent motor controlled by a reversing switch, both of which are standard equipment. All machines are arranged for direct motor to flywheel drive, Allis-Chalmers Texrope type.

The Largest Hammer Ever Built

WHAT is considered to be the world's largest and most powerful steam drop hammer was recently built by the Chambersburg Engineering Company, of Chambersburg, Pa., for the Crane Company of Chicago. This hammer will be used by the Crane Company exclusively for the drop forging of valve bodies for high pressure steam duty and its performance on this large work will be watched with much interest by the drop forge trade and industry.

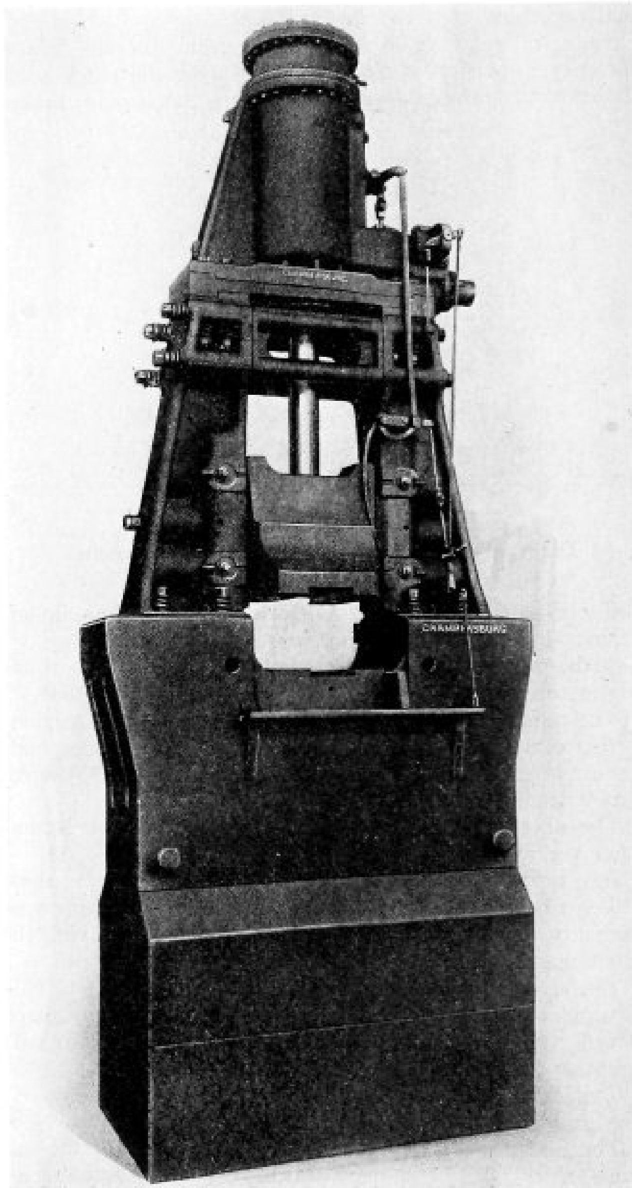
The total finished weight of this hammer approximates 536,000 pounds. The total height from the bottom of foundation to top of hammer is 48 feet 6 inches, or about the height of the average five-story building. The over-all height of hammer is 32 feet 6 inches and the timber and concrete foundation built to receive it is 16 feet deep.

With 100 pounds mean effective pressure, the energy in the ram at the instant of impact on full stroke is estimated at 428,000 foot-pounds. Its rated size, without the top die, is 22,000 pounds. Estimated weight of top die is 7,000 pounds, so that it has a total falling weight of 29,000 pounds.

To facilitate handling and transportation, the anvil, weighing 440,000 pounds, is made in three pieces, with a 20-to-1 ratio. The main members of the hammer consist of acid open hearth steel frames and anvil top. The bottom anvil sections are semi-steel and the cylinder is semi-steel with air furnace cast iron bushing. The ram and anvil cap are selected open hearth steel forgings specially heat treated. The piston rod, all bolts and other important connections are specially treated alloy steel.

The cylinder is 30-inch bore, 52-inch stroke. Distance between guides is 46 inches. The ram, front to back, measures 48 inches. The piston rod is 11 inches diameter. The frames are of I-beam construction, tied into the anvil with positive stops and compound wearing wedges. The tops of the frames are tied together with interlocking tie-plate and double tie bars.

The guides are of steel, with four V's, and are of universal adjustable type which permits ready adjustment without shutting down the hammer. Guides may be moved back into the frames to permit removal of the ram in any position without disturbing the frames of the cylinder assembly, and may also be removed without removing the rod from the ram.



Steam hammer that weighs 536,000 pounds

The cylinder is locked into the tie plate on its base and is fitted with a balanced piston type operating valve. It is also equipped with Chambersburg patented safety cylinder cover. Piston rings may be replaced or inspected without removing the rod from the ram.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

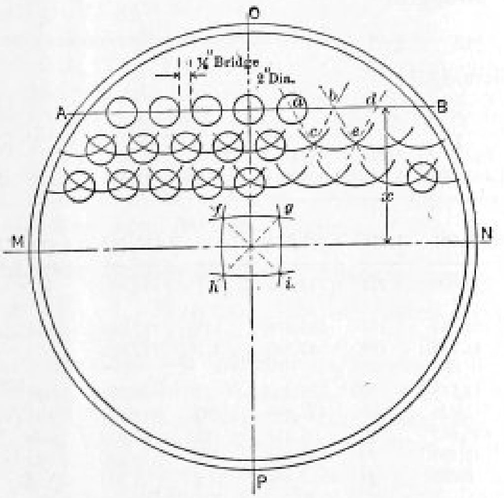
Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Laying Out a Tube Sheet—Back Pitch—Expanded Metal

Q.—Can you give me a method for locating the centers of tubes in a front tube and firebox tube sheet? What is meant by back pitch and also what is the meaning of "expanded metal"?—L. M. D.

A.—The illustration shown herewith gives a method for locating the centers of tubes that are staggered. First, it is necessary to locate the center of the circular tube sheet which may be readily done with a pair of trammels by describing arcs from *M*, *N*, *O*, *P*, taken along the sides of the flange. The intersections of the arcs are shown at *f-i-g-h*. Connecting the points *f-i* and *h-g* locates the required center. Next draw the required horizontal center line and vertical center line on the tube sheet. Lay off the line *A-B* from the horizontal center line *M-N* equal to the distance that the top row of tubes is above the center of the tube sheet. This distance is shown at *x* in this case. Then space off on this line the required distance on the pitch between the tubes which in this case is 2⅞ inches. The diameter of the tubes equals 2 inches and the bridge or distance between them ⅞ inch. To locate the tubes in a staggered position, proceed as follows:



Arrangement of tube holes in front tube sheet

With points *a*, *b*, *d* at line *A-B* as centers describe arcs intersecting as shown at *c-e*. It will be noted that the points *c* and *e* stagger or lie between the distances *a-b* and *b-d*, respectively. This procedure should be continued until the required centers for the tubes have all been laid out. The firebox tube sheet must be centered to correspond with the centers of the front and circular tube sheet. The center lines are then drawn and the required centers laid off about them.

By the term "back pitch" is meant the distance measured at right angles between any two horizontal rows of rivets.

The expression "expanded metal" means that the metal has been stretched or expanded beyond its original size. Tubes are expanded, for example, when rolled in a tube sheet.

Ogee Firebox for Vertical Boiler

Q.—I have experienced difficulty in obtaining the correct curves for an ogee firebox at the base where it is flanged to take the place of the mud ring. Will you please indicate a method for laying out this bottom section?—A. E. G.

A.—In Fig. 1 is shown a sectional view of a typical ogee firebox. In the development requested the work should be laid off from the neutral section; that is, the center line of

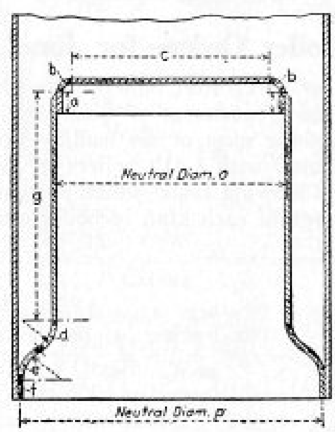


Fig. 1.—Section through boiler showing ogee base

the plate section. The problem consists in laying off a profile of the ogee curve full size according to the dimensions required for drawing the arcs *d* and *e* which are taken on the center of the plate section. With a traveling wheel the arc lengths *d* and *e* are then measured. These might be determined by calculation, but the above method is quicker and answers the purpose. Referring to Fig. 2, draw the line *x-x* and make its length equal to the circumference of the shell of the firebox by multiplying the neutral diameter *o*, Fig. 1, by 3.1416. Then in Fig. 2 establish the center point *y* and draw the arcs *a-a* from point *y*. With the trammels and *a-a* as centers draw arcs intersecting at *c*. Connect *y* and *c* with a straight line. Set the trammels equal to *g*. Fig. 1, and with *x-y-x* as centers in Fig. 2 draw arcs at *m*. Tangent to the arcs *m* draw a straight line. From g set off the arc lengths in d and e and the length f equal to the corresponding lengths in Fig. 1.

The next step is to figure the length or circumference of the base of the ogee by multiplying the neutral diameter p by 3.1416. Lay off this length on the base of the pattern. It will be noted in Fig. 1, that the ogee starts to flare from the top point of arc d to the base at the lower extremity of arc e. To take care of this the pattern must have sufficient metal to form the curved sections and so the ends will overlap for the riveted joint. This can be determined by figuring the net area on the center line of each curved section, but this is unnecessary since the material can be allowed approximately and laid off as shown in the pattern. It is well to thin down or scarf the lower corners where the plate overlaps so that there will not be a large offset in the plate where it is riveted to the outer shell.

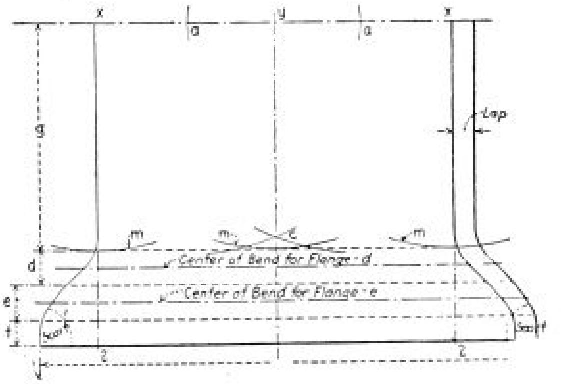


Fig. 2.—Layout of ogee base

Steel Boiler Orders for June, 1927

New orders for 1,511 steel boilers were placed in June, as reported to the Department of Commerce by 72 manufacturers, comprising most of the leading firms in the industry, as compared with 1,419 boilers in May and 1,551 in April. The following table, which presents the number and square footage of each kind of boiler ordered for each month of the current year, is not strictly comparable with the annual totals of boiler shipments previously published, due to the inclusion of a larger number of reporting concerns.

The Deaf and the Boiler Shop

By J. B. Dillon

No doubt you have often heard it said that a boiler yard is a good place for a deaf man to work. The National Fraternal Society of the Deaf met in Denver, July 13, and Foster D. Gilbert, chemist of Akron, Ohio, a delegate to the convention (and who is deaf), explains:

"Although it is generally believed that the deaf are utterly oblivious to noise, any change of tempo affects them through a mysterious sixth sense," and then he explained that while the deaf person would not feel any undue sensation from boiler making on ground or concrete floors, yet a wooden floor with its vibrations would make the deaf person more nervous than the one with normal ears.

"I don't hear the music from a brass band, but I enjoy military marches from the rhythm."

Most of the delegates are real optimists and do not "feel sorry" for themselves.

Business Notes

An announcement has been made that the Taylor Welder Company, The Winfield Electric Welding Machine Company and The Winfield Manufacturing Company, located on Atlantic Street, Warren, Ohio, will be merged into one corporation, under the name of The Taylor-Winfield Corporation with combined assets of over $350,000.

Officers of the company are, Albertis C. Taylor, president and general manager; G. P. Gillmer, vice president; J. H. Ewalt, treasurer and N. H. Cobb, secretary. Directors are A. C. Taylor, L. Jennings, Fred W. Platt, N. H. Cobb, J. H. Ewalt, G. P. Gillmer, W. A. Wilson and W. A. Jones. Work is already under way on the construction of a modern fireproof addition to the present plant, which will more than double the capacity of the plant as it is now arranged.

New Orders for Steel Boilers, 1927

	Total, 6 mo.		January		February		March		April		*May		June	
Type	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.
Grand total	8,026	8,118,281	1,021	1,179,183	1,101	1,389,984	1,413	1,492,240	1,551	1,500,503	1,419	1,355,061	1,511	1,201,310
Stationary														
Total	7,930	8,009,088	1,004	1,160,247	1,087	1,363,159	1,400	1,469,301	1,538	1,483,974	1,410	1,352,448	1,491	1,179,959
Watertube	723	4,077,711	108	648,598	108	789,051	132	713,600	121	713,835	117	646,646	137	565,981
Horizontal return tubular	785	939,918	92	107,074	87	115,304	173	192,512	151	185,078	134	152,808	148	187,142
Vertical fire tube	931	239,260	120	23,284	145	39,986	155	44,981	189	47,541	127	32,006	195	51,462
Locomotive (not railway)	151	66,323	21	9,275	21	12,674	26	11,576	30	15,228	27	9,380	23	8,190
Steel heating[1]	4,389	1,965,038	479	213,074	514	245,436	717	353,529	907	436,099	881	412,995	891	303,905
Oil country	551	463,155	116	105,488	161	126,836	122	108,007	49	35,450	59	50,823	44	36,551
Self-contained portable[2]	344	235,218	57	48,057	43	31,461	65	41,293	73	43,247	59	46,239	47	24,921
Miscellaneous	56	22,465	11	5,397	5	2,411	10	3,803	18	7,496	6	1,551	6	1,807
Marine														
Total	96	109,193	17	18,936	14	26,825	13	22,939	13	16,529	9	2,613	20	21,351
Watertube	9	29,495	2	5,000	6	22,320	1	2,175	....	......	....	......	....	......
Pipe	1	2,091	....	......	....	......	....	......	1	2,091	....	......	....	......
Scotch	72	76,217	12	12,736	8	4,505	12	20,764	12	14,438	9	2,613	19	21,161
Two and three flue	3	1,200	3	1,200	....	......	....	......	....	......	....	......	....	......
Miscellaneous	1	190	....	......	....	......	....	......	....	......	....	......	1	190

[1] As differentiated from power boilers. [2] Not including types listed above. *Revised.

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

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

Cities

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Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
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States

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California	New Jersey	Rhode sland
Delaware	New York	Utah
Indiana	Ohio	Washington
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

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

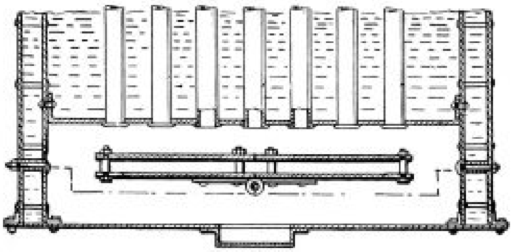
SELECTED BOILER PATENTS

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

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

1,625,046. MICHAEL MORLEY, OF BROOKLYN, NEW YORK. BOILER.

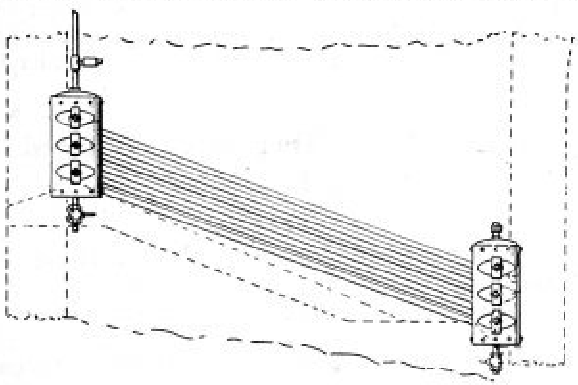
Claim. In a boiler, the combination of a body having a plurality of flues, a shaft connected to the body, a plate consisting of a pair of semi-



circular sections hingedly connected to said shaft, and a second plate consisting of semi-circular sections rigidly connected with said first named sections, said sections of the second named plate being in spaced parallel relation to the sections of the first named plate.

1,617,817. PATRICK McNULTY, OF NORWOOD, MASSACHUSETTS. WATER FIREBOX.

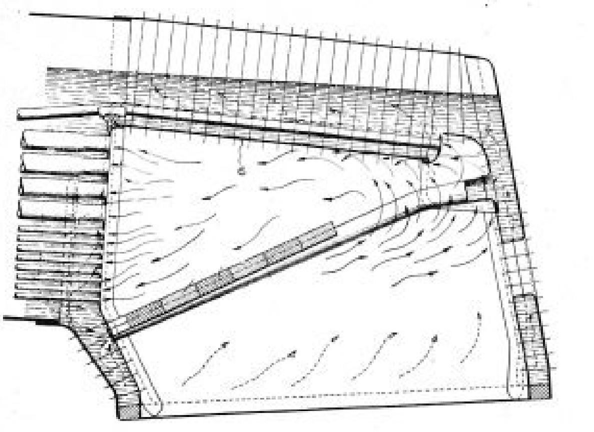
Claim. In combination with furnace walls, a water firebox comprising a series of drums in rectangular formation and each provided with an air vent and drain pipe, water-walls connecting said drums comprising



spaced side tubes having bent ends extending outwardly and projecting into the furnace walls, and expanded joints in adjoining drums, spaced end tubes having expanded joints in adjoining drums, covered hand holes in said drums complementary to said expanded joints, an inlet pipe to one drum, and an outlet pipe from another drum.

1,629,720. MYLES MAHONEY, OF MONTREAL, QUEBEC, CANADA. LOCOMOTIVE BOILER.

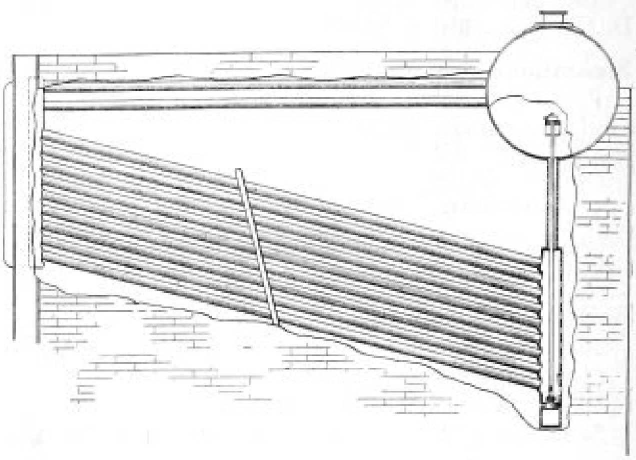
Claim—In a locomotive boiler the combination of a boiler barrel; a smoke-box; a fire-box the crown sheet whereof has an upwardly extend-



ing chamber at the top rear corner thereof and in open communication with the fire-box; fire tubes communicating with the fire-box and extending through the barrel to the smoke-box, and safety fire tubes communicating with the chamber and extending through the barrel above the fire-box for the purpose of directing a portion of the burning gases therethrough from the top of the rear end of the fire-box to the smoke-box, each of such safety fire tubes having an upwardly extending bend adapted to direct steam and water into the upwardly extending chamber in the event of a break in the bend. Four claims.

1,625,549. FREDERICK W. KRONENBERG, OF PHILADELPHIA, PENNSYLVANIA. STEAM BOILER.

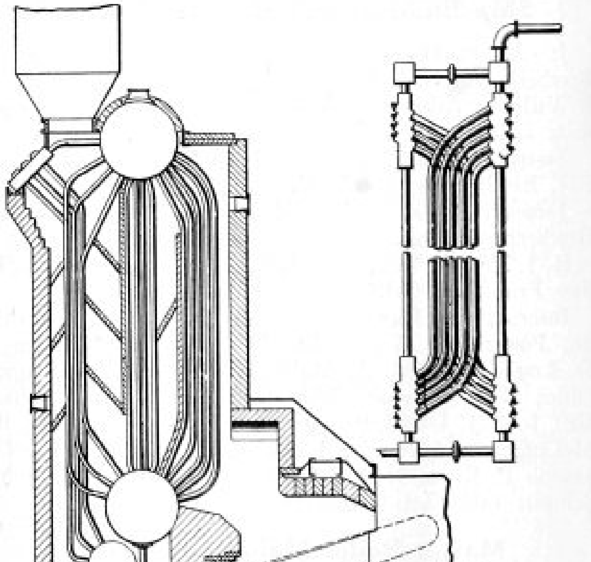
Claim 1.—In a steam boiler, the combination with the front and rear headers, tubes arranged in vertically disposed series between the headers, and a steam drum communicating with both of said headers, of means for insuring a supply of water from said drum to the lower portion of the



rear header and the lowermost tube supplied from that portion of the header, said means comprising a series of pipes extending from a point within the drum through the header to the bottom of the latter, the lower end of each pipe having lateral openings therein to discharge water laterally of the header. 9 claims.

1,627,871. LOYD R. STOWE, OF ST. LOUIS, MISSOURI. WATER TUBE BOILER.

Claim—The combination with a furnace and a tortuous flue therefor of a water tube boiler comprising upper and lower chambers and two banks of generating tubes located in the first and second passes of said flue and connecting said chambers, additional upper and lower chambers and a third bank of tubes disposed substantially vertically in the last



pass, alternate tubes in said last pass being connected to said first mentioned chambers and the intermediate tubes being connected to said second mentioned chambers, said flue having baffles in its last pass arranged to reduce the sectional area substantially below the sectional area of the initial pass whereby a relatively greater proportion of the products of combustion are brought into contact with the tubes of the last pass, said upper chambers communicating with each other and said lower chambers communicating with each other. Seven claims.

1,629,005. IRWIN A SEIDERS, OF READING, PENNSYLVANIA. STEAM SUPERHEATER FOR LOCOMOTIVES.

Claim—In combination with a locomotive boiler, superheater flues extending longitudinally through the boiler and arranged in concentric circular arcs, are shaped superheater headers of greater diameter than the outer row of super heater flues secured in front of the boiler and superheater tubes extending into the flues and having laterally extending end extensions secured to the headers. Four claims.

The Boiler Maker

Volume XXVII | September, 1927 | Number 9

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
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Mandeville, La.
Washington: 17th and H. Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.

Cable address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

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

CONTENTS

Making Ideas Count

IN the discussion of the subject "Electric Welding of Boiler Tubes," which was one of the most important features of the last convention of the Master Boiler Makers' Association, a wealth of practical information on the methods of doing this work was brought out. The discussion appears elsewhere in this issue and should be studied carefully by those who have the handling of this work in the shops. The development of arc welding machines to replace the work of a number of men struggling over hot oil fires is one of the outstanding examples of what the boiler makers themselves can do. The machine was conceived and developed through the efforts of John A. Doarnberger, master boiler maker of the Norfolk & Western, who is known to most of the men in the railroad field. There are a great variety of other ways in which each individual can help improve the methods of doing boiler work and the machines that are used. Most of them are not as spectacular as the flue welding machine, which in a few short years has revolutionized the method of safe ending tubes, but, nevertheless, they are important and deserve recognition.

There is hardly a progressive shop that in some form or other does not have a suggestion department, through which the men can propose changes in machines, methods or shop practice that will aid in turning out better work, or of doing it more efficiently. Practically all the best developments in any industry come as a result of the reactions of the men in that industry to their work. One great way in which to help progress is to simplify either the machines that are used or to make the method of doing the job easier. In other words, any job must be done with the brain as well as with the hands and where opportunity offers to improve that method leave no stone unturned in getting the idea before those whose duty it is to recognize the value of suggestions from the men.

One of the duties of the present day foreman is to help those under him advance in their work. When a man shows interest and initiative in doing his job it should be the first object of his foreman to see that such work is recognized by those in authority.

Questions and Answers—Shop Kinks

ARRANGEMENTS are being made by the editorial department of The Boiler Maker to make the Questions and Answers department in the magazine even more useful to our readers than it has been in the past. The reorganized department will have the consulting services of men prominent in each of the various branches of the boiler making trade. It will be the endeavor of the magazine to render prompt and complete answers to all questions submitted by readers pertaining to laying out problems, boiler design, construction, repair, inspection and operation, tank problems, and all others coming within the scope of railway, marine and stationary boiler work and the heavy plate construction field.

The department is designed to fulfil two objects; one, of course, is the answering of specific questions sent in by an individual, and the other by the publishing of the answers to such questions to supply information of an educational character that will be useful to a great many of our readers who from time to time encounter the same difficulties but neglect to have them cleared up by writing to us.

If you have a problem in connection with your work, no matter how simple or how complicated it may be, which you cannot solve, write out the full details of the case with sketches explaining the difficulty and a complete answer will be prepared and forwarded to you and will subsequently be published in the magazine. The service is yours for the trouble of spending a few minutes to jot down the details and in doing that, you not only will obtain a direct benefit yourself but also help stimulate the interest of others in the field who will be able to use the information brought out in the answer to your question. When published, the name of the individual asking the question does not appear, so no one need be hesitant in asking for information.

One other way in which each reader of the magazine can also benefit from a direct monetary return and at the same time help the other fellow along is to describe some of the shop kinks and shop methods used in his shop to speed up boiler construction and repair. A few minutes spent in writing out the details of any special equipment in the shop that is efficient or of some shop made device and sending such material to the magazine will be paid for at a liberal rate. Where possible, a rough sketch or photograph that will help explain the details of a device is desirable. In writing such descriptions, it is only necessary to describe the equipment as you would to one of the fellows in the shop—so long as the details are there the material can be put in shape for publication in this office.

If you read an article or a letter published in the magazine and you do not agree with what is said, write a letter expressing your opinions and it will be published at the usual rate of payment.

The editorial department of THE BOILER MAKER is interested in hearing from its readers personally and is trying to assist them in any way possible in their work. A personal letter addressed to the editor asking the answer to some question, a shop kink description, a comment on some phase of boiler work, or a suggestion as to articles on subjects of particular interest, will receive prompt and careful attention. The most important thing is to write and get better acquainted with us.

Safety Devices for Shop Tools

PRECEDENCE is established by the courts in the case cited in this issue of the award of damages to a boiler maker who received injuries while working with an unguarded pneumatic hammer. This case should serve as a warning to employers in general to take every precaution in safeguarding the health of the men in their shops, both from a sanitary standpoint and in the manner in which tools and equipment are provided with safety devices designed to prevent such accidents.

Guards on hand tools where they can be used and on fixed machinery do not lower the efficiency of the machine, are generally low in cost and should be insisted upon to protect both the employer from expensive law suits and the men from the danger to health and usefulness. In many instances the cost of applying commercially made guards to machines can be eliminated by turning them out in the shop. This is especially true for old machines which were never fitted with safety devices.

The idea of safety, however, should not stop with machinery safeguards, but should extend to the carrying out of every shop operation. Hazards exist at every turn in the shop and the exercise of a little care may prevent disaster.

LETTERS TO THE EDITOR

Horsepower of Boilers

TO THE EDITOR:

I noted in a recent issue of THE BOILER MAKER that a reader was enquiring how to find the horsepower of boilers. The reader will be fully answered if he studies the replies given by your Mr. Lindstrom. The term *horsepower,* however, is rapidly dying out as a measure of the power of a boiler, and the evaporative duty is the measure of efficiency, capacity and power now usually applied.

As a general rule boiler making firms are asked to quote for a boiler capable of evaporating a given quantity of water to steam from and at 212 degrees Fahrenheit, or for the price of a boiler capable of running a certain engine, particulars of the engine being given.

Example: Suppose we had to supply a boiler for a non condensing engine with a 26-inch diameter cylinder, 30 inches stroke, running at 80 revolutions per minute, with a cut-off of 5/12. Our first problem is to find the quantity of steam the engine will require and we arrive at this by the following formulae:

$$\frac{\text{Area of cylinder} \times \text{stroke} \times 2 \times \text{revs.} \times \text{numerator of cut-off}}{1{,}728 \times \text{denominator of cut-off}}$$

$$\left(\frac{531 \times 30 \times 2 \times 80 \times 5}{1{,}728 \times 12}\right) = 614.5 \text{ cubic feet of steam per}$$

minute. Assuming that the working pressure of the boiler is required to be 105 pounds per square inch, the volume of steam raised from 1 cubic foot of water at this pressure will be found on the following tabe:

Boiler Working Pressure	Volume of steam from 1 cubic foot of water
105	257
110	246
115	238
120	228
125	220
130	212
135	206
140	198
145	193
150	185
155	180
160	175
165	170
170	165
175	160
180	156
185	152
190	149
195	145
200	142
205	136
210	130
215	124
220	120

If the working pressure of the boiler is 105 pounds per square inch the volume of steam from one cubic foot of water is given as 257. Therefore, if 257 cubic feet of steam is raised from one cubic foot of water, 2.35 cubic feet of water would produce 615 cubic feet of steam at the same pressure. As this calculation is per minute we have to multiply by 60 to get the figures per hour. Therefore, $2.35 \times 60 = 141$ cubic feet of water or 8,777 pounds of water per hour. More detailed calculations could be made but are considered unnecessary at the moment.

Perhaps we had better have a litle margin and say that we want a boiler that can do 9,000 pounds per hour evaporation. Having decided on a Lancashire type we find that a 30-foot by 8-foot 6-inch diameter boiler will evaporate this amount.

With ordinary hand firing this boiler would burn 27 pounds of coal per square foot of grate per hour; it would have a total grate area of 42 square feet; that is, a fire in each flue 6 feet long by 3 feet 6 inches wide. An average of practical tests on Lancashire boilers has produced the evaporation as 8 pounds of water per pound of coal burned per hour, therefore we prove our 30-foot by 8-foot 6-inch boiler is ample by multiplying all three together, thus:

$$27 \times 42 \times 8 = 9{,}072 \text{ pounds per hour.}$$

Much would depend on the calorific value of the fuel, attention to scale and flue dirt and other practical matters.

It will be seen that the 30 foot by 8 foot 6 inch Lancashire boiler would be ample for the engine, but the theoretical evaporation arrived at by the formula is below what could be actually given by the same boiler.

An evaporation of 1,000 gallons per hour is a common figure for a boiler of this size and type.

Assuming that one boiler horsepower is the evaporation of 34.5 pounds of water per hour from and at 212 degrees Fahrenheit, then the 30-foot by 8-foot 6-inch boiler that evaporates 9,000 pounds per hour would be a 260 horsepower boiler and the same size that evaporates 10,000 pounds would be a 290 horsepower or a difference of 30 horsepower. The term *horsepower* has no real meaning when applied to boilers, for the wide range of conditions under which the same class of boiler could be designed and operated would make the rated horsepower of a given size of boiler unreliable for commercial purposes.

We can only say that if you comply with the following conditions the boiler we offer will evaporate so many thousand pounds per hour. You would then enumerate the conditions you consider necessary. Mr. Lindstrom points out in the article referred to that the horsepower of boilers is oftentimes found by a standard factor per square foot of heating surface. In the case of the tubular boiler one horsepower may equal 12 square feet of heating surface up to 16 square feet of heating surface. Therefore, if a boiler has a total heating surface of 1,500 square feet, it could be as high as 125 horsepower or as low as 93 horsepower. In the case of verticals the factor varies between 11 and 20 square feet of heating surface per boiler horsepower. Therefore, if a vertical has a total heating surface of 660 square feet its horsepower could be as high as 60 or as low as 33.

In the case of the watertube, the factor varies between 10 and 12. Therefore a watertube boiler with a total heating surface 2,000 square feet could be 200 horsepower or 166 horsepower. In the case of the locomotive boiler the factor given is 1 or 2 which means that a boiler with 500 square feet of heating surface could be 500 horsepower or 250 horsepower. These differences are far too sweeping to be of any use technically, and the term *horsepower* as applied to boilers is unreliable and that its use should be discontinued is the opinion of

London, Eng. J. G. KIRKLAND.

The Wade Engineering Company of Los Angeles, California, which handle products of The Lincoln Electric Company, Cleveland, Ohio, announces that the northern office has been moved from 69 Webster Street, Oakland, to 533-539 Market Street, San Francisco.

Repairing Cracks at the Back Flue Sheet Knuckle

TO THE EDITOR:

The problem of repairing cracks at the top of the back flue sheet is one that has worried the master minds of the boiler department for a long time, especially the cracks that occur vertically over the right and left top superheater flue to the knuckle of the flue sheet flange.

I am attempting to describe herewith a little stunt that worked out successfully in correcting this.

The practice was to remove the flue, V out the crack and electric weld it. The flue was then applied after the hole was trued up. Rolling and prossering the flue set up a strain on the welded section that caused it to break again in a very short time.

The way this was overcome is as follows:

Remove the flue, V out the crack over the flue and chip a 45-degree bevel on the flue hole. Next weld a plate over the flue hole on the water side, the plate to be ⅛-inch thick and have a tongue that will cover the crack. The hole in the plate should fit snug over the flue that has been swaged down to allow 3/16-inch clearance all around between the flue and the flue sheet. In other words, the hole in the plate is to be ⅜-inch smaller in diameter than the hole in the flue sheet. After the plate has been welded all around on the water side the flue is inserted in the hole in the plate and allowed to stick through into the firebox enough to make a No. 3 bead. The flue is then welded in solid, flush with the flue sheet and the crack is welded. Care should be taken in welding not to burn through the flue. The flue is then beaded and the calking edge of the bead welded.

I have known of the above method of repair to hold up for over two years on a locomotive of the Mikado type in heavy freight service.

Lackawanna, N. Y. H. W. DILLON.

Flues for Lancashire Boilers

TO THE EDITOR:

I was glad to read Mr. Kirkland's reply to my comments on his "New Design for Lancashire Flues" and note that he naturally does not agree with all I say. However, I fail to see where my objection to two thicknesses of plate in the fire area is answered. His "new" design, apart from being cheaper to construct, appears to revert back to the old style of furnace seam marked Fig. 1 in his article in the February issue, and has many of its bad points, the most obvious being the cracking of the furnace plate due to overheating where the hoops are welded to the furnace. Having this defect in view, is why many years ago numerous old Cornish boiler furnaces, which were taken over by a boiler inspecting association, and found to be weak, were strengthened by hoops.

With regard to Mr. Kirkland's reference to my remarks about corrugated sections in Lancashire boilers and to which he entirely disagrees, I would point out to him that I stated that this was practically insisted on in all *first* class high pressure Lancashire boilers built under the supervision of insurance companies and this being a fact I adhere to my previous statement.

Surely Mr. Kirkland cannot have seen the numerous high pressure Lancashire boilers now in daily use when he states that those with corrugated sections are comparatively rare. The corrugated section was first introduced into high pressure Lancashire boilers 25 years ago by the oldest boiler inspecting association in this country and is now their standard practice. It has stood the test of time in going a long way to remedy the mechanical grooving so often found on front furnace attachment flanges.

It is news to me to learn that either the Board of Trade or Lloyd's insist on corrugated furnaces in marine or launch boilers, but nevertheless the reasons for fitting these sections in Lancashire and marine boilers is entirely different, each having its own object in view and obstacles to overcome. I agree with Mr. Kirkland when he says that corrugated furnaces are rarely seen in Cornish boilers and from personal experience can only remember seeing one so fitted.

London, England. P. G. Tamkin.

Formulas for Diagonal Patches

To the Editor:

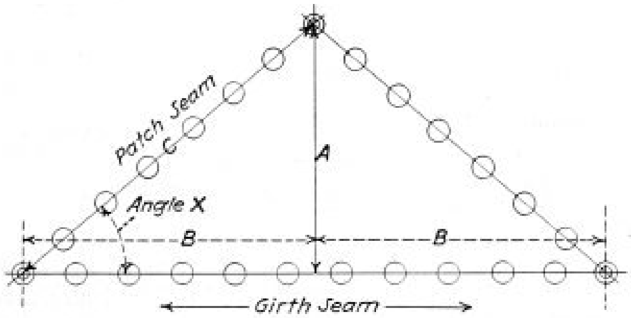
On page 239 of the August issue of The Boiler Maker there appeared an article on "A Simple Method of Figuring Boiler Patches."

The purpose of this article is to show how the formulas were developed.

The following sketch and notation will be used for this purpose. The following formula is used for determining the factor by which the patch seam efficiency is multiplied to give it a greater value.

$$\text{Factor} = \frac{2}{\sqrt{3\sin^2 \chi + 1}}$$

This formula cannot be used in its present form unless there is a table of trigonometric functions on hand. Since



A typical diagonal seam

there are times when such tables are not available it will now be shown how to change the formula to a simpler one.

Referring to the sketch.

I $\quad \text{Sin}\,\chi = \dfrac{A}{C}$

II $\quad C = \sqrt{A^2 + B^2}$

III Substituting the value of C as found in II, for C in I gives

$$\sin \chi = \frac{A}{\sqrt{A^2 + B^2}}$$

IV Therefore $\sin^2 \chi = \dfrac{A^2}{A^2 + B^2}$

V Substituting this last value of $\sin^2 \chi$ in the first formula gives:

$$\text{Factor} = \frac{2}{\sqrt{3\left(\dfrac{A^2}{A^2 + B^2}\right) + 1}}$$

VI Simplifying this last formula we have

$$\text{Factor} = \frac{2}{\sqrt{\dfrac{4A^2 + B^2}{A^2 + B^2}}}$$

VII Therefore, Factor $= 2\sqrt{\dfrac{A^2 + B^2}{4A^2 + B^2}}$

VIII and $A = \dfrac{B}{2}\sqrt{\dfrac{(2+F)\ (2-F)}{(F+1)\ (F-1)}}$

IX also $B = 2A\sqrt{\dfrac{(F+1)\ (F-1)}{(2+F)\ (2-F)}}$

In the last two formulas F = the factor.

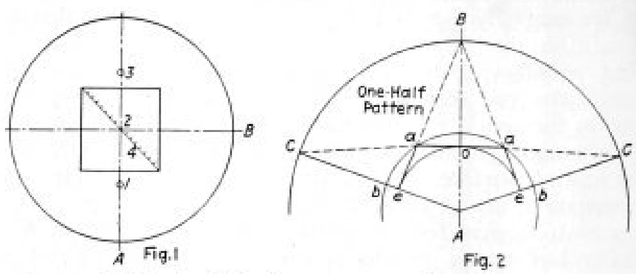
Troy, N. Y. Edward Hall.

A Short Rule for an Article Round at Bottom and Square at Top

To the Editor:

In the following short rule the height cannot be given and will not be known until the article is formed up. In Fig. 1 is shown the plan of the article.

Set the trams to three quarters of the diameter of the base, as shown from *A* to 3, Fig. 1, and on the vertical line *A-B*, Fig. 2 with *A* as a center scribe the arc *C-C*. Set off the distance *B-C* on both sides equal to quarter circumference shown at *A-B*, Fig. 1 and draw lines from *C* to *A*, Fig. 2. Draw a diagonal line on the square on Fig. 1 as shown and divide it into sixteen equal parts as shown. Set the dividers or trams to eleven of these points and with *A* as a center scribe the arc *B-B*, Fig. 2. Set the square on



Method of laying out transition piece

the line *A-B*, Fig. 2 and mark one-half the width of the square on Fig. 1 as shown at *a-a* and draw the *a-a*; then set the trams or dividers from *A* to *o* or where the line *a-a* cuts the line *A-B* and scribe the arc *C-C*. Where the line *C-A* touches the arc draw the side half of the square. The dotted lines show where it needs to be broken to make the top square. This will make half of the pattern.

Springfield, Ill. John Cook.

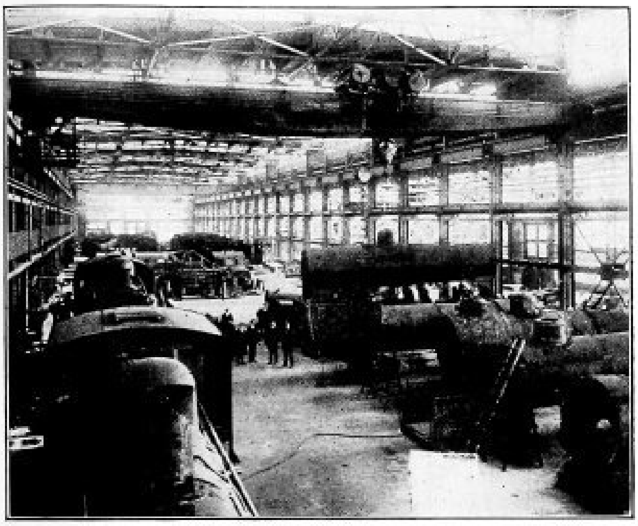
Welding equipment.—The safety construction features of the Torchweld welding and cutting torches are illustrated in a 32-page booklet of welding and cutting equipment issued by the Torchweld Equipment Company, Chicago.

Welding and cutting equipment.—Information and suggestions for the use and care of welding and cutting equipment are contained in catalogue No. 27 issued by the International Oxygen Company, Newark, N. J. The welding and cutting apparatus described and illustrated in this catalogue are of the Eyeosee and International types.

New B. & M. Boiler Shop at Billerica

Increases ground floor space of locomotive shop by 64 percent—Shop operation improved

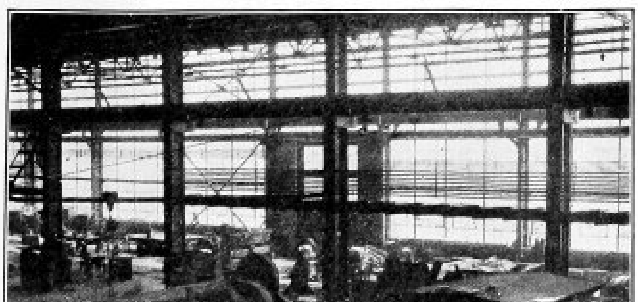
FOR several years the need has been apparent for larger space for the more expeditious handling of locomotive repairs at the Billerica shops of the Boston & Maine. Restrictions had become serious with the increasing number of the heavier types of locomotives coming to the shops for general repairs and the greater amount of boiler repairs due to new firebox requirements. In addition, owing to the lack of sufficient aisle space in the machine shop, the manufacture and repairs to rods and the repairing of engine trucks, boosters,



The end of the middle bay in which the boilers are repaired

feedwater heaters, stokers and power reverse gears, were being performed under adverse conditions. Furthermore, the noise of the boiler shop was more or less undesirable in the erecting and machine bays of the main shop.

In order to correct the existing undesirable conditions, an addition measuring 572 feet by 151 feet on the south side of the locomotive shop, has recently been constructed in remarkably quick time by Dwight P. Robinson & Company



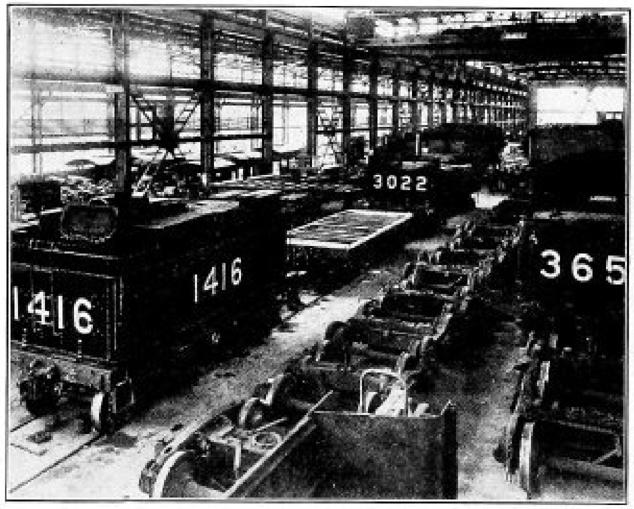
Looking towards the heavy boiler machinery section

New York. Pile driving work for the foundation piers was begun September 7, 1926; erection of steel work began October 30, and the building was closed in by the end of December. The contractor's building work was practically completed for occupancy the latter part of January. The moving in of machinery from the old shop was begun the last of January and the occupation completed February 21, with locomotive repair work already underway. The new building increases the ground floor space of the locomotive shop by 64 percent. The cost of the improvements amounts to approximately $500,000.

Construction of the Building

The new building is constructed in three long bays. The bay adjoining the erecting shop is 32 feet wide and has a low roof, permitting the admission of daylight to the old shop through its upper windows. This section provides for the tube work, machinery for sheet metal work, tender truck repairs, brake rigging and pipe jobs, and also accommodates a tool room, foremen's offices and toilet facilities.

The middle bay is 79 feet wide and is sub-divided into 26 bays, 22 feet wide between centers. Two electric traveling bridge cranes, one of 35 tons hoisting capacity and the other of 25 tons capacity, operate the entire length of the building on rails 33 feet above the floor, per-



The middle bay where trucks, tenders and boilers are repaired

mitting the handling of boilers, tenders and trucks with ample head room. Boiler repairs are made at the west end of the bay, tender repairs in the middle section and tender frames and truck repairs at the east end of the bay. Space is provided for 12 tender frames and 12 tenders.

In the third, or outer bay, which is 40 feet wide, a 10-ton crane travels on tracks 22 feet above the floor. Here repairs are made to trucks, cabs and ash pans. Two tracks, each accommodating two locomotives, enter at the west end, where locomotives are fired up for final tests and inspections. Smoke jacks or funnels provided with telescopic pipes are pulled down over the stacks to carry off all smoke and gases during the firing operations.

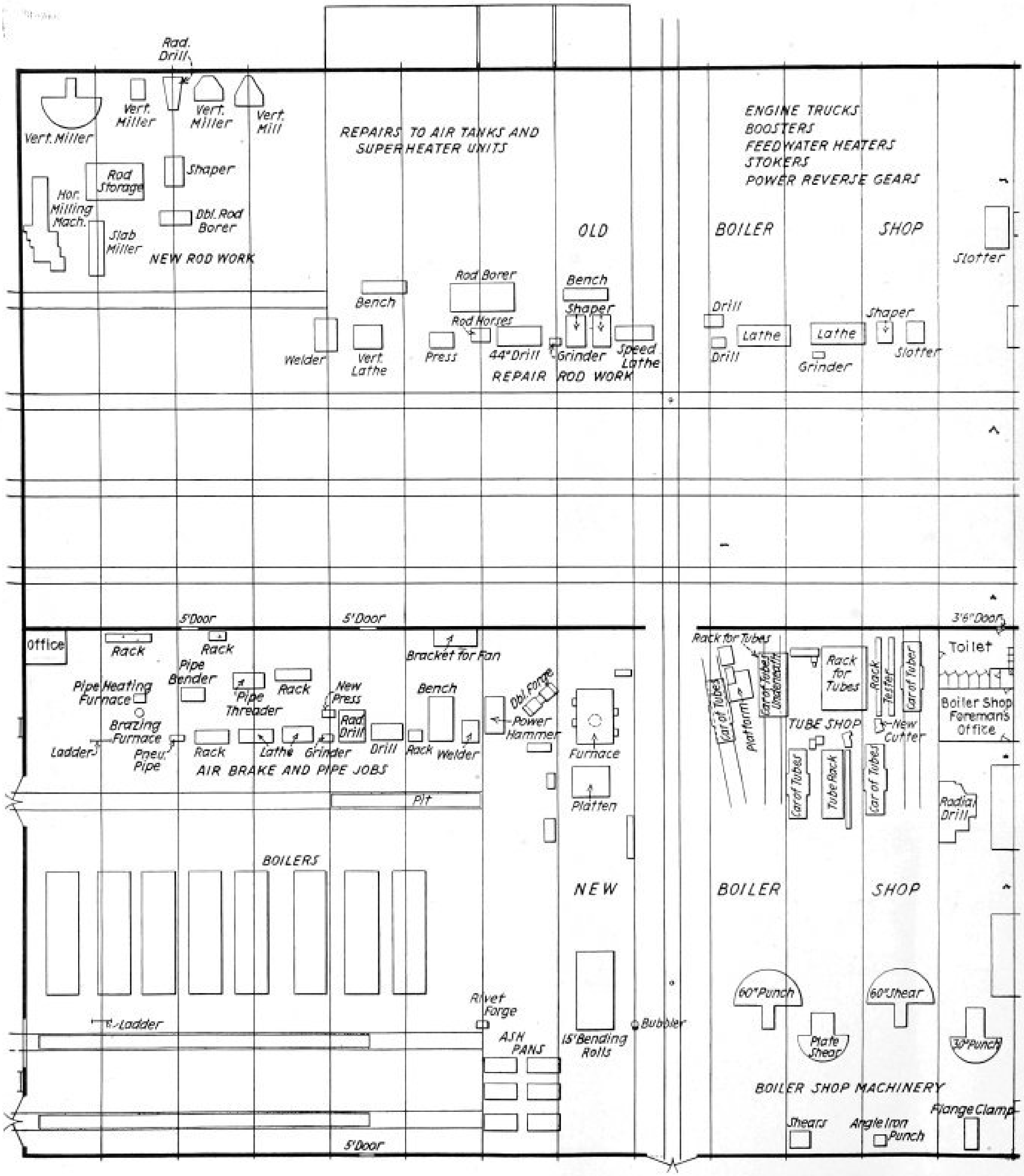
The new building has an abundance of day lighting afforded by the extensive use of glass in the outer walls and roof monitors.

Facilities in the new shop include steam, water, compressed air and oil pipe connections, as required at various points, as well as electric lighting and power circuits for extension lights and small power tools. Provision is also made at convenient locations for electric and oxy-acetylene welding operations. The acetylene and oxygen is supplied from a central station.

The building is heated from pipe coils by a hot water circulating system, an extension of that already provided for in the main shop.

A relocation of accessory structures was required and a small building adjoining the shop has been constructed for lye vats in which machinery parts are cleaned, also open sheds erected for the storage of parts removed from locomotives while they are not undergoing repairs.

The machines in the new boiler shop were transferred

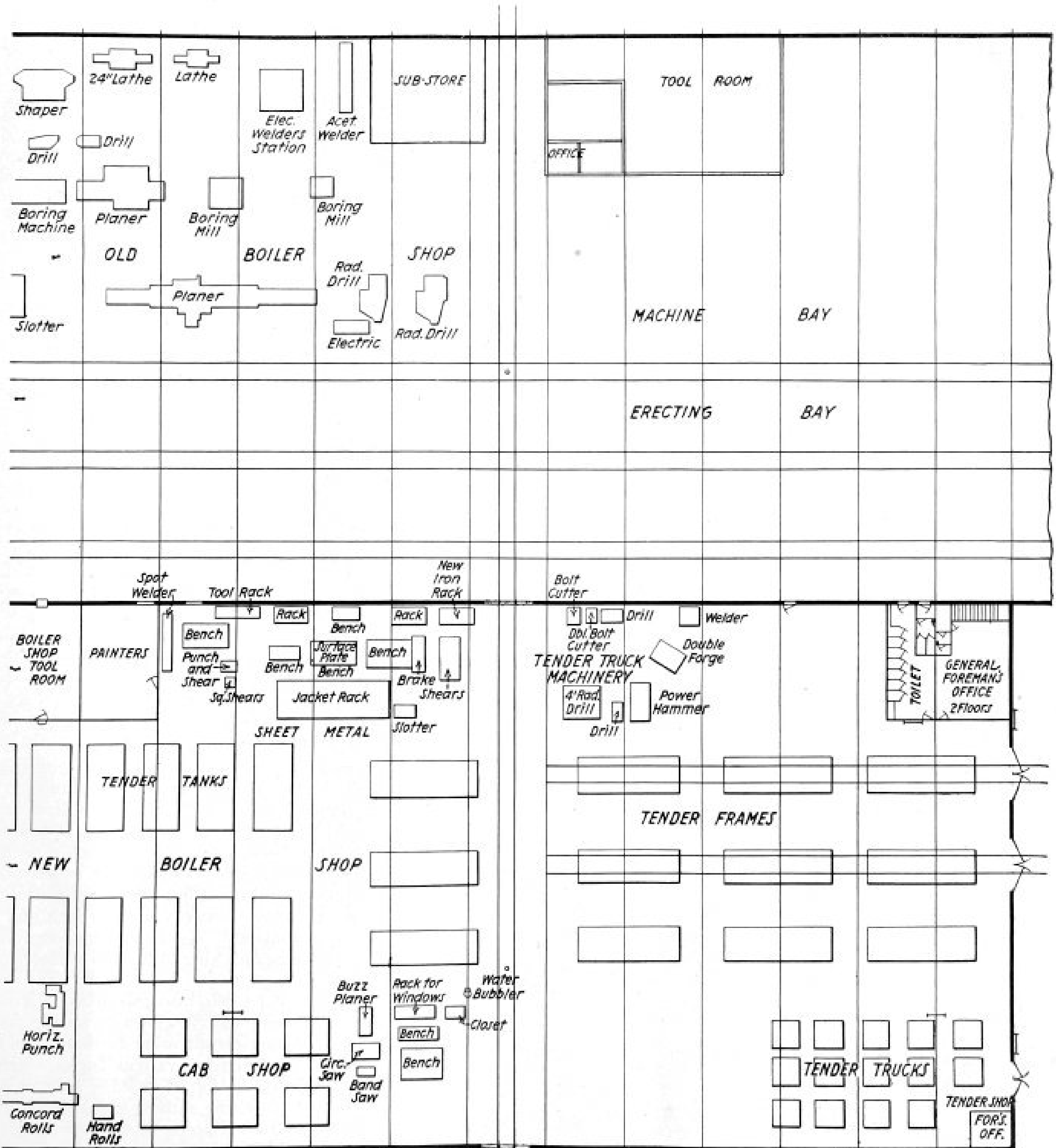


Floor plan of the west end of the shop showing the location of the machine tools in the new boiler shop and the machines in the old boiler shop

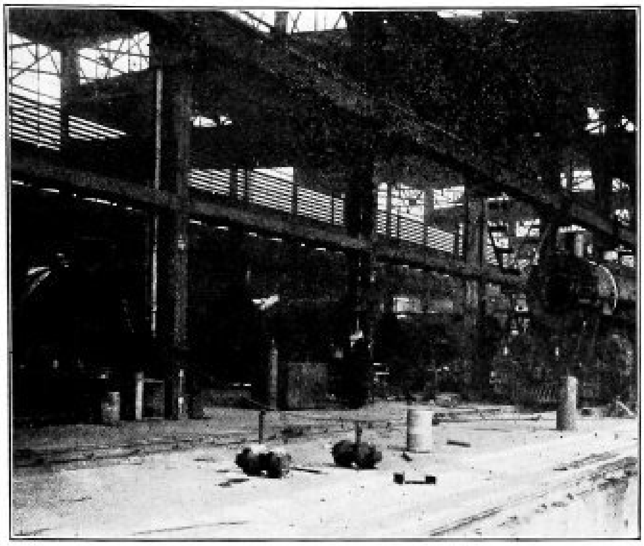
from the old boiler shop and other departments. The tin shop and some of the cab shop machinery formerly located on the balcony over the machine bay has been transferred to the boiler shop. All of the machines have been set on concrete foundations and equipped with individual motor drive. No new machine tools have been placed in the new boiler shop. Replacement of old equipment will gradually be made.

Changes Made in Old Boiler Shop

The old boiler shop that was formerly located along the northwestern end of the main shop has been made a part of the machine bay. Old machine tools have been removed from the original machine bay and the balcony and relocated and motorized in the new section. Some new machines have been installed. The machine tools required for making new rods and repairing old rods are now located at the extreme western end of the machine bay. Then follows the section set aside for repairs to air reservoirs and superheater units. Then comes the necessary space and machine tools required for making repairs to locomotive auxiliaries, such as boosters, feedwater heaters, stokers, etc. Each machine tool now has ample storage space which has resulted in a decided in-



The east end of the shop showing where the tender tanks, tender trucks and tender frames are repaired as well as the machine and erecting bay



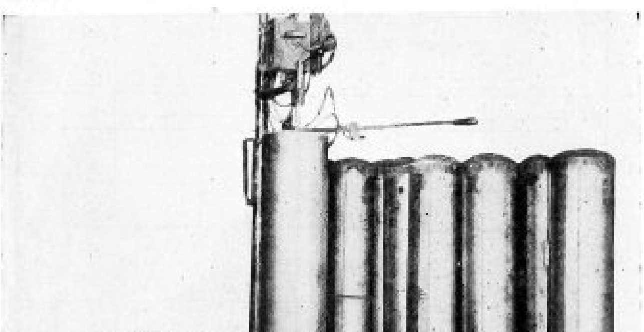
The two tracks where the locomotives are fired up and receive final inspection

crease in production. Furthermore, the relocation of the machine tools has relieved the overcrowded machine bay for other operations.

Automatic Bottom Welder for Cylindrical Tanks

THE accompanying illustration shows a new carbon arc automatic welding machine recently placed on the market by The Lincoln Electric Company of Cleveland, Ohio. The equipment is designed for the purpose of welding bottom seams on cylindrical tanks. The application of the machine illustrated is on range boilers. The equipment is standardized for tanks up to 6 feet in diameter and 8 feet high. Special equipment may be furnished to handle any diameter or length of tank.

On 14 gage material a lap head seam as shown on the tanks in the illustration has been welded at the rate of 135 feet per hour. The edge weld used on the bottom of some types of range boilers may be welded at the rate of 150 feet per hour, as the bottom is flanged and fitted so that the edges are together and flush with each other.



Lincoln welder in use for range boiler fabrication

Tanks which are to have the bottom seams welded are set on the revolving table and the arm carrying the automatic welding head is adjusted to bring the arc on the seam. Speed of the revolving table is adjustable over a wide range to handle various sizes of tanks. Welding current is adjustable through the controls located on the welder control panel. The operator has an automatic stop and start control on the automatic welder head.

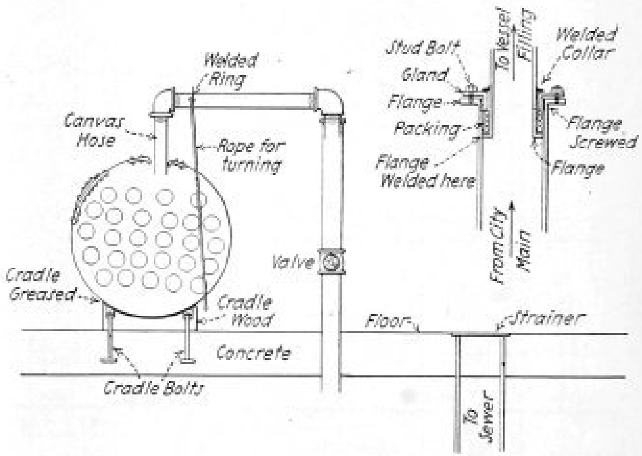
Filling Device for Hydrostatic Test

E. N. Treat

FOR many years it was the practice at our shop when filling a vessel for hydrostatic test to connect a length of hose from the hydrant and lead it into the boiler which was filled with water rather slowly.

At times the inspector would telephone our shop that he would be able to make a hydrostatic test of some particular vessel within the next hour. The inspector could give us that hour if we were ready. We were usually not ready and often had to make an appointment for the following day which somewhat held up our shipment.

A plan was decided upon by which the ordinary horizontal boiler or similar vessel could be filled in a very short time and upon short notice. In short we arranged a plan by which we could always be ready at a moment's notice. A section of 5-inch pipe was connected to the city main and led vertically through the cement floor a distance of 10 feet which was ample height for the usual boiler or tank built at our shop. To the top of this vertical pipe a flange was screwed. Next a 3-foot section of 3½-inch pipe was fitted with a flange at one end by welding it to the pipe. This flange was then turned down to just fit within the vertical pipe, leaving a distance between the 3½-inch and 5-inch pipes of approximately ⅝-inch circumferentially, which was filled with hemp packing to the top of the 5-inch flange.



Arrangement of hydrostatic boiler testing system

Next a stuffing box gland was fitted about the 3½-inch pipe by means of nuts and stud bolts which set the packing in place and would not permit water to issue from the joint when the pipe was changed to various angles. Before screwing on the tee fitting on top of the 3½-inch pipe, a collar was welded just above the stuffing box gland to prevent the enclosed pipe from slipping down into the larger pipe.

When a test was to be made, the vessel to be tested was placed upon the cradle of wooden blocks with the manhole on top. The 3½-inch hose was put into the boiler and the

5 inch valve of the city line turned full on, which filled the boiler very rapidly. The manhole cover was then put in place and the pressure applied. After the inspector had made his external examination and test the pressure was released and the top manhole cover removed.

To empty the boiler the overhead crane was brought directly over the boiler and the chain passed under the boiler and the hook fastened to the side of the manhole. By means of the crane hoist the boiler was slowly turned completely around draining the water out of the vessel. During this procedure the inspector could make his internal examination very shortly after the hydrostatic test.

The Atmos High Pressure Boiler

By G. P. Blackall

IN the Atmos high-pressure steam boiler, which is the invention of a Swedish engineer, the problem of preventing the overheating of tubes and ensuring a high rate of heat transmission has been dealt with in a particularly ingenious manner. The tubes in which the steam is generated are caused to revolve rapidly on their axes. Steam formed at the tube wall is thus immediately displaced by water owing to centrifugal action, the steam, being less dense, moving at once to the center core of the tube, from which it passes to the outlet headers.

The tube walls are effectively cooled by the water being kept closely in contact as a result of the rotation. The construction necessitates the admission of the feedwater and the withdrawal of the steam through the headers, which, as they are in rotation, cannot be connected rigidly to the water and steam chests.

The design and construction of packings which must remain steamtight at the exceedingly high pressures for which the boiler is intended and be reasonably free from wear and friction, present numerous difficulties. It is claimed, however, that all of these have now been overcome successfully. In the first designs the tubes were revolved at about 300 revolutions per minute. Subsequent improvements have enabled a considerable reduction of speed to be made. The stuffing boxes at the ends of the rotating tubes are packed with palmetto and supplied with a small quantity of lubricating oil at the pressure a little above the steam pressure.

The tubes are carried on ball bearings at one end and on roller bearings at the other, by which longitudinal movement due to expansion is freely permitted. The tubes are as big as the working pressure will permit. In an Atmos boiler for generating 16,500 pounds of steam per hour at 1,500 pounds pressure per square inch, for example, the tubes—eight in number—are 12 inches in external diameter, ¾-inch thick, and the length exposed to the furnace gases is 11 feet 2 inches. A special regulator controls the feedwater in such a manner that the layer of water in contact with the tube walls is kept automatically at a thickness of 1¼ to 2 inches, according to the boiler load. The tubes are horizontal and are set in a row across the top of the combustion chamber. After passing over the tubes, the furnace gases pass downward through flues at each side of the combustion chamber, in which are placed the superheater elements and, as a rule, two groups of feed heater tubes.

The feedwater is heated to about 320 degrees F. in the bottom section of the heater at about 140 pounds pressure per square inch and is then passed through a settling tank at low velocity so that mud and impurities are deposited. It is then pumped at boiler pressure through the remaining section of the heater, leaving the heater at about 600 degrees F., which is about the boiling point at 1,500 pounds pressure per square inch. As some of the water may be converted into steam in the heater, means are provided for the steam to pass directly to the steam pipe and only the water enters the rotating tubes. The tubes are provided with longitudinal internal stringers so as to ensure that the water contained in them shares in the rotational motion of the tube. A novel water gage indicates the thickness of the water layer in the tubes, and another ingenious fitting is an extension indicator, which serves not only to show the expansion of the tubes, but, in consequence, indicates whether the tubes have attained a temperature higher than normal. The deposition of scale reduces the heat transmission coefficient, and raises the temperature of the metal, so that this extension indicator gives warning regarding the scale on the tubes.

Results of Operation

Details of the working results of an Atmos boiler which has been in continuous operation since last December, except for Sundays and holidays, indicate that during this period a leaky economizer tube had to be replaced, but no interruptions of work due to the boiler itself were experienced. This boiler contains four rotors, has a mechanical stoker, and its guaranteed evaporation is 9,020 pounds per hour at 1,420 pounds pressure per square inch. The principal dimensions are: heating surface of rotors 140 square feet, of superheaters 183 square feet, of inner feed heaters 3,015 square feet, and of outer feed heaters, 2,015 square feet.

The chief results of a test carried out several months ago and lasting six and one-half hours were as follows:

Steam pressure, 1,440 pounds per square inch.

Temperature of feedwater before heating, 112 degrees F.

Temperature of superheated steam, 824 degrees F.

Temperature of exit flue gases, 352 degrees F.

Carbon dioxide in flue gases, 12.6 percent.

Water evaporated per hour, 11,020 pounds.

Coal burned per hour, 1,503 pounds.

Calorific value of coal, 11,928 B.T.U. per pound.

Water evaporated per pound coal (actual), 7.33 pounds.

Water evaporated per square foot of rotor, 67.9 pounds.

Thermal efficiency (boiler, superheater, and feed heater), 80.4 percent.

K.W. to drive feed pump motor, 18.2.

K.W. to drive flue gas fan, 6.5.

K.W. to drive rotors, 3.4.

This test boiler is in operation in a Swedish pulp mill, and supplies a high-pressure De Laval turbine, from which the steam is exhausted at 85 pounds per square inch for use in the digesters and drying machines. Formerly power was purchased from a water power station, and steam for process work was generated at low pressure. The installation of the Atmos boiler has brought about a very considerable saving.

Welding Conference

A conference embracing all phases of the welding industry is to be held at the University of Minnesota on October 20, 21, 22, 1927, according to plans worked out by Professor S. C. Shipley, acting head of the Mechanical Engineering Department of the College of Engineering. This is the first conference of this nature held by the University of Minnesota, but according to the considerable interest shown by the users of welding equipment in the territory, the holding of such a conference promises to be a yearly event. A large part of the meeting is to be given to papers read by practical users as well as round table discussions led by experts in their respective lines.

Boilers for D. & R. G. W. 2-8-8-2 Type Locomotives

Fireboxes have the largest grate area and heating surface of any locomotive boiler ever built

THE Denver & Rio Grande Western recently received 10 four cylinder simple articulated 2-8-8-2 type locomotives from the American Locomotive Company which represent the most recent effort to produce in a single traction unit the maximum power obtainable within the restrictions of rails, curves, grades and clearances. Permissible rail loads were relatively high and clearances relatively large so that it was possible for the designers to take complete advantage of these two important factors. As a result, a locomotive of abnormally large size was made possible for handling the desired tonnage over the ruling grade at the desired speed.

These locomotives develop a maximum tractive force of 131,800 pounds produced at 70 percent cut-off, which is believed to be the largest power output of any coal burning locomotive ever built. The cylinders are 26 inches in diameter by 32 inches stroke, and the boilers operate at a working pressure of 240 pounds per square inch. The driving wheels are 63 inches in diameter. The eight pairs of coupled drivers carry a load of 559,500 pounds which gives a factor of adhesion of 4.2. These locomotives were designed to negotiate 22-degree curves. The dimensions, weights and proportions of these locomotives are shown in the table.

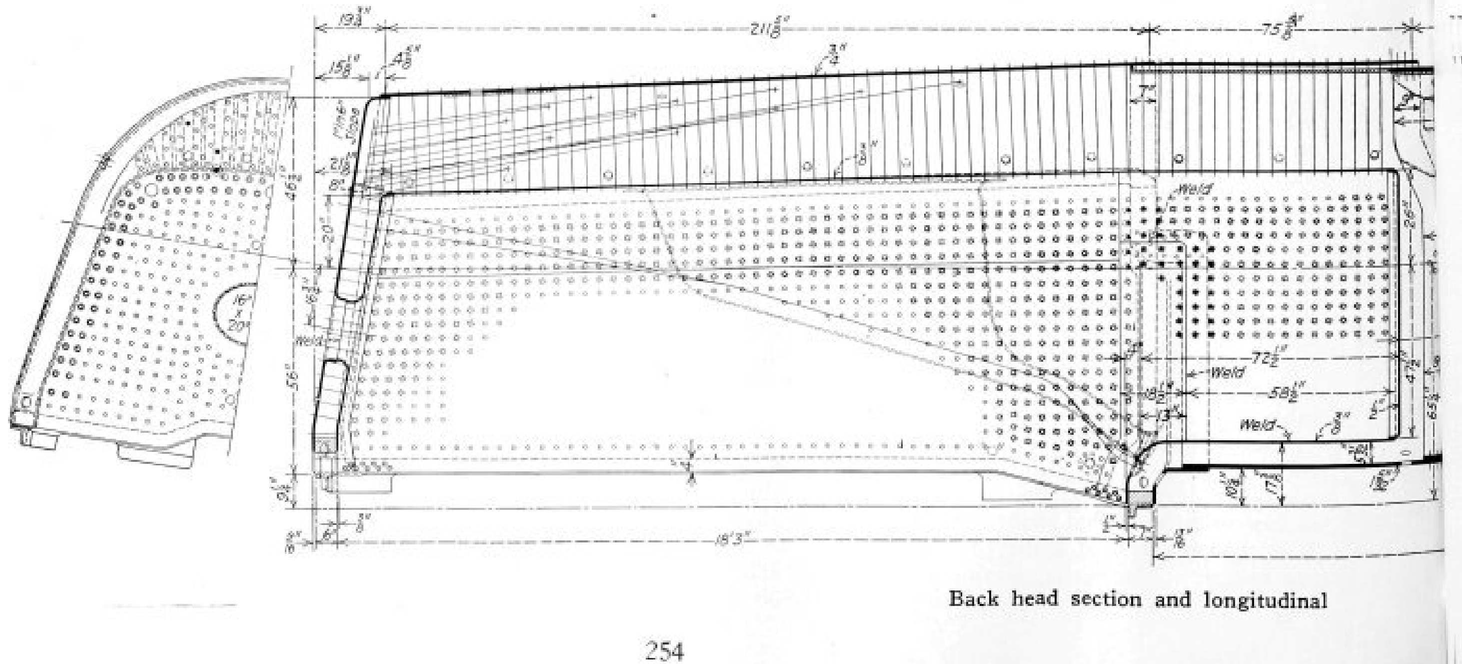
Boiler Has Unusually Large Firebox

To supply the steam to the four 26-inch by 32-inch cylinders, a straight top boiler having an inside diameter at the front of 100 15/16 inches and an outside diameter of 110 inches at the throat is provided. The barrel contains 284, 2¼-inch tubes and 74, 5½-inch superheater flues, 24 feet long. The firebox is believed to be the largest, both in grate area and heating surface, of any locomotive firebox ever built. It has a length of 218 inches and a width of 108 inches, together with a combustion chamber 72½ inches long, which gives a total evaporative heating surface of 560 square feet. The length of the grate is 182 inches giving a grate area of 136.5 square feet, with a Gaines arch located at the front end of the firebox. Two Nicholson syphons are applied in each firebox, together with American arch brick, and a Type A superheater of 74 units is employed. Bituminous run of mine coal is fed to the grates by a Standard Type B stoker. The total evaporating surface of 7,265 square feet is made up of 4,000 square feet in the tubes, 2,550 square feet in the flues, 560 square feet in the firebox, 45 square feet in the arch tubes, and 110 square feet in the syphons. The superheating surface is 2,295 square feet.

A dry pipe of steel tubing 12 inches in diameter, conveys the steam from the dome to the superheater header containing the built-in American throttle which governs its supply to the cylinders. The steam pipes carrying 240 pounds pressure through swivel joints presented a new problem in ball joint packing design, but by the use of a special Johns-Manville packing and adjustable packing glands, perfectly steam-tight joints were obtained. The entire steam pipe arrangement always presents considerable of a problem on an articulated locomotive, but it is believed this locomotive illustrates the simplest arrangement using the least amount of pipe that has yet been produced.

The header has the two regular equal size steam outlets connecting with curved steam pipes following the inside contour of the smokebox. The right hand pipe projects through the smokebox wall below the running board and is turned to the rear by means of an elbow containing an expansion joint to lead the steam to the rear cylinders. It joins a cross-over pipe at a point just in front of the rear cylinder saddle which conveys the steam to each of the rear cylinders. The left hand steam pipe in the smokebox terminates at its lower end in a ball joint packing gland, from which an S-shape connection provided with a slip joint leads the steam to the cross-over pipe feeding the two front cylinders.

The exhaust from the front cylinders returns to the bottom of the smokebox through a similar S-shape con-



Back head section and longitudinal

nection, while the exhaust from the rear cylinders is brought forward through a pipe on the left side, located similar to the steam pipe on the right side. Only two outside lines of pipe are required to convey the steam to and from the rear cylinders.

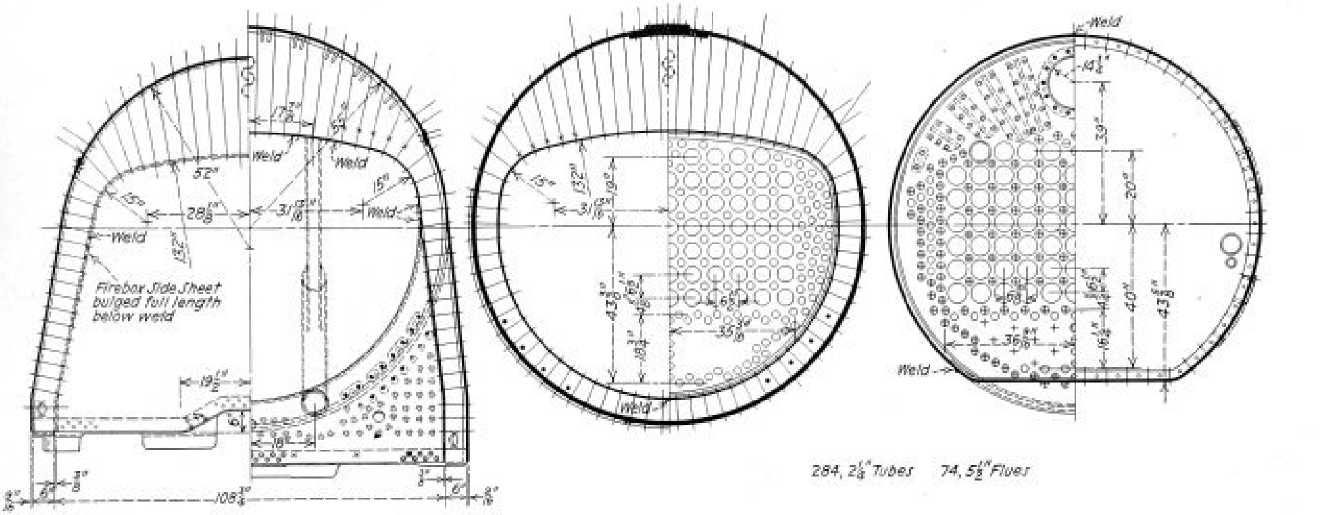
Constructional Features of Boiler

Going into the special structural details of this boiler, the crown and side sheets are in 3 sections while the combustion chamber is in one piece. Both the boiler and firebox steel was supplied by Lukens. The combustion chamber is welded to the crown and side sheets over the inside throat sheet and also at the bottom. The crown and side sheets are electrically welded at the sides and in order to allow for expansion at this point a bulge is provided where the sheets are welded. This bulge will be noted in the boiler drawings shown herewith. Welding was also used for the seams at the inside throat sheet connections. Provision was made in the design of the boiler by a special arrangement of stays and staybolts in the combustion chamber for the application of a combustion chamber thermic syphon in the future, if it becomes desirable.

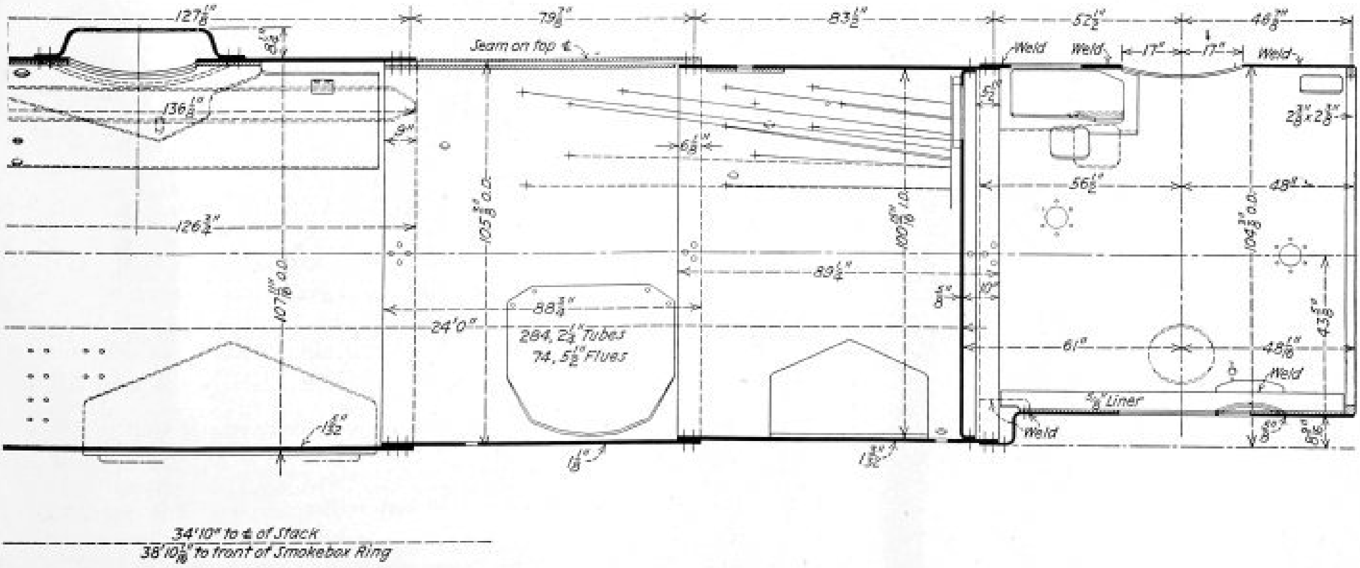
It will also be seen in the boiler drawings that the crown sheet is parallel to the center line of the boiler for the full length of the combustion chamber, but from the back of the combustion chamber to the door sheet it slopes 3 inches in 100 inches. With this arrangement the firebox tube sheet can be more readily removed and reapplied in repairing it than is ordinarily the case. With this slope, too, a more satisfactory arrangement of firebrick and arch tubes and syphons was worked out to give the required operating characteristics.

A total of 1,916 flexible staybolts of American Locomotive Company make were used in the boiler. Of these 102 bolts were used in the throat sheet; 103 in the back head; 960 in the boiler side sheets and 751 in the combustion chamber. Old Dominion staybolt iron was used in making the staybolts. The dome of the boiler is made of 1 inch plate, in accordance with American Locomotive Company practice. This dome has a diameter of 40 inches, with a 29-inch opening.

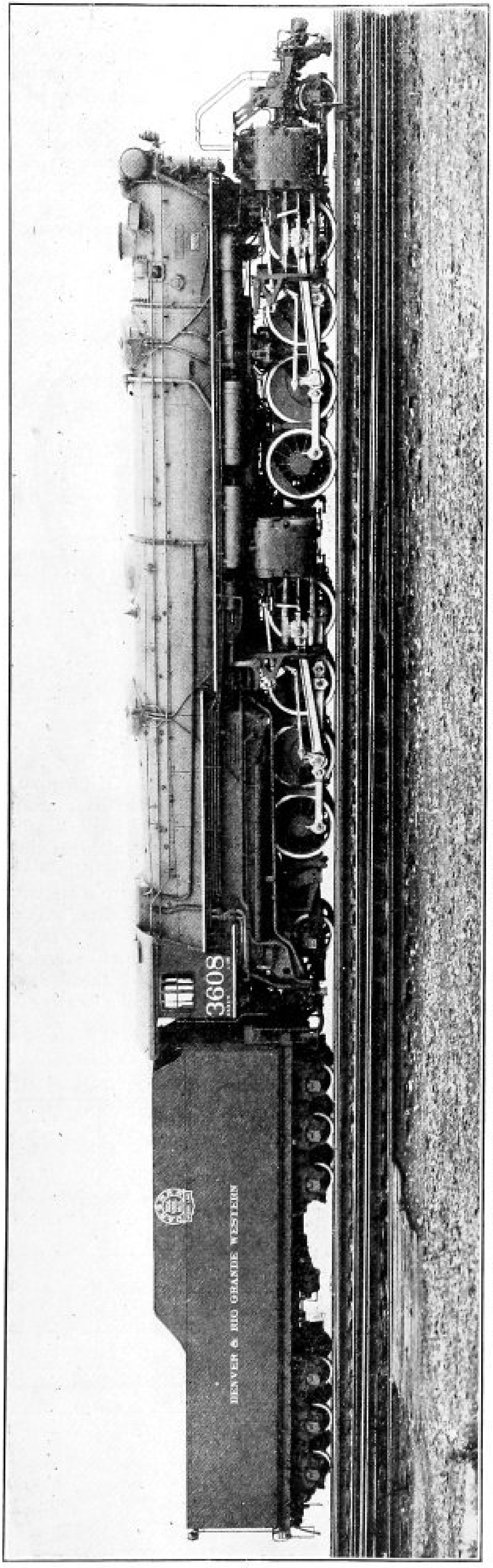
In conjunction with the sliding bearings for the firebox supports, used at both the front and back of the firebox, expansion sheets were also applied. The boiler bearing is



Turnover sections through boiler



section of D. & R. G. W. locomotive boiler



One of the 2-8-8-2 type locomotives recently delivered to the Denver & Rio Grande Western by the American Locomotive Company

applied between the second and third driving wheels of the front engine.

The firebrick in the boiler is supported on the two syphons and on three 3½-inch arch tubes, the arch tubes being located as high in the firebox door sheet as possible, in order to provide for as great a slope as could be obtained in the tubes.

The smokebox front is made in three pieces. The feedwater heater is located in the smokebox front at the top, so as not to interfere with the air pumps, steam for the heater being taken from the exhaust stand inside of the smokebox. The top section of the smokebox front, back of the feedwater heater, is permanent, as is also the small section at the bottom, which allows the front end when open to swing clear of the steam pipe elbow of the front cylinder. The feedwater heater is the type A Superheater Company's K60 unit with a C.F.2 pump. Reinforcing liners are applied to the inside of the boiler shell for the feedwater heater pump foundation and boiler bearing and outside for the cylinder saddle.

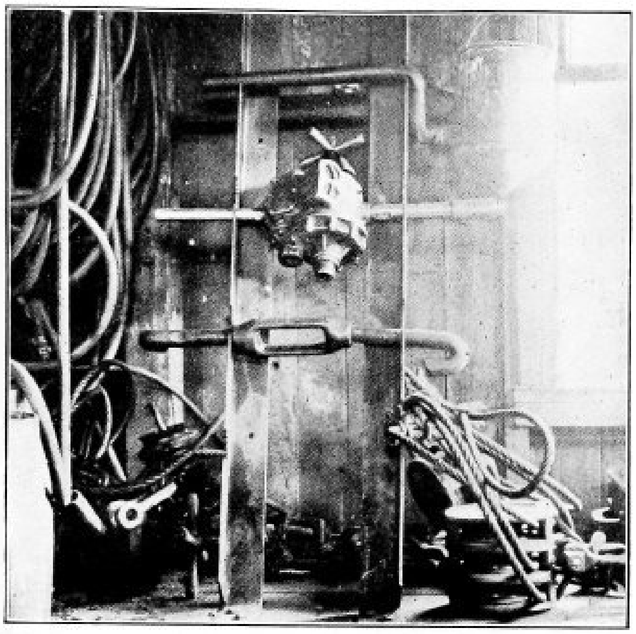
The main steam pump is so arranged that the removal of the shut-off valve will not be necessary in order to make interior examinations.

Table of dimensions, weights and proportions of the 2-8-8-2 type D. & R. G. W. locomotives

Railroad	D. & R. G. W.
Type of locomotive	2-8-8-2
Service	Freight
Cylinders, diameter and stroke	4—26 in. by 32 in.
Valve gear, type	Walschaert
Valves, piston type, size	14 in.
Maximum travel	7¾ in.
Outside lap	1⅞ in.
Exhaust clearance	None
Lead in full gear	3/16 in.
Cut-off in full gear, percent	70
Weight in working order:	
On drivers	559,500 lb.
On front truck	40,500 lb.
On trailing truck	49,000 lb.
Total engine	649,000 lb.
Tender	343,500 lb.
Wheel bases:	
Driving	33 ft. 6 in.
Rigid	16 ft. 9 in.
Total engine	62 ft. 10 in.
Total engine and tender	108 ft.
Wheels, diameter outside tires:	
Driving	63 in.
Front truck	33 in.
Trailing truck	42 in.
Journals—diameter and length:	
Driving, main	12 in. by 14¾ in.
Driving, others	11 in. by 14¾ in.
Front truck	6½ in. by 12 in.
Trailing truck	9 in. by 16 in.
Boiler:	
Type	Straight top
Steam pressure	240 lb. per sq. in.
Fuel, kind	Soft coal
Diameter, first ring, inside	100 13/16 in.
Firebox, length and width	218 in. by 108 in.
Combustion chamber, length	72½ in.
Tubes, number and diameter	284—2¼ in.
Flues, number and diameter	74—5½ in.
Length over tube sheets	24 ft.
Grate area	136.5 sq. ft.
Heating surfaces:	
Firebox and combustion chamber	560 sq. ft.
Arch tubes	45 sq. ft.
Syphons	110 sq. ft.
Tubes and flues	6,550 sq. ft.
Total evaporative	7,265 sq. ft.
Superheating	2,295 sq. ft.
Comb. evap. and superheating	9,560 sq. ft.
Tender:	
Water capacity	18,000 gal.
Fuel capacity	30 tons
Wheels, diameter outside tires	33 in.
Journals, diameter and length	6½ in. by 12 in.
General data, estimated:	
Rated tractive force at 70 percent cut-off	131,800 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine, percent	86.25
Weight on drivers ÷ tractive force	4.27
Total weight engine ÷ comb. heat. surface	67.8
Boiler proportions:	
Tractive force ÷ comb. heat. surface	13.78
Tractive force × dia. drivers ÷ comb. heat. surface	868
Firebox heat. surface ÷ grate area	4.1
Firebox heat. surface, percent of evap. heat. surface	7.7
Superheat. surface, percent of evap. heat. surface	31.6

Storing Portable Motors in a Tool Room

Air and electric portable motors on account of their shape and weight are rather hard to stow away in the tool room. They should not be piled on the floor. In the tool room of the D. & R. G. W., Denver, Colo., a convenient rack has been devised for this purpose.



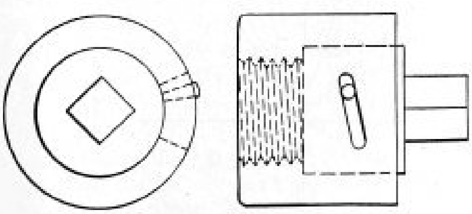
A convenient rack for holding motors

It is made of two 4-inch by 4-inch angles, 8 feet long, sloping sharply from the floor to the wall, and securely bolted at each end. At short intervals, notches are cut with an acetylene torch to receive the handles of the motors.

Flexible Sleeve Driver

The writer has experienced much difficulty installing flexible sleeves, with the present day driver. When releasing the driver from the sleeve the sleeve becomes stuck and therefore turns back out of hole with the driver.

The accompanying sketch is a driver that has been devised to overcome this difficulty. It consists of a sleeve



Sketch of driver

threaded to fit the flexible sleeve with a slot 1¼-inch long with a ¼-inch taper to fit a ½-inch pin to slide in it freely.

The pin is attached to a nut fitting inside the sleeve, when a bushing is installed into a boiler. Immediately after the release of the motor the pin will slide freely back into the slot thus releasing the driver from the flexible sleeve.

This device has been tried out and is used extensively at our plant, and is giving satisfactory results.

Rectangle to a Circle at an Angle

By I. J. Haddon

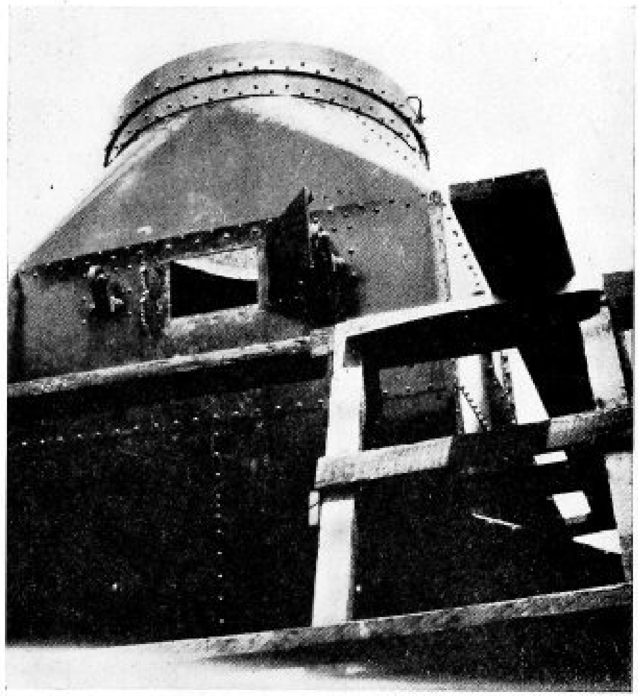
This is a connection from a rectangular part of a breeching to a smokestack.

The blue print for this is generally given to the layerout as follows: *C, A, B, D,* 13′, 7′, 1′ being the half plan, 13′, 7′, 1′ being half an ellipse, and *A*, 13, 1, *B* is the elevation, *X Y* being the usual base or "ground line."

The method of developing this problem is simplified by using a new ground line as *X′, Y′* passing through 13 and 1.

Below *X′ Y′* draw the elevation *A*, 13, 7, 1, *B, E* as shown.

With 7 as center describe the semicircle representing the half diameter of the stack, and divide it into say 12 equal parts; this will give 7″ as the apex of a triangle, as well as 13 and 1 apexes of triangles.



Smokestack breeching when completed

Draw *B, B′* and *A, A′* perpendicular to *X′ Y′* and make *G B′* equal to half the rectangle as *B D;* also make *H A′* equal to half the rectangle as *A C.*

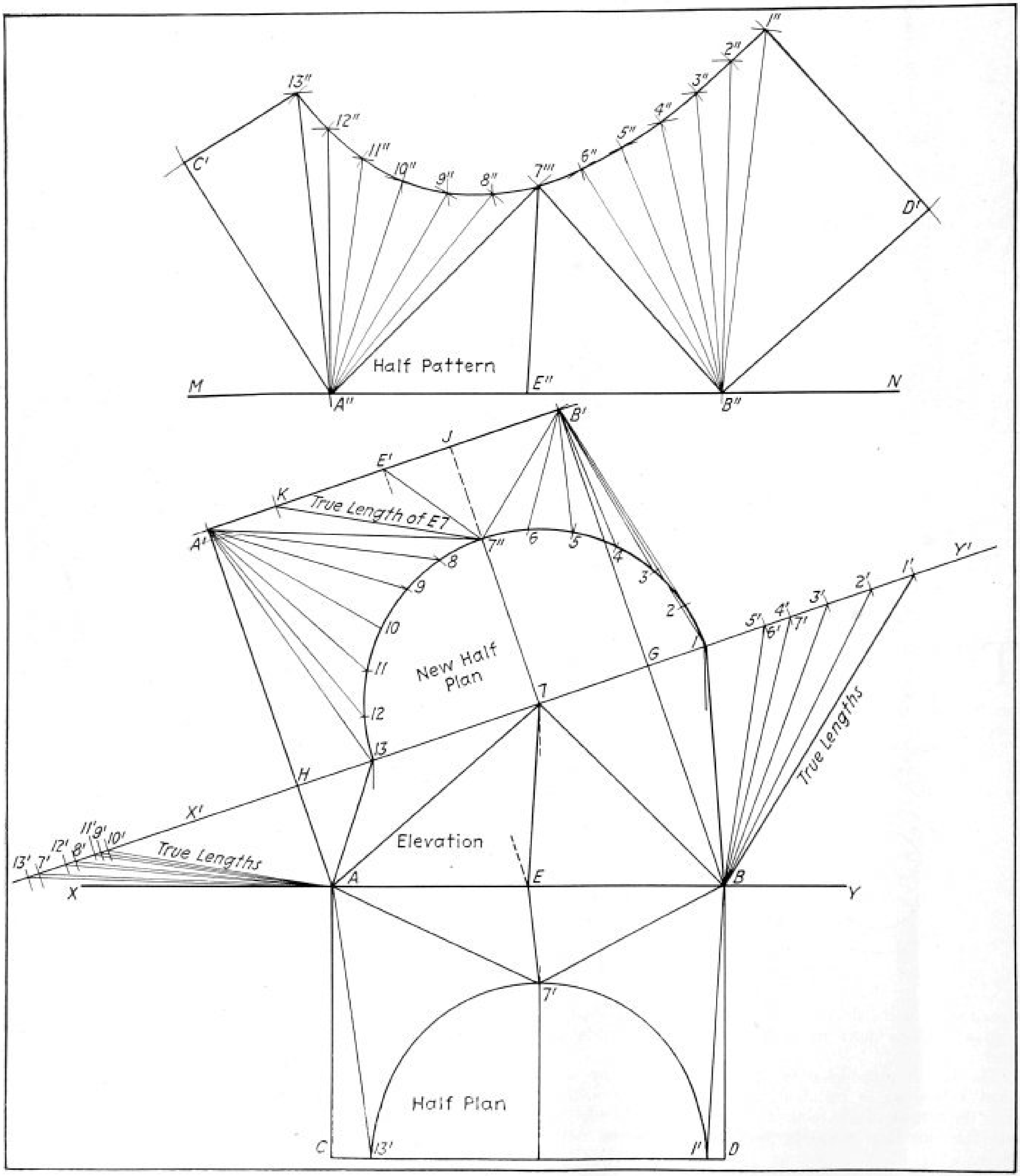
Note: As these sizes are given on the blue print it is not necessary to draw the lower half plan containing the ellipse.

Finding the True Lengths

Number the spaces around the semicircle 1 to 13 as shown. From *G* as center and radii *B′* 1, *B′* 2, *B′* 3, etc., cut the ground line *X′ Y′* in 1′, 2′, 3′, etc., as shown. Connect *B* 1′, *B* 2′, *B* 3′, etc., which will be their true lengths respectively.

From *H* as center and radii *A′* 13, *A′* 12, *A′* 11, etc., cut the line *X′ Y′* in 13′, 12′, 11′, etc., as shown and connect *A* 13′, *A* 12′, *A* 11′, etc., which will be their true lengths respectively. To develop, draw the line *M-N* of indefinite length and on it mark *A″ E″ B″* equal to

A E B. From *B″* as center and radius *B 7′* describe an arc as shown. Then from *A″* as center and radius *A 7′* cut the arc 7‴, join 7‴ *B″* and 7‴ *A″*. The triangle *A″*, 7‴, *B″* will remain flat at all times. From *B″* with radius *B 6′*, *B 5′*, *B 4′*, etc., draw arcs as shown, and starting from 7‴ with radius equal to one space around the semicircle such as 1 to 2, cut each arc in 6″, 5″, 4″, 3″, 2″ and 1″. Join 1″ *B″*, then the space between *B″* 7‴ and 1″ is the part that has to be bent. From *B″* as center and radius *G B′* describe an arc and from 1″ as center and radius 1 *B* cut the arc in *D′*; join *B″ D′* and 1″ *D′*, then *B″* 1″ *B′* will be one-half of a triangle that will always remain flat. Proceed in a similar manner for the other part of the pattern. Allow for flanging at the bottom to connect to breeching according to the width of seam required; also allow for connecting to smokestack; also allow for connecting the ends of this figure, as the lines 1″ *D′*, or in fact any of the lines shown in the development represent a butt, or center line of rivet holes in the case of a lap joint.



Development of smokestack breeching

The Ideal Boiler Shop

By James F. Hobart

This introduction to a series of stories on the facilities and unusual arrangements found in a new boiler shop, deals with the methods employed for storing plates and handling materials from the storage departments to the various points in the shop where they will be used. Further articles will deal with other special features of the shop and shop kinks developed by the men to facilitate their work.—The Editor.

"GOOD morning, Mr. John Ideal, I hear that your new boiler shop is the finest one between Key West and Winnipeg. Got it all finished, I suppose and turning out all kinds of boilers by the hundred?"

"Well, hardly as bad as that," laughingly replied Mr. Ideal, "but we have the buildings all done, the overhead cranes in operation and we are putting out a few boilers to take care of 'hurry' orders, but we wont have everything completed for several weeks yet. In fact, we are right now, just putting in the storage posts where we intend to carry all kinds of small flange and tank plates which we intend to procure by the carload and keep enough on hand, so that we can fill almost any ordinary order without having to order and wait for the material.—What's that?—Yes, to be sure—We always buy material for our stock boilers, all cut to exact size and shape, with edges planed, all ready for the sheets to be laid out, for punching and drilling.—Yes, our new shop is a pretty sizeable building, 75 x 150-feet with a foundry building about half that size at one end of the boiler space. There are two overhead cranes which sweep over the entire floor space, which is without post or any other obstruction."

"The cranes, or overhead travelers are electrically operated, I suppose?"

"Of course. Some other time, I may tell you about these cranes and the manner in which an operator can send an overhead operated trolley out into the shop, and even outside of the building, alone but just now, we are putting in the sheet storage layout, and I want to tell you about that, which, I believe, will be the 'handiest ever' that has been placed in any boiler shop."

"Going to arrange heavy racks around the wall, I suppose in which the sheets can be placed and removed by the overhead traveler?"

"Not quite. Not a sheet will be placed against the building walls, either in racks, or otherwise. We have put in heavy concrete foundations and underground piers for the sheets to rest upon, where they will stand edgewise, between stout steel pipes or I-beams, to retain the plates in a vertical position. The piers, save for the necessary passages at intervals, extended across the entire width of the building and projected about 6-inches above the floor of the shop which was concreted all through the stock-storage section which in turn was located at one end of the shop and served by the railroad track along the entire length of the shop, close to one side thereof. The storage for sheets was also served by the overhead travelers, both of which could park above the plate storage space when necessary."

"How are the plates supported? It must require something pretty stout to sustain heavy steel plates in a vertical position?"

"The plate storage 'racks' as we call them, are very strong and substantial. As stated, the concrete piers extend about 6 inches above the floor and the piers are about 12 inches wide. Pieces of 4-inch steam pipe are placed upright in the concrete, about 12 inches apart, from edge to edge of the pipes, or about 16 inches, center to center. Running lengthwise of the piers, on either side of the vertical pipes, two 4- by 6-inch timbers, of the hardest, toughest wood to be found, were placed end to end, and simply butted together on either side of the line of posts on each pier. Then the timbers were fastened in place by ¾-inch bolts placed through both lines of timbers, thus clamping them fast to themselves and to the posts."

"Wonder how many of those 4-inch pipes will be broken off, when it comes to storing, placing and removing heavy plates from between those 5-inch pipe stubs?"

"I don't believe any of them will be broken off unless somebody hits them with a slingfull of plates attached to the overhead traveler, for the reason that where heavy plates are to be stored, each pipe is filled with reinforcing steel, and then thin and strong cement mortar poured in. Where the heaviest plates are to be stored, pieces of old shafting, from a junk yard, were cut to pipe length and slipped inside of each pipe and where the piece of shaft did not quite fill the pipe, neat cement was mixed and poured into the pipe around the piece of old shafting. Where the 1-inch plates are to be stored, pipes were not used. Instead, two 4-inch I-beams, placed side by side, and web bolted together, were set in the concrete piers and also spaced 16 inches on centers.

Placing Steel In Storage

"How is steel plate gotten off the railroad cars into the vertical rack-spaces? It must be something of a 'chore' to attend to that detail?"

"It is, but we are getting that work well down to a satisfactory basis. We have not yet gotten every detail quite perfected, but we will soon have everything down 'pat.' At present, for large lots of plates we use both overhead travelers and two men, one on the freight car, the other man at the storage racks. The man on the car, makes a hitch upon one plate or a bunch of them, as he can, or as weight of plates and conditions permit."

"Both overhead travelers have something like a 'boatswain's chair, was attached to the hoist of each overhead traveler in such a manner that after a man had made a hitch to bunch of plates, he could step or sit upon the 'chair' and go with the load to cast off and recover such chains or hooks as might have been used in making the hitch.

"When both travelers are being used, one stays above the storage racks, while the other traveler lifts plates from the flat car and deposits them upon a double blocking, from which the second traveler takes the unloaded plates and deposits them edge uppermost, in the vertical racks. The man on the car, makes a hitch as best he can, sometimes having plates raised by a temporary hitch with an edge grab hook and held up, while the man passes a chain underneath the plate or bunch of sheets, for a permanent hoisting hitch. Then the workman gets upon the boatswain's chair, which is lowered for him, and rides with the sheets to the 'lay-down' blocking, where the plates are released and left 'high and dry' upon a double blocking, After this the workman returns to the car for another load of sheets, leaving those deposited upon the double blocking to be placed in rack storage by the second traveler and its workman. He places a chain sling around the bunch of plates, when they are raised to an edgewise position by the second traveler, and deposited in the rack as required. The craneman rides the 'chair' so as to be able to unhitch the lifting chain or sling, in such a manner that the chain would be pulled out by the traveler, leaving the bunch of sheets in their proper storage place and position.

"Couldn't one traveler do the unloading, allowing the other one to attend to other work?"

"To be sure it can, and has been so stated, but both travelers are used when it is desirable for the car be unloaded as quickly as possible. When only one traveler is used, but one man is needed and he rides the chair from railroad car to storage rack, stopping at the intermediate station to make a vertical instead of a horizontal hitch upon each bunch of plates."

Removing Plates From Storage

"Mr. Ideal, your way of putting plates from the car into storage, 'listens good' to me, but I'll be hanged if I can see how you are going to get those plates out of the racks again, especially when the racks are almost full, and represent an almost solid wall of edgewise, steel plates. How do you do it?"

"One man and the overhead operator, does the whole thing. This man has a sort of grab consisting of a thick steel plate with a notch in one side and the hoisting hook placed in a hole on the opposite side. After the workman has pried a plate or so loose from the others in the rack position, or found a projecting plate end or corner, over which the hook may be slipped, the plate is easily withdrawn. The grab is so connected to the overhead tackle that the pull comes upon the plate in a manner similar to what it would when pulling upon the handle of a monkey wrench which had been slipped snugly over the edge of a plate."

"That will pull the plates out of the rack, fast enough, but how do you handle them afterwards, to get the plate to the layoff bench or to the various machines?"

"Before a plate is pulled out of the rack, a doubled chain or chain sling is placed on the floor and the plates allowed to fall upon the chain, which is afterward drawn tight and hooked to the overhead traveler which picks up the bunch of plates in the chain and carries them to their destination."

"Say, what is that thing on the floor, out there?"

"That is a special flanging forge. I'll tell you about that later."

Right of Boiler Maker to Damages for Injury Received in Operation of Unguarded Pneumatic Hammer

By Leslie Childs

As a general proposition of law, an employer is not bound to furnish his employees with the newest and best tools and implements for their work. However, an employer is bound to furnish reasonably safe tools and implements, and if a workman suffers injury in the use of a tool that a court or jury finds is not reasonably safe, liability on the part of the employer may follow.

So much for the general rule, and as an illustration of its application to a case involving injury to a boiler maker, in the operation of an unguarded pneumatic hammer, or air gun, the recent Missouri case of Hoffman v. Philip A. Rohan Boat, Boiler & Tank Company is worthy of review. The facts and circumstances which culminated in the action were, briefly stated, as follows.

Pneumatic Hammer Ejects Die

In this case the plaintiff was a boiler maker's helper and had been so employed about five years prior to his injury. On a certain date he was assisting in the riveting of angle irons on the inside of a semicircular caisson or frame. Some of the rivet holes were not in line, or not round and smooth and it was necessary to ream them before the rivets were inserted.

The boiler maker whom the plaintiff was assisting was on one side of the irons to be riveted together, while the plaintiff was on the other side at a distance of three or four feet. While the boiler maker was driving a reaming pin through a hole with a pneumatic hammer, the die in the hammer was shot out by the air pressure and struck the plaintiff in the mouth.

The accident was quite serious, and resulted in a permanent injury to the plaintiff's upper lip and mouth for which he brought the action for damages. This action was based, for the most part, on the claim that the defendant, employer, had been negligent in not providing the pneumatic hammer with a safety guard that would prevent the die and plunger from being ejected.

In support of his contention, the plaintiff introduced evidence that there was a certain guard on the market, known as the M-S safety device, designed to be attached to pneumatic hammers for this purpose. Plaintiff further alleged that this guard had been in frequent use, though not in general use, for ten or twelve years, and that its attachment to a pneumatic hammer in no way interfered with the normal operation of the hammer.

From the foregoing, the plaintiff took the position that it was the duty of the defendant to equip its pneumatic hammer with a safety device; that, in failing to do this, it had failed to furnish a reasonably safe tool for its employees to work with, and that for this reason it should be held liable for plaintiff's injury.

Upon the trial of the cause, the trial court gave an instruction in respect to what the jury must find in order to give a verdict to the plaintiff. On this instruction, and the evidence, the jury returned a verdict in favor of the plaintiff in the sum of $1,000. The defendant appealed, and the higher court in passing upon the correctness of the instruction given the jury, in part, said:

Instruction Held Proper

"The whole instruction must be read together in order to get its true meaning. So read, it advises the jury that it was the duty of the defendant to exercise ordinary care to furnish the plaintiff reasonably safe tools . . . and requires the jury to find, before they are authorized to return a verdict for plaintiff, not only, that there was a likelihood of the die of the hammer being shot out or ejected while in use, but also that the hammer was not reasonably safe because not equipped with a guard. . . . The instruction, read as a whole, declares the law as it is generally put in the books, and in instructions many times approved by the courts. . . ."

Following the above summary of the instruction, the court turned to the evidence in respect to there being a safety device that would have prevented the accident, had it been employed by the defendant. In this connection the court said:

"Plaintiff introduced evidence in extenso showing that the hammer was not provided with any guard to prevent the ejection of the die and that there was a guard on the mar-

(*Continued on page 270*)

Electric Welding for Safe Ending Boiler Tubes

Discussion by master boiler makers on most efficient methods of reclaiming tubes and flues

PROBABLY the most important report presented at the annual convention of the Master Boiler Makers' Association last May was the subject of reclaiming boiler flues. The report, which was prepared by a committee consisting of Henry J. Raps, chairman, S. M. Carroll and A. J. Redmond, appeared on page 139 of the May issue of THE BOILER MAKER. Not only was the committee report one of the most carefully prepared in all the proceedings of the association, but it also led to a valuable discussion of the methods employed for safe ending tubes. This discussion centered around the electric welding process that has been developed for this character of work and is published in a slightly condensed form below:

A. F. STIGLMEIER (New York Central): Electric safe ending is today one of the best methods. Welds can be made far better because they can be seen. Looking over Mr. Pack's report, you will find references to failures due to safe ends giving out. Most of them are due to burning flues. This we do not have in the electric weld. It will cost you far less; the output is far greater. While we are doing some of this work at our shop, I am sure, with the information that we can gather here, each and every member, if they will tell us what they are doing, will be able on returning to their shops to do far better work than they are doing at the present time.

G. W. BENNETT (I. C. C.): I would like Mr. Stiglmeier to explain the method of welding tubes on his railroad. He has a system that I have not seen in any other shop.

A. F. STIGLMEIER: The method we use is an oil weld. I hardly believe it could be done successfully by electric welding, due to the fact that the heat is too short. With an oil weld, it spreads out more. What we have is a machine that has a cylinder on top and bottom and on each side. We have had the outfit installed directly in back of our furnace. We have an attachment on a bar, the bar being 60 inches long. It is nothing more than a roller in that bar; the same as any flue roller.

We put the flue into the fire, heat it, shove it through. We have a three-way valve, which shuts off the air back between the water back and the machine. It next travels into the roll, working the pin into it. Then, it travels and starts up the machine by throwing in the clutch. When released it throws out the clutch, releases the pin and clamps, and puts on the air between the furnace and the machine.

Some of you may say, "Why do you have air between the furnace?" First, to keep the fire away. Why do we shut it off? So no holes will be blown through the flue. As to our method in electric welding tubes: We cut them off and roll onto a rack; a helper puts them on an emery wheel. He can grind an average of 120 per hour. It is nothing more than an emery wheel with a roller attached, on the bevel, which draws in the flue. It is very easy to operate, very easy to make. The roller can be made for $5.00. Use any emery wheel, say 28 by 3 inches, and straighten it up once a day.

Next, we have a bolt cutter, where we have a reamer. We ream out the little burr in the flue which costs 32 cents a hundred. This is done to hold the mandrel to size. We put it on a rack where it is put into the welding machine. As to disk cutting we have recently developed something new. After the safe end has been cut off we put it on a reaming machine and skim off the short edge, getting a perfect thickness before welding it at a cost of 20 cents per 100 without bothering with straight back disk cutters or hot saw.

GEORGE AUSTIN (A. T. & S. F. R. R.): Our method of rolling the weld when electric piecing flues might be interesting to some members. We copied it from the Norfolk & Western Railroad, and use it for safe ending, as well as reclaiming. I imagine that we have made millions of electric welds during the time we have had these machines in our principal shops.

We have improved the rolling of the welds by having the top roller idle, rotating the flues with the bottom rollers, that is, the bottom rollers do the turning. I have often thought the same principle would improve the method of cutting flues to length with the disk cutter if the cutter were idle on the shaft, and the flue turned under the cutter with the rollers. Then the cutting edge will not burn or wear off so quickly.

W. H. LAUGHRIDGE (Hocking Valley R. R.): The report of the committee, and my personal experience, suggest the welding of flues is nearer a solution of perfect welding that ever before. Few are doing any talking about it. We have been discussing this subject more than 25 years. We could always get an argument, but can not do so today. It appears to be and is one sided. We have been electric welding for three years, and it is as nearly perfect as we could possibly expect. Our procedure is to clean the flues and piecing ends, cutting them off in a disk cutter which bevels them to about 45 degrees. We experimented with reaming and scarfing, and every kind of a connection. We finally decided to cut the piecing end through the bolt, using a disk cutter. It leaves a little burr on the end of the flue and the piecing end, and the task is done much quicker. The ends cannot be cut off square and put up. There will be a little spot that will not connect; but with the little fuse mentioned they flash, and the flue begins to get uniformly hot all the way around.

J. A. DOARNBERGER (Norfolk and Western): The reclaiming and safe ending of boiler flues is probably the most important of the many subjects considered by the association and the committee is to be congratulated upon its excellent report.

It is probably well known to at least a majority of you that the first application of an electrically welded safe end to a boiler flue was made in 1912 at the Roanoke shops of the Norfolk & Western Railway, the art having been suggested to my mind by chance while passing a wagon factory where I saw a tire welding machine in operation. We at once had a flue welding machine designed for us which was a success from the start.

At first we used what is known as the butt weld. In November, 1918, it was abandoned and a 15 degree scarf weld adopted. This change was made because if a butt weld failed the flue dropped down completely, leaving a free passage for the water, whereas, when a scarf weld failed the two ends remain in place against each other, permitting only a comparatively small leak—not sufficient to cause an engine failure or possible injury.

While, as in the case of the samples just exhibited, laboratory tests often show the butt type of weld to be slightly stronger than the scarf type, our experience with the two types in actual service leads us to lean decidedly toward the scarf weld as, aside from its safety feature, our flue mileage has shown a decided increase since its adoption. Though we personally prefer this type we do not condemn the butt weld nor attempt to maintain that the experience of others will necessarily lead them to the same preference.

G. W. Bennett (I. C. C.): I would like some of the men who have been welding flues with electricity to explain why the welding machine burns holes in the old flues several inches from the end. In a shop I recently visited several hundred flues could not be used on that account. In another shop they put borax on the flue before the weld is made, because, before they did so, when the flue was laid down, the safe end broke off.

A. F. Stiglmeier (New York Central): I believe Mr. Bennett is referring to our shops. It was due to the location of the machine. You know that a blacksmith in olden times, and at the present, when making a weld covers his heat with borax or other welding compound. The answer is to keep the weld clean and the material from oxidizing, to keep the ozone out of the material. When our machine was placed where the atmosphere was greater the material would oxidize and the tube at the point welded broke like glass. After covering the weld with borax we found it excluded ozone and we could bend the tube at the weld to 90 degrees. Since that time we have been using borax in the manner mentioned with very good results.

K. E. Fogerty (C. B. & Q. R. R.): On the Burlington we use an electric welding machine on the small flues, up to 3½. I certainly agree with Mr. Doarnberger and do not approve of the butt weld, because, if that flue fails, we will have one of the greatest disasters ever known, from the safety standpoint. Superheater flues are lap welded 1¾ inches, as a matter of safety, on a Harter roller.

H. J. Raps (Illinois Central): I expected that matter to come up in the discussion. Years ago we had plenty of flues that were slightly burned break off outside the lap weld. When we began welding steel flues, we did not have very good success, and plenty of them broke off outside the weld. (Showing samples.) No 1 is a specimen of a lap electric welded two-inch tube. When subjected to the pulling test it broke outside of the weld at an actual load of 19,500 pounds. It is slightly burned. You will have the same condition with electrically welded flues that you have with oil welded flues. You may have a flue that breaks outside of the lap weld, and if it does what comfort can you get out of it? There is none. You have an engine failure. The condition with the electric lap weld is the same as with the oil weld. What is the difference? There is none.

Mr. Laughridge spoke of the disk turner. I do not agree with him. These samples were cut off with a cold saw. The contact is perfect when you put them together; you have it flush and there is nothing better. The disk is old fashioned.

C. L. Hempel (Omaha): In 1922, we had a convention at Minneapolis. I made a report upon acetylene and electric welding. If I recall correctly, I showed some samples of tubes there that were electrically welded. Some objection was made to them by the Federal men. They thought it might be a pretty good scheme to visit Omaha and check up my statement that we made 260,000 welds and had only one failure. That looked pretty big to them. They did not believe it.

E. W. Young was one of them who came to our shops. I do not recall the others. He selected a half dozen samples at random, and in response to his wish we pulled them. Five of the six broke outside the weld. They said, "Now, that is pretty good."

There is something else wrong. The sample just exhibited here is not welded; it is oxidized! Mr. Bennett asked why there are holes in the flue, back of the weld, put in like a shot. Take a toothpick, or a match, and run it through, six inches from the weld! That is what has caused it. The metal is oxidized one-half inch from the weld, and it is broken. The original flue was broken where it is oxidized; the flue is not welded. It was welded. It is not welded now.

As I remember this electric welding game, in the butt weld, or lap welding of flues, I went down to Roanoke one time and saw John Doarnberger "monkeying" with some kind of a machine. He said he wanted to develop an electric welding machine. He drifted along, for a time, and made pretty fair progress. A little later, I went down to Waycross, Georgia, and saw Lee Stewart with an electric welding machine, trying to make some welds. He was operating the machine with a negro and progressing pretty nicely. I said to him, "Lee, I believe we ought to be able to do anything that those negroes can." So, I got interested in that, and other people did. They wanted to make an electric machine to put on the market. Each one wanted to make a better machine than the other fellow, the same as each of us wants to make a better weld than the other fellow. We have all been trying to do something of that kind. I have been trying to beat John Doarnberger and Lee Stewart to it, ever since. So we have all been trying to make perfect welds. We have reached a point where we can make perfect welds, and it has been thoroughly demonstrated that we can, by pulling them afterward, as well as by the service that we are getting.

First, we went to butt welding. We found in cutting off these flues that we could not get them to match satisfactorily in the jaws of the machine. So, we had some failures, as John Doarnberger told you. Everybody has them. When one of these flues broke squarely off the Federal men investigated it, and were not very well pleased because it had hurt somebody. We did not want anybody hurt; nobody does. We thought we ought to try to develop some way of preventing it, in case of a bad weld. We do not say that every weld is good. But, even if a bad weld has been made, it is very easily discovered before the flue goes into the boiler.

So, we developed and worked along the same line as John Doarnberger—lap welding. When the Federal men made their pulling tests at Omaha, the tubes were lap welded. I found that the trouble was in getting the proper chamfer. It is necessary to find a way to chamfer that safe end at an angle of 30 degrees with the axis; also counterbore the flue with a machine that prepares your flue. Then when the two ends come together they fit.

With the lap welded flue we find that when you turn on the current, the feather edge first begins to get white. The red gradually runs; you can see it heat, and in place of bringing this together and throwing the spark fuses it. What did John tell you? He said that at some place he saw them welding something, meaning spot welding, fusing. That is what you want to take care of. You do not want to turn on the current quickly—that will throw stars. It should be gradual, and come to the proper fusing heat. It will not spark, it will not oxidize, but it will just properly fuse itself, by what you may call gradual fusing. To my mind the whole thing is just simply education. It is necessary for men operating the machines to become proficient, to know what they are doing. It may be that some of you have machines that do not properly control the amperage, and that it is not properly graduated. I saw two men welding a set of flues—the one who made the machine, and the one who sold it. They may be here today, I do not know. But I am going to say what I want to say, anyhow. These two men wanted pay for the machine. After they had welded a set of flues, not one of which was welded, I said, "I know what the trouble is;

you are at loggerheads. Neither of you knows what you are talking about." They asked, "What is the matter with the machine?" "Nothing!" said I. "You tell Mr. Fuller that I will run that machine in 40 minutes after it is paid for, if it is sent over to me." They were very much surprised. One wanted to sell the machine, and the other to get his money. So I said, "I will make you just one weld." If the General Boiler Inspector of the Union Pacific Railroad is here, he will know that that weld is in my office yet. I made it. I said, "You welded 250, and have not got a weld. I have welded one, and is not that a good weld?" Their answer was, "Yes." There was nothing the matter with the machine. The proof was that it is up to the man, in making welds, to know what he is doing, to get a machine that is good; and these men, who are selling these machines, are all trying to make good machines to meet service demands.

The electric welding of flues is here today. It is going to stay. The hand weld is something that has passed out. I do not believe that it is up to us to go backwards, to criticize these new devices. Just as I said some years ago about the electrical welding of firebox plates. Instead of condemning the process, let us try to educate ourselves up to it. And we can do it! I do not blame the Federal men for telling us that they do not want welds in an engine that are improperly made, and liable to cause trouble and injury. Neither do we. We can make good welds by following the advice of men who have had large experience, and by trying to improve ourselves. Take hold of them, and try to do better than those men.

K. E. Fogerty (C. B. & Q. R. R.): I do not believe I thoroughly understand whether Mr. Hempel approved of the lap or the butt weld?

C. L. Hempel: The lap weld, because it eliminates accident and possible injury.

E. P. Fairchild (Atlantic Coast Line): After listening to the discussions of safe ending the flues, I would like to relate our experience on the Atlantic Coast Line at Waycross. We began electric butt welding of safe ends and continued it for quite a while; then we began to have plenty of trouble. The flues were removed from the boiler and run through the cleaner. The safe end pulled loose from the flue. When the flues were safe ended the second time and applied they leaked in the old butt weld. We had so much trouble with leaky welds that something had to be done. This caused us to get away from butt welding and we began to scarf or lap weld. At first we reamed the inside of the flue and scarfed or chamfered the safe end on the outside.

We found the upkeep of the reamers for the inside of the flue very expensive. This operation was eliminated by scarfing the outside of the flue. We put a 45 degree bevel on the outside of the disk cutter for cutting off the flues. This beveled the outside of the flue 45 degrees. We buy safe ends beveled in that way. We are now getting good results and our flue trouble practically eliminated.

L. M. Stewart (Atlantic Coast Line): In other words, we put the safe end on the outside of the body. That is a little different from the way most of you do it. We do not use borax, but baratese, to equalize the heat and bring it up, especially on the superheater flues.

P. J. Conrath (National Tube Company): I believe I should say something about welding. I served on a committee a number of years ago which handled this subject. The principal cause, in my opinion, of tubes breaking off in the boiler is due to overheating in welding.

Expansion and contraction of the tube in the boiler puts a strain close to the weld, and the material being crystallized, owing to overheating, will eventually cause it to break off.

Personally, I am in favor of the lap weld. I have known it to fail, but the tube did not break off and drop into the boiler shell, as will the butt weld, and it is liable to scald someone. It is our place to guard against loss of life and limb as much as possible. As a foreman, I would want to have the tubes lap welded by an electrical spot welding machine.

Mr. Doarnberger of the Norfolk & Western can tell you something in regard to safe ending tubes by both butt weld and lap weld, as he was one of the first to use this method. The National Tube Company had some of the butt weld safe ends on tubes made by Mr. Doarnberger pulled at their laboratory, and the strength of the weld averaged about 92 percent of the strength of the metal. Therefore, there is no question about the strength of the weld. Mr. Doarnberger has also changed to lap weld for the reason stated.

The most important part in welding safe ends on flues is careful observation of the heat. Steel will fuse at about 2,450 degrees Fahrenheit, and will make a very sound weld, but not as smooth as with the degree of heat at about 2,500 to 2,600 Fahrenheit, at which point, of course, the metal is much softer. At 3,000 degrees the danger point of overheating the material will be reached. This applies to steel. On iron heat should be at 2,900 degrees Fahrenheit for welding, 3,200 to 3,300 degrees being the point at which there is danger of burning. The National Tube Company has conducted a number of experiments with a pyrometer on the furnace to prove the degree of heat best adapted for welding and which we find is about 2,500 to 2,600 degrees for open hearth steel tubes.

Electric spot welding, in my opinion, is the best method for welding safe ends to flues. My recommendation would be to use a reamer inside the flue with about a 32-degree taper, which will be pretty nearly right for the bevel on the rotary cutter. These will join together nicely, and will give a lap to guard against the tube falling into the boiler if the weld is defective or overheated.

W. H. Laughridge (Hocking Valley): Going back into ancient history—or about 35 years ago, I took charge of a shop. An old-time blacksmith that could weld anything was butt welding flues by hand. He had obtained patents on the mandrels and devices that he used for holding the flues together. They were cut off square. He made a nice, smooth job, but the output was slow and expensive. I did not take to it very strong, as I had been used to lap welding. However, they got along very nicely, but every now and then one of them would break off and drop down and caused an engine failure. I got tired of it, and finally told the superintendent of motive power I did not like it, and would like to have a machine, which was provided. We scarf welded, using an oil furnace for heating, until the electric welder came onto the market. While we were butt welding the Norfolk & Western sent a representative to our shop who stayed about a week to learn how it was done. On his return they adopted the butt weld system, and, I understand, used it for years. Am I right, Mr. Doarnberger? Did they use it after you went there?

J. A. Doarnberger: Are you talking about ancient or modern history?

W. H. Laughridge: That was before you were on the Norfolk & Western.

J. A. Doarnberger: You mean prior to the days of electric welding?

W. H. Laughridge: Yes. The Norfolk & Western had a lot of trouble because the flue was merely butted up and fused and hammered on the mandrel. If they broke, it was right in that weld.

I believe there is a misunderstanding in regard to what Mr. Raps, or the committee, considers a butt weld. I do not consider that we make such a weld, yet we cut off the piecing end and the flue at an angle of about 15 degrees and butt them. When that metal comes to a heat, and the lever is shoved down in the machine, the flue laps itself a quarter of an inch. I think the committee, and the rest of you, would call that a butt weld. It is, really, not a lap weld. Any more lap is superfluous and does not add strength to the weld as one-fourth of an inch gives as much holding surface as the thickness of the metal will permit if you have a quarter of an inch of metal. The thickness of the flue is greater than that of the metal, and the result is a lap. If it were six inches long it would not add any metal to it. If you have the heat, you will have a weld, and the original thickness of the flue will be maintained next to the cold, as there is no wastage. I am speaking of an electric heated flue where you get the nearest to perfect heat possible, because the electric current heats the metal from its neutral point, or, in other words, from its center out, which insures amalgamation of the metal all the way through. The electric welder has brought us into an era of almost perfect welding. As an example of what can be done by this method, would say that we have had numerous delegations visit our shop and take samples for testing, as we have no testing plant.

I can only give you figures from one large railroad that sent delegations three different times. One of the men told me that the lowest test showed 96 percent and some pulled 100 percent. Our own experience of flues in service is equally as good, as we have over 100,000 in service and never had one break.

We do not test before applying to boiler and have only had 20 leaks on the boiler test of 100,000 in service.

We are acetylene welding superheater tubes and put them together the same way. We have never had a failure, nor a leak. We test them before we put them into the boiler. As long as we have such a record as I have stated, I think what they call a butt weld should be the practice. The electric welded flue is the best method that can be used for uniting the tubes. There is a difference of opinion here, and there is a difference in the machines. Some use a flashing machine; we do not. We use the same kind of a machine as Mr. Hempel. I think the committee will agree, as their tests have shown, and my own personal experience has proven, that the weld in the electric machine is, to date, the nearest to perfection of any method. What is the difference if you stick one flue inside the other, for half an inch, or an inch. One member said they use a 1¾-inch lap. I do not know what good it does, because the end of the piece, where it projects into the flue, would be the weakest place. The sample shown looked as though it had not been sufficiently heated. It did not weld as it should. That is a lap weld, and it looks just like one of the old oil welds which were brought up to enough of a slippery heat to make them stick. I have wondered how they held together as well as they did because so many fall off when rattled. Examination would show that they were only stuck together and not fused, the flue being wasted thin back of the weld by the cutting action of the air in the oil furnace.

J. D. Osborn (A. T. & S. F. R. R.): We weld many flues at San Bernardino, and we use a flue welding machine on all small flues. While we use a half lap, we work with a flashing machine. If flashed to a heat, and the tubes were then pulled apart, the scarf would be found burned off. It would be a butt weld, anyway. We have good success, and get possibly about one in 100 that leaks. Superheater flues are welded in the oil furnace, with good results. We have no electric welder for such flues, but I do not believe in a flashing machine.

L. M. Stewart: After you have welded your flues in the electric machine, upset them, and rolled them to size, do you use a roller or a hammer?

J. D. Osborn: A roller.

L. M. Stewart: We have both hammer and roller. The latter gives best results.

J. D. Osborn: When we began electric welding a hammer was used after the flue was welded. More were broken than we could fix up. Finally, we used the roller, and it is a wonderful machine. The weld may not be perfect, but the roll will finish it, and make a fine job.

K. E. Fogerty (C. B. & Q. R. R.): There has been much discussion on the weld of the tube, and many shops are using a flux. I would like to learn whether those who are handling electric welding of flues are having any better success in using flux than those who do not? While I thoroughly understand that many of the members here are using, or intend to purchase, electric machines, I would like to know why some use flux, and others do not.

C. L. Hempel (Omaha): I wish to answer a few questions that have been asked and explain how we prevent a flue being shot full of holes 6, 8 or 10 inches from the weld.

It is necessary to clean the jaws of the machine with emery cloth or sand paper. They have spots close to the electrodes. While flux is used with some advantage, it is not necessary. If employed it will run around the weld and vitrify the metal so that it cannot run. It is not necessary to heat the flue to more than 2,800 degrees.

Inquiry has been made as to which is best, a hammer or roller. It is necessary to have something to reduce flues to the proper size. Otherwise it would not be necessary to roll the flue after the weld is made. The flue is sized by rolling, so that it will go into the hole. In making these welds flues will be enlarged so you could not get them into the flue hole, and it might be the same on the inside from the pressure of uniting two flues.

As to butt and lap welds, there is no difference if properly made. Mr. Laughridge is correct in his statement that a butt weld is a good weld, if properly made, but if it is not like the sample shown here, it would pull out, the flue would fall down and a large volume of steam go out. In the other case, it will pull back 1/16 of an inch, the steam will blow out through the fire door, and gives warning of trouble. That is the only difference between a lap and a butt weld.

W. H. Laughridge: In regard to what Mr. Hempel has said about shooting a hole through flues. We had that trouble when we first received our machine; in fact, we could do nothing with it in our effort to make a good weld. We kept shooting holes through the flues. It had a diameter of six inches for taking the piecing end and for taking the flue. The flues had been oil welded and in service. They were more or less rough, and when put into the six-inch die, there was contact only in spots. As a result they would heat in spots and holes made. We took out the dies, bored them out an eighth of an inch larger than the size of the flue, except for a length of two inches. That eliminated the shooting of holes through flues. Close observation is required or there will be a little knot on the die which will burn a hole.

We used an old-fashioned rolling machine, with the two bottom rollers, and a top roller that operate together with an air cylinder. When a man puts his foot on the pedal, the top roller comes down on the flue, bringing the bottom rollers up, while the spindle is running in the opposite direction from the wheel.

C. L. Hempel: That is a splendid way to overcome die trouble. It is new to me. It works just the same as cleaning the dies and is better. That is a good arrangement.

(*Continued on page* 270)

Dictionary of Locomotive Boiler Terms

Definitions of boiler parts adopted by Master Boiler Makers Association at annual convention

At the recent annual convention of the Master Boiler Makers Association, W. H. Laughridge, chairman of the committee on "Standard Boiler Terms" proposed that the association adopt such portions of the "Dictionary of Terms" appearing in the *Locomotive Cyclopedia* published by the Simmons-Boardman Publishing Company, New York, as applied to boiler work. The convention passed the motion unanimously and adopted the definitions of terms which for the benefit of members of the association and all others connected with locomotive boiler work appear in part below. Earlier sections appeared on page 171 of the June issue, page 201 of the July issue and page 236 of the August issue. Further instalments of these terms will be published in later issues.

Definition of Terms

H

Hand Hole. An opening in a water leg or in the shell of a boiler for cleaning out mud and scale. It is closed by a cast or wrought iron plate or cover held in place by studs set in a heavy ring riveted around the hole. Usually called wash-out hole. British, mud door.

Hand Hole Plate. See Hand Hole.

Hand Hole Plate Bolt. One of a number of bolts passing through holes in the hand hole plate cover to secure it to the ring riveted to the boiler.

Hand Hole Plate Clamp. See Hand Hole Plate Dog.

Hand Hole Plate Dog. A curved piece with its ends or feet resting against the sheet of a boiler near the edge of a hand hole. A bolt attached to the dog passes through a hole in the center of the hand hole plate, and a nut screwed on the end of the bolt draws the plate tight against the boiler.

Heater Cock. A valve attached to the boiler head, to admit steam from the boiler to the pipe running under the tender and train for heating the cars. It is a reducing valve and allows sufficient steam to pass to maintain a pressure of from 20 to 80 pounds per square inch in the train steam pipe at the valve.

Heater Cock Extension. The pipe leading from the cab turret on the boiler to the heater cock.

Heating Surface. That part of a locomotive boiler exposed to heat action on one side and available for the evaporation of water on the other, and expressed in square feet. Usually divided into firebox heating surface and tube heating surface. See Firebox Heating Surface, Tube Heating Surface.

Hip Joint. The joint between the roof sheet over the firebox and the shell of a boiler with a Belpaire firebox.

Hip Joint Casing. A sheet steel cover flanged and pressed to the shape of the hip joint and forming part of the jacket of a boiler with a Belpaire firebox. See Jacket.

Hollow Staybolt. A staybolt with a small hole lengthwise through the center.

Hood. A roof apron which is attached to the back end of a cab and extends out over the cab apron to protect the firemen. See Firedoor Hood.

Hopper (Extended Smokebox). A receptacle for cinders or sparks on the under side of a smokebox. It is shaped like the frustum of a cone or a pryamid, and empties into the Cinder Pipe, which see. Also called cinder pocket and spark pocket.

Horsepower. A term used as a measure of power. One Horsepower is equivalent to a force that will raise 33,000 pounds one foot in one minute.

Hudson Type Locomotives (4-6-4). A locomotive having a four-wheel leading truck, three pairs of coupled driving wheels and a four-wheel trailing truck. First used on the New York Central in 1927.

I

Injector. A device for forcing water into a steam boiler in which a jet of steam imparts its velocity to the water and thus forces it into the boiler against the boiler pressure. See Inspirator, Boiler Inspection.

Injector Bracket. A projection secured to the boiler for the attachment of an injector.

Injector Check Valve. See Boiler Check Valve.

Injector Connecting Rods. On injectors located outside the cab, rods secured to the steam and water valves and passing through the front of the cab so that the injector may be operated from inside.

Injector Delivery Pipe. A copper or iron tube through which feed water is forced into a boiler. Also called an injector check pipe.

Injector Delivery Pipe Hanger. A hanger fastened inside a boiler to support the delivery pipe of an injector. Used when the injectors are on the boiler back-head and deliver through a pipe terminating near the front end.

Injector Feed Pipe. A tube secured to the water inlet of an injector and connected to the hose from the tender.

Injector Feed Pipe Coupling. A coupling or union on the injector feed pipe to connect it to the hose from the tender tank.

Injector Hole. An aperture either in the first course of a boiler near the smokebox, or in the back head, for the injector delivery pipe to enter the boiler.

Injector Overflow Pipe. A pipe which receives the overflow from the injector and delivers it underneath the engine.

Injector Steam Pipe. A pipe which conducts steam from the turret to the injector.

Injector Steam Valve. A valve in the turret or injector steam pipe for the purpose of supplying steam for the use of the injector.

Inside Connected Locomotive. A locomotive having the main rods connected to cranks formed or built on the driving axle between the frames. Some four-cylinder compounds have two cylinders inside connected. Three-cylinder locomotives have one cylinder inside connected.

Inside Stack. See Smoke Stack Extension.

Inside Throat Sheet. See Firebox Throat Sheet.

Inside Welts. A strip or narrow plate riveted on the inside of the abutting edges of two plates of a boiler to form a butt joint. See Welt.

Inspection Card Holder. A frame provided with a glass cover for holding an inspection card in the cab.

Inspection Locomotive. A locomotive having a large cab built over the front of the boiler for the use of officers in inspecting railroad track.

Inspirator. A device similar to an injector and accomplishing the same end. See Injector.

J

Jacket. A covering of thin sheet iron over the lagging of a locomotive boiler, cylinder or other protected radiating surface. Sometimes of planished, but more commonly of sheet steel painted. British, clothing plate.

Jacket Bands. Strips surrounding the jacket to cover the joint between any two sections.

Jacket Clamps. Fasteners for holding the edges of the jacket in place.

Jacket Edging. A turned up molding on the joint of the jacket sheets.

Jacobs-Shupert Firebox. See Sectional Firebox.

K

Knuckle Joint. "A joint in which a projection on each leg or leaf of a device is inserted between corresponding recesses in the other, the two being connected by a pin or pivot on which they mutually turn. The legs of dividers and the leaves of door hinges are examples of true knuckle joints. The term, however, has been somewhat commonly restricted to compound or universal joints designed to act in any direction."—Knight.

L

Lagging. A covering laid on the outside of the boiler and cylinders to prevent loss of heat by radiation. Usually composed of magnesia and asbestos and applied in sections made to fit the curvature of the boiler. Sometimes applied to the boiler shell in the form of plaster. It is sheathed with a sheet iron Jacket. Formerly wood was used. See Asbestos Insulating Cement.

Lagging Angle. A holder or bracket secured to a boiler to hold the lagging in position.

Lap Joint. A method of fastening together the ends of a boiler plate or of two plates by laying the edge of one plate over that of the other and then riveting them. The number of rows of rivets designates the kind of lap joint as single riveted lap joint and double riveted lap joint. Formerly used in making the longitudinal seams in locomotive boilers but now generally restricted to the circumferential and throat seams.

Liner. A facing interposed between two surfaces to diminish the wear and as a means of reinforcement. Liners are used between the driving wheel hubs and driving boxes, between the firebox and the expansion pads, etc. See Smokebox Door Liner.

Locomotive. A self-propelled vehicle running on rails, for the purpose of hauling cars. It may be operated by steam, electricity, gas from volatile oils, or compressed air. Compressed air locomotives resemble steam locomotives in general design, but use the expansive force of compressed air instead of steam. Steam locomotives consist of a boiler and engine mounted on a frame supported on wheels which are turned by the engine. The boiler contains water and has a firebox forming part of it in which fuel is burned to supply heat to the water and convert it into steam. The steam passes through a throttle valve, thence through pipes to the steam chests, from which valves, operated by various forms of valve gears, automatically admit it alternately to each end of the cylinders and exhaust it therefrom into the atmosphere through the exhaust pipes and stack. The expansive force of the steam moves the pistons, piston rods and crossheads back and forth, and, as the crosshead moves in guides, and has one end of the main rod connected to it at the wrist pin, while the other end of the main rod is connected to the crank pin on the driving wheel, the reciprocating motion of the piston is thereby changed into a rotary motion of the driving wheels. A locomotive thus transforms stored-up or potential energy of fuel into kinetic energy or mechanical work.

For different classes and wheel arrangements of locomotives see Whyte's Nomenclature. See also American Type, Atlantic Type, Bicycle Type, Centipede, Columbia Type, Compound, Consolidation, Cross Compound, Decapod, Double Ender, Dummy. See also Eight-Coupled, Eight Wheel, Eight Wheel Switcher, Electric, Fireless, Forney Type, Four-Coupled, Four-Wheel Switcher, He per, Inside Connected, Inspection, Logging, Mallet, Mastodon, Mikado, Mining, Mogul, Mountain Type, Oil-Burning, Prairie Type, Pacific Type, Rack, Saddle Tank, Santa Fe Type, Side Tank, Six-Coupled, Six-Wheel Switcher, Steam Storage, Switching Tank, Ten-Wheel Switcher, Three-Cylinder and Twelve-Wheel, Shay Geared, Snow Plow, Gasolene Locomotives.

Locomotive Badge Plate. See Name Plate.

Locomotive Classification. See Whyte Nomenclature.

Locomotive Frame Cradle. A steel casting attached to and connecting both main frames and extending back under and supporting the firebox resting on trailing truck serving as frame box back extension and foot plate with which the usual brackets, supports, and fulcrums are cast integral.

Logging Locomotive. A locomotive used on logging railroads. See Locomotive.

Longitudinal Seam. A riveted joint in the boiler shell and in the same plane as the axis of the boiler. The style of riveting and method of joining and reinforcing the seam is varied to suit the requirements.

Low Water Alarm. A device for notifying the enginemen when the water in the boiler is dangerously low.

Lug. A projecting stud or ear to afford a bearing or point of attachment.

M

McClellan Firebox. See Water Tube Firebox. Firebox.

Magnesia. Magnesium Oxide, MgO. A light, white, earthy substance which is tasteless and has a feeble alkaline reaction. In locomotive shops the substance commonly called magnesia is a mixture of magnesia and asbestos fiber, usually about 85 percent magnesia and 15 percent asbestos. It is used for lagging locomotive boilers and cylinders, steam pipes, etc.

Mallet Articulated Compound Locomotive. A locomotive having two sets of frames connected by a hinge or pivot joint. The rear frames, which are held rigid in alinement with the boiler, are carried on a separate group of driving wheels, and frequently a trailing truck, and are driven by the high pressure cylinders mounted on the frames at the leading driver, thus forming a separate engine or unit. The low pressure cylinders are mounted on the front set of frames.

Similar locomotives are built, on which all four cylinders receive steam direct from the boiler. Such single-expansion articulated locomotives are not strictly speaking "Mallets." See Whyte's Nomenclature, for various wheel arrangements. See also Baldwin Articulated Compound Locomotive and American Articulated Compound Locomotive.

Mallet Articulated (Triplex) Compound Locomotive. A locomotive with three pairs of cylinders and three groups of drivers. The third group of drivers being located under the tender. Two cylinders are high pressure and four low pressure, the high pressure pair driving the middle group of wheels. The right high pressure cylinder exhausts into a receiver which supplies the front pair of low pressure cylinders, and the left high pressure supplies the rear pair in a similar manner.

Manhole. See Tank Filling Hole.

Manhole Cover. A lid to close a Tank Manhole.

Manhole Eye. A ring fastened to the lid of a Tank Manhole.

Manhole Hinge. A hinge by which a tank manhole cover is attached to the manhole ring. See Tank, Filling Hole, Lid Hinge.

Mastodon Locomotive (4-10-0). A locomotive having a four-wheel front truck and five pairs of coupled driving wheels, but no trailing truck. Not in general use.

Mikado Locomotive (2-8-2). A locomotive having a two-wheel front truck, four pairs of coupled driving wheels and a two-wheel trailing truck. Extensively used for heavy freight service.

Mining Locomotive. A small locomotive operated by steam, compressed air or electricity for hauling cars in mines.

Mogul Locomotive (2-6-0). A locomotive having a two-wheel front truck and three pairs of coupled driving wheels, but no trailing truck. Used in light freight service.

Mountain Type Locomotive (4-8-2). Locomotive having a four-wheel front truck, four pairs of coupled driving wheels and a two-wheel trailing truck. Also called Mohawk type. Used for heavy fast passenger service over heavy grades and for fast freight traffic.

Mud Drum. A shallow cylindrical receptacle in the bottom of the shell of a boiler near the smokebox, closed by a cast iron cover or plate bolted to a ring that is riveted to the plate forming the drum. Its purpose is to facilitate the removal of mud and sediment that accumulates in that part of the boiler. See Hand Hole.

Mud Drum Plug. A plug cock or blow-off cock screwed into the mud drum cover.

Mud Ring. See Firebox Ring.

Mud Ring Cross Brace. A casting bolted to the bottom of the mud ring and placed transversely across the firebox for the purpose of supporting the grate bearers.

N

Name Plate. A cast iron or brass plate, commonly fastened on each side of the smokebox, giving the name of the builder and builder's number of the locomotive.

Narrow Firebox. A firebox narrow enough to extend down between the frames and driving wheels. See Firebox.

Number Plate. A round or square metal plate fastened to the smokebox door, with the road number of the locomotive in raised figures upon it. See Name Plate.

(To be continued)

Robert E. Kinkead has resigned as chief engineer, welder division of The Lincoln Electric Company of Cleveland, Ohio, to engage in consulting engineering in connection with electric arc welding. Mr. Kinkead's office is located at 3030 Euclid Avenue, Cleveland, Ohio.

Small Tools.—Believing that the buyers of small tools and machinery were interested in complete information in handy convenient form, Joseph T. Ryerson & Son, Inc., Chicago, has issued a catalogue on metal working small tools and machinery. The new book is unique in that it covers both the small tool and machinery fields and combines with it a price supplement. The catalogue gives the list prices and specifications. The supplement provides the f. o. b. points, discounts, and other price information. This saves the buyer considerable time in determining the price of tools in which he is interested.

The Cause and Prevention of Embrittlement of Boiler Plate—II*

By S. W. Parr† and F. G. Straub‡

It will be at once evident that if a method could be devised for reproducing the feature of embrittlement at will, a ready means would be available for determining both the cause of and the remedy for the difficulty. Intercrystalline cracking of mild steel is an abnormal type of failure; consequently if mild steel can be made to crack under conditions which may be controlled or modified at will and under conditions which parallel those of actual boiler operations, both the cause and the remedy may be in a fair way of solution.

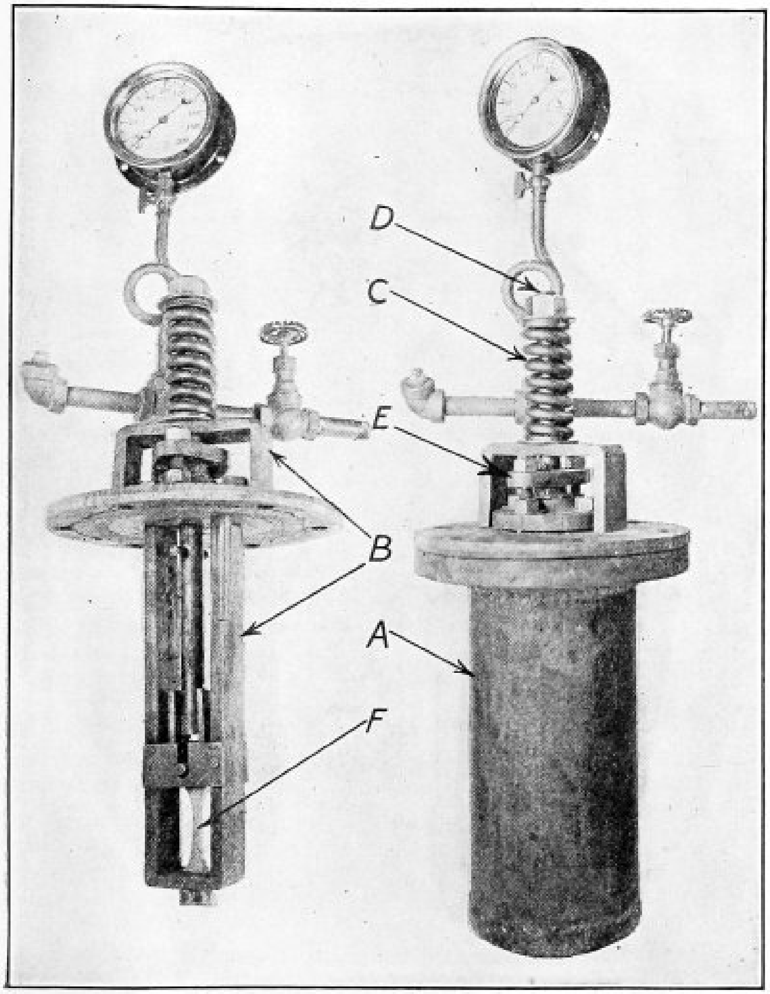


Fig. 9.—Apparatus used for embrittlement tests

The value of direct accessibility of information obtained in this way may be well illustrated by the only other means, namely, a long-time experiment in connection with boilers in actual operation. Since the embrittling effect is insidious and in many cases very slow in developing, it will at once be understood why this method of experimentation is almost hopeless because of the time element involved. However, it should be said that one such experiment extending over the time intervening since publication of the former bulletin, namely, ten years, has been in progress, and all of the results obtained in that connection are consistent with and indeed are substantiated by the results of these short-time laboratory tests.

The apparatus finally used for reproduction of embrittlement is shown in Fig. 9. It consisted of a welded steel container *A* which held the solution and the tension producing equipment *B*. The tension was produced and maintained by means of the spring *C* and the plunger *D*. The gland *E* allowed the plunger to enter the container steam tight. The specimen is shown at *F*. Part *B* fitted into *A* and was secured by bolts (not shown). The proper temperature and pressure were maintained by means of an electric furnace.

The materials used for the embrittling tests were all mild steels. Table III gives the chemical analyses and reference numbers of the different metals tested. Table IV gives the physical properties of the metals.

The materials to be tested were cut to the shape shown in Fig. 10. Care was taken in machining the specimens to have the holes alined so as to properly distribute the stress. The specimens were finished by polishing the small section with No. 1 polishing emery paper. The direction of polish was parallel to the length of the specimen.

The specimen to be tested was measured with a micrometer and the area calculated. The load necessary to give the required stress was calculated and the compression of the standardized spring to give this load determined. The specimen was set in the yoke and pinned to the plunger which was tightened by screwing down the nut on the upper end. When the spring was compressed to the right length the gland was tightened and the upper part of the apparatus placed on the container in which the desired solution had been previously placed. After the parts had been tightly bolted together they were placed in an electric furnace and heated until the desired pressure was obtained. A record of the pressure, temperature, and spring length was taken at regular intervals. When embrittlement had progressed sufficiently to break the specimen, the spring forced the plunger up, thus indicating that the specimen had broken. The release of the spring was in all cases found to be instantaneous and free from any indications of slow yielding.

The average area of the test specimens was 0.05 square inch. The accuracy of the estimated load on the specimen was within 1,000 pounds per square inch when the stress was in the range of 40,000 pounds per square inch. In calculating the stress, on the specimen, allowance was made for the stress added by the steam pressure acting on the plunger.

* This paper was presented at the 29th annual meeting of the American Society for Testing Materials. The paper is reproduced herewith as it was also presented in part and formed a special feature of the recent annual meeting of the American Boiler Manufacturers' Association. The first instalment of this report appeared on page 204 of the July issue.

† Professor of Applied Chemistry, University of Illinois, Urbana, Ill.

‡ Special Research Assistant, University of Illinois Engineering Experiment Station, Urbana, Ill.

TABLE III—CHEMICAL ANALYSIS OF METALS TESTED

Reference	Description	Carbon, Percent	Manganese, Percent	Phosphorus, Percent	Sulphur, Percent	Silicon, Percent	Nickel, Percent	Molybdenum, Percent
F. S.	Flange Steel	0.18	0.45	0.012	0.027	.....	.....	.....
Armco	Armco Iron	0.023	0.017	0.003	0.010	0.01	.....	.....
M. I.	Magnetic Iron	0.04	0.020	0.004	0.007	0.01	.....	.....
C. R.	Cold Rolled	0.30	0.42	0.015	0.044	0.04	.....	.....
1112	S. A. E. 1112	0.15	0.76	0.215	0.176	0.01	.....	.....
2312	S. A. E. 2312†, ‡	0.115	0.45	0.018	0.025	0.20	3.5	.....
2212	Special†, ‡	0.13	0.45	0.018	0.020	0.26	1.57	0.25
2330	S. A. E. 2330‡	0.30	0.478	0.023	0.015	0.05	3.42	.....

† Furnished by Central Steel Co., Massillon, Ohio.
‡ Cut to ¾ in. flat from 1¼ in. round.

TABLE IV—TENSION TESTS OF MATERIALS USED

Reference	Description	Heat Treatment†	Elastic Limit, Lbs. Per Sq. In.	Yield Point, Lbs. Per Sq. In.	Tensile Strength, Lbs. Per Sq. In.	Reduction of Area, Percent
F. S.	Flange Steel	As received	32,600	35,200	60,400	61
Armco	Armco Iron	Annealed 950° C.	32,000	40,600	52,600	70
M. I.	Magnetic Iron	Annealed 950° C.	25,000	30,000	50,700	72
C. R.	Cold Rolled	As received	70,000	84,000	85,500	55
C. R. A.	Cold Rolled	Annealed 850° C.	......	36,400	64,700	55
1112	S. A. E. 1112	Annealed 900° C.	47,500	49,000	74,000	56
2312	S. A. E. 2312	Annealed 900° C.	37,000	40,000	74,800	75
2212	Special	Annealed 900° C.	35,000	36,800	75,000	75
2330	S. A. E. 2330	Annealed 850° C.	41,000	49,200	77,300	57

†Annealed specimens heated to temperature indicated for 30 minutes and furnace cooled.

Test Data on Embrittling

The results of the tests on the various metals embrittled are given in Tables V to IX, inclusive. They indicate that two conditions must be present simultaneously to cause embrittlement of steel: first, the actual stress must be above the yield point of the metal; and second, the concentration of sodium hydroxide must be in excess of 350 grains per liter (350,000 parts per million, 20,000 grains per gallon). The variation of pressure up to 200 pounds per square inch seems to have no marked effect on the rate of embrittlement.

TABLE V—EFFECT ON FLANGE STEEL OF STRESS AND CONCENTRATION OF SOLUTION

Solution, g. NaOH Per Liter	Stress, Lbs. Per Sq. In.	Container	Time: Break	Time: No Break	Gage Pressure, Lbs. Per Sq. In.
415	30,000	No. 1	......	22 days	65
400	31,600	No. 4	......	18 days	65
400	33,000	No. 4	......	16 days	70
415	34,400	No. 1	......	27 days	90
400	35,400	No. 1	1½ days	......	60
400	39,200	No. 4	2 days	......	55
400	44,300	No. 4	30 hours	......	50
400	46,000	No. 2	1½ days	......	45
400	50,500	No. 4	27 hours	......	50
40	50,000	No. 1	......	17 days	55
200	47,000	No. 3	......	16 days	40
210	47,600	No. 3	......	21 days	65
345	46,000	No. 4	14½ days	......	65
405	50,000	No. 4	4½ days	......	50
400	39,200	No. 4	2 days	......	55
455	52,000	No. 3	2¾ days	......	95
575	46,700	No. 3	8½ days	......	50

TABLE VI—EFFECT ON FLANGE STEEL OF SOLUTIONS OF SALTS OTHER THAN SODIUM HYDROXIDE

Salt Used	Concentration, Per Liter	Stress, Lbs. Per Sq. In.	Container	Time No Break, Days	Gage Pressure, Lbs. Per Sq. In.
None	Distilled water	48,600	No. 1	28	50
Na_2CO_3	500	50,000	No. 3	34	70
Na_2SO_4	500	45,000	No. 4	30	70

TABLE VII—EFFECT ON FLANGE STEEL OF PREVIOUS HEAT TREATMENT, CHEMICAL ACTION AND PRESSURE

Solution, g. NaOH Per Liter	Stress, Lbs. Per Sq. In.	Container	Time: Break	Time: No Break	Gage Pressure, Lbs. Per Sq. In.	Treatment
400	39,200	No. 4	2 days	......	55	No treatment.
400	50,000	No. 2	2 days	......	55	Annealed 1,050° C.
418	50,000	No. 2	20 hours	......	55	No treatment.
407	50,000	No. 2	20 hours	......	45	Dilute HCl 20 minutes.
407	50,000	No. 2	17 hours	......	55	Lower half $PtCl_8$ Solution.
400	50,000	No. 2	36 hours	......	55	All $PtCl_8$ Solution.
404	50,000	No. 4	......	16 days	0[1]	
400	46,000	No. 2	1½ days	......	45	
390	50,000	No. 2	2 days	......	200	

[1]Open to air.

TABLE VIII—EFFECT OF COLD WORK

Specimen Tested	Stress Before Testing	Stress During Test, Lbs. Per Sq. In.	Container	Time: Break	Time: No Break	Gage Pressure, Lbs. Per Sq. In.
F. S.	......	39,200	No. 4	2 days	......	50
F. S.	55,000 lbs. per sq. in.	25,000	No. 2	......	22 days[1]	50
F. S.	Cold worked 20 per cent elongation continued	25,000	No. 1	......	27 days	55
F. S.	......	45,000	No. 1	12 hours	......	60
C. R.	......	25,000	No. 2	......	24 days	85
C. R.	......	38,000	No. 2	......	24 days	85
C. R.	......	45,000	No. 2	17½ days	......	80
C. R.	......	55,000	No. 2	28 hours	......	85
C. R. A.	......	38,000	No. 2	36 hours	......	85

[1]Tested for tensile strength after 22 days in solution. Tensile strength 69,200 lbs. per sq. in.; reduction of area 52 percent.

TABLE IX—EFFECT OF CHEMICAL COMPOSITION

Specimen Tested	Solution, g. NaOH Per Liter	Stress, Lbs. Per Sq. In.	Container	Time: Break	Time: No Break	Gage Pressure, Lbs. Per Sq. In.	Yield Point, Lbs. Per Sq. In.
Armco	409	40,200	No. 2	......	14 days	75	40,600
Armco	400	45,000	No. 2	21 hours	......	70	40,600
M. I.	405	35,000	No. 2	23 hours	......	50	30,000
F. S.	418	50,000	No. 2	20 hours	......	60	35,200
1112	409	55,000	No. 2	3½ hours	......	50	49,000
1112	400	40,000	No. 2	15 hours	......	80	49,000
1112	427	35,000	No. 4	......	20 days	80	49,000
1112	427	25,000	No. 4	......	25 days	85	49,000
2312	375	48,000	No. 2	29 hours	......	80	40,000
2312	450	43,000	No. 4	8½ days	......	85	40,000
2212	385	45,000	No. 2	20 hours	......	65	36,800
2330	375	55,000	No. 4	3½ days	......	65	49,200

When distilled water, sodium-carbonate solution, or sodium-sulphate solution was used in place of sodium hydroxide, the metal was not affected even when the stress was equal to that causing failure when sodium hydroxide was used.

The temperature of the previous complete annealing sample has no marked effect on the rate of embrittlement, neither has the amount of stress once it passes the yield point.

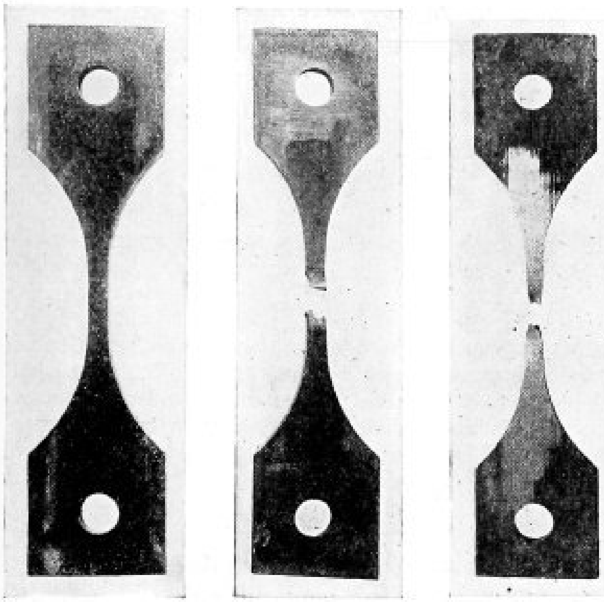
If the metal has been extremely cold-worked previous to testing for the rate of embrittlement, it will not lower the stress necessary to start this effect, but it appears that it will actually require a higher stress than would be required for the original unworked metal.

The change of chemical composition of the metal within the limits set for flange steel has very little effect on the rate of embrittlement. Thus, steels of the following general composition show no variation in behavior in respect to embrittling action.

Carbon	0.023 to 0.30 percent
Manganese	0.017 " 0.45 percent
Phosphorus	0.003 " 0.012 percent
Sulphur	0.007 " 0.027 percent

The introduction of 3.5 percent nickel with the carbon either 0.115 or 0.3 percent has no effect other than raising the yield point and consequently the initial stress necessary to start embrittlement. A combination of 1.5 percent nickel with 0.25 percent molybdenum behaves the same as nickel.

When the sulphur becomes 0.215 percent and the phosphorus 0.126 percent, the rate of embrittlement shows a marked acceleration.



(a) Test specimen (b) Embrittled specimen. (c) Tension test specimen.

Fig. 10.—Test specimens

The embrittled specimens are not corroded but are covered with a thin, shiny, blue-black, coherent coat of magnetic oxide of iron. They show no marked elongation or reduction of area at the break. Fig. 10 shows an embrittled specimen as compared with a regular tension-test specimen with a resulting characteristic break.

Micro-Examination of Embrittled Metals

Samples of cracked steel were obtained from different instances of this type of boiler distress. These when examined under the microscope showed that the cracks were intercrystallin. The manner in which mild steel fails under ordinary stress, either static or fatigue, is almost invariably trans-crystallin. The fact that embrittlement cracks progress between the grains indicates that this is not a normal fracture. Furthermore, the crack progresses without any marked deformation of the grain, another deviation from the general behavior of mild-steel static failures. When examined under higher magnification, the crack is observed to pass between the smaller grains of pearlite which make up the carbon areas.

The specimens embrittled in the laboratory have been examined and found to have a large number of cracks progressing into the strained portion and all of these are intercrystallin without any marked deformation of the grain, as is shown by the micrographs in Figs. 11 and 12.

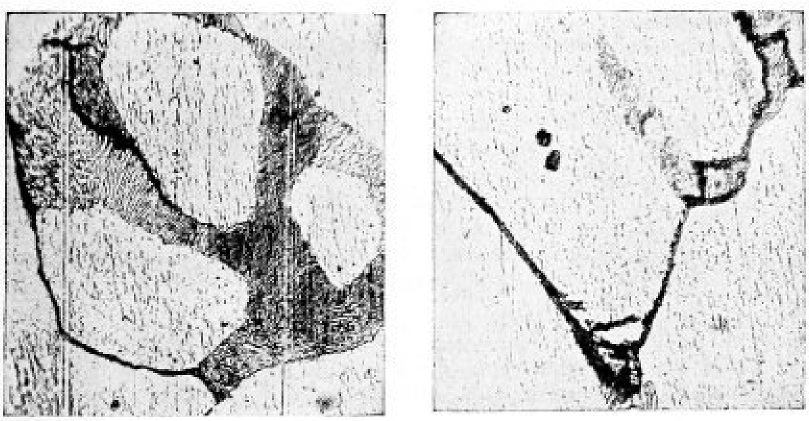


Fig. 11.—(a) and (b) Micrographs of flange steel embrittled in tests

Fig. 12.—Micrograph of magnetic iron embrittled in tests

Inhibition of Embrittlement

Since embrittlement is the result of the combined action of chemicals and stress on the metal, it appears possible to stop it by at least one of two methods. The stress may be reduced to a point where embrittlement will not occur. This might be possible if the actual concentrated stresses such as at rivet heads, around rivet holes, etc., could be calculated and the boiler constructed so as to keep these stresses low enough. Even this could not be an absolute prevention since some unknown localized stresses might still exist and meet the embrittlement conditions.

Table X—Effect of Increasing $\frac{Na_2SO_4}{NaOH}$ and $\frac{Na_2CO_3}{NaOH}$ Ratios

Solution, g. NaOH Per Liter	Ratio		Stress, Lbs. Per Sq. In.	Container	Time		Gage Pressure, Lbs. Per Sq. In.
	Na_2SO_4 to NaOH	Na_2CO_3 to NaOH			Break	No Break	
455	0	...	50,000	No. 3	2¾ days	....	90
447	0.7	...	50,000	No. 3	4½ days	....	90
365	1.2	...	40,000	No. 3	6½ days	....	90
500	1.8	...	40,000	No. 3	10½ days	....	90
430	2.1	...	40,000	No. 3	....	41 days	100
398	...	0	40,000	No. 1	2⅓ days	....	90
415	...	0.3	40,000	No. 1	5 days	....	100
430	...	0.7	40,000	No. 1	11 days	....	100

The removal of the causes of the chemical action, in the absence of which embrittlement would not occur, would be the best procedure; but even this is difficult in some cases by the fact that a change of water is not always possible. A close approach could be made by neutralizing the alkalinity with some chemical, but complete neutralization would be impossible without endangering the boiler.

When it is noticed that embrittlement never has occurred even in carbonate waters when the sulphate content is high, the question is raised as to whether or not the existence of a definite ratio between the sodium sulphate and the sodium hydroxide is sufficient in itself to prevent this cracking. Tests as to the effectiveness of the various ratios of Na_2SO_4 and Na_2CO_3 to NaOH have been run in the laboratory. The results of these tests are given in Table X.

In testing for the inhibiting effect of sodium sulphate and sodium carbonate, it was found that these salts are not very soluble in the hydroxide solution used. When the regular test apparatus was used, the introduction of sulphate up to a ratio of two parts of sulphate to one of hydroxide had no effect on the time of embrittlement. The sulphate was found to be precipitated on the bottom of the container and out of contact with the specimen.

The container was then modified so that the specimen was surrounded by a steel jacket which left a space of about 1/32 inch around the specimen for the solution to penetrate. A dilute solution was used to start with and concentrated by releasing steam from the container until the proper concentration of the hydroxide was obtained. In this manner conditions approaching those of concentration in the seam of a boiler were obtained. The results tabulated in Table X were obtained using this modification of the testing apparatus. When the containers were opened the inhibiting salts were found to have crystallized on the surface of the test specimen.

The effect of a sulphate-carbonate ratio in plant operation has been studied in one plant for a period of ten years. This plant, the University of Illinois power plant, had been experiencing embrittlement troubles for some time and when in 1915 three new drums had to be replaced after only five years of service the following system of water treatment was inaugurated: The sulphate-carbonate ratio of the feed water is maintained at 2. This is done by neutralizing about 70 percent of the alkalinity with sulphuric acid. The water is treated in two 40,000-gallon settling tanks. About 110 pounds of lime is added to each tank and, after sufficient agitation and settling, the required amount of acid. Analyses of each tank are made daily after lime treatment, and again after the acid is added, to determine total alkalinity. Daily analyses are also made of the water in each boiler for causticity and total alkalinity. After ten years of operation on this treatment the boilers were given a thorough inspection during February, 1926. Test rivets were removed and a close inspection made for signs of leaking or cracks around the rivet holes. At that time the boiler inspector from the Hartford Steam Boiler Inspection and Insurance Company pronounced the drums to be in perfect condition. The rivets were redriven and the boilers are back in operation.

A system of treatment on a continuous flow principle has been devised and is now in use in several central power plants in the Chicago district. The water is a zeolite water low in the sulphate carbonate ratio and this ratio is raised by allowing a definite amount of dilute acid to flow into a mixing chamber through which a definite amount of water is being passed. A regular chemical analysis of the boiler water is also maintained at these plants.

A power plant in Champaign had boilers go into service in 1916 using the same type of water as the University of Illinois but without the acid treatment, and in 1925 considerable trouble was experienced due to embrittlement. Fig. 8 shows one of the condemned drums from this plant. These two plants operating for 9 and 10 years, within 20 pounds of the same steam pressure, and upon precisely the same type of water, one sulphate-treated and the other not, serve as a long-time experiment with results that are strictly in accord with the laboratory indications. The boilers using the treated water are in excellent condition while the others have been condemned after only nine years of service.

The results that have been obtained justify the opinion which has prevailed in the United States that mild steel is embrittled by sodium hydroxide. They go further in that they show that sodium hydroxide is the only salt in the boiler which will embrittle steel. Stress and chemical attack now appear to be the predominating factors, neither of which can produce embrittlement in the absence of the other.

(To be continued)

Electric Welding for Safe Ending Boiler Tubes

(Continued from page 264)

R. W. CLARK (N. C. & St. L. R. R.): We scarf all of our tubes in welding, from about 30 degrees on the tubes, against the square, or 90 degrees on the safe end. Flashing makes a lap weld. The electric method of welding tubes is 100 percent over what we used 20 years ago. We are doing it at the Nashville, Tenn., shops of the N. C. & St. L. We use a 100 percent flux made of ground rock to control the heat while the operator is working with the machine. That is all it does. We roll our tubes in a machine.

L. M. STEWART: We use machines for both small flues and welding two, 2¼ and 5½-inch tubes. With the small machine we make the dies in the shops, and are now experimenting with welding the return ends on the superheater units. It makes a very good job. They do not have to be rolled down and it does not matter if the tube is upset.

Right of Boiler Maker to Damages Received from Unguarded Tools

(Continued from page 260)

ket, and in use, known as the M-S safety device, which could have been provided, at a moderate cost, to prevent the ejection of the die. This evidence was offered and received without any objection whatever on the part of defendant. . . .

"If the place where the plaintiff was required to work was not safe, it was solely because of the unsafe condition of the pneumatic hammer furnished for doing the work in which plaintiff was engaged. There was no suggestion either in the evidence or the pleadings that the place was otherwise in any manner unsafe, and the case was submitted by plaintiff solely on the theory of the unsafe condition of the hammer. . . ."

In conclusion the court, after passing upon other points not material here, affirmed the judgment rendered by the trial court in favor of the plaintiff. Holding, as outlined in the opinion, that on the evidence of record the failure of the defendant to equip the hammer with a guard constituted a sufficient basis to support the judgment rendered against it by the trial court.

SUMMARY

The foregoing case constitutes an apt illustration of circumstances under which the failure to equip a pneumatic hammer with a safety device was held to constitute negligence, on the part of the employer. And, while the decision does not announce any hard and fast rule on the subject, it does exemplify the possible danger to employers in situations of this kind.

For while an employer, according to the weight of authority, is not required to furnish the newest and best in tools and equipment to his employees, he is bound to furnish reasonably safe tools. It follows, if injury results from the furnishing of tools that plainly could have been made safer by the use of guards, the employer, at least, may run the risk of being conpelled to submit the question of whether he has been negligent, in not furnishing guards, to a court or jury.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Ash Pan Openings

Q.—What size openings should be provided in ash pans?—T. M. P.

A.—It requires about 24 pounds of air to properly burn one pound of coal. One pound of air occupies about 13 cubic feet; to properly burn one pound of coal requires 312 cubic feet of air. On an engine with a firebox with 60 square feet of grate surface, and burning about 120 pounds of coal per minute, it would require 37,000 cubic feet of air per minute to burn the coal properly. Therefore, knowing the grate area and the amount of coal consumed per minute and the amount of air necessary for perfect combustion per pound of coal consumed, the required openings in the ash pans may be readily determined.

Details of Thermic Syphon Layout

Q.—I will appreciate it if you will publish a development of a Nicholson thermic syphon, as advertised on page 13 in the July issue of THE BOILER MAKER.—W. T.

A.—A typical installation of three Nicholson syphons is shown in Fig. 1, as ordinarily applied in the fireboxes of locomotive boilers. A general view of the syphon is illustrated in Fig. 2. The neck of the syphon at *a* fits in the diaphragm plate to which it is welded as indicated at *b*, Fig. 3.

The syphon is made usually from one plate of firebox steel 3/8 inch in thickness, being first cut to shape, then

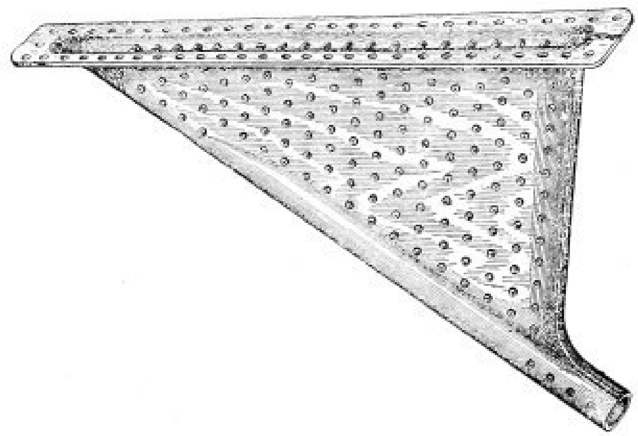


Fig. 2.—General view of syphon

punched for the staybolts and then formed under hydraulic pressure with suitable dies to the shape shown in Fig. 2. After the body of the syphon is pressed, the top flange *b* is turned under hydraulic pressure and the edges *c* are welded by the gas or electric method.

The construction, Fig. 4, is not produced to the required

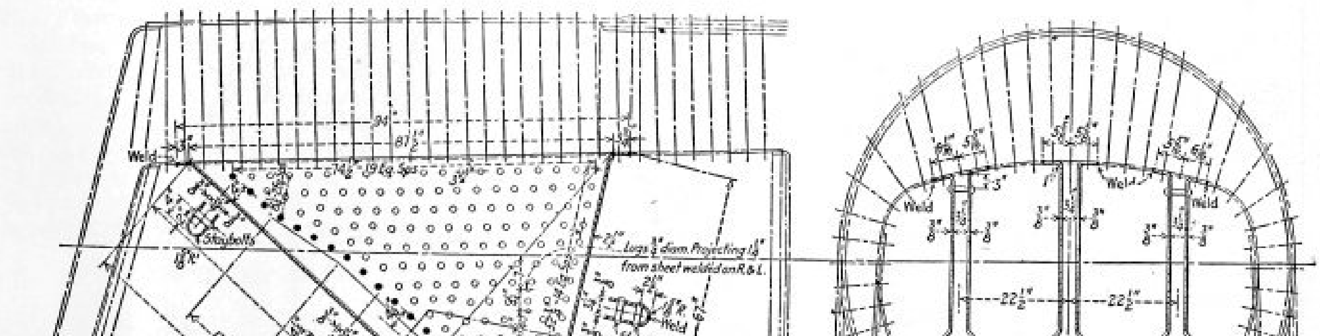


Fig. 1.—A typical three syphon installation

dimensions of the syphons, Fig. 1, it is enlarged somewhat to show the general method of producing section on *w-w*, *x-x* and *y-y*. Owing to the sloping sides, the sections *w-w* and *y-y* are ellipses when the sections *o-o* at the ends of the plan view are semicircular; or, if sections on *w-w* and *y-y* are semicircular sections, *o-o* would be elliptical. Ow-

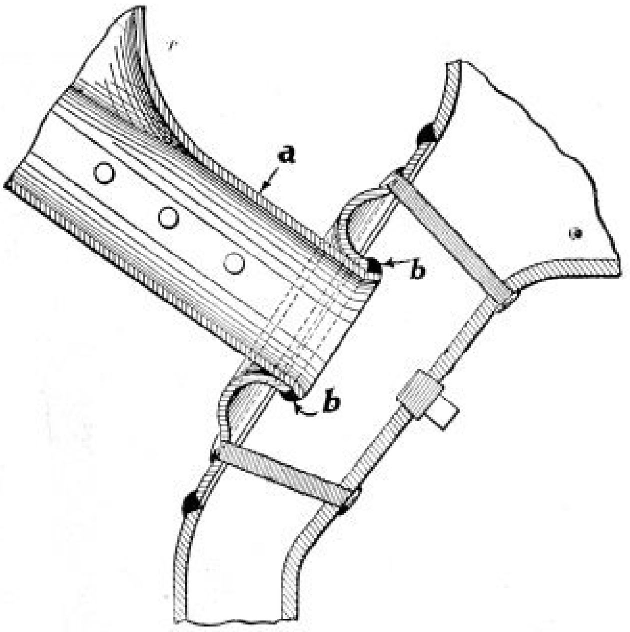


Fig. 3.—Connection of syphon with throat sheet

ing to the shape of the syphon and as it is formed from a single sheet, a developed pattern can cover only the principal dimensions, allowances must therefore be made for the curvature in the flange and where the circular section gradually runs into the elliptical section *w-w*.

Fig. 4 is drawn to the neutral layer of the plate and the curved section spaced off as required for securing the development lines *1-1*, *2-2* and *3-3*, etc. The one-half pattern, Fig. 5, is laid off from Fig. 4 and, as the respective construction lines are numbered the same in both views, the layout should be readily understood.

A typical installation of the thermic syphon will be found in the boiler drawings of the D. & R. G. W. *2-8-8-2* type locomotive appearing on page 254 of this issue. Provisions have also been made in this boiler for combustion chamber syphons.

Boiler Seam Efficiency

Q.—(1) What is meant by a boiler seam having 90 percent efficiency? (2) Why should several holes close together in a horizontal row be avoided in the barrel of a boiler?—F. J. S.

A.—The efficiency of a joint is the ratio which the strength of the joint bears to the strength of the solid plate. In the case of a riveted joint this is determined by calculating the breaking strength of a unit section of the joint, considering each possible mode of failure separately and dividing the lowest result by the breaking strength of the solid plate of a length equal to that of the section.

A riveted joint may fail by shearing the rivets, tearing the plate between the rivets, crushing the rivets or plate, or by a combination of two or more of the above causes. To determine the efficiency or relative strength of a riveted joint, calculate the breaking strength for the different ways in which it may fail. That method of failure which gives the least value determines the actual strength of the joint. This value divided by the strength of the solid plate gives the efficiency of the joint.

The boiler seam of 90 percent efficiency is one that has 90 percent of the strength of the solid plate.

(2) Any holes close together in a horizontal row are to be avoided as they weaken the shell and increase the danger of rupturing it under the working pressure.

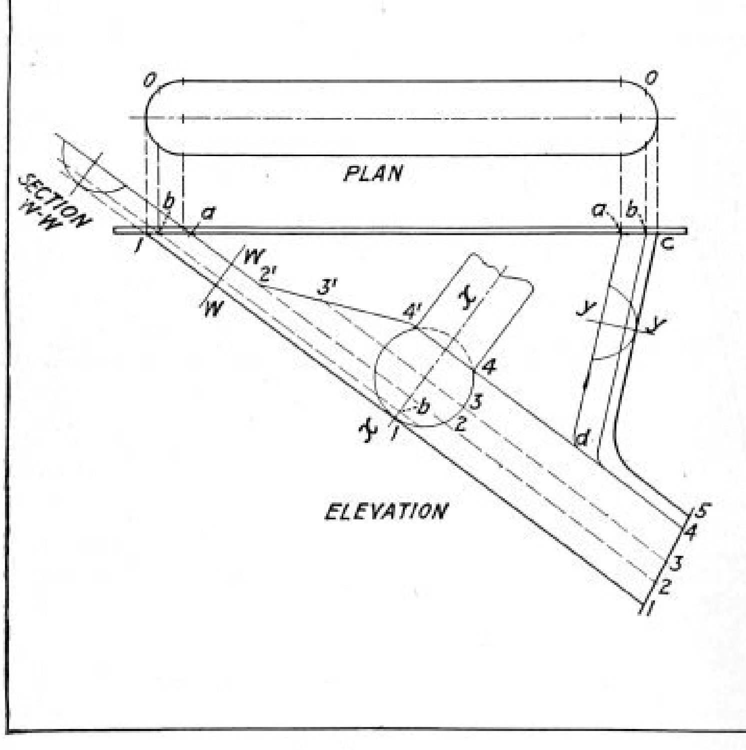


Fig. 4.—Details of syphon layout

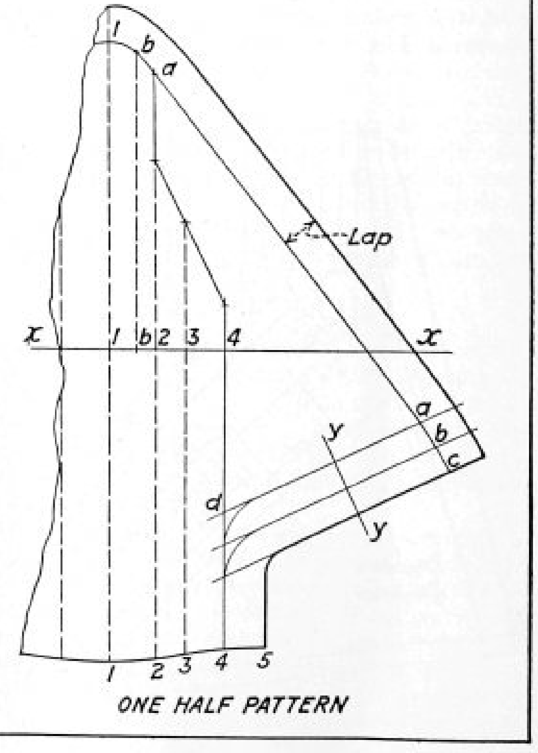


Fig. 5.—One half pattern of syphon

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California	New Jersey	Utah
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Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

Cities

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States

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Delaware	New York	Utah
Indiana	Ohio	Washington
Maryland	Oklahoma	Wisconsin
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Cities

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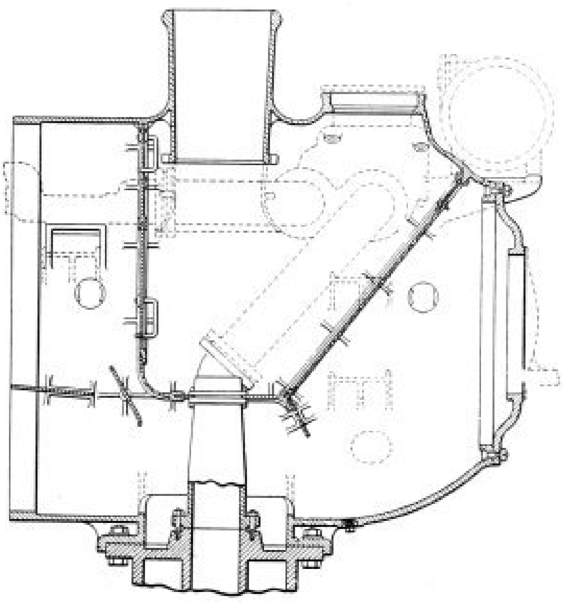
SELECTED BOILER PATENTS

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

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

1,625,784. WILLIAM L. BEAN, OF WEST HAVEN, CONNECTICUT. LOCOMOTIVE SMOKE-BOX AND SADDLE CONSTRUCTIONS.

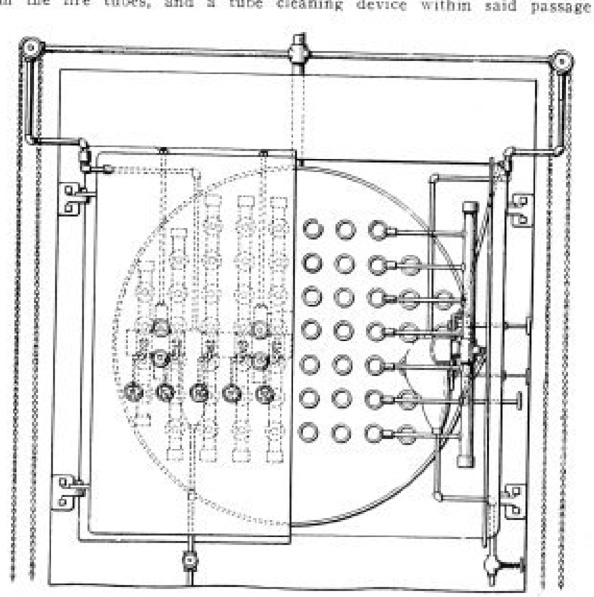
Claim 1.—In a locomotive, the combination of a cylinder saddle and a smoke-box interengaging with each other and held against relative dis-



placement in a horizontal direction by reason of their interengagement, and means rigidly attaching said smoke-box to said saddle. 18 claims.

1,626,385. MARION R. BOWE, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO WILLIAM D. HARRIS, OF PHILADELPHIA, PENNSYLVANIA. BOILER-CLEANING DEVICE.

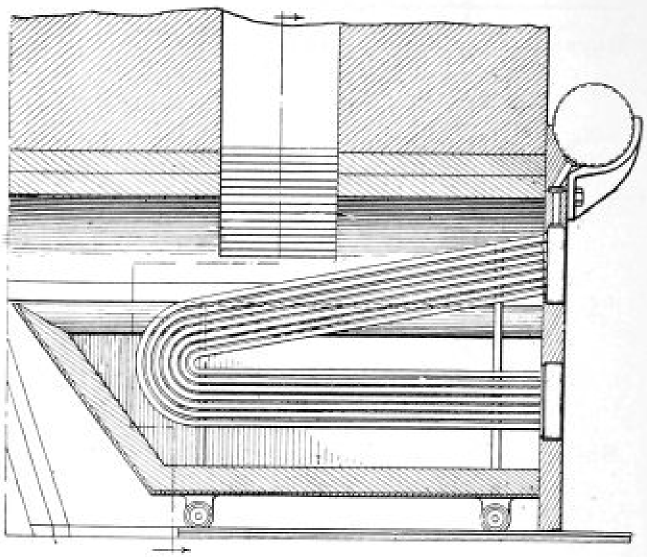
Claim 1.—The combination of a fire tube boiler, a housing enclosing the same and providing a passage for products of combustion leading from the fire tubes, and a tube cleaning device within said passage in



front of the discharge end of said tubes and comprising a steam header, pipes connected to the header and provided with steam discharging nozzles directed toward the open ends of said tubes, a steam separator within said passage in front of the discharge end of said tubes and communicating with the header, a steam supply pipe leading to the separator, and valves for controlling the discharge of steam from the nozzles. Six claims.

1,625,112. BRADLEY P. WHEELER OF DULUTH, MINNESOTA. WASTE-HEAT BOILER FOR REGENERATIVE FURNACES.

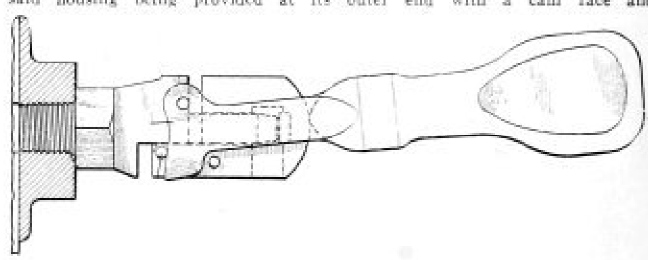
Claim 1.—In combination with a passage of a regenerative furnace, a truck and waste heat boiler located in said passage, which passage



is adapted for transmission of heated incoming and outgoing gases, said truck supporting said boiler and serving as a removable bottom for a portion of said passage. 5 claims.

1,625,828. JOHN C. SHAFFER AND LYNN S. MANKIN, OF TULSA, OKLAHOMA, ASSIGNORS TO TULSA VALVE COMPANY, OF TULSA, OKLAHOMA. WATER GAUGE FOR BOILERS.

Claim 1.—In a water gauge, a tubular body portion for connection with a boiler, said tubular body portion having a tubular stem provided with an outlet opening at its free end, a reciprocatory housing mounted to slide upon the tubular stem and having a laterally extending outlet opening, said housing being provided at its outer end with a cam face and

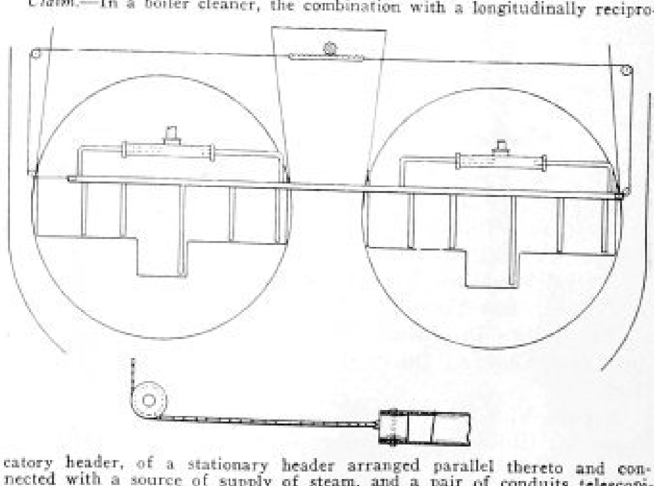


having a seating part to engage with the outlet end of the tubular stem, a handle provided at its forward end with a pair of spaced arms and having a cam face between the arms for contact with the cam face of the housing, said arms being provided at their forward ends with transverse heads extending above and below the same, means for pivotally connecting the upper ends of the transverse heads with the body portion, and shifting elements carried by the housing and arranged forwardly and rearwardly of the lower ends of the transverse heads to contact therewith. 7 claims.

1,624,576. FRANK BOWERS, OF DETROIT, MICHIGAN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DIAMOND POWER SPECIALTY CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN. BOILER CLEANER.

Application filed June 21, 1919. Serial No. 305,818.

Claim.—In a boiler cleaner, the combination with a longitudinally recipro-



catory header, of a stationary header arranged parallel thereto and connected with a source of supply of steam, and a pair of conduits telescopically engaging said stationary header at opposite ends thereof and laterally connected to said reciprocatory header, thereby forming a balanced connection. 2 Claims.

The Boiler Maker

Volume XXVII | October, 1927 | Number 10

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

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Cable address: Urasigmec, London.

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

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

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CONTENTS

Boiler Manufacturers and the Safety Fire Door Latch

All boiler manufacturers are probably well aware of the requirement in Par. P-328 of the American Society of Mechanical Engineers' Boiler Construction Code for substantial and effective latching devices for the door openings in watertube boiler settings, but many are without question unaware of the responsibility that attaches upon them to see that such safety devices are used. The pressure for enforcement of this measure that is being brought to bear by the various state and municipal inspection departments would appear to indicate that greater thought should be given to this provision as one of the elements that go to make up an A. S. M. E. Code standard boiler.

Reports from certain of the state inspection departments would seem to indicate the reason why boiler manufacturers are prone to overlook this responsibility in regard to safety fire door latches. Many manufacturers are accustomed to stamp their boilers A. S. M. E. Code standard even when selling without setting or furnace, although safety valves and other similar attachments are usually supplied. In such cases, the purchaser sets the boiler with any form of furnace he may desire, but in ignorance of the code requirement he omits the installation of safety fire door latches, with the result that he is soon penalized by the state inspector for the violation of the code. The purchaser is thereby subjected to unnecessary annoyance and unwelcome expense by the neglect or oversight of the boiler manufacturer.

The frequency with which tube ruptures and furnace explosions have been occurring of late has been a strong incentive to not only the state departments, but also to boiler insurance companies, to demand protection for the boiler room operatives by the safety door latches. The results from these apparently unavoidable accidents are well known to be serious in a large number of cases, and many cause fatalities. The situation has become so grave that the Pennsylvania Board of Boiler Rules ruled last year that such furnace door latches must be of the automatic, positive-locking type in order to be acceptable in that state. Realizing the wisdom of Pennsylvania's action in this matter, the National Board of Boiler and Pressure Vessel Inspectors has also taken corresponding action at its recent annual meeting in Nashville, Tenn., and in addition has made recommendations to the Boiler Code Committee that Paragraph P-328 of the Power Boiler Code be revised to incorporate this exact wording for the requirement.

The Rivet

Not often in these days of expansion in the welding industry with developments in a thousand and one directions and constant broadening of its applications, do we stop to consider the lowly rivet and the far-reaching effects which its use has had in the development of our present industrial and commercial structure. In his paper before the recent annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, A. F. Jensen, presented a few facts that bring home to all of us the tremendous part played by the rivet in this age of steel.

In the fabrication of structural steel alone, statistics show that more than 32,000,000 rivets are used each month in this country. In the average size freight steamship of 7,500 tons capacity 700,000 rivets are required for the fabrication of hull and machinery. And in the field of boiler making the rivet plays one of its greatest parts in protecting life and property. Every boiler is a potential infernal machine and without the safeguard of properly made joints in either a boiler or pressure vessel, an unforeseen stress is liable to let loose the power for destruction to life and property contained in it. The remarkable fact is that of all the boilers and pressure vessels in operation so few ever cause serious trouble. This is particularly true since an organized effort has been made by the American Society of Mechanical Engineers' Boiler Code Committee and other state and national bodies to make uniform the construction and inspection of these vessels. But in addition to that, the rivet can be given the highest of all ratings for safety.

Opportunities in Boiler Making

THE two papers published in this issue by W. J. Murphy, president of the Master Boiler Makers' Association and by J. F. Raps, past president of this body, discussing such widely divergent subjects as qualifications of foremen and water treatment for improving locomotive boiler operation indicate that in this field of boiler work there are talents which are gradually receiving the recognition that is their due. As in any line of endeavor, or in any trade, the progress that can be made by an individual is limited only by his qualifications. Too few of the men seem to realize this fact, but with the example of men in their own particular line of work advancing rapidly and becoming recognized for their worth the incentive should be present to advance themselves.

Many of the suggestions made in Mr. Murphy's article on foremanship will indicate the qualities necessary not only to advancement to the position of foreman, but on up the scale to higher positions in the mechanical departments of the railroads. It requires constant study, an open mind and a steady application to the every-day problems of the shop to arrive at any position of authority. The ground work must be laid in the earliest days of shop experience for whatever future the trade has to offer and the best word of advice that can be given the younger men in the field of boiler making is for them to study the careers of those men who have reached positions of authority after coming up through the ranks.

J. W. Faessler Dies

JOHN W. FAESSLER, president of the Faessler Manufacturing Company, and well known to the boiler making fraternity through long association with its members, died recently at Moberly, Missouri. The concern of which Mr. Faessler was the head is one of the oldest and most important in Moberly, and was founded by his father. Mr. Faessler entered the works when but ten years of age. His father died in 1899 and in 1900 the business was incorporated and he was elected president, while still only 22 years of age. In line with his plans for expansion of the business a new plant was under construction at the time of his death.

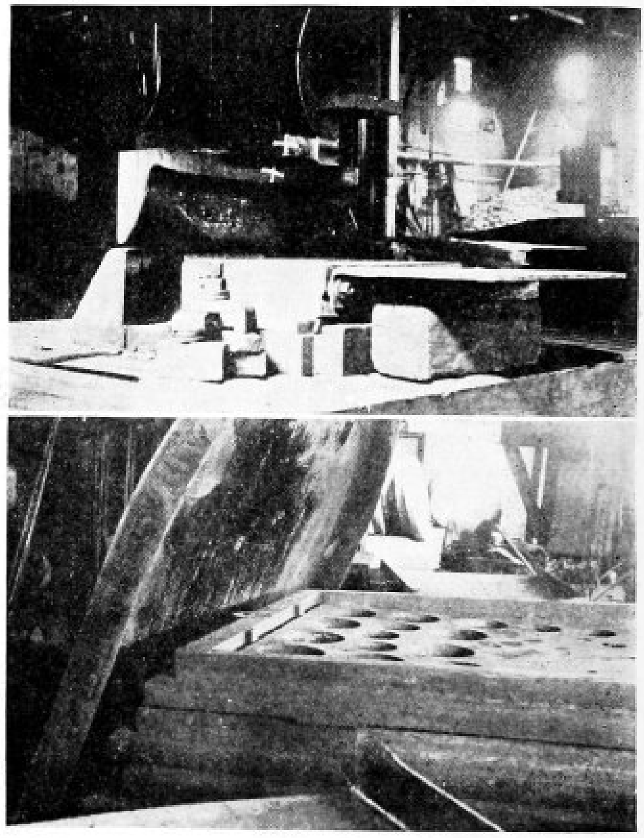
LETTERS TO THE EDITOR

Sectional Flanging on a Four Post Hydraulic Machine

TO THE EDITOR:

Those who are familiar with flange work know the amount of time required to flange a head at the hand fire. In recent years sectional flanging machines have reduced this time to a minimum, besides turning out work of superior quality.

For many years our plant management was planning to install such a machine, but the flange shop foreman said with specially designed dies he could do the same class of

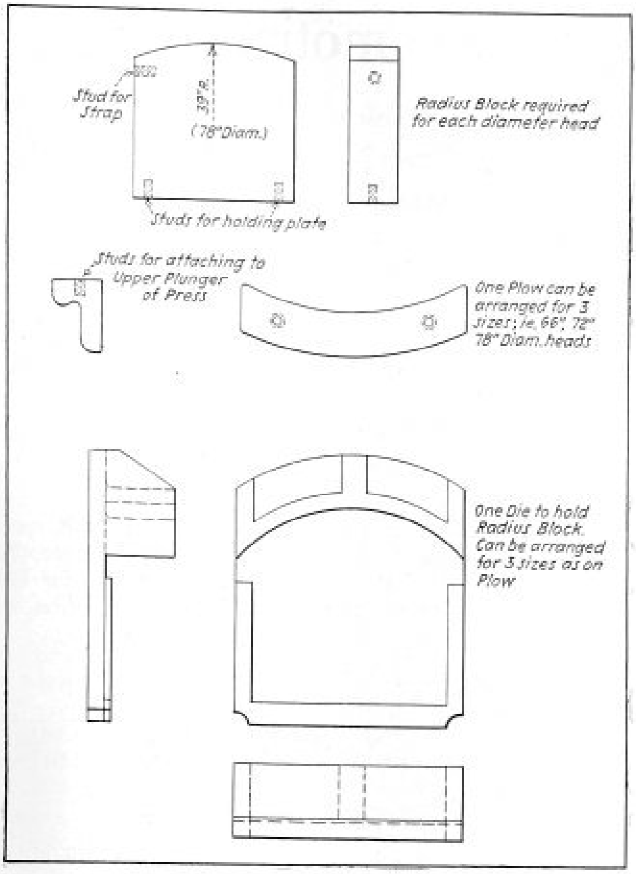


Two views of flanging operation

work on the four post hydraulic flange press. It has proved to be such a success here that possibly other shops thus equipped might follow the same idea with equal or better results.

The circular part of a locomotive type front head 78 inches diameter, as shown in illustration, can be finished in three heats. There has been no cold flanging attempted, but we believe it can be done.

The 78-inch diameter head was worked up in the following manner: when the flange lines were layed out, the straight sides were bent cold on the regular dies, then a portion of the circle was heated at a small coke fire placed close to the machine. Care is taken to see that only the portion to be turned is heated. A 1-inch hole has been punched at the center of the head, the base of the 39-inch radius line. This will correspond with a like hole in the plate bolted to the radius block (this plate is used so a long block will not be necessary). A drift pin used in these



Flanging dies

holes keeps the head straight, the plow is worked down with a light pressure, so the plate will not receive undue stresses; when this is done the plow is released and then sent down with the full pressure holding it in this position for a few seconds. This procedure is followed until completed.

The operator has turned out work on the press which was far superior to any done at the hand fire. He also has many original methods of bending angles, mud rings, etc., which will be illustrated in some future article.

With the rough sketches and illustrations it should be very easy for anyone to do sectional flanging on a four post hydraulic machine.

Oswego, N. Y. J. A. Shannon.

Welding in Boiler Repair Work

To the Editor:

We note in Mr. Dillon's comments on the welding of cracks at the top of the knuckle of a flue sheet that their previous practice had been to vee out the crack, weld and then apply the flue. I note also with interest their present practice. The method we follow and with good results is to remove the flue, bevel out the crack, then apply copper ferrule with flat prossers, removing one section of the set so that the prosser is applied with this space directly in line with the crack. This prevents the forcing of the copper ferrule out of round, or up into the cut out. Then the flue is applied, expanded but not beaded down until the crack is welded. Where the dome cap is removed we have got good results from welding over on the inside after the crack is welded.

The welding of broken bridges on upright boilers was quite a problem for some time, as they would generally break again when the flues were applied. Now, we cut out and bevel the crack, apply coppers in the two flue holes where the crack is located, drive in a prosser's snag, then weld; when cool remove prossers and apply flues.

Lorain, Ohio. Joseph Smith.

Bending Angle Rings

To the Editor:

I am enclosing a rough sketch showing how to bend angle rings by the use of plate sweeps or templates cut to size required. These are found to be quick and accurate with the use of a square, to square the upstanding leg of the angle from face plate while making bends. The idea is to get a fairly long heat of even temperature so that the bending action will be regular. Of course this applies where there are no angle rolls and the bending has to be done on the fire, or by the mechanic himself. The sketch shows inside and outside rings finished and in progress. On the

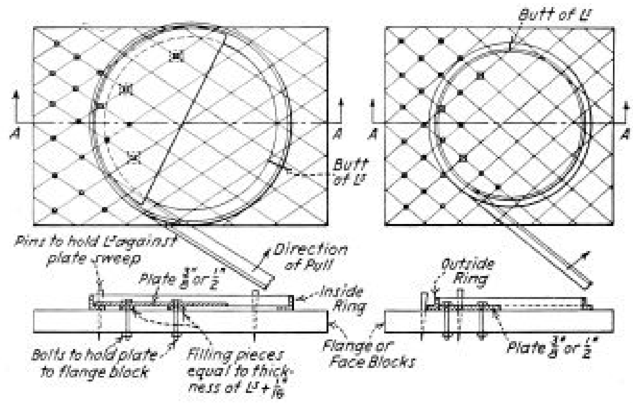


Plate templates used in bending angle iron

inside rings allowance must be made for the thickness of angles by the use of filling pieces under plates, also for fillet of angles at the root. On outside angle rings no allowance is required, only both inside and outside templates should have a fairly smooth (emery wheel) finish to size required. In setting plates on the block, it is so placed as to obtain two or three open holes for pins to force and hold the angle against the plates, then two or three holes marked from block to plate for bolts or pins and dogs. This method will hold the material rigidly in position.

I hope that these suggestions will be of some use to readers of the magazine, as I have seen many ideas in it that have been very useful to myself.

Montreal, Quebec, Canada. Alex McKay, Jr.

Industrial Heating.—The Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has issued a complete catalogue of industrial electric heating apparatus, designated as Catalogue 25. Twenty-seven different types of equipment are listed, including box furnaces, lead and salt baths and pots, pit, rotary hearth and pusher furnaces, special furnaces and ovens, drawing baths and ovens, baking ovens, laboratory furnaces, strip heaters of all classes, automatic melting pots, control equipment and accessories. For the standard furnaces and ovens production curves are given which enable one to estimate accurately in advance the kilowatt hours required to turn out a certain amount of steel when heated to a definite temperature. The publication is profusely illustrated to show the various apparatus and its construction.

High Pressure Steam Locomotives

What type of power is best suited economically to utilize pressures of 800 pounds and over?—A discussion of the boiler of the future locomotive

By James M. Taggart*

IT is the general belief that higher steam pressures than any now used would add to the economy of locomotive operation. It is also generally conceded that for higher steam pressures there is at present no satisfactory type of locomotive boiler. There is considerable divergence of opinion as to what pressure would be most advantageous. Also there is an uncertainty as to just how much gain will result from any increase.

Late advances into moderately high pressure locomotives have produced various designs largely based on, or supplementary to, old types. All the designs that have been tried out are limited as to pressures attainable by the water barrel feature of the boiler though many of them have eliminated the flat surfaces and staybolts.

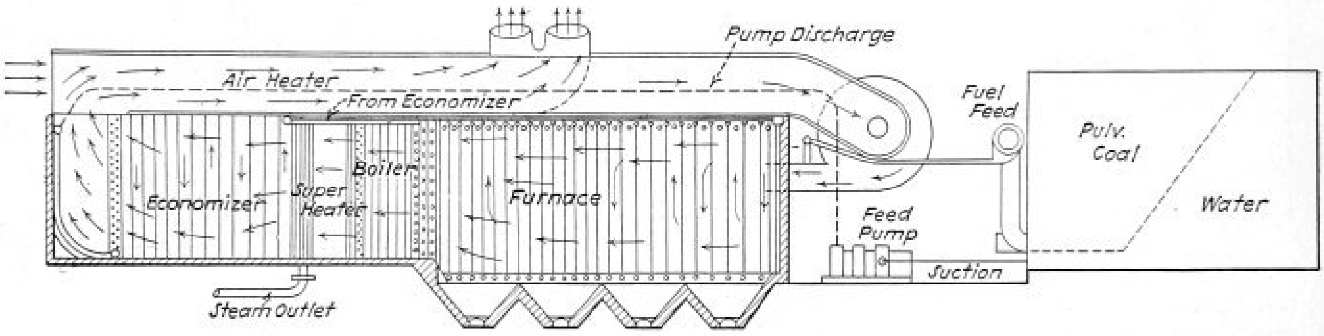


Fig. 1—Sketch of proposed locomotive boiler arrangement

Formerly the author advanced the suggestion that a complete watertube boiler, preferably of the flash or non water line type, would be best suited for the extremely high pressures contemplated. For complete safety from explosion the non water line type of boiler would be needed. The inclusion of an economizer, superheater and air preheater sections would, of course, be necessary for good economy.

Up to the present time increases in steam pressures have been accompanied by decreases in boiler efficiencies. This, of course, has been due to the higher steam temperatures and, therefore, the lower heat absorption. Stokers and better furnace design have reduced the losses that might be expected. On the other hand, greater combustion intensities have further decreased efficiencies for high loadings.

All the gain in economy that has been realized up to the present has been due mainly to the increased power availability of the steam. On account of the limited expansions that can be readily used in any design of locomotive cylinders as yet devised, the decrease in water rate has not been in proportion to the increase in power availability.

In the moderately high pressure locomotives now in use there has, therefore, been a moderate increase in overall economy. There has also been a considerable increase in capacity. Apparently there has also been some increase in reliability even though the design has been complicated to a certain extent.

In the proposed trial arrangement intended to illustrate the factors involved there should be a further decrease in water rate and an increase in capacity. In addition, there should be an increase in boiler efficiency and an added element of safety. The fuel assumed is coal, though oil-burning would fit in equally well.

Experiment with Fuels

Pulverized coal burning is being tried out on a number of railroads. It has often been used to suit special conditions. John E. Muhlfeld, consulting engineer, New York in Vol. 38 of the A. S. M. E. transactions for 1916, describes a series of tests and periods of operation with pulverized fuel. He successfully burned a mixture of 60 percent anthracite screenings and 40 percent bituminous in a standard locomotive. The results apparently were increased economy and capacity. With the present type of locomotive and the pulverized fuel burning equipment then obtainable, the advantages were not sufficiently evident to warrant further adoption.

During the last six or seven years there has been a rapid development in the art of burning pulverized fuel, especially in power plant boiler furnaces. Equipment has been improved and experience linked up to theory.

It has been ascertained that with a turbulent form of burner, with fine pulverization and the air preheated, pulverized coal can be burned at higher furnace volume intensities than can be attained by any other method of coal burning. This applies, of course, to approximately complete combustion within the furnace.

For pulverized coal burning the fuel should be prepared at the loading bunkers. The cost of pulverization and drying should not be a serious factor. It often works out in power stations that the cost of pulverization and drying for pulverized fuel burning is more than equalized by the extra equipment and power required for stoker operation. This might be especially true for locomotives where each stoker has its added crusher and the blowing units are inefficient.

At the present time the intensity of combustion for the larger locomotives at maximum loading runs up to 220,000 B.t.u. per cubic foot of furnace volume. It is quite probable that at the later figure a good deal of the combustion is not complete before reaching the stack. The efficiencies even

* Consulting engineer, New York.

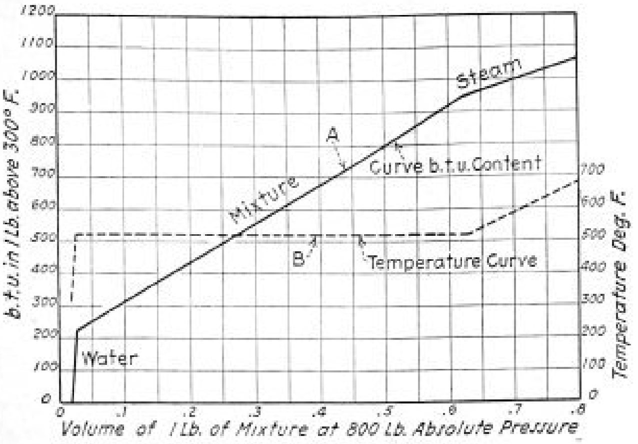


Fig. 2

in tests at these maximum loadings run only between 50 and 60 percent.

Design of Firebox

The limit of combustion intensity with pulverized fuel, as we know now, depends on a number of functions which are all controllable. The practicable limit as applied to boiler furnaces apparently is fixed by the endurance of the furnace walls, other conditions being suitable. It is even probable that intensities such as are noted for present locomotive practice, could be attained with approximately completed combustion.

It is known that with the proper conditions formerly noted and with a suitably designed furnace, intensities up to 100,000 B.t.u. per cubic foot are feasible. Avoidance of violent flame impingement against furnace walls combined with a quick and thorough mixture of fuel and air are the main requirements. Just what fineness of pulverization is required for any specific intensity is not accurately known. This depends partly on the shape of the furnace and the form of burner.

With the locomotive, apparently the general shape of the furnace would need to be the same as at present. No grate, bridge wall or arch tubes would be needed while the bottom would be formed of some heat absorption surface or ash cooling surface.

It is not believed that it will be advisable to reduce the present horizontal area allowed for the combustion chamber or firebox. Removal of the grate and bridge wall as well as the contained fuel bed should, therefore, increase the volume. Since the economy with the arrangement proposed would be much higher than at present obtainable, therefore, the combustion intensities required for maximum loads should be well below 100,000 B.t.u. per cubic foot, or within the range where it is known fairly good results can be obtained.

Increasing the effective height of the furnace and adding surface to the bottom also increases materially the furnace or firebox heating surface. With relatively high combustion intensities and with most of the coal now burned by railroads, increase of the direct radiant heat absorbing boiler surface is now known to be a distinct advantage on the economic side.

Absorption of Heat

It is customary to speak of boilers, superheaters, economizers and air preheaters as separate apparatus. In reality, they are interdependent and form a heat absorber. They should be proportioned and designed with a view to obtain the most economical heat absorption. Economical heat absorption includes consideration of first cost and maintenance as well as thermal effect. Of recent years numerous old theories of heat absorption have been proved or disproved so that at present effects can be computed closely for known conditions. Variance in certain conditions, such as character of fuel, cleanliness of surfaces, and eccentricities of control constitute the chief uncertainty in results.

The amount of radiant heat absorption surface will evidently be limited by the volume of the furnace. It should be made normally as great as possible, or, in other words, all furnace surfaces should be made fully effective for radiant heat absorption.

To determine the remaining boiler surface required, it is necessary to compute the amount of additional surface required for changing the feedwater to steam. Beyond this point should extend the economizer. This follows since economizer absorption efficiency will be greater with proper design and the space occupied will normally be less.

The air heater should receive the gases at the point where the heat flow for an economizer does not much exceed what could be attained in the first sections of the air preheater. By using a plate preheater 10 to 12 square feet of heating surface per cubic foot can be obtained. This is more surface per cubic foot than would be feasible for an economizer. There would be no contained pressures and the cost per square foot would be much lower for the same heat transfer for the temperature ranges down from the economizer.

It is quite probable that it may be impossible to find a suitable arrangement for a counter-flow air heater. The arrangement shown in the sketch, Fig. 1, has a parallel flow air preheater. Parallel flow has some advantages on the side of maintenance, though the heat transfer per square foot would be less than for counter flow. This follows since the principal maintenance required is due to corrosion and soot adherence, which occurs when the temperature of the gas falls below dew point. In a counter flow heater this condition is often found at low loads, while in a parallel flow heater it seldom occurs at any load.

With the high pressures proposed some form of series or regenerative feedwater heating would be advisable. With this in view the feedwater has been considered as heated to approximately 312 degrees F. Any arrangement installed would give a varying final temperature. Just what final feedwater temperature would be most advantageous would depend largely on the form of drive and the type and number of heaters selected.

A tentative proportioning of heat absorbing surfaces is given in Table I. The proportioning is based on an assumed size of firebox, steam pressure, feedwater temperature and coal.

Table I—Surface Proportions and Estimated Effects

	Surface		Heat absorption			Temperatures		
	Proportion of total per cent	Amount, sq. ft.	Total, million B.t.u.	Average per sq. ft. thousand B.t.u	Per cent of total	Of gases, deg. F. Inlet	Of gases, deg. F. Outlet	Average
Furnace walls	7.05	702	29.5	42.	52.7	....	....	....
Boiler........	7.03	700	8.4	12.	15.	2,200	1,750	1,975
Superheater...	8.92	866	6.2	7.	11.1	1,750	1,420	1,585
Economizer...	33.8	3,370	11.8	3.5	21.2	1,420	790	1,105
Total........	....	5,658	55.9	...	100.0	....	....	....
Air heater....	43.2	4,300	6.	1.4	....	790	470	630
Total........	100.0	9,958	61.9	...	....	....	....	....

Steam pressure taken as 800 lb. absolute per sq. in.
Steam temperature taken as 700 deg. F.
Feedwater temperature taken as 312 deg. F.
Water per hour, maximum, 51,277.
Coal per hour, maximum, 4,850 lb.
Gas per pound of coal, 15.5 lb.
Temperature of atmosphere, 70 deg. F.
Firebox volume, 800 cu. ft. approx.
Combustion intensity, 80,600 B.t.u. approx. max.

The firebox size is taken approximately as for present practice with the grates and bridge wall removed. The radiant heating furnace is considered as the amount of cooled surface exposed with an extra allowance for the top and back tubing.

The relation between the heat absorption by boiler surfaces exposed to the fire and the total heat liberated in a furnace are fairly well known. There is some disagreement relative to reasons and causes. Tests show, however, a close agreement as to results where the fire and furnace conditions are similar. Thus with high CO_2 and air preheated, there is a much higher proportion of radiant heat absorption by exposed surface than with low CO_2 and cool draft. The value given in Table I is conservative for the CO_2 and fine pulverization proposed.

Functions of the Superheater, Boiler and Economizer

The remaining heat required to change the water to steam is considered as generated in the convection area of the boiler. The surface required is found based on an initial temperature of gases, assumed from a computed flame temperature and coefficient based on numerous tests for similar conditions.

The superheater surface is considered as placed between the boiler and economizer surface. In Table I the boiler surface as shown refers only to steam generating surface not exposed to the fire. Thus its amount will be relatively small and the gas temperature into the superheater will be high.

The economizer surface proposed includes all the surface needed for heating the feedwater up to the steam temperature. Thus with unbalanced conditions and load variations there will be at times some steam formation in the economizer and at other times heating up of the feedwater will be continued in the boiler sections. In effect the superheater, boiler and economizer would all form parts of one absorber and their functions would over and interlap.

The air heater, though it forms an extension of the heat absorbing cycle, only affects the furnace efficiency. Thus all the heat absorbed therein is returned to the furnace. As before noted, its size should be relative to the economizer. All heat absorbed by the surface exposed to the flame is spoken of as radiant effect, while heat absorbed from the gases is referred to as heat transference by convection. Neither is true since there will be some heat transference by convection in the furnace and, on the other hand, the gases will give off considerable radiant heat. This latter is especially true where the gases are at a high temperature which, in the boiler outlined below, will comprise about all of the surface rated as boiler and superheater surface. In the economizer the radiant effect will reduce in proportion, but will still be considerable.

As the convection heat effect increases in proportion, the velocity flow of the gases and their turbulence of flow should be increased.

It will be noted in Table II that the efficiency is given as 83.4 percent. This figure for the arrangement proposed and the surface provided is conservative and should be easily realized with good design and construction. The boiler efficiency should increase up to 90 percent as the load drops. It is a characteristic of the arrangement proposed that for all average loads the efficiency curve is very flat. The steam pressure and temperature assumed are not extreme. The construction proposed would fit any pressure.

Table II—Heat Balance Estimated

	Million B.t.u.	Percent
Heat in coal	65.468	100
Heat in combustible in refuse	.654	1
Heat required to evaporate moisture	.981	1.5
Heat liberated in furnace	63.833	97.5
Heat absorbed, except for air preheater	55.910	85.4
Heat loss by radiation	1.309	2
Heat lost out the stack	7.920	12.1
Heat given to water and steam	54.510	83.4

With higher temperatures special steels would be advisable for the superheater, steam piping and a portion of the boiler surface. It is possible that it may be advisable in all cases to use high temperature steel for surfaces exposed to the fire.

All that has been said descriptive of the boiler, etc., can refer to any watertube type of boiler. For locomotives, as has been suggested formerly, a flash type or a non water line boiler would be preferable, provided its operation can be depended on. It has often been stated that the present form of locomotive boiler cannot be replaced by a watertube boiler since large heat storage is necessary. This same argument has been advanced against the use of watertube boilers for various industries. In most cases it has proved that the quicker steaming possible with the smaller contained water was as much an advantage as the smaller heat storage was a disadvantage. This has proved especially true for boilers with oil, gas or pulverized fuel. Thus with automatic combustion control and pulverized coal burning, especially where the pulverized fuel is obtained from storage, the control of the steaming within wide ranges can be made almost instantaneous. With the non water line boiler, this feature is even more pronounced since the water content is smaller and the heat effect is progressive. Thus there could be no injection of cool feedwater into the steam to hold down the steaming and the radiant heat effect, which is the first part to respond to a change in combustion, is all concentrated on the steaming section of the boiler.

Automatic combustion control has been successfully carried out for stationary power plants. The principles are now fairly well understood. The regulations as applied to a pulverized fuel system that introduces all the secondary air through one duct are simple. Much of the apparatus on the market is fragile, complicated and unsuited for use on a locomotive. There is, however, no reason why reliable rugged automatic combustion control cannot be applied to a locomotive furnace using pulverized fuel.

Flash Type Boiler

There have been many attempts to put a non water line type of boiler on the market. Some of the attempts ended in failure. Notable of these is the Belleville boiler, which was later changed to a water line boiler. Some have had, for small sizes, a fair amount of success. Among these are various steam automobile boilers and the Talbot boiler. The latter was used on small boats to a limited extent. The performance of these boilers, as tested and proved by operation, are illuminating. None of them, it is believed, are suitable for the conditions here considered. Practically all were on the counter flow principle, thus exposing the superheater surface to the furnace radiation. Also in all cases the area of flow through the economizer, boiler and superheater surfaces were constant. This results in excessive flow velocities through the superheater and parts of the boiler.

The principle of counter flow is important for economizer sections. It is not important for the boiler sections. With the superheater direct exposure is dangerous, and a shrouded type would materially lower the total radiant heat absorption.

In Fig. 1 is shown an outline of the general arrangement proposed. It will be noted that counter flow is proposed for the economizer sections and that thence the flow goes through the tubular furnace walls, then to the boiler tubes next to the fire, thence to the remaining convection surfaces of the boiler and finally through the convection superheater.

With the non water line boiler, the feed pump and flow control become essential parts of the boiler. No arrangement could be tolerated that allowed any probability of failure of supply. However, almost the same condition holds for certain types of water tube, water line boilers running at high ratings. Emergency control probably would be advisable for shutting off the fire in case of any abnormal breakdown. The equipment, however, should be of such character that only an abnormal failure could take place.

In non water line boilers, two methods of automatic feedwater control have been used. Automobile boilers have regulated the flow by the steam pressure and the Talbot boiler used temperature control. For the larger size boiler here considered and also for the better protection of the engines, temperature control is considered best. It is entirely possible to build an automatic temperature control for feedwater that will be reliable and positive from valve closure to a full open valve.

In Curve *A*, Fig. 2, are shown the relative volumes of the water and steam from the feed to the outlet of the heat absorber relative to their heat absorption. In the economizer the volume is small and nearly constant. As steam formation progresses, the volume increases rapidly. Where superheating occurs, there is a steady and more rapid increase in volume. Different velocities will be desirable for the water, the mixture and vapor. The area of flow should thus be proportioned to give the velocities best suited, considering pressure drop, heat absorption, and maintenance of mixture for all loads.

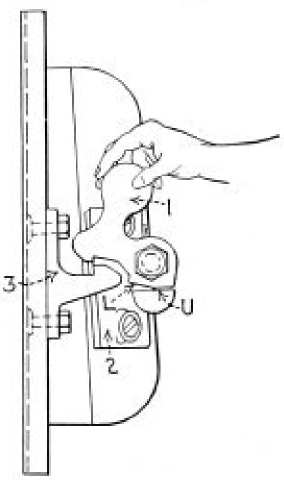
Of course, the heat transfer will vary with the velocity of flow, or, to be exact, with the turbulence of flow. Since it is not permissible to use other than even section tubes in a boiler, only the velocity of flow and area of flow will effect the turbulence and thus the heat transfer as far as the fluid side is concerned. Numerous tests have been made to determine just what heat transfer we might expect for different velocities. Also there are records of operation with various types of boilers, superheaters and economizers. From this data the velocities of flow required to insure the desired heat absorption can be selected. This selection will always be a compromise. Thus the velocity for an emergency maximum flow must not require an excessive pressure drop. Minimum flow velocities should be sufficient to prevent a separation of water and steam in the boiler. This will involve design that will insure evenly distributed flow through the tubes and remixing in the headers. Since with the use of a differential pressure pump governor, the pump must always work against the boiler pressure plus the maximum pressure drop through the boiler, it is desirable to use a regulator that will vary the total pressure drop in approximate ratio with the load.

It is probable that with clean feedwater and good design, boilers such as are suggested would require less maintenance than present types. The first cost, it is estimated, might be lower than for the present designs. These estimates are based on the consideration that the boiler, superheater and economizer would be composed of standard tubes and uniform forged headers of moderate strength. Also the air heater would be built up from standard light weight plates. Thus parts could be easily cleaned or replaced. The whole thus would be simplified, though the number of parts would be increased.

Safety Fire Door Latch

In order to meet A. S. M. E. Boiler Code requirements and state safety rulings for a fire door mechanism that would prevent rebound of the latch bar, the DeWaters Safety Latch Company, Inc., New York, developed a safety latch some years ago which over a long period of time has never failed to function. The device has been formally recognized by the A. S. M. E. Boiler Code Committee in an official interpretation and has been approved as standard by the Underwriters Laboratories and recently by the National Board of Boiler and Pressure Vessel Inspectors. It is incidentally the only safety latch so approved or available on the market the present time.

The DeWaters safety latch is a door latch of the overlocking type with counterweighted handle and controlled movement, so designed as to be unfailingly secure in its locking whenever the door is moved to the closed position. Its action is so designed that it will positively catch and hold, no matter whether it is closed softly or is forcibly slammed shut. This feature is absolutely automatic, and is the basis upon which it maintains constantly that degree of protection which is so greatly needed in the boiler room.



DeWaters safety latch

The DeWaters latch consists of the latch member (1) which is supported by the latch block (2) fastened to the furnace door and catch lug (3) which is attached to the door frame. A glance at the drawing which shows the latch in unlocked position will show that the movement of the latch is limited by the stop bracket underneath at *U*, so that the backward movement is just sufficient for the lip of the latch to clear the catch lug. In this position, the door can be opened freely, the knob serving as a convenient handle. When not held in this unlocked position, however, the latch drops, due to the weight of the knob, until it rests at *L*, the locked position, and it is then in readiness to engage with the catch lug and lock securely whenever the door is closed.

The latch is generously designed with contact faces of sufficient strength to withstand the force of any shock of a tube rupture or gas explosion within the furnace. In fact, it has been the purpose to render the latch stronger than the door which it locks. All parts of the latch are made of heat treated cast steel that conforms to the requirements of the A.S.M.E. Boiler Code specifications for Cast Steel, class B grade.

New Locomotives Will Have Largest Boiler Pressure in Britain

By G. P. Blackall

Ten Pacific type locomotives are about to be constructed by the London and North-Eastern Railway Company, this type having proved so satisfactory in hauling the heavy East Coast expresses that they are now to be put on further routes. These locomotives have the largest boilers in use in the United Kingdom, both in grate area and in heating surface. Unlike previous locomotives which had a boiler pressure of 180 pounds per square inch, they will have boilers working at the higher pressure of 220 pounds. The increased weight due to the necessary strengthening of the boiler has been made use of to increase the weight on the coupled wheels from 60 to 66 tons, and thereby sufficient adhesion has been provided to utilize the greater power exerted by the cylinders as a result of the raising of the boiler pressure.

Tests on Rolled Boiler Tubes

By Johann Jaschke

DESIGNING a boiler for a pressure of 570 pounds per square inch we were searching for a good method of rolling the tubes into the plates of the drums. For low pressure it was not difficult to roll the tubes in the plates so that the boiler became tight, but for such a high pressure experience failed. Therefore we made trials to get some figures as to how great the powers must be for pulling out the rolled tubes from the plates.

Four series of trials were made. The tubes had an outside diameter of 2¾ inches and a thickness of ⅛ inch. They were rolled in plates of a thickness of 1 37/64 inches. The plates were countersunk, so that the rolling face was 1 19/64 inches thick.

In the first series the bore for the tubes in the plate was

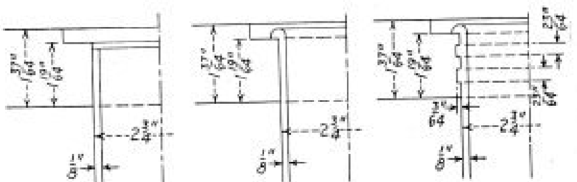


Fig.1 Fig.2 Fig.3

Details of tube tests

cylindrical, smooth without any groovings. The tubes were rolled by use of a motor driven rolling machine. The power which could pull out the tubes averaged 12,790 pounds.

Next trials were made in the same manner, but the tubes were rolled by hand. The necessary power in this case averaged 8,930 pounds.

A third series of trials was made with tubes rolled in smooth holes but the outer ends having been beaded as shown in Fig. 2. The rolling was made by hand. The tubes were pulled out by a pull averaging 15,630 pounds.

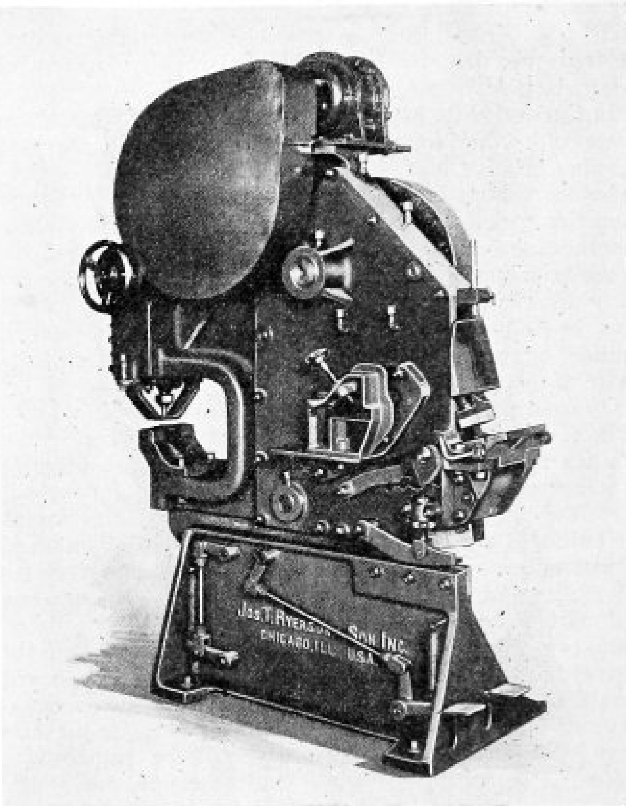
The fourth series was made with beaded tubes rolled in a hole with two groovings, as shown in Fig. 3. The strongest power was necessary to pull out the tubes, the average being 29,870 pounds. The rolling was done by using a motor driven tube roller.

The boilers then were fitted with tubes, rolled as in the fourth series. After six months' service no leakage or another trouble could be found. The boilers ran with a rating of 330 to 360 percent.

Combination Shear, Punch and Coper

THE Ryerson combination shear, punch, and coper is the outgrowth of several years' intensive effort to produce a machine of this class incorporating all the desirable features used in former designs with many new ideas for the modern up-to-date fabricator.

Into this single machine is built a punch, shear and coper. The punch is capable of handling almost all of the varieties of structural shapes found on the market today. The operation of this punch is not interfered with in any manner by the other units built into the machine. The shearing end of the machine is constructed so that a single slide handles the shearing of angles, bar cutting, plate shearing, and coping. The angle shear attachment handles both inside and outside miter cutting as well as straight shearing. The blades in this unit are made in sections for cheap and easy replacement. The bar cutting blades are located directly below the angle shear blades. These cutters handle both round and square sections and consist of two blades only. Directly below the bar cutter are located the plate shearing blades. This device handles plates of any width or length and up to ½ inch thickness. The coping device is built at the shear end of the machine and is extended out from the frame and located at a convenient height for operation. This is a built-in feature so that no time is lost in making special set-ups for this class of work. The coping device is regularly furnished in the V-notch type, but the square notching feature can be provided. The time required to change from one to the other is very nominal. The drive is taken through all steel gears to alloy steel eccentric shafts. The clutches are of the



Ryerson combination machine

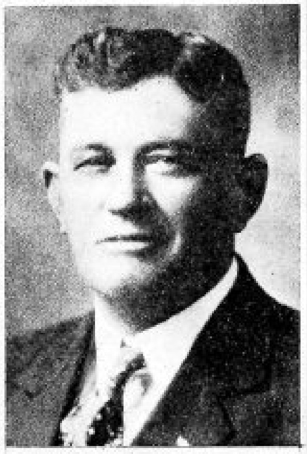
three-jaw type, giving the operator a chance to engage the clutch each third of a resolution of the clutch gear. This is a feature commonly lost sight of in shops not employing the piece work or bonus system. The main frame of the machine consists of a one-piece alloy steel casting, extending from the feet up to the motor shelf. The bearings throughout are bronze bushed and special care has been taken to provide proper lubrication. The working heights of the various attachments have been made such that the feet of the machine can be placed directly on the floor thereby eliminating the necessity of building up a concrete pier in order to bring the machine to a proper working height.

The punch attachment has a 15-inch throat and a capacity for punching 13/16 inch through ¾ inch. The plate shear will handle ½-inch material of any length or width. Other capacities include flat bar shearing 6 inches by ⅝ inch; round bars 1¾ inches; square bars 1½ inches; angles 4 inches by 4 inches by ⅜ inch; angles in miter 3 inches by 3 inches by 5/16 inches; notches 3 inches by 3 inches by 5/16-inch angles and tees.

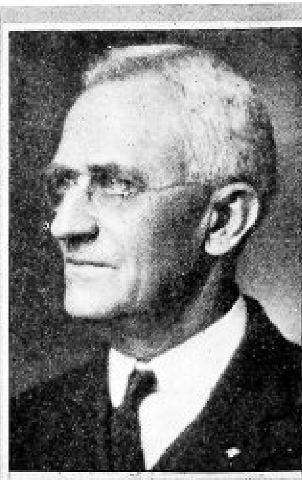
The machine makes 35 strokes per minute and can be furnished either direct motor driven as illustrated or arranged for belt drive. For complete information—write to Joseph T. Ryerson and Son, Inc., Chicago.

J. I. Fussell

H. J. Dickman



L. M. Stewart



G. M. Petrinovich

One Hundred and Fifty-four Years Service With One Road

ALTHOUGH in some other shop or on some other railroad in this broad land of ours there may be a group of boiler makers who have served at the trade a longer time or with one railroad longer than the five whose photographs are reproduced herewith, nevertheless the record of these men with the Atlantic Coast Line is a notable one.

L. M. Stewart, first vice president of the Master Boiler Makers' Association, leads the group as general boiler inspector of the entire Atlantic Coast Line System. This post he has held since 1920. Mr. Stewart's career in boiler making began with his apprenticeship at Water Valley, Miss., with the Illinois Central in October, 1890. On the completion of his term as an apprentice in 1894, he was with the Frisco Railroad as a boiler maker until June, 1898. Like most boiler makers, his early years in the trade were employed in obtaining an education in the methods of various roads, so that next we find him with the Louisville & Nashville Railroad at Birmingham, Ala. Next Mr. Stewart tried his hand at contract work as a foreman of the blast furnace contract shops at Sheffield, Ala., Florence, S. C., and Birmingham, Ala. This period of activity occurred between 1900 and 1904. Then back to the railroad, this time with the Atlantic Coast Line at Sanford, Fla., where he served one year as a boiler inspector and then as a boiler foreman. In 1909, he was transferred to the main shops of the system at Waycross, Ga., as boiler foreman. Until November, 1920, he continued to hold this position, when he was promoted to his present one as general boiler inspector.

L. D. Shumaker

The next to help swell the total of service with the Atlantic Coast Line by a matter of 40 years with the road is H. J. Dickman, who came with the company as foreman boiler maker in 1887, at Florence, S. C., shops, which position he still holds. Mr. Dickman's apprenticeship was served with the Chesapeake & Ohio at Richmond, Va., between the years 1876 and 1880. He continued with the C. & O. until October, 1887, when he entered the employ of the Atlantic Coast Line.

Thirty-eight years with the Atlantic Coast Line and 48 as a boiler maker is the contribution of G. M. Petrinovich towards this record. Mr. Petrinovich served his apprenticeship at the East Bay Iron Works, Charleston, S. C., between the years 1879 and 1883. He graduated into railroad boiler work in 1883 when he went with the Charleston & Savannah Railroad at the Charleston shop, serving at this point until 1886. The next year contract work again took up his attention, when he was employed by the Charleston Iron Works as a boiler maker with the Savannah, Florida & Western Railroad (plant system) until 1889. In that year his connection with the Atlantic Coast Line began when he came to the Savannah shops as foreman boiler maker, where he has continued ever since.

L. D. Shumaker having 28 years service on the Atlantic Coast Line to his credit began his apprenticeship of 4 years at the Baltimore & Ohio shops at Grafton, W. Va. After a year and a half with the Baltimore & Ohio and with the Chesapeake & Ohio and a short time at the Richmond Locomotive Works, Mr. Shumaker resigned and began a hobo tour of the south. This tour, as Mr. Shumaker tells it, is an interesting part of his career and in his own words follows:

"I landed in Atlanta, Ga., and accepted work in a contract shop and remained there for about six weeks. Then I went to Macon, Ga., and accepted employment with the Central of Georgia, in October, 1891. I left the Central of Georgia in 1895 for the purpose of resuming my hobo tour and then landed in Delaware, Ohio, where I worked about one month for the Big 4 Railroad. From there I went to Cleveland, where I worked in a contract shop for about three weeks and then to Huntington, W. Va., where I stayed with the Chesapeake & Ohio for a short while, and then went back to the Central of Georgia at Macon, where I remained for two years. At the end of the two years with the Central of Georgia I went to St. Augustine, Fla., and accepted employment as boiler maker with the Florida East Coast Railway, where I stayed for about a month. On September 22, 1899, I accepted employment as boiler maker with the Atlantic Coast Line at Montgomery and here I finally got married and my hobo tour was suddenly ended. About three months after beginning work as boiler maker with the Coast Line I was promoted to the position of foreman boiler maker and have been in the service continuously at Montgomery since then."

Finally the youngest of the five in point of service, but whose years in the trade are many, is J. I. Fussell, at present boiler maker foreman at the Tampa shops of the Atlantic Coast Line. Mr. Fussell's early training was gained with the Atlanta & West Point Railroad at Montgomery, Ala. In 1902 his connection with the Atlantic Coast Line began in the shops at High Spring, Fla., where he worked as a boiler maker until 1911. In that year he was made boiler inspector and continued in that capacity until 1914, when he became boiler maker foreman. He held this position at various points on the system from then until his present post at the Tampa shops.

It would be extremely interesting if any of our readers, or a group of them, could produce a longer continuous record of service with any railroad.

Qualifications of a Foreman*

Experience combined with understanding and appreciation of the men constitute the greatest requirements for success as a foreman

By W. J. Murphy†

A FOREMAN is what the term implies; the man in front. It is his duty to organize and manage his forces as circumstances may require and keep them rounded up so there will be no lagging back, staying out of line, or lost motion.

A successful foreman to my mind, should be fully equipped with all necessary qualities, only one, of which, I will mention here and that is experience. Practical knowledge is absolutely necessary and all other qualifications are secondary to this one. I feel, for several reasons, that a man debarred, as some of us were in early life from most of the advantages that young men enjoy in the present day, should, by looking back over many years of practical experience, be able to form as correct a judgment, as one who, perhaps, has greater natural ability, but lacks the obvious advantage of being able to see things from more than one point of view and that one purely theoretical.

Our scientific schools are doing great work in fitting young men to take the place of us older men, who, in the natural course of events, must soon drop out and leave the younger men to carry the heat and burden of the day. They teach the essential principles of technical work. They train the mind by discipline, until it becomes a practical working machine. They instruct him thoroughly on the technical end of business, but they cannot make him a complete manager, though they can start him in the right direction. The instructor can lead a man to a certain point, but no further. From that point he steps off into the unknown field of practical experience, and there will find that his troubles have just commenced.

Now I want to say that I am not a believer that all men are born equal. They are born equal in the eyes of the law, but as a rule in no other way. Nature, our great mother, never works along such lines, otherwise, she would have a perfectly flat world. Rather, everything is adapted to its own peculiar end. Men are born leaders in destiny, in law, in finance and war and, in every walk of life, just as surely we have some men born physically stronger and mentally more powerful than others, and no amount of academic theory will change destiny.

But to get closer to our subject as leaders of men and leaders of work. You must, yourselves, have a thorough knowledge of the details of such work. A very inefficient workman soon finds out, if his superior in rank is weak in practical knowledge and learns to despise him accordingly. Lose no proper opportunity to mix with your men and if you can show them by actual demonstration that you are a better man than they are, their respect for you will vastly increase and your hold on them will be greatly strengthened.

Never ask impossibilities and never be satisfied with less than reasonable results. In giving orders, let them be clear and explicit and never give the same order more than twice to the same man. If you do, it is certain that either he or you is unfitted for the position, always remember that you will never get too old to learn, even from your humble

* Paper read before numerous foremen's clubs.
† President of the Master Boiler Makers Association, and division boiler foreman of the Pennsylvania system.

subordinates. Above all, when you accept a good idea from one of them, see that he gets full credit for it: not only among his companions, but with your superiors in rank and file, as well.

Become a good mixer if it is in you. If not, try to cultivate the faculty. However, I do not advocate too much familiarity between the foreman and his subordinates, as there is a certain amount of dignity connected with a foreman's position that must be maintained. Where this is lacking, his usefulness as a foreman is at an end.

When you get to the point where the men call you "The Old Man," your battle is won. In short, in all your associations with them, treat them as men, but never let them forget, or do not forget yourself that you are the boss under all circumstances.

To be a first class leader of men in my opinion, one must first learn to be led and to obey. There is no one test so certain to show the real character of a man, as the one of how he carries himself when elevated to a place of responsibility, and there is no one disease so deadly and so blighting in effect on the subject himself as the "big head." Do not for a moment imagine that the average man under you does not appreciate your true worth and not at your own estimate. Proper dignity can and should be preserved and the measure of self respect you allow yourself will be meted out to you by your men, no more, no less. You should show your men that you respect them in many natural ways: By approval of their good work; by condemnation of their bad work, remembering that a reproof once administered, the matter is closed for all time.

Good Equipment Without Good Foremen Not Efficient

While first class equipment and labor saving devices mean increased output and higher efficiency, their value is small compared with the results which may be obtained by properly handling and inspiring the men to put forth their best efforts. As a matter of fact, good equipment often seems to lose its value, because of the lack of proper organization and good management on the part of the foreman and shop superintendent. The foreman who is ambitious to make a better record, should, therefore, realize the importance of getting close to and studying the men. The moment he understands the necessity of doing this his whole attitude towards his work will change. He will probably be surprised to find himself looking inward and studying himself and will undoubtedly awaken to some of his own shortcomings and, in striving to overcome them, will develop a broader sympathy with his men in assisting them to overcome their faults.

At the same time, although he may not realize it, his influence over the men will grow stronger. Too often the failure of men to make good is not due so much to lack of proper qualities, as to the fact that the men over them do not understand how to develop and get the most out of them. This is not so surprising for the human being is a complex piece of machinery, the working of which is little understood, and also because no two men are exactly alike, each requiring different treatment.

The successful foremen are those who understand this, and from observation and study combined with certain natural gifts, learn how to best encourage and inspire the different men under their charge. This is a far more difficult problem to solve than any mechanical proposition with which they may be confronted. The unfortunate part of it all is that so many foremen fail to realize that this is the most important part of their duties.

A foreman should never forget that men have feelings and he should never use profanity at or in the presence of his men. There is nothing that will lower him in the eyes of his men as quickly as the continual use of profane or vulgar language.

Your superintendent or master mechanic has confidence in you. If he did not have, he would not have you. Now you play the game the same way. Have confidence in your men, or rather employ men you have confidence in.

More than all, if any of your men does a good job, in quick time, show your appreciation of the fact by telling him so. You know your men and know whether it will swell his head or stimulate the good in him. If appreciation were a saleable or commercial article, you would find that fifty cents worth would bring one dollar in results. Too often, a deserving man is expected to take for granted the praise for his efficient work, while if he commits an error, he hears from it in ten minutes.

Any foreman desiring peace of mind must stand honest criticism. Quoting James Whitcomb Riley's opinion: "He who does the best, gets more kicks than all the rest." It is a good thing sometimes to be called: it shows whether you are bluffing or have a good hand. If you have the goods, "stand pat."

If a foreman expects high efficiency from those under his charge, he must first: Attain high efficiency himself to accomplish what he does with an unassuming manner and not with a blustering and bragging air. I have noticed that the greatest and the most successful railway officials are the most unassuming in their attitude toward their subordinates and this proves true in every walk of life.

If you are a big man, others will recognize it in a short time, and if you are not, no amount of bluster or grandstand play on your part will make you one, or give any lasting convictions to others that you are one.

No one has a greater opportunity to be a great asset in his employer's business than the foreman. Therefore, it behooves every man who occupies this position to be a credit to himself and his employer.

You should keep the details of your business well in hand and your eyes open for opportunities to strengthen your forces, as your own success depends entirely on your organization and the better organization you have, the more successful you will be.

A man succeeds because he lives, eats, sleeps, dreams and builds air castles about his business. Referring to air castles, I want to say that the man who never builds air castles, never builds castles of any kind.

Give me the man who can hold on when others let go, who pushes ahead when others hold back, who knows no such a word as "can't" or "give up," and I will show you a man who will win in the end, no matter what opposes him, no matter what obstacles confront him, he will make good.

Now before I close, I want to say something more about personality. It is one of the greatest assets of man. I will not admit that all the brains in the world are up in the main office. Neither do I believe that all the brains on the job are vested in the foreman. They are not. But the man in the main office and the foreman are occupying their present positions chiefly through their personality. Personality is the greatest salesman in the world; for ability. Ability without a personality is a long time in gaining recognition. Ability with personality is recognized instantly everywhere. What is personality? Personality in a nut shell is a cool head, a warm heart, an absolutely tolerant brain and a character that is absolutely fair to both sides at all times. Everywhere, or in other words, a man who can recognize the fact that there are two sides to every quarrel. There is a certain amount of merit in the man who is on the wrong side of it. Pleasing personality is never impertinent, seldom sarcastic, and never borders on a desire to ridicule.

The Dependability of the Riveting Art*

Riveting plays an important part in making boilers safe—Examples of structures in service for long periods without showing any deterioration

By A. F. Jensen†

RIVETING is one of the oldest arts and there are no intangibles when considering its application; the strength of a riveted joint can be mathematically predetermined, its efficiency does not depend on the man doing the riveting and a riveted joint may be inspected and reasonable assurance of its soundness obtained.

The explosion of a riveted boiler built to code requirements due to an inherent defect of either material or workmanship is practically unknown. F. R. Low, in an editorial in the March 22, 1927, issue of *Power*, stated:

"A riveted joint is not an embellishment to a structure. It adds weight, involves objectionable irregularities in thickness and surface protuberances and a joint held tight only by the pressure of the sheets upon one another cannot be depended upon to remain entirely free from leakage.

"But properly made it is safe, and its *proper making can be assured*."

It is a recognized fact that serious boiler explosions cannot occur unless the rupture in the boiler is sufficient to suddenly reduce the pressure. Locomotive boiler explosions are never of sufficient severity to throw the boiler off its frame unless the sheets tear and suddenly release the pressure.

Crown sheet failures are largely the result of overheating, due to low water, and nothing will prevent the crown sheet coming down when it has been overheated. However, if a particular method of joining metals will minimize the fatalities and property damage it should be used. That riveting accomplishes precisely that is evidenced by the records of the Bureau of Locomotive Inspection.

The May 31, 1927, issue of *Power*, in an article "A Boiler That Almost Exploded," contributes this to the rivet's record of dependability:

"Some time ago the fire under a gas-fired horizontal return tubular boiler was left burning without attendance from 10 o'clock in the evening until 4 o'clock the next morning. When an employe came on duty at 4 o'clock, he found the boiler room in an uproar from the popping off of the safety valve. The whole boiler room was filled with steam, and the boiler was red hot from the intense heat of the fire. He promptly shut off the gas. Next morning, when the boiler had cooled down, it was observed that the shell courses between the girth seams had swelled up like balloons, that the rivets were sheared part way through and that all the tubes were loose in the boiler heads. The metal had been yielding until rupture was just about to occur."

The first shell course increased 1.32 inch in circumference at its center, the second 1.86 inch and the third 0.125 inch. There was no increase in circumference of the riveted seams at the heads or in the circumference of the riveted seam joining the second course to the third. In our humble opinion the reinforcing affect of the riveted girth seams saved that plant and prevented a serious loss of life.

The April, 1927, issue of *The Locomotive*, published by The Hartford Steam Boiler Inspection and Insurance Company, concludes an article, "An Epidemic of Bulged Boilers," as follows:

"The pictures .... well illustrate the reinforcing effect of the girth seams of a boiler shell. Although in this case the seams were overheated equally with the immediately adjacent plates, and perhaps to a greater degree because of the greater mass of metal concentrated here, yet it can be seen that the seams did not yield to the pressure as did the plates."

The modern laboratory instruments for research in applied mechanics were not available when tests were made which determined the design rules followed today in riveted joint structures. The unquestioned reliability of millions of riveted joints made to those rules demonstrates that if the tests were crude to present day standards the inaccuracies resulted in errors on the safe side. But how much on the safe side? A recent investigation by Commander E. L. Gayhart (C.C.), U. S. N., of the behavior and of the ultimate strength of riveted joints under load disclosed an efficiency of 80 to 85 percent on gross section for all joints instead of the theoretical value of 76 percent. This suggests further research of this seemingly unimportant metal pin—the rivet.

The pressure applied when driving rivets and the length of time the pressure is maintained upon the rivet are two important factors which materially affect the efficiency of the riveted seams of boilers. To those engineers who are inclined to the opinion that the riveting process has some influence on the so-called caustic embrittlement of metals we suggest a consideration of these factors. Such an investigation will undoubtedly disclose a wide difference in the practice of various boiler shops.

If plates fit well, only a moderate pressure is required to obtain a tight joint provided the pressure is maintained or "held on" for a sufficient period of time. Prior to 1924 ten of the most important boiler shops in Germany used pressures between 65 and 95 tons per square inch of rivet area. Since that time they have reduced the pressure to less than 52 tons. Assuming a 7/8-inch diameter rivet, they would drive it with 32 tons, whereas we would probably use 70 tons, more than twice as much pressure per square inch of rivet area.

Part Played By Riveting

This, the greatest building age in history, has been made possible by riveted steel. Approximately 150 rivets are required per ton of structural steel. Bookings of fabricated structural steel have more than doubled in fourteen years, the average monthly bookings in 1925 and 1926 being 218,000 tons. A consumption of more than thirty-two million rivets per month conveys some idea of the rivet's important place in structural steel fabrication.

Probably one million tons of riveted steel bridges were erected in this country between 1890 and 1900, nearly all of which are still in service, except when too light for increased traffic. On the Pennsylvania Railroad, east of Pittsburgh, over 500 bridges built previous to 1897 are still in excellent condition, notwithstanding the large increase in loads to which they have been and are subjected. There are 70,000 linear feet of bridge structures on the Lehigh Valley Railroad (the oldest structure is about sixty years old), and none has been replaced except on account of accident or unduly increased loads. Some of the New York Central and Hudson River bridges have been in

* Address delivered at annual convention of National Board of Boiler and Pressure Vessel Inspectors.
† President of the Hanna Engineering Works, Chicago, Ill.

service forty years. Other notable examples are the steel arch ribs of the famous Eads Bridge over the Mississippi River at St. Louis, which have seen fifty-two years of service, and the trusses of the Brooklyn Bridge, in service forty years. When the Blair Railroad bridge over the Mississippi was removed after forty years service, the structure showed no signs whatever of deterioration. Is there a better monument to the dependability and stability of the riveted joint?

Modern steel shipbuilding history is a story of rivets; keels, decks, hulls, superstructures, boilers and even masts are built of riveted steel. America's activity in ship construction during the World War brought most forcefully to the public's attention the dependability of riveting. There are 700,000 rivets in a 7,500-ton cargo ship and American ship yards averaged approximately 280,000 tons gross weight per month during that period.

In automotive construction 90 percent of the riveting is done cold; a very successful and economical process. Automotive manufacturers the world over entrust the safety of humanity and cargo to a riveted chassis frame.

Railroad equipment, boilers, bridges, buildings, tanks, stacks, gas holders, automobiles, tractors, cranes, concrete mixers, agricultural implements, etc., all reflect the dependability of riveting and its contribution to engineering progress.

Riveting stands firmly upon its record, an accredited success as a fabricating process. It has played a very important part in the development of our most important industries and will only be supplanted by methods more economical, less dependent on skilled labor and assuring equal safety.

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

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

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

Below are given records of the interpretations of the Committee in Cases Nos. 547, 551, and 553 to 556 as formulated at the meeting of June 24, 1927, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 547 *Inquiry: a*—Is it permissible under the requirement of Par. P-186 of the Code to form corner joints between the shells and heads of power boilers by the use of fusion welding, where the shell is extended beyond the head and carries an angle or other structural shape riveted thereto on the inner side, so as to withstand the thrust on the head due to steam pressure?

b—Is it permissible under the requirement of Par. P-186 of the Code to form the girth shell joints of firebox-type boilers having furnaces and water legs extending the full length of the shell, by fusion welding, when such joints are disposed half way between adjacent rows of staybolting and the head-to-head stresses on the shell are fully carried by through rods and tubes?

c—Is it permissible under the requirement of Par. P-186 of the Code, in firebox-type boilers, to weld the corner joints of furnaces that are subject to compressive stresses when both head and side sheets are supported by rows of staybolts close to the corners?

Reply: a—If the shell is cylindrical or in the case of firebox construction is retained by staybolting, it is the opinion of the commitee that the use of such a structural member so disposed as to oppose the thrust due to steam pressure and properly attached to the extended shell by riveting according to the rules for circumferential joints, will not conflict with the requirement of Par. P-186.

b—It is the opinion of the committee that while the through rods and tubes may perhaps be sufficient to withstand the calculated head-to-head stresses of such a firebox-type boiler, neither the longitudinal staying effect of the through rods nor the transverse reinforcement of the staybolting in the water legs will be sufficient to insure freedom of the girth joint from transverse tension stresses due to weight components or variations in temperature, and thus the construction proposed will not meet the Code requirement.

c—It is the opinion of the Committee that while the staybolting will perhaps amply support the head and side sheets, their attachment by fusion welding at the corners will not meet the requirements of the Code, as the welds would not be free from bending and tension stresses due to both steam pressure and contraction and expansion.

Case No. 551. *Inquiry:* Will it be permissible to form a nozzle on a drum of diameter not less than 30 inches, where the shell is 2 inches or more in thickness, by the use of a steel tube not exceeding 3 inches in diameter, which is rolled into a hole in the drum and into an outer flange? Attention is called to the fact that if a flanged nozzle were to be attached to a drum by riveting as required in Par. P-268 of the Code, the rivets would become so long that it would be difficult to make a tight and satisfactory joint, and also it is believed that the method of screwing a threaded pipe connection into the drum as provided for in Par. P-268 would be unsatisfactory on account of damage to the threads through corrosion or other means.

Reply: A revision of the requirement pertaining to nozzles in Par. P-268 is being considered which will modify the present mandatory requirement for the riveted attachment to shells or drums. It is the opinion of the Committee that the proposed construction is allowable under the conditions specified.

Case No. 553. *Inquiry:* What will be the proper location for the fusible plug of a horizontal return tubular boiler that is set with a slope to the rear so that the rear end is 1 or 2 inches lower than the front end? Par. A-21*a* specifies the location as in the rear head not less than 2 inches above the upper row of tubes.

Reply: It is the opinion of the Committee that if the lowest visible part of the water gage glass is located on a level 2 inches above that of the fusible plug in the rear head, the requirement of Par. P-291 of the Code will be met.

Case No. 554. *Inquiry:* Is it the intent of Par. H-68 of the Code, wherein it is stipulated that the stamps shall not be covered by insulating or other material, that the term "other material" shall include painting? If the section of the boiler shell to which the stamping is applied is not painted it is found to corrode badly during shipping and erecting of the boiler.

Reply: It is the opinion of the Committee that the term "other material" was not intended to include a thin protective coating which does not obscure the easy reading of the stamping impressed upon the boiler.

Case No. 555 and Case No. 556.

(Both of these cases are still in the hands of the Committee)

Rivet Spacing in Sketch Plates of Steel Tanks—For Bottom and Roof Plates

By D. W. Phillips

THE accompanying diagram is submitted with the hope that it may benefit those of our readers who may be interested in the complete layout of all holes necessary for securing the outer edge of bottom plates to the angle ring which connects the shell and bottom of steel tanks. The work involved in the complete layout of holes in work of this kind really belongs to the designing or engineering department of the plant and should be included in the shop details. However, it may be of interest to others, engaged in the fabrication of this class of material, and especially to the apprentice and the new beginner at laying out. No great amount of explanation is necessary as the diagram is self explanatory, however, I will just introduce each step of progress, as we should go from one process to the other.

The first step is to draw a plan view of the bottom of the tank we propose to build, take ¼ of this plan as our working base, drawing this to scale will be of no advantage to us whatever. The tank we are to build will be 120 feet diameter, the height, thickness of plate or capacity does not interest us or will not aid us in our determination. Make the vertical and horizontal radius lines a ninety-degree angle. Now, beginning with the bottom horizontal radius line, divide the ¼ plan into 12 equal spaces; these spaces will represent bottom plates and, in our case, will measure 60 inches or 5 feet center to center of rivet lines. Draw these lines through parallel with the bottom radius line. Then set the dividers at a distance equal to ½ the diameter of the rivet center line at the outer edge of the bottom plate, draw this radius around, cutting the parallel lines, and terminating at the base and vertical center lines. While it is not necessary for the work we have in hand to determine the length of these parallel lines, however, we will describe a method for this determination, as these lines represent the length of the bottom plates at the seams or laps. These lengths can be readily found from a table of squares (Smoleys).

Our next step is to ascertain the degrees, minutes and seconds in the various angles formed by the intersection of the parallel lines with the 60 foot radius line as shown on our diagram (this radius line being the center line of rivets in outer edge of bottom plates). To determine the value of these angles, draw radial lines through the intersections

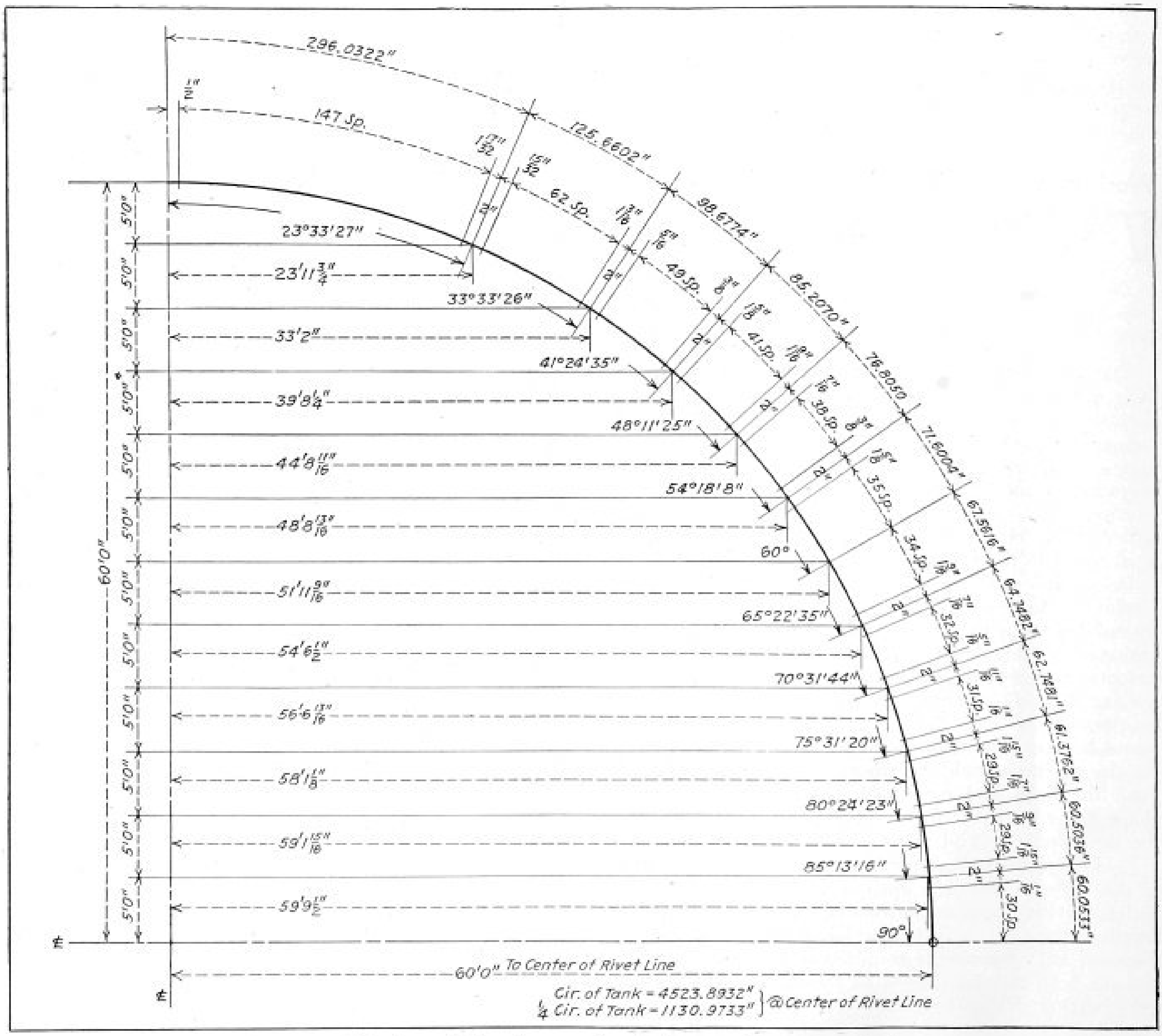


Diagram used in determining rivet spacing for top and bottom tank plates pointing toward the center of the large circle, as shown on the sketch, extending these lines out beyond the center line of rivets for further convenience, as shown. Now, we first have to find the sine of these angles before we can find the value in degrees, minutes and seconds, so we will start at the bottom of our plan and divide 5 feet by 60 feet; the quotient will be the sine of the first angle; for the second angle we divide 10 feet by 60 feet; for the third angle we divide 15 feet by 60 feet, and so on until we complete the circle. Now we consult a table of natural sines and tangents for the values in question.

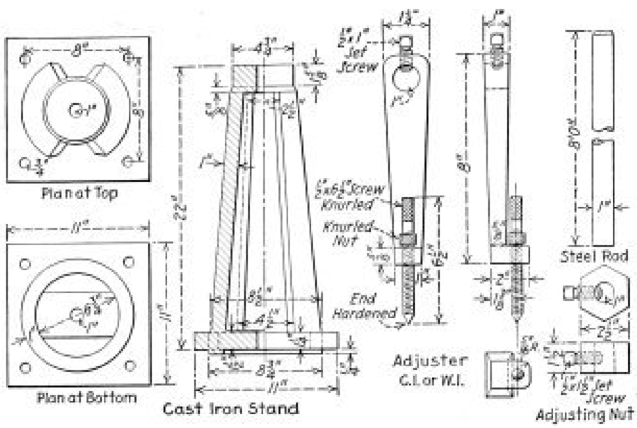
We must know the length of the arc formed by these intersections, or we cannot space our rivets accurately. There are several methods given in various handbooks for finding the lengths of circular arcs; one is to multiply the circumference of the whole circle by the degrees in the angle in question and divide the product by 360, but the shortest and easiest method the writer has found is to obtain a table of lengths of circular arcs to a radius of (1), such as found on page 331 of the Lukens Steel Company hand book, multiply the values here given for the degrees, minutes and seconds by the radius of the circle, in this case 60 feet. The result is in feet. Then multiplying again, the result will be inches, which will be the length of the circular arc between each intersection of the different radial lines with the seams in the floor plates. From these results we obtain the spacing of our rivets as follows: As stated before, our rivet pitch is to be 2 inches, and we must not vary from this, as our angles we will assume have already been punched. We have to determine from our calculation the length of the first circular arc, a distance of 60.0533 inches, this divided by 2 inches gives us 30 spaces and 1/16 inch over. Well, the ordinary shop man would say, what is 1/16 inch? We will just include that into the one pitch and let it fall on the lap of the bottom plate. Well, that wont make any difference in that one space, but we must not neglect the 1/16 inch. As our spacing is 2 inches we must subtract the 1/16 from 2 inches and place the 1 15/16 on the other side of the radial line. Then, we must subtract the 1 15/16 from the value of our next circular arc, in order to begin our new spacing for the next angle; thus, 60.5036 minus 1 15/16 divided by 2 inches gives us 29 spaces and 9/16 inch over. This 9/16 taken from 2 inches leaves us 1 7/16 inch; this subtracted from 61.3762 inches divided by 2 gives us 29 spaces again, with 1 15/16 inch over; 1 15/16 inch from 2 inches leaves 1/16 inch; 62.7481 minus 1/16 and the remainder divided by 2 gives us 31 spaces, with a remainder of 11/16 inch. The reader should very easily see the method of procedure and have no difficulty in understanding each step of the way. I have omitted all formulas and have attempted to give the method in the simplest manner possible.

Gage for Alining Smoke Stacks on Locomotives

By H. H. Parker, Jr.*

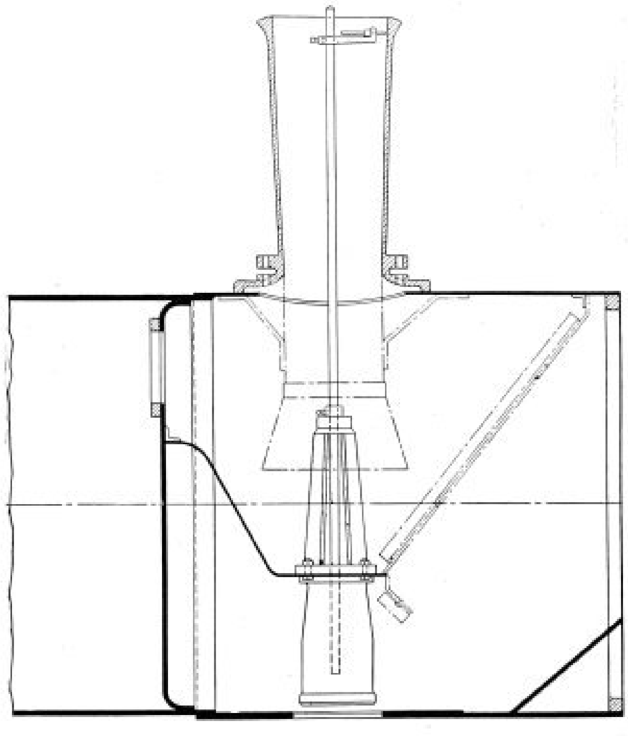
It is essential in order to secure the best results when a locomotive is in operation, that the stack, base and smoke box extension be in perfect alinement with the exhaust nozzle. The Norfolk & Western Belt line has a home-made device, shown in the two drawings, with which a mechanic can quickly line up a new stack and have it ready to fit to the boiler in less time than usually required to get the jacks ready for leveling the stack.

This device consists of a cast iron stand 22 inches high,



Detail construction of the smoke stack aliner

as shown in the detail drawing, a 1-inch round steel or iron rod, 8 feet long, an adjusting nut with a ½-inch set screw and an adjuster as shown. This device can be made in any small shop at comparatively low cost, the stand being the only part that has to be cast. All that is necessary to line up the stack with this device is to remove the exhaust nozzle tip, clamp the aliner on the exhaust stand, set the adjuster and revolve the rod. This method has proved to be a time saver over the old way. The aliner is kept in the tool room, is light in weight and does not take up much room.



Method of alining the stack with the nozzle by means of the gage

* Shop draftsman, Norfolk & Portsmouth Belt Line, Portsmouth, Va.

The Alexander Milburn Company, Baltimore, Maryland, manufacturer of welding and cutting apparatus, portable carbide lights, oil burners and preheaters, and paint and lacquer spraying equipment, has organized an office in Boston to be known as The Alexander Milburn Sales Company, Wiggin Terminals Building, 50 Terminal Street, Boston, Mass.

Measure of Damages for Breach of Warranty of Boiler

By Leslie Childs

WHERE a boiler or other machinery is sold under a warranty as to condition, the question of the measure of damages for a breach of the warranty may be one of great importance. And, while each case of this kind must necessarily be decided in the light of its facts, the California case of Armstrong v. Lassen Lumber and Box Company, 257 Pac. 214, is one of value on this question.

In this case Armstrong was engaged in the business of buying and selling steam boilers. He had a customer for a used steam 80 horsepower return tubular boiler, good for 140 pounds per square inch pressure, and was informed that the box company had such a boiler for sale at their plant at Susanville, California.

Pursuant to this information, Armstrong communicated with the box company, explained just what he wanted and that the boiler was being sought for resale. The box company replied that it had such a boiler and quoted a price of $800 thereon f.o.b. cars at its plant. Armstrong accepted the offer, remitted the $800, and the box company executed the following bill of sale:

"For value received, we hereby sell, assign, and transfer to the L. D. Armstrong Company the following described personal property, viz.:

"One butt-strap boiler 60-inches in diameter by 16-feet long for 140 pounds working pressure with breeching, stack, half arch front, and safety valve.

"This equipment is now located at our plant at Susanville, California. Above consideration includes delivery on car in good condition at Susanville.

"In witness whereof, we have hereunto set our hand this 24th day of March, A.D., 1922.

[Corporate Seal]

"Lassen Lumber & Box Co.,
"R. D. Baker, President.

"Witness: L. Johnson."

Boiler Found Defective

According to instructions, the box company then shipped the boiler and it duly reached Armstrong's customer at Brownstown, California. The boiler was then inspected for the first time, and found defective as follows: There was a bag in its bottom, twelve burnt off rivets at its rear seam, a lamination in one of its plates and an injured left hand sheet.

The buyer refused to accept the boiler, and Armstrong then spent $180.11 in an attempt to repair it. While this was in progress, an inspector and a member of the State Industrial Accident Commission, who had been sent for by Armstrong to inspect the boiler, arrived. They immediately stopped the work, on the ground that because of the defects they would not allow the boiler to be operated at 140 pounds pressure.

Armstrong was then compelled to supply his customer with another boiler, in accordance with his contract, which cost him $1,933.18. He thereafter brought the instant action against the box company for damages for breach of warranty. The trial court held there had been a breach of the warranty and that the boiler was worthless to Armstrong. The latter was thereupon awarded damages for his attempted repairs, the cost of the boiler he was compelled to install under his contract, and interest on the $800 he has paid, making a total of $2,113.29, with a provision allowing the box company to retake its boiler.

From this judgment, the box company appealed and the first question raised was whether or not, under the terms of the bill of sale, there had been a warranty. In passing upon this point the court said:

"At the inception of the transaction, defendant [box company] was informed that the boiler was being purchased for purposes of resale and that the boiler required was one of 80 horsepower in good condition and good for 140 pounds working pressure.

"The description in the bill of sale * * * describing the property sold as 'one butt-strap boiler 60 inches in diameter by 16 feet long for 140 pounds working pressure, with breeching, stack, half arch front, and safety valve,' and stating that this equipment was located at defendant's plant at Susanville, and that the consideration received included delivery on car in good condition * * * cannot be construed as other than a warranty on defendant's part that the boiler sold was in good condition and capable of being used with safety under a steam pressure of 140 pounds. * * *"

Following the above disposition of the warranty question, and after holding that the evidence amply supported a finding of a breach of warranty, the court turned to the question of the measure of damages therefor. In this connection the court said:

"Plaintiff [Armstrong], in reliance on defendant's statements as to quality and its warranty of quality, had obligated itself to furnish * * * an 80 horsepower tubular boiler, designed and built for 140 pounds working pressure, and its inability to furnish this boiler made it liable for damages * * * when it became apparent that defendant's boiler was valueless.

"A search of available markets disclosed that a return 80 horsepower tubular boiler of 140 pounds pressure capacity could not be secured for less than $2,100. In an endeavor to mitigate the damages consequent on the boiler being found defective, plaintiff attempted to repair it, expending $180.11. When plaintiff learned that, after all possible repairs were made, the state inspector would not allow it to be operated under 140 pounds pressure, it induced Leal and Sons Lumber Company to accept a different type of boiler for the purchase and installation of which plaintiff expended the sum of $1,933.18.

"Defendant is not in a position to complain of the cost of the boiler which was installed, as it cost less than would have been the cost of a boiler having the specifications agreed to * * *. Neither should defendant be freed from liability for the cost of the attempt to repair the boiler sold by it. The amount of damages awarded by the judgment, $2,113.29, was not in excess of the amount to which the respondent [Armstrong], was entitled. * * * The allowance in the judgment of interest on the sum of $800 * * * is stricken out. As so modified, the judgment is affirmed, * * *."

Conclusion

The above California decision is one of force and value on the question of what constitutes a warranty of a boiler, as well as upon the measure of damages for a breach thereof. And, in the light of its holding, it is obvious that a breach of such a warranty may result in substantial liability being placed on the seller, depending, of course, upon the facts and circumstances involved. Truly, the case is one that may well be borne in mind by both buyers and sellers of equipment of this kind, when same is being bought or sold on the strength of a warranty.

The Chicago Pneumatic Tool Company, 6 East 44th Street, New York City, announces the appointment of J. C. Fitzpatrick as district manager of sales at 1241 East 49th Street, Cleveland, Ohio, succeeding J. L. Westenhaver who has resigned to enter into business for himself.

The Ideal Boiler Shop—II

Special flanging fires—Pipe lines—Shop flooring—Heating and ventilation systems—Drives for shop machines

By James F. Hobart

LOCATE it wherever you choose in your "Ideal" shop, but be sure to place somewhere, a special flanging fire, at least 8 feet in diameter and capable of delivering the necessary heat for hand forging any job from a 30-inch boiler brace to a 10-foot head for a scotch boiler.

Bend up an eight-foot shell of 5/8-inch tank steel, if you have a piece of that thickness; make the sheet about two feet long and after the longitudinal seams have been riveted, place the shell upon a solid concrete foundation, which will stand up under a load of ten tons or more. In fact, this foundation should carry safely all the plate which may for convenience be temporarily piled upon the forge. It is the writer's opinion that this forge will prove very handy indeed, if located adjacent to the plate storage end of the new shop, where the forge would prove exceedingly convenient, not only as a special forge, but for use when selecting plates from storage, and also, very probably, for supporting some material during the laying out process. So build this forge case stout and strong.

In some convenient spot, locate a pressure blower adequate to supply all the smith's forges in the shop. Run a main air pipe underground, from the blower to all parts of the shop wherever forge fires will be required and make the air pipe of twice the capacity you expect ever to need. Then, no matter what demand for air may arise, you will need only to put in another blower, or displace the one in use with a larger blower, and you can supply air in your shop, even after it has been enlarged to the limit, without ever having to enlarge or change the forge air mains.

Bring a 6-inch air pipe up through the concrete foundation of the 8-foot forge and arrange the end of the air pipe for the taking off of a considerable number of tuyre connections. With the cutting torch, make several openings, "man-hole size" in the side of the 8-foot forge. Then, inside of that shell, build a 4-foot tuyre in four separate sections, each of which shall be supplied from a separate branch of the air pipe so that the whole 4-foot tuyre could be used, or one or more sections, whether a small or a large fire was required. In the two spaces between the 4-foot tuyre and the other shell, place as many small tuyres as can be located in the space mentioned. Some of these many tuyres should be very small, perhaps only a couple of inches in diameter, while other of the "small" tuyres should be 6 or even 8 inches in diameter.

Arrange the tuyres in such a manner, that by reaching a hand in through one of the "man-hole openings" in the steel shell, the clinker-gate of each tuyre, as well as the air valve for each, can be easily reached and operated, thus having no operative devices outside of the steel case, to be accidentally opened, or broken off. With the tuyre arrangement above described, any size of fire ever needed, could be obtained at will, from a little blaze over a 2-inch tuyre, up to a mammoth fire nearly 8 feet in diameter which may be done by lighting fires over all the tuyres in the big forge and permitting the fires to run themselves together.

Portable Smith's Tool Outfit

As it is the intention to use the big forge only occasionally as work to be done requires, no tools are ever kept around the circular forge to clutter up the shop when such tools are not in use.

Instead of having a bunch of tools sprawling around when not in use, a bench was made up, carrying a husky leg-vise, and with an anvil and even a slack tub securely attached in such a manner that the entire outfit could be picked up by the overhead traveler and deposited at the circular forge—or anywhere else in the shop where such a collection of tools might be needed.

Service Pipe Lines

In addition to the air pipes for the smith's forge blast, the boiler shop should have in addition, water pipes of course and compressed air with service openings everywhere, as usual. In addition, there should be provided an oxy-acetylene service for welding and cutting, making it unnecessary to have gas tanks attached to the welding or cutting torches. Possibly it will prove profitable to generate acetylene from calcium carbide and thus avoid the expense of purchasing gas in cylinders. Should this be done, then, by all means avoid the necessity of attaching a portable washer wherever acetylene is taken off for use, by setting up a "scrubber" in the generating house and washing the gas there, before it goes into the distributing pipes and is sent everywhere throughout the shop. Let oxygen gas be likewise distributed, but it will probably prove profitable to purchase this gas in tank cylinders and not bother with generating that gas from the black oxide of manganese, as the retorts used for that purpose have a way of clogging up their pipe connections, to the injury of whoever chances to be in the way of flying fragments of the retort head—which usually "lets go" in cases of this kind.

When 40 men or over are employed, it will probably prove profitable to pipe drinking water to a considerable number of "bubble" fountains, placed at convenient points so that no man need walk more than a few steps to obtain a drink of water, no matter where, in the shop, he may be at work. In arranging such a system, the "bubbles" should all be self-closing, thus making it necessary for a man to hold the bubble open while obtaining the quantity of water required. There should be no "dead-end" connections whatever, in which "dead-ends" the water might become warm and unpalatable. Thus, instead of a "dead-end" pipe extending from water pipe to the "bubble" a double pipe should be used, so that water is always flowing past the bubble, the water turning to the cooler after having made a passage through one of the shop pipes. These pipes should be run underground whenever possible and also heavily heat-insulated in order to make the cost of water cooling as slight as possible. With a carefully arranged drinking water system and with well insulated pipes, it is quite possible to provide an adequate supply of cool—not ice cold—drinking water by simply expanding a quantity of compressed air in the water cooling device whatever it may be.

Paint the Pipes

To paraphrase the old Irish maxim of:—"Whenever you see a head, hit it," let the shop maxim be—"Whenever you see a pipe, paint it" and use a different color of paint for each pipe line. For instance, all water pipes, when above ground, to be painted black, all air pipes painted green, acetylene pipes, red, oxygen pipes blue and so on for the list of service conduits, making it easy to select the particular pipe desired and to prevent accidents.

Shop Heating and Cooling

Working in a northern latitude boiler shop in zero weather is no joke, and the quality as well as the quantity of the work turned out, suffers alike from low temperature. Provide several heaters which may be fired with either coal, coke, oil or gas and have these heaters so made that they may be fired-up outside of the shop if necessary, then picked up by the overhead traveler, and set down at a job, where heat will do the most good. A couple of heaters, with lively fires inside, set down beside a job, will cause a surprising increase in the amount of work accomplished. In like manner, placing braces inside of a boiler when the shop thermometer indicates 100 degrees or thereabouts, is a piece of work which can barely be endured, much less hurried. With a few ventilating fans arranged to be attached by clamps to almost anything, it will be found that such "hot-weather work" is much expedited by the use of the fans.

In the "Ideal Shop" the idea should be carried further and a decently clean, heated or cooled room provided in which workmen may keep their lunches and eat them in warmth and comfort. Furthermore, the management may entertain the ideas of a sort of dining room, where lunches may be eaten by the men and where hot coffee, tea and soup may be obtained at cost. The shop management may have no fears that such accommodation will cause heart failure in any of their workmen. Neither will a warm place in which to wash and put on street clothes.

Boiler Shop Floors

The matter of a suitable floor for a boiler shop nearly always receives no more attention than a last year's circus poster. Usually, whatever kind of native dirt chances to be present forms the boiler shop floor. It will prove profitable to "work" the floors of boiler shops a bit; concrete floors are not desirable, neither is any soil which will not "pack" and become hard underfoot. By experimenting a little, a desirable floor may be made out of the shop soil wherever it may be, by the use of dirt usually close at hand. For example, should the soil be sandy, mixing in about 2½ percent of clay, will cause the sandy soil to pack down hard. In like manner, clay soil may be improved by plowing or spading in a considerable amount of sand. However, it will probably be necessary to moisten the soil often enough to prevent it from drying out, in which case, the floor might become "mealy" again and soften up under the feet of the workmen.

Service Openings

The "Ideal Boiler Shop" being a clear-story affair, with an overhead traveler sweeping over almost the entire floor surface, there was no opportunity for suspending electric lamps from the ceiling or roof. Along the walls, it was easy to attach "iron-clad" extensions to wall fixtures but it was not considered very desirable to use extensions 50 to 60 feet long for the danger of entanglement and breakage was too great. It was the same with all other service wires and hose, therefore service boxes of most substantial construction, were plentifully distributed through the shop. These boxes were made of heavy material, 24 inches square and about 12 inches deep. The covers were split and hinged, also made removable, and with "gains" in them, whereby a wire or a hose could issue from the service box while the cover was still in place. No attempt was made to keep extension wires or hose in the boxes for reason that such things stored there were always getting into trouble with some of the service connections. Therefore, all extensions and hose not in use, were kept in the tool or store room.

The service boxes were purposely made so rugged that they could be used to pile boiler material upon, to stand upon, and to snub a boiler shell against.

Drives for Shop Machines

Do not tolerate anything but electric motor drives for operating the shop machines. Give each machine its own motor and then a machine may be located exactly where its work can be done most effectively and economically. To be sure, a few dollars may perhaps be saved by setting up a motor-driven counter shaft and belting two or more machines to the shaft in question. But this is doubtful economy, for the reason that shaft driven machines can never be set up where their efficiency is the greatest. The machine must be erected where it can best be driven, not where it can do its work to the best advantage. Bear this well in mind when placing machines in the new boiler shop and see to it that you obtain real efficiency, instead of a mere imitation.

The Hydraulic Riveter

This invaluable machine should invariably be placed at one end of the shop, where it will interfere as little as possible with the overhead traveler and its operation. Sometimes it may be possible to place the riveter in a little building of its own, at one side of the main shop building. This is a very good arrangement when it is possible, for the reason that the riveter has the advantage of crane service and at the same time, does not prevent full crane service over the entire shop floor. Consider well, the advisability of placing the riveter in a pit of such depth that the riveting action takes place about breast high above the shop floor, thus enabling close watch to be kept of the riveting action without the observer having to work upon scaffold or a ladder.

Furthermore, test frequently the action of the riveter by driving a few rivets in narrow strips of plate and then cutting through, lengthwise with the rivet, in two directions and thus determine whether or not the rivets are being driven exactly straight or permitted to cant to one side more or less. This test is a valuable one and should be very frequently made.

The time-honored chain hoist is still doing good work in many shops, but just give the "once-over" to the work of a sturdy man-size air-hoist placed above the pneumatic riveter. The chain hoist is not "in it" with the air lift. Next month we will take a look at the other shop machines, their location and operation and the quality of the work they are doing and are capable of turning out.

The Air Reduction Company, Inc., 342 Madison Avenue, New York, has purchased the oxygen plant, equipment, and entire business of the New England Compressed Gas Company, Boston, Massachusetts. With this new purchase the Air Reduction Company, Inc., and the Air Reduction Sales Company command the production and distribution facilities of thirty-five oxygen plants, all located in or near the chief industrial centers of the United States.

The Alliance Tank Company announces an increase in authorized capital stock from $60,000 to $95,000. This company was organized May 19, 1926, under the laws of the State of Ohio, for the purpose of manufacturing steel tanks and miscellaneous plate work by means of the Lincoln "Stable-Arc" welding process. This company specializes in gasoline, oil storage and pressure tanks, vats, oil pits for filling stations, paint kettles and varnish tanks, distributed under the trade name of "Thoro-weld" tanks.

The Value of Boiler Water Treatment to the Mechanical Department

By J. F. Raps†

THE paramount issue with the transportation department of any railroad is essentially the efficient and economical movement of traffic, causing ever increasing demands on the mechanical department, for motive power capable of handling heavier tonnage at increased speed, which has resulted in constructing larger and heavier locomotives with higher steam pressures.

The boiler has been designed to accommodate and serve this increased power; the firebox has been made larger but in a great many instances no provisions have been made to increase the circulation at the forward end of the boiler. This contributes to the sluggish movement and concentration of those agents in the water, which lead to pitting and corrosion and is responsible for the trouble experienced from the flues pitting and corroding just inside of the front flue sheet.

There is no other type of steam generator that compares with the locomotive boiler in its intermittent duty and capacity range while in service, which ordinarily is only for a few hours of the 24. The balance of the time it is subjected to destructive stresses due to standing idle, cooling down, washout and firing up, and these stresses are greatly augmented by the scale adhering on the plates, staybolts and flues, which has a tendency to cause these parts to become fatigued due to overheating, resulting in cracked plates, broken and leaky staybolts and leaky flues.

The necessity of developing the maximum efficiency from the motive power at hand has resulted in the cooperation and coordination of the railway officials, in both the mechanical and transportation departments. It is becoming generally recognized that an adequate supply of water suitable for use in locomotive boilers is the first essential towards obtaining greater locomotive efficiency.

The cost of boiler feed water does not end, however, with its delivery to the locomotive tender as boiler troubles and the majority of their repairs and renewals are traceable to the water supply. Therefore, it is very essential to secure suitable water even though the initial cost may seem prohibitive and entirely out of proportion to the actual cost of water requiring treatment obtained from another source. Where it is not possible to secure a good or fair grade of water, arrangements should be made to employ some effective means for purification to prevent scale formation and corrosion within the boiler.

Impurities in the water are in the nature of mineral salts, mud, vegetable matter and gas, and are contained in all waters in varying amounts and proportions, the mineral salts in sufficient quantity and suspended matter form a more or less coherent scale on the flues, firebox sheets and interior of the boiler.

The principal scale forming impurities are carbonates and sulphates of lime and magnesium. Calcium sulphate is responsible for the formation of the hardest kind of scale and is the most detrimental to the firebox sheets and flues, causing the flues to leak and the beads to burn off, the staybolts to leak and the side sheets to crack around staybolt holes, necessitating the renewal of the flues and side sheets after about fourteen to eighteen months service.

The incrusting solids contained in boiler feed water, while contributing largely to the maintenance cost and the decreased efficiency of the locomotive, are not the most detrimental ingredients encountered. Waters containing calcium chloride, magnesium chloride or sulphate, sodium chloride or sulphates or nitrates, cause a pitting and corrosive action which is exceedingly dangerous and expensive.

Frequent Renewal of Boiler Parts

Locomotives operating in territories where the feed waters are impregnated with incrusting solids, require frequent washing of the boiler and increased maintenance expense, such as the renewal of staybolts in the fire line and flues, the latter can be cleaned, safe ended and replaced, the interior of the shell scaled and the firebox sheets can be vibrated at regular intervals and their life very materially prolonged. This, however, does not apply to locomotives receiving highly corrosive waters which attack the flues, firebox and shell plates. In some instances holes will develop in the flues after about eight months service and firebox sheets will become dangerous and require renewing after two to three years service. These waters will also attack the boiler shell making it necessary to renew the lower portion of the shell, back head, throat sheet and casing sheets.

While corrosive waters are not as prevalent as those causing heavy incrustation, they are more detrimental and more expensive to the railroad, as it is necessary to scrap from 25 percent to the entire set of flues removed from some locomotive boilers.

The ordinary Mikado type locomotive has 262 2-inch and 36 5⅜-inch flues, which can be removed, cleaned, safe ended and reset for $.75 each for the 2-inch and $2.25 each for the 5⅜-inch flues, or a total cost of $277.50 as compared to a total cost of $1,274.25 when it becomes necessary to scrap the entire set due to pitting. This comparison is also true only to a greater degree, with respect to the renewal of boiler and firebox sheets.

Improving the Feed Water

Improving the quality of boiler feed water is one of the most vital factors to be considered by the railroad officials, as it directly or indirectly affects every department on the railroad. The maintenance of way department is concerned chiefly with the cost of supplying the water, the operating department is deeply interested because its members use the water and the mechanical department, is vitally interested: First—In reducing maintenance cost and maintaining the locomotive in service for a longer period between shopping. Second—In providing free steaming locomotives, free from leaks and capable of performing the hardest kind of service, without danger of a boiler failure.

The economies of water purification are far reaching, making it difficult to determine the value of indirect benefits, such as decreased boiler failures, improved locomotive performance, less time out of service, better steaming engines, fewer delays to traffic and lower maintenance cost. Even the savings affected by the increased life of flues and firebox sheets, reduction in broken staybolts, reduction in boiler washouts and less boiler repairs are hard to determine, due to the transfer of motive power. In some instances the entire assignment of locomotives has been changed after the installation of the treating plants.

* Paper read at the 47th annual convention of the American Water Works Association, recently held at Chicago, Ill.

† General Locomotive Inspector, Illinois Central Railroad.

Prior to the treatment of the water, it was necessary to remove the flues after 25,000 to 30,000 miles, the firebox sheets were vibrated every thirty days and the rear flue sheet and side sheets were renewed at each general repairs. Since the installation of the treating plants we have discontinued vibrating the firebox sheets, the flues are averaging 120,000 miles between resettings and the locomotives are being turned out of the shop without the renewal of firebox sheets, although the locomotives are larger and evaporate a great deal more water than those formerly used in the treated water district. These are only some of the benefits obtained from treating water.

The railroad with which I am connected has in service 36 treating plants located at points where the raw waters contain 8.3 to 35.3 grains of incrusting solids per gallon. At other points where the consumption of water is not sufficient to justify the expense of installing treating plants the waters are treated by chemicals applied in the roadside tanks or in the locomotive tenders. During 1926, 2,167,365,320 gallons of water were treated in the 36 plants, at a cost of $204,150.83, resulting in the removal of 4,334,900 pounds of scale forming solids at an estimated net saving of $359,386.17 based upon the figure of $.13 per pound for solids removed as adopted by the American Railway Engineering Association.

The above does not include the saving affected by reason of treating the water by chemicals applied in the roadside tanks or in the locomotive tenders for the removal of scale or the prevention of pitting and corrosion.

On one division where the waters are all corrosive, it was necessary to renew the flues in the stationary boilers after eight months service. Locomotive flues and fireboxes were renewed on an average of 40,000 and 157,000 miles respectively. Since the introduction of anti-corrosive compound, the flues in the stationary boilers require removal after four years service and then about 75 percent are scrapped. The locomotive flues average about 95,000 miles and from 30 to 50 percent are scrapped, the entire firebox will require renewing on an average of 202,000 miles. Prior to the installation of the anti-corrosive compound we were securing an average of 15,303,455 miles per bursted flue failure per year, at present we are securing 35,145,548 miles, an increase of 19,842,093 miles per bursted flue failure per year.

The increase in the service secured from the flues and firebox sheets represents an expenditure of approximately $18,000 per year, covering the cost and handling of the chemicals. The saving affected insofar as the maintenance and renewal costs are concerned is easily computed, but as previously stated, it is the savings of an intangible nature such as the elimination of engine failures, decreased overtime for crews, traffic delays, etc., which are difficult to estimate in order to arrive at the total benefit accruing to the railroads, through improved water conditions.

Dictionary of Locomotive Boiler Terms

Definitions of boiler parts adopted by Master Boiler Makers Association at annual convention

At the recent annual convention of the Master Boiler Makers Association, W. H. Laughridge, chairman of the committee on "Standard Boiler Terms" proposed that the association adopt such portions of the "Dictionary of Terms" appearing in the *Locomotive Cyclopedia* published by the Simmons-Boardman Publishing Company, New York, as applied to boiler work. The convention passed the motion unanimously and adopted the definitions of terms which for the benefit of members of the association and all others connected with locomotive boiler work appear in part below. Earlier sections appeared on page 171 of the June issue, page 201 of the July issue, page 236 of the August issue and page 265 of the September issue. Further instalments of these terms will be published in later issues.

Definition of Terms

O

Oil Burner. A device for burning crude oil in a locomotive firebox by vaporization in a nozzle to which a supply of air and steam can be admitted to effect complete combustion. In modern practice the burner is placed at the front end of the firebox thus projecting the flames toward the back of the fire pan and causing them to completely fill the firebox before entering the fire tubes.

Oil Burner Blow-out Cock. A valve for admitting steam or air to an oil burner for the purpose of cleaning it of soot and dirt.

Oil Burner Clamp. A clamp for holding the oil burner in place.

Oil Burner Cock. A valve for admitting oil to an oil burner.

Oil Burning Locomotive. It is possible to adapt a locomotive designed for burning coal to the burning of oil by installing the proper apparatus in the firebox and making the necessary changes in the draft appliances. Naturally, however, in order to secure the best results, the locomotive should be designed and proportioned for the burning of oil. A topical discussion on the best proportion of grate service and arrangement of draft appliances for oil burning locomotives will be found in the Master Mechanics' Proceedings, 1902, page 384.

Oil Burning Piping. The piping used to conduct and distribute oil from the tank to the oil burners in the firebox of oil-burning locomotives.

Open Return Bend (Pipe Fittings). A short cast or malleable iron U-shaped tube for uniting two parallel pipes. It differs from a close return bend in having the arms separated from each other.

Outside Firebox Sheet. The outside plate of a boiler forming the side water legs at the firebox and riveted to the roof sheet and mud ring. Frequently the roof sheet and outside firebox sheets are combined in one continuous sheet. The outside firebox sheet is secured to the firebox side sheet by staybolts.

Outside Welt. See Welt.

P

Pacific Type Locomotive (4-6-2). A locomotive having a four-wheel front truck, three pairs of coupled driving wheels and a two-wheel trailing truck. Used for heavy fast passenger service.

Patch Bolt. A small threaded plug with a square head and washer formed on it, used for plugging staybolt holes, or applying temporary patch plates to the boilers.

Petticoat Pipe. A pipe in the smokebox over or surrounding the exhaust pipe for the purpose of causing a partial vacuum in the front end and tubes.

Petticoat Pipe Bracket. A bracket bolted to the smokebox shell for the purpose of supporting the petticoat pipe.

Pneumatic Cylinder Cock. See Cylinder Cock.

Pneumatic Cylinder Cock Valve. See Cylinder Cock Valve.

Pneumatic Firedoors. Firedoors operated by compressed air.

Pop Safety Valve. A valve set with a spring so as to open suddenly with a wide opening at a fixed pressure and close suddenly when the desired drop in pressure is reached; hence the name. They are frequently muffled to deaden the noise of escaping steam, by causing it to take a tortuous passage through perforated plates to the atmosphere.

Prairie Locomotive (2-6-2). A locomotive having a two-wheel front truck, three pairs of coupled driving wheels and a two-wheel trailing truck.

Pressure Gage. A device for indicating the pressure in a boiler or air reservoir. Usually placed in the cab and illuminated by a gage lamp. Three gages are commonly mounted in a locomotive cab to indicate boiler steam pressure, train line steam heat pressure, and brake pipe and main reservoir air pressure.

R

Rack Locomotive. A locomotive for climbing grades too steep for good adhesion. It runs on rails as other locomotives. On moderate grades the adhesion of the driving wheels is sufficient, but on the steepest grades a rack rail is laid between the two running rails and engages with gears keyed on the center of the driving axle, thus giving a positive tractive effort. The boiler is mounted so as to preserve a uniform water level when the locomotive is climbing a steep grade. Rack locomotives are provided with powerful air, hand and water brakes to prevent runaways down grade.

Radial Stay. In most boilers the crown sheet of the firebox is supported by a number of rods or stays passing through the roof sheet and riveted over. The firebox end usually has a button head. Flexible radial stays are used where the liability of breakage due to expansion is greatest. These stays are set radially to the curvature of the crown and roof sheets, hence the name.

Radial Stay Boiler. A boiler having a transversely arched crown sheet, supported from the roof sheet by stays or stay bolts set on lines that are radii of curvature of the inner and outer sheets.

Reading Type Locomotive (4-4-4 T). A tank locomotive having a four-wheel front truck, two pairs of coupled driving wheels and a four-wheel trailing truck. Old.

Reheater Flue. A large flue in the forward part of a boiler in which the reheater is placed and through which the gases from the firebox pass on their way to the smokebox.

Return Bend (Pipe Fittings). A short cast-iron or other metal U-shaped tube for uniting the ends of two wrought-iron pipes. They are called close return bends, or open return bends, according as the section of the pipe is kept a distinct circle at all points. The close return bend has simply a partition dividing the two parts for a short distance. Used to join the ends of superheater tubes sometimes being forged integral with the tubes.

Riveted Joints. See Butt Joint, Chain Riveting, Circumferential Riveting, Diamond Boiler Seam, Lap Joint, Longitudinal Seam, Staggered Riveting.

Rocking Grate. A grate having grate bars carried in bearings on the side frame so that they can be revolved out of a horizontal position to drop the ashes by means of a system of crank arms and levers operated from the cab deck. See Grate and Shaking Grate.

Roof (Cabs). The cover or upper part of a cab with a surface sloping to the sides to shed water. See Arch Roof.

(Firebox.) See Crown Sheet.

Roof Sheet. A boiler plate or sheet directly over the firebox crown sheet and to which the crown sheet stays are attached. In some designs the roof sheet and outside firebox sheets are made in one continuous plate. In wagon top boilers the roof sheet and dome course are usually identical.

S

Saddle. That part of a cylinder casting on which the smokebox rests and containing the steam and exhaust passage is called a half saddle. In very large engines the saddle is sometimes cast separately and bolted to the cylinders through flanges on each. With the introduction of outside steam pipes the steam passages have been shortened and the casting made simpler and stronger. See Driving Box Saddle, Link Saddle.

Saddle Bolt. The bolt that is used for bolting the two halves of the cylinder saddle together. Usually the cylinder is cast with a half saddle and the saddle bolt is for fastening these two halves together.

Saddle Tank Locomotive. A locomotive having a water tank over the top of the boiler and operated without the usual tender. Used for contractor's, industrial and suburban service.

Safe End. A bushing or short piece of pipe welded in the expanded end of a tube or flue. See Tubes (Specifications and Tests).

Screw Thread Gage. A steel plate with notches in the edge of the precise form of screw threads, used for giving the proper form to the edges of screw-cutting tools.

Seam Lap. That portion of one edge of a boiler plate that is laid over the other edge of the same plate or an adjoining plate to rivet them together.

Seams. See Riveted Joints.

Sectional Firebox. A firebox in which the usual arrangement of flat sheets supported by staybolts has been abandoned except in the front sheets and door sheet. Side sheets and crown sheets have been replaced by sets of channel-shaped sections riveted together, with their flanges away from the fire. Stay bolts have been replaced by stay sheets, one at each joint of the channels, which are interposed between the sections and secured by the same rivets that hold adjacent flanges. These sheets are partially cut away in the water leg to permit horizontal circulation of water around the firebox and the edges of the sheets from calking strips for making tight joints between adjacent channel sections. All seams are submerged and no joints are exposed to the fire or hot gases. See Firebox.

Segmental Arc Draft Pan. A fire or draft pan for an oil burning locomotive, the bottom of which is built to form the segment of an arc.

Separable Boiler. A boiler composed of two units joined together in a separable joint. The rear unit forms the boiler proper with firebox and tubes, while the forward unit contains a superheater, re-heater, feedwater heater and smokebox. Used on some Mallet locomotives.

Shaking Grate. A grate with broad, flat or finger grate bars carried on eccentric bearings or links and arranged to move up and down relatively to each other to shake the ashes from the fire through to the ashpan below.

Shell. See Barrel, Boiler Shell.

Side Sheet. See Firebox Side Sheet.

Side Sheet Angle Iron. A steel angle bar or post to which one of the sides of a tender tank is riveted. See Tank Angles.

Side Sheet Step Support. A bracket secured to the side of a boiler for holding a step.

Side Tank Locomotive. A locomotive having water tanks attached to both sides of the boiler and usually operated without the usual tender. Generally used in contractors' industrial and suburban services and built with various wheel arrangements.

Side Water Space (Boilers). The space formed by the firebox side sheet, mud ring and outside firebox. See Water Space.

Siphon. A steel pipe to which the water scoop of a tender is attached, passing through it and having the upper end bent over to deliver water into the tank. Also called siphon pipe.

A siphon is placed between a steam gage and the boiler to prevent the steam reaching the inside of the gage. With a siphon, only water can actually enter the bent tube of the gage. See Syphon.

Six-Coupled Locomotive. A locomotive having three pairs of coupled driving wheels. Built with engine or trailing truck, or both.

Six-Wheel Switcher (0-6-0 Type). A locomotive having three pairs of coupled driving wheels, but no front or trailing truck. Used for switching purposes. This type is frequently built with either side or saddle tanks and without the usual tender.

Sling Stay. A boiler stay attached at each end with a pin fitting through a hole in a tee or channel bracket on the boiler plates and a corresponding hole in the end of the stay. It gives some degree of flexibility and allows the plates to contract and expand freely and independently. Usually placed over the crown sheet. Not commonly used in modern construction.

Sling Stay Channel. A commercial channel iron or a bent plate riveted to the boiler plates and to which the sling stays are fastened.

Sling Stay Tee. A commercial tee iron riveted to a boiler plate and used to support one end of a sling stay.

Smokebox. The forward portion of a boiler to which the products of combustion pass from the tubes before being discharged through the stack. Frequently called front end.

Smokebox Back Ring. A steel or iron ring to which the back edge of a smokebox and the front tube plate or front edge of the boiler shell are secured, forming the joint between the boiler shell and the smokebox shell.

Smokebox Bottom Liner. A plate or pad riveted on the inside and at the bottom of the smokebox shell to strengthen it where the steam pipe opening is cut out and also to prevent wear on the smokebox shell by the abrasive action of cinders.

Smokebox Brace. A heavy steel rod fastened to the smokebox at one end and to the front bumper or frame at the other. One is usually placed on each side of a smokebox. Erroneously called front boiler brace.

Smokebox Cleaning Hole. See Cinder Cleaning Hole.

Smokebox Cleaning Hole Cover. See Cleaning Hole Cover.

Smokebox Crane. A swinging arm pivoted to the smokebox and carrying on it a chain hoist for conveniently handling parts around the front end of the locomotive in case of breakdowns.

(To be continued)

Revisions and Addenda to the A. S. M. E. Boiler Construction Code

It is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision in the rules in its codes. Any suggestions for revisions or modifications that are approved by the committee will be recommended for addenda to the code, to be included later on in the proper place in the code.

Important addenda that have been suggested for insertion in the code are published below and are submitted for criticism and comment thereon from anyone interested therein. Discussion should be mailed to C. W. Obert, secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

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

Proposed Standard Practice for Making Hydrostatic Test on a Boiler Pressure Part to Determine the Maximum Allowable Working Pressure in Accordance with Par. P-247

1. *Material.* The structure shall be made from material approved for the intended use by the A.S.M.E. Boiler Code.

2. *Workmanship.* The dimensions and minimum thickness of the structure to be tested should not vary materially from those actually used. If possible the structure to be tested should be selected at random from a quantity of such intended for use.

3. *Preparation for Test.* It is necessary to test only the weakest point of the structure, but several points should be checked to make certain that the weakest one is included. The less definite the location of the weakest point, the more points should be checked.

The movement of the reference points may be measured with reference to a fixed surface, or two reference points may be located on opposite sides of a symmetrical structure and the total deformation between those two points measured.

Indicating micrometer gages accurate to 0.001 inch are most suitable for measuring deformation of the structure at the reference points although any form of accurate micrometer may be used.

A hand test pump is satisfactory as a source of hydrostatic pressure. Either a test gage or a reliable gage which has been calibrated with a test gage should be attached to the structure.

The maximum hydrostatic pressure that must be provided for will vary from 2 to 3 times the expected maximum allowable working pressure for carbon-steel structures.

The location of the weakest point of the structure may be determined by applying a thin coating of plaster of paris or similar material, and noting where the surface coating starts to break off under hydrostatic test. The coating should be allowed to dry before the test is started.

4. *Hydrostatic Test.* The first application of hydrostatic pressure need not be less than the expected maximum allowable working pressure. At least ten separate applications of pressure, in approximately equal increments should be made between the initial test pressure and the final test pressure.

When each increment of pressure has been applied the valve between the pump and the structure should be closed and the pressure gage watched to see that the pressure is maintained and that no leakage occurs. The total deformation at the reference points should be measured and recorded and the hydrostatic pressure recorded. The pressure should then be released and each point checked for any permanent deformation which should be recorded.

Only one application of each increment of pressure is necessary.

The pressure should be increased by substantially uniform increments, and readings taken until the elastic limit of the structure has obviously been exceeded.

5. *Physical Characteristics of Metal.* The following physical qualities of the metal should be determined from test specimens if method 8*a* for determining the maximum allowable working pressure is used:

a Tensile Strength
b Proportional Limit

After the test is completed, cut out at least five tensile test coupons that can preferably be machined to standard ½-inch diameter by 2-inch gage length specimens (Fig. S-4, Section II of the Code). These coupons should preferably be representative of the metal at the weak sections of the structure and their axes should preferably be parallel to the direction of greatest stress. These coupons must not be cut out with a gas torch as there is danger of changing the physical qualities of the material.

6. *Plotting Curves.* A single cross-section sheet should be used for each reference point of the structure. A scale of 1 inch = 0.01 inch deformation and a scale of at least 1 inch equals the approximate test pressure increments has been found satisfactory. Plot two curves for each reference point, one showing total deformation under pressure and one showing permanent deformation when the pressure is removed.

7. *Determining Proportional Limit of Pressure Part.* Locate the proportional limit on each curve of total deformation as the point at which the total deformation ceases to be proportional directly to the hydrostatic pressure. Draw a straight line that will pass through the average of the points that lie approximately in a straight line. The proportional limit will occur at the value of hydrostatic pressure where the average curve through the points deviates from this straight line.

In pressure parts such as headers where a series of similar weak points occur the average hydrostatic pressure corresponding to the proportional limits of the similar points may be used.

The proportional limit obtained from the curve of total deformation may be checked from the curve of permanent deformation by locating the point where the permanent deformation begins to increase regularly with further increases in pressure. Permanent deformations of a low order that occur prior to the point really corresponding to the proportional limit of the structure, resulting from the equalization of stresses and irregularities in the material, may be disregarded.

It should be made certain that the curves show the deformation of the structure and not slip nor displacement of reference surfaces, the gages, or the structure.

8. *Determining Maximum Allowable Working Pressure.* *a.* Having determined the proportional limit of the weakest point of the structure the corresponding maximum allowable working pressure may be determined by the formula:

$$P = \frac{H \times S}{E \times 5}$$

P = maximum allowable working pressure.
H = hydrostatic pressure at the proportional limit of the pressure part.
S = average tensile strength of material.
E = average proportional limit of the material.

b. As an alternate method of determining the maximum allowable working pressure, eliminating the necessity of cutting coupons for tensile tests, the proportional limit of the material may be considered as $^2/_5$ of its tensile strength. The maximum allowable working pressure may then be taken as one-half of the hydrostatic pressure corresponding to the proportional limit of the pressure part.

9. *Retests.* A retest should be allowed on an additional structure if errors or irregularities are obvious in the results.

Revisions and Addenda*

Par. M-3. Present paragraph to be made section *a*. Insert Par. M-6, revised, as section *b*, which reads as follows:

b. Steam boiler parts [generator elements] of not over 600 cubic inches in volume may be made of cast copper or bronze having a copper content of not less than 90 percent and wall thickness of not less than ¼ inch. Such steam boiler parts [generators] shall be equipped with at least two brass washout plugs of not less than 1 inch iron-pipe size and shall be tested to a hydrostatic pressure of 600 pounds per square inch.

Par. M-4. Revised:

M-4. The construction of miniature boilers, except where otherwise specified, shall conform to that required for power boilers. The factor of safety and method of computing the maximum allowable working pressure shall be the same as for power boilers. The flat surfaces of boilers or pressure parts shall be stayed in accordance with Par. P-204 of Section I of the Code.

Par. M-6. Revised:

M-6. The temperature of the heating element for electrically heated steam boilers (closed system) shall be so controlled that it will not exceed 1200 degrees Fahrenheit.

Par. M-8. Revised:

M-8. Tubes may be made of wrought iron, steel, drawn copper, or drawn brass. Fire tubes 1½ inches and over shall have both ends substantially expanded into the tube sheet by rolling and beading. Fire tubes less than 1½ inches shall be expanded and beaded, or expanded and welded. The gage of the tubes shall not be less than that specified for watertube and firetube boilers in Pars. P-21 and P-22 of Section I of the Code.

Tube holes shall be drilled full size from the solid plate, or they may be punched at least ½ inch smaller in diameter than full size, and then drilled, reamed or finished full size with a rotating cutter.

The sharp edges of tube holes shall be taken off on both sides of the plate with a file or other tool.

* For convenience to the reader, in studying the following revisions all added matter appears in small capitals, and all deleted matter in smaller type.

Par. M-9. Revised:

M-9. All rivet holes shall be drilled full size with plates, butt straps and heads bolted up into position, or they may be punched not to exceed ⅛ inch less than full diameter and then drilled or reamed to full diameter with plates, butt straps and heads bolted up into position. The finished holes must be true, clean, and concentric. After drilling or reaming rivet holes the plates and butt straps of longitudinal joints shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fitting the holes, and with tack bolts.

Par. M-10. Revised:

M-10. The calking edges of plates, butt straps and heads shall be beveled to an angle not sharper than 70 degrees to the plane of the plate, and as near thereto as practicable. Every portion of the unfinished [sheared] surfaces of the calking edges of plates, butt straps and heads shall be planed, milled, or chipped to a depth of not less than ⅛ inch. Calking shall be [so] done with a tool of such form that there is no danger of scoring or damaging the plate underneath the calking edge, or splitting the edge of the sheet.

Par. M-12. Revised:

M-12. Every miniature boiler shall be provided with at least one feed pump or other feeding device, except where it is connected to a water main carrying sufficient pressure to feed the boiler except that when the steam generator is operated with no extraction of steam (closed system), no feeding device is required, but in lieu thereof a suitable connection or opening shall be provided to fill the generator when cold. Such connection shall not be less than ½ inch pipe size.

Par. M-13. Revised:

M-13. Each miniature boiler shall be fitted with feedwater and blow-off connections, which shall not be less than ½ inch iron-pipe size unless operated on a closed system as provided in Par. M-12. The feed pipe shall be provided with a check valve and a stop valve. The feedwater may be delivered to the boiler through the blow-off connection, if desired. The blow-off shall be fitted with a valve or cock in direct connection with the lowest water space practicable.

Par. M-14. Revised:

M-14. Each miniature boiler for operation with a definite water level, shall be equipped with a [water] gage glass for determining the water level, except that when it is operated with no extraction of steam (closed system), not less than two gage cocks may be used instead of a gage glass. The lowest permissible water level shall be at a point one-third of the height of the shell except where the boiler is equipped with internal furnace, when it shall be not less than one-third of the length of the tubes above the top of the furnace. For closed-system boilers the location of the lower gage cock shall not be less than ½ inch above the heated surface.

Par. M-16. Revised:

M-16. Each miniature boiler shall be equipped with a sealed spring-loaded pop safety valve, not less than ½ inch in diameter, connected direct to the boiler, independent of any other connection. Where there is no extraction of steam (closed system) a fracturing disk safety valve may be used in addition to the spring-loaded pop safety valve. The safety valve shall be plainly marked by the manufacturer with a name or an identifying trade-mark, the nominal diameter, the steam pressure at which it is set to blow, and A.S.M.E. Std. The minimum relieving capacity shall be determined on the basis of 3 pounds of steam per hour per square foot of boiler heating surface.

Par. C-20. Revised:

C-20. The most important rule in the safe operation of boilers is to keep water in the boiler and as constantly at the proper level as conditions will permit. Never depend entirely upon automatic alarms or feedwater regulators, no matter how effective or valuable these devices may SEEM TO be.

Par. C-25. Revise first sentence to read:

C-25. If any unusual or serious foaming occurs, close OR PARTLY CLOSE the steam outlet valve long enough to determine the true level of the water in the water glass.

Par. C-30. Revise first section to read:

C-30. When small leaks occur, locate their source and repair them as soon as the boiler can be removed from service. If a serious leak occurs, such as a leak along the longitudinal seam or near a flange of a drum head, shut down the boiler immediately by gradually reducing the steam pressure and have the boiler examined by an authorized inspector BEFORE RESTEAMING.

Par. C-31. Revised:

C-31. Many casualties have resulted from the practice of repairing boilers, pipe lines, and attachments under pressure; such practice should not be permitted except when officially authorized and under the supervision of a competent and responsible [person] ENGINEER.

Par. C-33. Revised:

C-33. Remove ashes frequently and do not permit the accumulation of any large amount of ashes in the ashpit, boiler flues, CONNECTIONS TO CHIMNEYS, CONNECTIONS THROUGH ECONOMIZERS, or base of chimney. Do not pile ashes against the boiler front and when wetting down ashes, make sure that no water is thrown upon hot castings. To avoid being scalded, stand well back from hot ashes or refuse while spraying water on them. Do not leave ashes banked about blow-off pipes as a protection.

Par. C-36. Revised:

C-36. Allow the setting to cool SLIGHTLY, [slowly, particularly if there is much sediment in the boiler. After the setting has been cooled] and WHEN there is no pressure on the boiler, open A [the] vent to prevent the formation of a vacuum, and empty the boiler. WHEN PRACTICABLE, EMPTY BOILER ONLY WHEN THE SETTING IS COOL SO AS NOT TO BAKE OR DRY SCALE ON TO TUBES AND HEATING SURFACES AND AVOID ANY TENDENCY TO CAUSE LEAKAGE AT SEAMS OR EXPANDED JOINTS. When it is not practicable to empty a boiler at atmospheric pressure, blow it down at as low a pressure as is consistent with operating conditions. When the boiler to be emptied is set in a battery of two or more boilers, make sure that the blowoff valves that are opened are on the boiler that is to be emptied. As soon as the boiler is emptied, close the blowoff valves, remove the manhole plates, and, when necessary, the covers of other openings.

Par. C-40. Revise first section to read:

C-40. Use hose with sufficient water pressure or hand tools, if necessary, to remove scale. Disconnect the blowoff line and run the water to waste, or when [practical] PRACTICABLE, provide a screen which can be inserted in the OPENINGS TO THE blowoff [hole] CONNECTION. Wash the tubes of horizontal return tubular boilers from below as well as from above.

Par. C-61. Revise sixth sentence of this paragraph to read:

If the valve does not then pop, the boiler [or the part] to which the valve is attached shall be taken out of service and the safety valve cleaned or repaired.

Par. C-64. Revise first sentence of this paragraph to read:

Do not allow the setting or adjustment of safety valves by any one but a competent AND AUTHORIZED person.

Par. C-71. Revised:

C-71. When making a hydrostatic test, remove the safety valves and blank the opening or clamp the valve disk securely to the seat. Also remove the water column floats, if necessary. Make sure that the safety valve is restored to working condition after the hydrostatic test has been made AND TEST THE SAFETY VALVE BEFORE THE BOILER IS AGAIN PLACED IN SERVICE.

Par. C-78. Revised:

C-78. Allow the setting to cool SLIGHTLY [slowly, particularly if there is much sediment in the boiler. After the setting has been cooled] and WHEN there is no pressure on the boiler, open A [the] vent to prevent the formation of a vacuum, and empty the boiler. WHEN PRACTICABLE, EMPTY BOILER ONLY WHEN THE SETTING IS COOL SO AS NOT TO BAKE OR DRY SCALE ON TO TUBES AND HEATING SURFACES AND AVOID ANY TENDENCY TO CAUSE LEAKAGE AT SEAMS OR EXPANDED JOINTS. When it is not practicable to empty a boiler at atmospheric pressure, blow it down at as low a pressure as is consistent with operating conditions. When the boiler to be emptied is set in a battery of two or more boilers, make sure that the blowoff valves that are opened are on the boiler that is to be emptied. As soon as the boiler is emptied, close the blow off valves, remove the manhole plates, and, when necessary, the covers of other openings.

Par. C-89. Revised:

C-89. In the event of flareback or the snapping out of THE burners where oil or gas is used, shut off the fuel supply and thoroughly ventilate the boiler before resuming firing.

Par. C-92. Revised:

C-92. All power boilers should be given one internal INSPECTION and at least one, but preferably two external inspections per year by the state or municipal inspectors having jurisdiction, or by the inspectors of the insurance company carrying the risk. These inspectors are hereinafter termed "authorized inspectors."

Par. C-94. Revised:

C-94. A record of each inspection shall be kept in a uniform manner so that any change of condition can be definitely compared, especially with reference to thickness of scale, corrosion, EROSION, cracks, and other unusual conditions.

Par. C-96. Revised:

C-96. An external inspection by the authorized inspector shall comprehend the superficial examination of the boiler, its appurtenances and connections, and does not necessarily require that the boiler be off the line. It is a form of examination made primarily to check up THE care and management.

Par. C-97. Revised:

C-97. The internal inspection of the boiler SHALL INCLUDE THE EXAMINATION OF THE PREVIOUS BOILER REPAIR AND INSPECTOR RECORDS [shall be] AND a comprehensive and thorough examination in every detail OF THE BOILER ITSELF, embracing particularly the determination of the suitability of the boiler for the pressure carried, strength of its parts, possible deterioration in service, and advisability of its continuance under the pressure APPROVED [carried] previous to inspection.

Par. C-100. Revised:

C-100. The walls, baffles, tubes, and shell shall be thoroughly swept down and the ash and soot removed to give the plant inspector opportunity to closely examine ALL the parts [and to eliminate danger from hot contact].

Par. C-104. Revise first section to read:

C-104. Use hose with sufficient water pressure or hand tools, if necessary, to remove scale. Disconnect the blow off line and run the water to waste, or, when practicable, provide a screen which can be inserted in the OPENINGS TO THE blow off [hole] CONNECTION. Wash the tubes of horizontal return tubular boilers from below as well as from above.

PAR. C-107. REVISED:

C-107. The plant inspector shall examine the boiler for level, noting whether or not there has been any tendency to settlement especially the transverse level of the top tubes in horizontal return tubular boilers. He shall see that proper provision is made for expansion AND CONTRACTION OF THE BOILER AND THE SETTING.

PAR. C-111. REVISED:

C-111. The plant inspector shall note the proximity of overhead shafts or any machinery which might drop [down] on or strike the boiler in case of accident.

PAR. C-113. REVISE FIRST SECTION TO READ:

C-113. A careful examination shall be made of the safety valve, its connections to the boiler, its escape pipe, its [drip] DRAIN and supports. ALL OPENINGS SHOULD BE FREE AND CLEAR.

PAR. C-116. REVISED:

C-116. Before entering the shell or drum the plant inspector shall see that the blow off AND SURFACE BLOW OFF valve, the main AND AUXILIARY steam valves, feedwater valves, and ALL other valves ON CONNECTING PIPES are closed AND A [use some] reliable method of safeguarding THESE VALVES WHILE any one IS inside the boiler SHALL BE USED.

(To be continued)

Preventing Eye Injuries in the Shop

INDUSTRIAL executives, superintendents, and foremen should cooperate in enforcing definite rules which will compel workmen to wear eye protectors on all jobs that are likely to present eye injury hazards.

In many factories employees may be seen using old matches, toothpicks, soiled pocket handkerchiefs, etc., for removing particles from the eyes of their fellow-workers. In some cases the particle actually penetrates the coat of the eyeball, and unless it is properly removed, especially if it is a particle of metal, the sight of both eyes is in danger through sympathetic inflammation which may cause blindness.

Efficient eye protectors should be worn by workmen when grinding, buffing, handling molten metal, babbitting, chipping, riveting, drilling, welding, handling acids or dangerous chemicals, and all other operations that endanger the eyes. Forging machines and drop hammers also add to the hazards. Hot saws send large showers of sparks in all directions, which may cause serious injury to the eye. Many workmen have lost the sight of an eye by being struck with a bit of steel broken from the head of a cold chisel, set punch, or other tool.

With proper eye protection, production will actually be increased on many jobs, since the workman can work faster when he does not have to be constantly guarding his eyes against chips, dust, or flying scale.

The goggles or eye protectors selected should be adapted for the particular work handled. They should be as light as possible and have suitable side protectors. The metal parts should be rustproof and easily adjusted, by bending, to conform to the shape of the face. Let us keep in mind the fact that the proper use of suitable safety goggles has proved the most effective means of protecting the eyesight of workmen in large industrial plants.—A. Eyles in *Machinery*, August, 1927.

C. W. Obert Resigns as Secretary of Boiler Code Committee

CASIN W. OBERT, who for the past sixteen years has been secretary of the A. S. M. E. Boiler Code Committee, tendered his resignation as secretary at the committee meeting on June 24, 1927, to form a connection with the Union Carbide and Carbon Research Laboratories, Long Island City, N. Y. Mr. Obert's retirement from this work marks the close of a period of remarkable activity embracing the early stages of formulation of the A. S. M. E. Boiler construction codes, their introduction into general use and the establishment of the interpretation service of the Boiler Code Committee that now holds the committee so closely to its work.

C. W. Obert

It was with much regret that the members of the committee accepted Mr. Obert's resignation, but he was persuaded, in view of his long association with the work, to remain a member of the Boiler Code Committee and his appointment as member was authorized at that meeting.

At its meeting of September 16, the committee passed the following resolutions, to express its appreciation of the services which Mr. Obert has rendered in the development of the work of the Committee:

WHEREAS, It is with deep regret that we learn of the desire of Mr. C. W. Obert to retire from the secretaryship of the A.S.M.E. Boiler Code Committee which he has served continuously for sixteen years, and

WHEREAS, Mr. Obert's assiduous attention to his secretarial duties, his intelligent and skilled handling of the work of his office, his uniform courtesy and capable conduct of the work, have won the respect and admiration of the members of the committee and of those who have transacted business with the committee, and

WHEREAS, his work has constituted a large factor in the successful outcome of this very important work with its far-reaching effect and influence, now therefore be it

RESOLVED, that we bespeak for Mr. Obert's distinguished success and congenial surroundings in his future undertakings and be it further resolved, that we record our affection and regard for him by spreading of this resolution on the minutes of the Boiler Code Committee and the sending of a copy of it to Mr. Obert.

Following the presentation of a watch as a token of appreciation and esteem the committee passed a resolution appointing Mr. Obert Honorary Secretary to the Boiler Code Committee.

FEEDWATER HEATERS.—Bulletin No. 103 descriptive of Webster feedwater heaters of genuine puddled wrought iron has been issued by Warren Webster & Co., Camden, N. J. These heaters are provided in four different series in a total of 25 standard size units, and are of rectangular and cylindrical designs.

The Morse Twist Drill and Machine Company of New Bedford, Mass., has opened a store at 92 Lafayette Street, New York City, where they have put in a complete stock of their products, consisting of high speed and carbon drills, cutters, reamers, taps, dies, etc., for the convenience of their distributors, dealers and users.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. J. Zusy

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Exhaust Pot Leaks

Q.—What effect would an exhaust pot leaking at joint at bottom have on the drafting of a locomotive?—J. L. F.

A.—A leaking joint on the bottom of the exhaust pot will blow back into the tubes and destroy the vacuum in the smokebox; therefore there will be no draft on the fire and the engine will not steam properly.

Layout of An Elbow of More Than 90 Degrees

Q.—Please furnish me with a layout of an elbow which is more than 90 degrees. Please send this drawing as soon as you can, for it is very urgent that I get it at an early date.—J. F. D.

A.—To lay out a multifold bend or elbow, it is necessary to construct the elevation as shown in Fig. 1, incorporating the desired angle and diameter of pipe. The number of sections in the bend is optional with the designer.

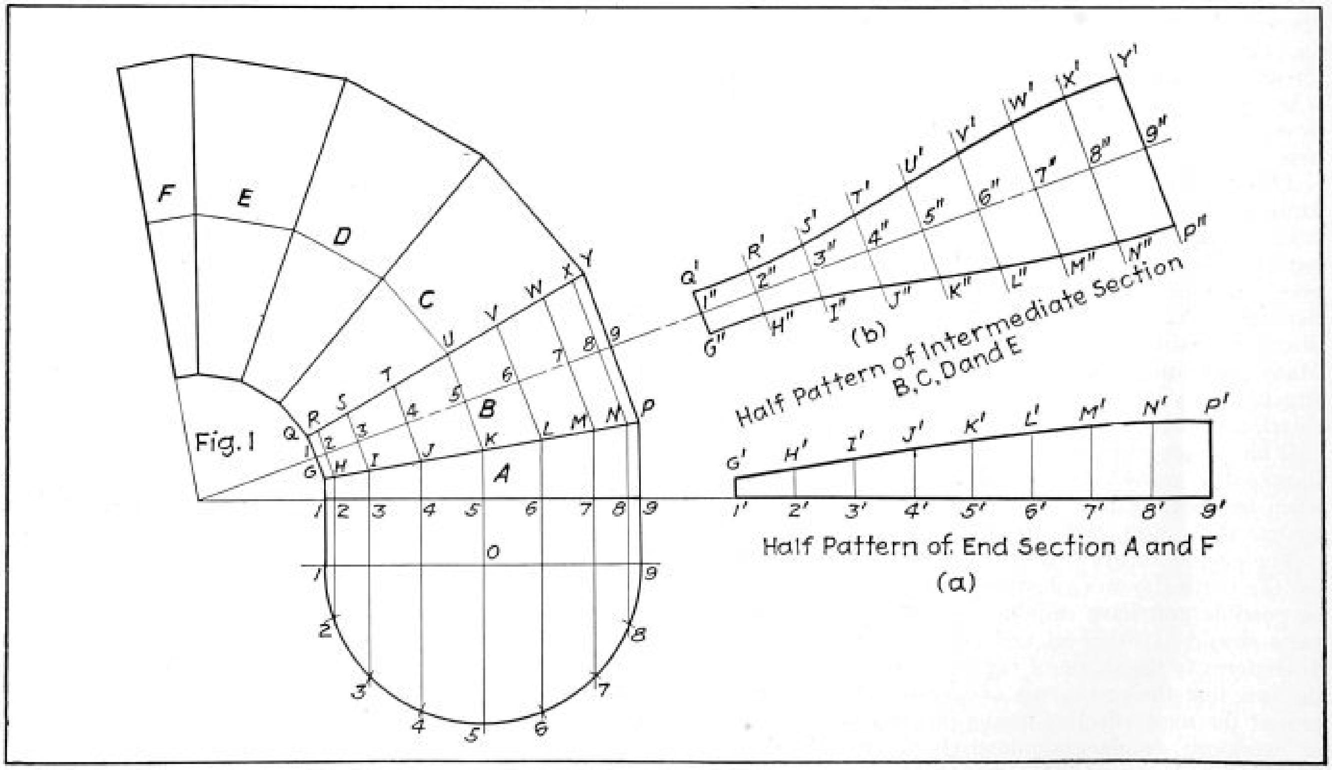
The intermediate sections can be made uniform, likewise the end sections, thereby making only two patterns necessary.

Bisect intermediate section at points *1*, *9*, and line thus found will be center line of intermediate section and pattern.

Draw semicircle *1*, *5*, *9*, and divide into a convenient equal number of parts, 8 in this case, and through the points of division draw the lines *2*, *3*, *4*, *5*, *6*, *7*, *8*, parallel to lines *1*, *G* and *9*, *P*. Then through intermediate section draw lines parallel to lines *Q*, *G*, and *Y*, *P*, intersecting points *H*, *I*, *J*, *K*, *L*, *M*, *N* on junction line *G*, *P*.

To develop half pattern of end section as shown in (a) draw line *1'*, *9'* equal in length to half circumference of pipe and divide this line into the same number of equal parts as used in semicircle. Draw lines at *1'*, *2'*, *3'*, *4'*, *5'*, *6'*, *7'*, *8'*, *9'* at right angles to line *1'*, *9'*. Measure off length of lines *1'-G'*, *2'-H'*, etc., same lengths as lines *1-G*, *2-H*, etc. Then draw edge line *G'*, *P'* through point, *H'*, *I'*, *J'*, *K'*, *L'*, *M'*, *N'*, *P'*, completing pattern.

To develop pattern for intermediate section, as shown at (b), follow same procedure as for end section, except length of lines *G''-Q'*, *H''-R'*, etc., are measured from center line.



Elevation and patterns for elbow of more than 90 degrees

Working Pressure on Wrapper Sheet of a Locomotive Boiler

Q.—Would you advise me of the correct application of formulae given in paragraph L43, clause b, of the A. S. M. E. Boiler Code, for working pressure on a wrapper sheet of a locomotive boiler.

In my application of the formulae given I cannot get the working pressure above 126 pounds per square inch with a ½-inch plate. Yet, by another method which I state later, the ½-inch wrapper plate is quite sufficient for 200 pounds per square inch boiler pressure.

Part 1, Section III, of the A. S. M. E. Boiler Code, paragraph L43, clause b, states:

The maximum allowable working pressure for a stayed wrapper sheet of

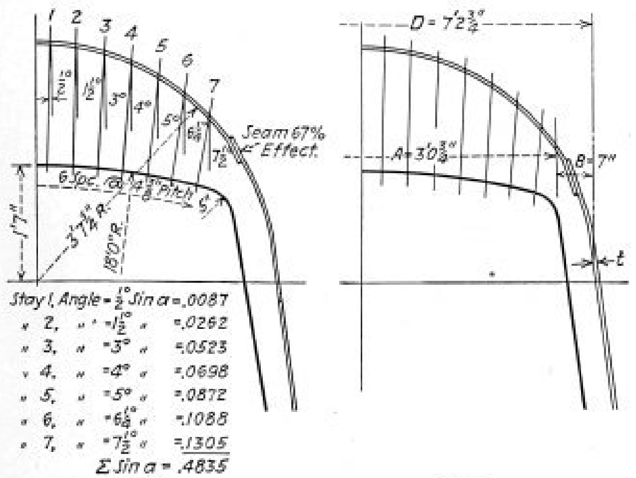


Fig. 1 Fig. 2

Sketches of wrapper sheet problem

a locomotive boiler shall be determined by the two methods given above, and by the method which follows, and the minimum value obtained shall be used:

$$P = \frac{55{,}000}{FS} \times \frac{t \times E}{R - (s\,\Sigma\,\text{Sin}\,a)}$$

in which, a = angle any crown stay makes with vertical axis of boiler.

$\Sigma\,\text{Sin}\,a$ = Summated value of Sin a for all crown stays considered in one transverse plane and on one side of vertical axis of boiler.

s = Transverse spacing of crown stay in crown sheet, inches.

E = minimum efficiency of wrapper sheet through joints or stay holes.

t = Thickness of wrapper sheet, inches.

R = Radius of wrapper sheet, inches.

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

FS = Factor of safety, or ratio of ultimate strength of material to the allowable stress.

$\Sigma\,Sin\,a = 0.4835$
$s = 4.375$
$E = 0.67$
$t = 0.5$ inch
$R = 43.75$
$P = 200$ pounds per square inch.

$$FS = \frac{58{,}240}{4.2}$$

$$\text{By formulae } P = \frac{58{,}240 \times 0.5 \times 0.67}{4.2 \times [43.75 - (4.375 \times 0.4835)]}$$

$$= \frac{58{,}240 \times 0.5 \times 0.67}{4.2 \times 41.64}$$

= 126 pounds per square inch maximum allowable working pressure.

This result of 126 pounds per square inch working pressure means that a ½-inch wrapper plate is not thick enough to stand 200 pounds per square inch working pressure as called for.

Analyzing the formulae, I find that in paragraph L21 of the A. S. M. E. Code, the maximum allowable working pressure on the shell or barrel of a boiler is determined as follows:

$$P = \frac{TS \times t \times E}{FS \times R}$$

Comparing this formulae with the one for the wrapper sheet given previously I find that it is similar, except that R in the denominator has been altered, everything else being the same.

Now in the same boiler under consideration the

Diameter of barrel inside max.	= 7 feet 2 inches = 86 inches
Ultimate plate strength	= 58,240 pounds
Factor of safety	= 4.2
Joint efficiency	= 0.84
Plate thickness	= ¾ inch

$$\text{Then substituting values } P = \frac{58{,}240 \times .75 \times .84}{4.2 \quad 43}$$

$$= \frac{36{,}691}{180}$$

= 231 pounds per square inch max. allowable working pressure.

Therefore, with a ¾ inch barrel plate, 200 pounds per square inch is a safe working pressure.

By the wrapper sheet formulae I can only get 126 pounds per square inch working pressure using a ½-inch plate and the two formulae are exactly alike, except that in the wrapper sheet formula E and R are slightly smaller quantities.

It appears to me that the plate thickness would have to be somewhere in the region of ¾ inch in thickness.

Working it out another way as follows I find that a ½-inch wrapper plate is quite sufficient.

By Fig. 2.

The intensity of stress in the wrapper sheet is $D \times L \times P$.

Where D = inside width of box = 7 feet 2¾ inches
L = length of box = 144 inches
P = boiler pressure pounds per square inch = 200

But the crown of the firebox is stayed to wrapper sheet and relieves the wrapper sheet of a load = $A \times L \times P$, as both sheets for this distance will have equal surface loads in opposite directions; then the load left on the wrapper sheet will be $B \times L \times P$, and the area of plate to resist this load will be $t \times L \times$ *Efficiency of Joint.*

$$\text{Substituting values, stress} = \frac{B \times L \times P}{t \times L \times E} = \frac{7 \times 144 \times 200}{0.5 \times 144 \times 0.67}$$

= 4,179 pounds.

$$\text{then } FS = \frac{58{,}240}{4{,}179} = 13.$$

By this method a ½-inch plate with a joint efficiency of 0.67 has a factor of safety of 1. under a boiler pressure of 200 pounds per square inch. I would be obliged if you could inform me if my application of formula in paragraph L43, clause b, is correct. As it appears to me that being similar to the formula in pargraph L21, by comparison the answer is correct, a ¾-inch plate for 200 pounds per square inch and a ½-inch plate for 126 pounds per square inch. Yet by the method given last a ½-inch plate is sufficient which I am convinced is thick enough.—F. H.

A.—Your application of the A. S. M. E. formula L-43B is incorrect as you did not take into consideration the force acting on the crown sheet and transmitted to the wrapper sheet down to a horizontal line passing through the center of the radius of the wrapper sheet whereas you did consider the forces acting on the wrapper sheet down to this point.

A. S. M. E. Boiler Code paragraph L-43B.

$$P = \frac{55{,}000}{FS} \times \frac{T \times E}{R - s\,\Sigma\,\sin a}$$

in which;

P = maximum allowable working pressure, pounds per square inch

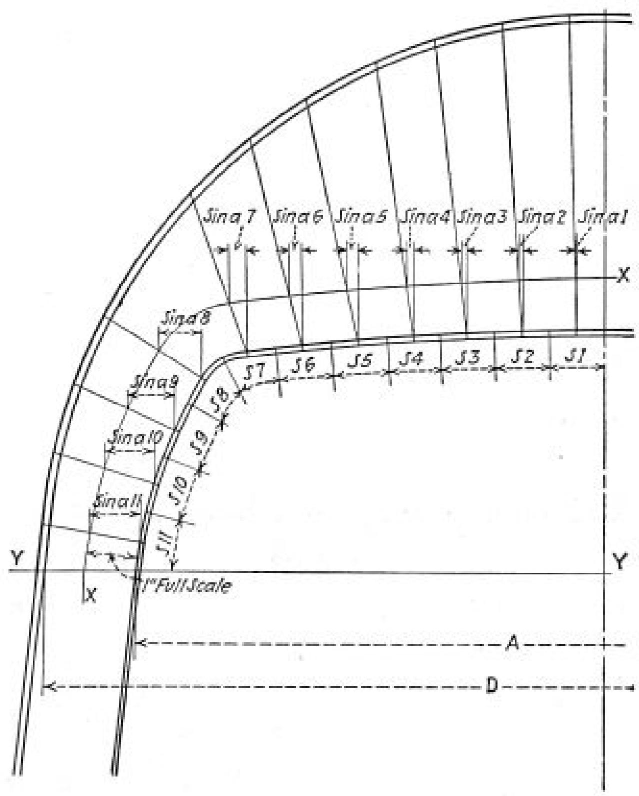


Fig. 3.—Accurate layout of crown sheet and wrapper sheet should be made

FS = factor of safety, or ratio of the ultimate strength of the material to the allowable stress.
t = thickness of wrapper sheet, inches.
E = minimum efficiency of wrapper sheet through joints or stay holes.
R = radius of wrapper sheet, inches.
s = transverse spacing of crown stays, inches.
a = angle any crown stay makes with vertical axis of boiler.
$\Sigma \sin a$ = summated value of $\sin a$ for all crown stays considered in one transverse plane and on one side of vertical axis of boiler.

This formula applies to the longitudinal center section of the wrapper sheet when the crown stays are applied with a uniform transverse pitching. When the transverse pitching is not uniform more accurate results are obtained by taking $\sin a$ for each individual stay and multiplying by the pitch of that stay.

To get accurate results, a layout of the wrapper sheet and crown as shown in Fig. 3 should be made. This layout should be made sufficiently large to permit accurate scaling, about 3 inches to the foot.

The simplest method of obtaining the *sin* of the angle that the stays make with vertical axis of the boiler is by drawing a line *x—x* parallel with and one inch (full scale) from the top of the crown. Then draw lines parallel with the vertical axis of the boiler intersecting the stay at the top of the crown and the stay at the one inch line. The distance (full scale) between these two vertical lines, is the *sin* of the angle the stay makes with the vertical axis of the boiler.

The stays and pitching should be considered down to the horizontal line *y—y* which intersects the center of the wrapper sheet radius.

Then $(s_1 + \sin a_1) + (s_2 \times \sin a_2) + \text{etc.} = s\,\Sigma \sin a$.

If the pitch of the stays is uniform from the vertical center line down to horizontal line *y—y* then $\Sigma \sin a$ can be multiplied by s the uniform pitching.

The formula which you quote

$$\frac{(D-A) \times L \times P}{2 \times t \times L \times E} = T$$

where

L = length of firebox, inches.
P = boiler pressure, pounds per square inch.
t = thickness of wrapper sheet, inches.
E = efficiency of wrapper sheet through joints or stay holes.
T = tension in sheet.
D & A = see Fig. 3.

will give the tension in wrapper sheet at sides of firebox and will be considerably lower than the tension in wrapper sheet at top center due to the angle of the stays.

Efficiency of Combustion Chamber Seams

Q.—Kindly show in your next issue the method used in calculating the efficiency of the seam in the boiler course at the combustion chamber of a locomotive boiler, as shown on the attached sketch, Fig. 1, between lines *A-A* and *B-B*.—A. B.

A.—The combustion chamber does not enter into the calculations for the efficiency of the joint unless the combustion chamber stays enter some part of the joint.

The joint illustrated by Fig. 1 between lines *A-A* and *B-B* is a single riveted butt joint with inside and outside welts. The pitching of the rivets being uniform it will only be necessary to consider one pitch.

This joint may fail in the following ways:

1. Tearing shell plate between rivet holes.
2. Crushing shell plate in front of one rivet.
3. Shearing one rivet in double shear.

Let

E = efficiency of joint.
P = pitch of rivets.
D = diameter of rivet holes.
t = thickness of boiler plate.
TS = tensile strength of boiler plate.
A = area of rivet hole.
C = crushing strength of steel plate.
s = shearing strength of rivets.

Strength of seam case 1. = $P\text{-}D \times t \times TS$.
Strength of seam case 2. = $D \times t \times C$.
Strength of seam case 3. = $A \times S$.

Then,

$$E = \frac{\text{Least value obtained in case 1, 2 or 3}}{P \times t \times TS}$$

In addition to calculating the efficiency of the joint, the efficiency through the stay holes must also be calculated

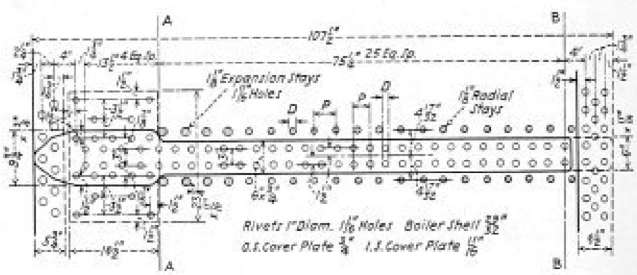


Fig. 1.—Calculation of boiler seam

and the lowest efficiency must be used when computing the maximum allowable working pressure.

The efficiency through staybolt holes is computed in the following manner:

$$E = \frac{P\text{-}D}{P}$$

Where, P = pitch of stays.
D = diameter of stay hole.

When the diameter of stay holes or the pitching of stay holes is not uniform, care should be exercised to assure selecting the pitch and size of stay hole which will give the lowest efficiency.

The formulas in A.S.M.E. boiler code paragraph L-43*A* and *B* should be used when calculating the maximum allowable working pressure as formula, paragraph L-21 is not applicable to a stayed shell sheet.

The appointment of Paul Hecht, of the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company, as assistant to the vice president, has just been announced by H. T. Herr, vice president of the company.

Horace A. Beale, Jr., president of the Parkesburg Iron Company, Parkesburg, Pa., died on September 6, at the age of 57. Mr. Beale was born at Hibernia, Pa., and began work with the Pennsylvania Steel Company, Steelton, Pa., in 1892, and in 1893 he entered the employ of the Parkesburg Iron Company where he became vice president in 1898 and president in 1900. During his administration of the Parkesburg Iron Company, a tube mill for manufacturing charcoal iron into boiler tubes was built in 1908.

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

States

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

Cities

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

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

States

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

Cities

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

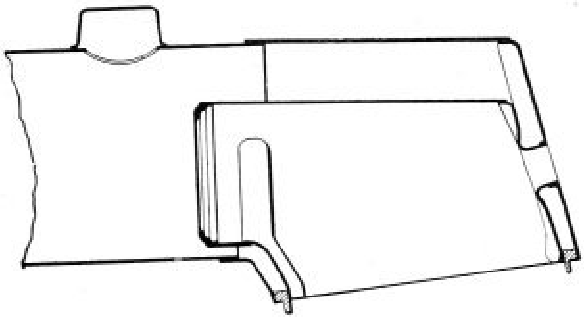
SELECTED BOILER PATENTS

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

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

1,633,993. HUGH McCABE, OF LAWRENCE, MASSACHUSETTS, ASSIGNOR TO McCABE MANUFACTURING COMPANY, OF LAWRENCE, MASSACHUSETTS, A PARTNERSHIP. LOCOMOTIVE BOILER.

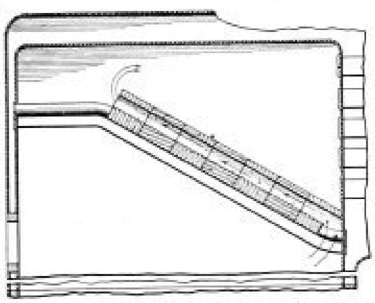
Claim. A tube sheet for fire boxes of locomotives having a tube sheet proper formed with a flange at its edges, the angle between the tube



sheet and the flange being thicker than the tube sheet proper to enable it to bear the stresses of expansion and contraction due to fluctuations in the temperature.

1,641,043. DORSEY EUGENE MOORE, OF BRUCETON, TENNESSEE, ASSIGNEE OF ONE-HALF TO OLIVER A. HARKER, JR., OF PURYEAR, TENNESSEE. FIRE-BOX ARCH.

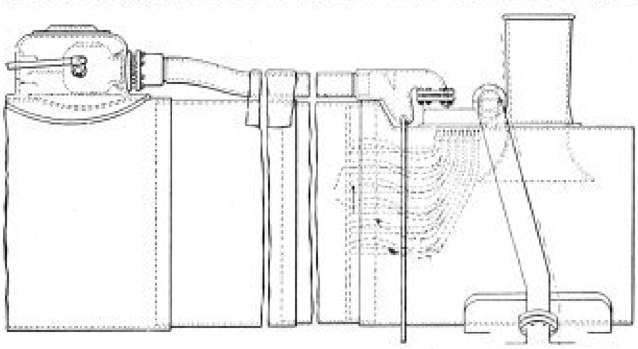
Claim. In a furnace fire box, an upwardly and forwardly extending arch formed of a plurality of longitudinally extending courses of brick, the bricks of each course being hollow and communicating with each other to thereby form flues straight from end to end and discharging



at their upper ends at the crest of the arch, said arch terminating short of the rear wall of the fire box, the lower end of each flue opening upon the underface of the arch at the forward end thereof, the bricks of each course being cut away at their lower corners, and tubes extending upwardly and longitudinally through the fire box and engaging the cut away corners of the bricks to support the arch, said tubes communicating with the water space of the boiler.

1,627,402. JOHN E. MUHLFELD, OF SCARSDALE, NEW YORK, AND AUGUST G. SANDMAN, OF BALTIMORE, MARYLAND. STEAM LOCOMOTIVE.

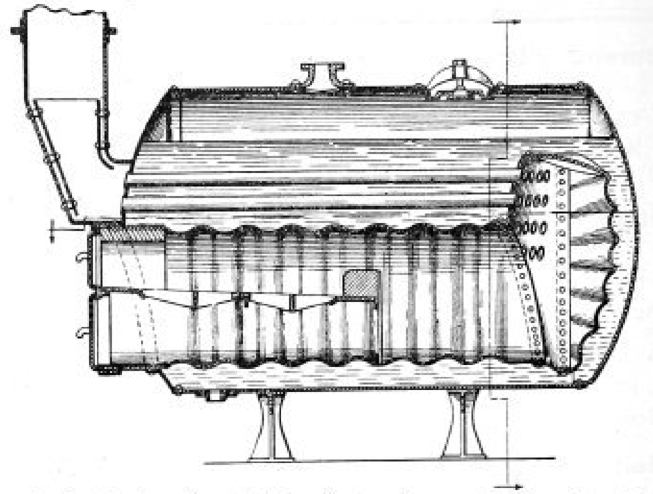
Claim 1.—In a railway locomotive, a fire tube boiler having a smoke box at its forward end and working cylinders on opposite sides thereof,



a superheater header mounted exteriorly of the smoke box, a supply pipe connection between the boiler and the superheater header arranged externally of the boiler shell, superheater elements connected with the header extending through the smoke box and into the fire tubes of the boiler, and superheated steam supply connections between the header and said working cylinders. Four claims.

1,634,056. JAMES HALL TAYLOR, OF OAK PARK, ILLINOIS. STEAM BOILER.

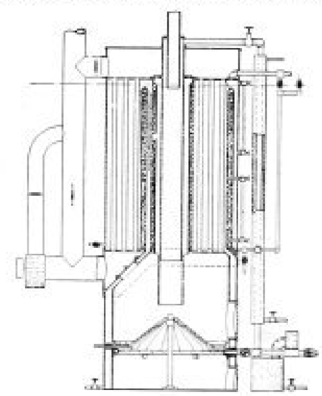
Claim 1. In a boiler, the combination of walls forming an outer shell, a furnace disposed inside the shell, a combustion chamber formed inde-



pendently of said walls, and having front and rear outwardly and spherically bulged walls marginally united, the furnace being joined to one of the walls of the combustion chamber, and flues leading from the chamber. Seven claims.

1,624,908. OLIVER S. BOWMAN, OF COLORADO SPRINGS, COLORADO. VERTICAL FIRE-TUBE BOILER.

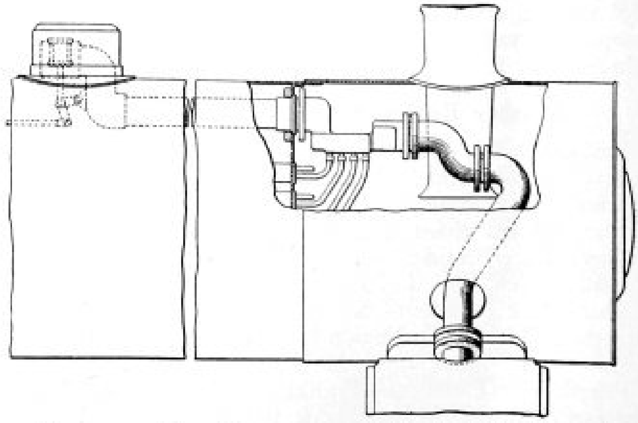
Claim. In a vertical return-draft fire tube boiler, in combination, a main shell; a fire box, comprising concentric shells, positioned below said main shell; a lower tube sheet, divided into minor segment, the arc of which is fixed to the rear of said main shell, and a major segment mounted



on the inner shell of said fire box; a continuous insulating wall, conforming to an arc at the front and to a chord of a circle at the back, vertically disposed within said main shell and spaced therefrom, said wall comprising concentric shells connected at the top and insulating material therebetween, the outer shell being secured to the chord of the minor segment of said lower tube sheet and to the bottom of said main shell, and the inner shell mounted on the outer shell of said fire box. 7 Claims.

1,621,600. WILLIAM L. REID, OF LIMA, OHIO. LOCOMOTIVE STEAM PIPES.

Claim 1.—In a locomotive, the combination of a smoke box, a dry pipe, a steam supply casting in the smoke box receiving steam from said dry pipe, a valve chest, a section of steam pipe having a jointed connection



to said steam supply casting, a second section of steam pipe angularly disposed with respect to the first section and having a jointed connection to said valve chest, and a jointed connection between the other ends of said sections.

Two claims.

The Boiler Maker

Volume XXVII | November, 1927 | Number 11

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

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

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CONTENTS

Shop Kink Prize Competition

THE value of real boiler shop kinks and practical short cuts for doing boiler construction and repair operations quicker, better and easier is well known to the men who have developed them. An opportunity is now offered to every man in the field of boiler, tank and plate construction, repair and inspection to cash in on his knowledge of shop kinks.

Beginning with this issue of THE BOILER MAKER a shop kink prize competition will be conducted which will close January 20, 1928. The prizes for the winners of this contest will be awarded as follows: For the best two practical boiler shop kinks or methods submitted by each individual, a first prize of $50; for the second best set of two, $35, and for the third best set of two, $20. All contributions to the contest that are suitable for publication, but which do not win prizes, will be paid for at regular space rates at the time they appear in the magazine. Also, if more than two descriptions of kinks are included in a prize-winning contribution, space rates will be paid in addition to the prize at the time such articles are published. All material submitted that is suitable for publication will therefore receive remuneration.

The length of contributions will not be the determining factor in selecting the prize winner, descriptions of 500 words or less for each kink are the most desirable. Photographs, drawings or sketches are desirable and should accompany descriptions whenever possible. The sketches need not be made on a drawing board but should be prepared carefully and accurately, so that they may be readily understood by the judges and by the draftsman who will make a finished drawing for publication. Consideration will be given to the appearance of the article; that is, it should be written legibly on one side of the sheet only.

Do not feel that you are unable to write well enough to enter such a competition, the prime factor in determining awards will be the extent to which the method or device submitted is valuable in saving labor, time, cost, ease in handling the work or in the promotion of safety. The *idea* is the thing, not the manner in which it is presented. You are not restricted to two kinks, methods or devices, but may send as many as you like. The awards will be made on the basis of what the judges believe to be the best two which you submit.

As has been noted in these columns many times, one of the most instructive features of discussions at meetings of a body of boiler makers or other craftsmen is the exchange of practical ideas on how any given job may be done and the tools to be used in doing it more easily or better. While it is only possible to discuss such kinks with a few people at any time, THE BOILER MAKER offers an opportunity of exchanging ideas with men throughout the entire country every month. The present prize competition is being conducted to stimulate the interest of men in the boiler making trade in taking advantage of the opportunity offered of using its pages to exchange their experiences in developing shop and tool improvements so that everyone may be benefited by a wider contact with his fellow craftsmen.

Every boiler maker, layerout, welder, foreman, inspector, apprentice and any individual connected with the trade is eligible to submit kinks or methods which he has found useful in his shop.

A group of judges has been selected—practical men who will recognize the value of the kinks offered and who will select the three sets of prize-winning contributions.

Articles will be received by the contest editor of THE BOILER MAKER, 30 Church street, New York, up to, but not later than January 20, 1928, and the announcement of the prize winners will be made in the February issue of the magazine.

Manuscripts will be returned if requested. If so desired, the author's name will not be published with his article but it is highly desirable that full credit be given to each individual who submits a kink that is accepted for publication by publishing his name as the author.

The opportunity is in your hands to obtain a real return for your ideas and it should be the endeavor of every foreman, apprentice, inspector, mechanical official, plant manager and others having men engaged in boiler work under their charge to see that advantage is taken by these men of submitting material that can be made into a permanent and valuable record of the shop kinks that are being developed for the betterment of the trade in every shop.

We will depend on every man in the shops to give this competition serious thought and cooperate with the others in the craft to produce a series of suggestions on boiler shop practice that will be of value to the industry at large and will in addition give them a definite return for their work.

Hire Careful Men

SO many features enter into the problem of promoting safety in the operation of a shop that not infrequently some obvious but rather intangible phases of it are overlooked. One of these is found in the hiring of men who, although they are good workmen, skilled in their trade, have never learned the habit of safety. An examination of the active record of such men shows that during their careers they have been involved in a number of accidents of either lesser or greater degree. The assumption can be made in most cases that a serious accident will develop a sense of caution in the handling of dangerous tools and in carrying out dangerous operations—and in every shop operation is an element of danger. If only minor accidents have followed the individual there is grave danger that a really serious one may next overtake him.

Accidents whether they are minor in degree or actually cause considerable damage to life and property should be avoided and one of the best ways to accomplish this end is to judge carefully with his other qualifications the ability of a man to keep out of trouble. The place to do this is at the office before such a man has been put on the pay-roll.

In the matter of example to others in the shop, the careless man is in a position to indirectly sew the seeds of trouble that will have far-reaching effects. Time lost on account of accidents, direct hospital and medical costs, compensation and other expensive items enter into the bill for carelessness. The solution of the problem is of course to measure a man's safety habits at the time he is hired.

Proper care of machine tools to keep them in good condition and free from hazard, the maintenance of a supply of goggles for eye protection, the use of guards on hand tools, adequate repair and maintenance of floors, staging, and other forms of protection can all be attended to by the plant superintendent, but these are not sufficient by themselves. Each individual in the shop must be constantly on guard against accident to himself and to those around him.

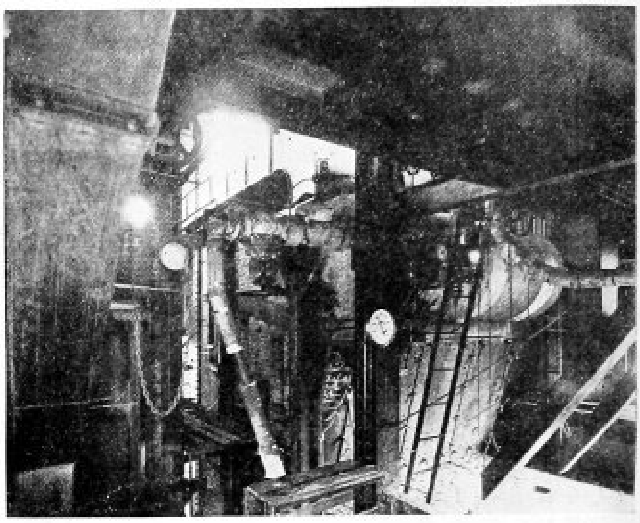
LETTERS TO THE EDITOR

One Thousand Pounds Steam Pressure

TO THE EDITOR:

At Laurel, Mississippi, in the plant of the Mason Fiber Company is a steam boiler that furnishes steam for the manufacture of a sawmill waste product called Presswood. This boiler operates at the highest pressure so far employed for process purposes.

A pressure of 200 pounds is first applied to waste wood chips and they are cooked for only 15 to 20 seconds. The



Boiler plant using pressure of 1,000 pounds per square inch

valve is then opened fully and the chips subjected to a pressure of 1,000 pounds. This pressure is maintained for the brief period of 3 to 5 seconds. Immediately after this the container is suddenly opened and the pressure released, the pressure dropping 1,000 pounds. This causes the chips to explode for reasons known to all engineers. A wood-pulp of long fiber is thereby produced. After this the exploded chips are pressed into fiberboard.

The illustration herewith shows the boiler which is a 4,000 square foot Babcock & Wilcox cross drum type. It has two-inch tubes 3/8 inch thick. The drum is of a solid steel forging. It has drum ends, 4 feet in diameter, and 4 inches thick.

Newark, N. J. W. F. SCHAPHORST.

The Missing Link

TO THE EDITOR:

Ever since the era of steam began there has been a steady advance in the art of steam boiler making. Pressure has been increased from time to time until today 300 to 500 pounds per square inch is not at all unusual; the material has been improved by new discoveries and processes of manufacture and today there is no uncertainty—and everything is figured down to the least fraction and relied on as being correct. Yet in spite of all this there has been an indefinable want. What was this want? It was education along the lines of scientific boiler making. How to remedy this has been the wish of the writer for years. That there were others in the same condition is evident by the fact that some of them awoke in January, 1902, and formed the Master Steam Boiler Makers' Association, the chief object of which was to benefit the rank and file and by this they meant everyone, good, bad, or indifferent who worked in the boiler shops. They proposed to do it by placing before each man employed at the trade the means of procuring an education and for practically nothing. How would they accomplish this?

The answer they found was in publishing a journal monthly devoted to boiler making in the interest of boiler makers and in which would be given everything that is up-to-date in the trade. It also should include answers to questions concerning laying out, mathematics or any subject connected with the theory or practice of modern boiler making. Early in October, 1902, some of the men who had awakened to a realization of what might be done with united effort held a convention in Chicago and in the convention devised ways and means to establish the journal and carry on the good work of education and they made Thomas C. Best, the president of the Master Steam Boiler Makers' Association, its editor. That they were not wrong in their judgment the three first issues gave proof.

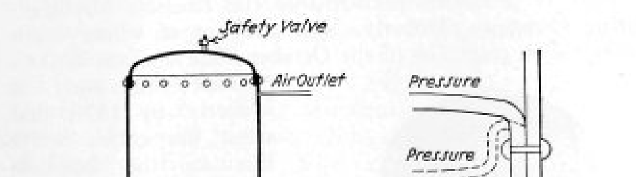
In 1904 the *Motive Power* was sold and the name changed to THE BOILER MAKER, and it has continued in the good work. I hope all those that are interested in boiler making will help the good work along. You all know that all the time there are changes made and to keep up with the changes we have to have an up-to-date journal. The writer has worked in boiler shops for 73 years and is still learning and so can all that work in boiler shops.

Springfield, Ill. JOHN COOK.

An Odd Accident

TO THE EDITOR:

A vertical compressed air tank in our shop was supported by a circular wooden base with the convex to pressure head at the bottom of the tank. Little attention was ever given the tank or its connections or appliances and it apparently was a part of the shop equipment that was doing its work and was forgotten for weeks at a time. The ¾-inch spring



Arrangement and details of tank

safety valve never was raised from its seat by hand and the relief valve on the compressor governed the air pressure in the tank and connecting lines.

One morning the relief valve on the compressor was removed for repairs and the safety valve on the tank was the only relief valve on the apparatus. The compressor engine was operated by the throttle and at a speed which furnished sufficient air for the requirements of the shop. As the foreman came into the shop, he signaled for all work to stop until he could be heard by those working with the air appliances. As the last air machine stopped, the compressed air tank rose a few inches from its plank foundation and rolled a few inches breaking the pipe connections at the tank and allowing the tank to fall upon its side as the escaping air raised a cloud of dust.

Examination did not show any reason why this accident should have taken place until it was noted that both heads were now concaved to the pressure instead of only the top head being concaved. What actually had occurred was that the concaved external bottom head had suddenly become concaved internally by the quickly rising pressure as the last air machine was stopped. The safety valve did not work freely by hand and with this condition it was presumed the quickly rising pressure had forced the bottom head down before the ¾-inch safety valve had opened sufficiently to relieve the accumulated pressure. This opening of the safety valve was too late to save the tank from falling on its side and breaking the pipe connections at the tank.

Removing the manhole, an examination of the internal parts did not show any unusual distress at the short turned flange at the bottom. Where the turn was most severe there was a breaking of the mill scale which covered the plate but no cracking could be found. The tank was relocated horizontally and fitted with a one and one-half inch spring safety valve and continued in service, special care being given the safety valve in the future by raising it from its seat by hand each morning to insure it not being corroded and stuck to the seat.

Coatesville, Pa. E. N. TREAT.

Arc Welding Tank Seams at High Speeds

By Robt. E. Kinkead*

CONSTANT increase in speed of welding tank seams on the part of tank manufacturers has opened up the whole question of what ultimate speeds will be reached.

The matter has a direct bearing on the selling price of tanks. An instance of this occurred several years ago when a Western Pennsylvania tank builder suddenly doubled the speed of welding on his product and was able to deliver tanks in Boston profitably at a price below the price at which the tanks could be made in Boston.

Many tank builders have looked on increasing welding speed as merely a labor saving. Thus if a tank could be welded in four hours instead of eight hours, with labor at 70 cents per hour, the tank builder would figure that he had saved about $2.80 on the job. This is a bad underestimate of the saving. With overhead on direct labor at 150 percent, there is an additional saving of $4.20. Increased speed of welding also means greater output for the same space. Increased welding speed with these tangible savings means price concessions to get more business without killing the profit.

Until recently it was believed that higher welding speeds by using larger welding rods and more welding current would "burn" the metal. The fact is that higher currents and larger rods do not burn the metal any worse than the low currents and small rods.

The physical properties as shown by test of the metal deposited at comparatively high currents are materially improved instead of spoiled. This is perhaps due to a considerable extent to the fact that it is easier to get good fusion with high currents than it is at low currents. The following physical tests by E. V. Kesinger of the Empire Companies of Bartlesville, Oklahoma, indicate the facts rather clearly. Both average and maximum strength of the welds was increased in going from 120-160 amperes to 200 amperes.

No one knows at the present time what the ultimate speed of metal electrode arc welding may be. One-half

*Chief Engineer, Welding Division, The Lincoln Electric Company, Cleveland, Ohio.

inch thick tank steel has been welded manually at the rate of 30 feet per hour. The work is done without beveling the plates. Penetration half way through is made from each side using ⅜-inch diameter rod and 700 amperes. This means a speed on each side of 60 feet per hour.

There is reason to believe that 60 feet per hour is not the ultimate speed at which the arc may be advanced with penetration ¼-inch deep between two plates being welded. In the first place no ⅜-inch diameter welding rod has been available which is particularly well suited to metal electrode welding. A stable-arc welding rod in large diameters has recently been offered on the market. Secondly, known methods of electrostatic arc control have not been applied to high current high speed welding with the metal electrode process.

Limitations of Equipment

Commercially, one of the obstacles to higher speeds of welding comes from the fact that existing welding equipment in the shop is not large enough to furnish the heavy currents required for the work. The general tendency in the purchase of welding equipment is the same as in many other lines of equipment. A man buys about the same size equipment he finds other people using in the same line of business. Yet, owing to the rapid development of arc welding in the direction of using higher currents, it would seem wise to provide ample capacity for future development. A case illustrating the point is that of installing a 200 ampere or 250 ampere arc welding unit for tank shop welding. Three hundred and four hundred ampere equipment for each operator is already being used by tank shops with substantial reductions in cost of welding.

Higher speed welding is being done because economic forces are at work making it necessary to do welding at steadily decreasing costs. Large welding outfits are being installed because they are necessary if high speed high current welding is to be done.

SUMMARY OF WELDING TESTS—DRUMRIGHT 16-INCH LINE

	Elect. weld. No. 18 gage rod, 125-160 amperes 4 specimens	Elect. weld. No. 14 gage rod, 125-160 amperes 4 specimens	Elect. weld No. 14 gage rod, 175 amperes 12 specimens	Elect. weld. No. 14 gage rod, 200 amperes 16 specimens
Tensile strength, ave......	35,507	42,430	44,745	45,514
Tensile strength, max....	40,650	46,240	52,320	51,820
Tensile strength, min.....	35,410	41,030	36,600	33,560
Yield point, ave..........	26,957	27,385	36,887	35,327
Yield point, max.........	29,270	28,870	39,190	43,460
Yield point, min..........	25,680	26,770	32,370	27,170
Elongation in 8 inches, ave.	0.23	0.45	0.23	0.64
Elongation in 8 inches max.	0.42	0.65	0.68	1.69
Elongation in 8 inches min.	0.12	0.41	0.16	0.04

Suitable Materials for High Pressure Boilers

By G. P. Blackall

At a meeting of the Northwestern Branch of the British Institution of Mechanical Engineers recently held in Manchester, a paper by Professors Mellanby and Kerr on the use and economy of high pressure steam plants was presented and discussed. The authors' aim was to show not only the gains obtained by running at temperatures and pressures much beyond what are generally accepted as normal practice, but also to indicate the difficulties that are likely to be encountered in aiming at higher efficiencies. As indicating the progress of a decade, pressures have risen from 250 pounds to 750 pounds and even to 1,200 pounds per square inch, with projected attempts at 1,800 pounds, and temperature increased from 600 degrees Fahrenheit to 750 degrees and even 900 degrees.

The paper dealt interestingly with the problems of suitable materials to stand the pressure and temperature stresses. On account of the temperature differences between inside and outside, say, of tubes, the stresses involved become important, and a wrong idea of the probable safety is obtained if only the pressure effects are considered. It was contended that the temperature margin on the creep limit of a metal is the soundest criterion of judgment as to its suitability. In attempting to define the probable upper values according to plant conditions, further considerations were advanced to show that the factor of the boiler materials indicated a maximum of 1,500 pounds per square inch pressure and 900 degrees Fahrenheit temperature as possible with the same degree of security as in moderate practice, always provided that special materials are employed. Up to now the best results have been shown by a nickel chromium alloy, and assuming that this can be adopted for boiler tube construction it would appear that both water cooled, radiant heat walls and the superheater tubes would have about the same temperature safety margin at 1,500 pounds.

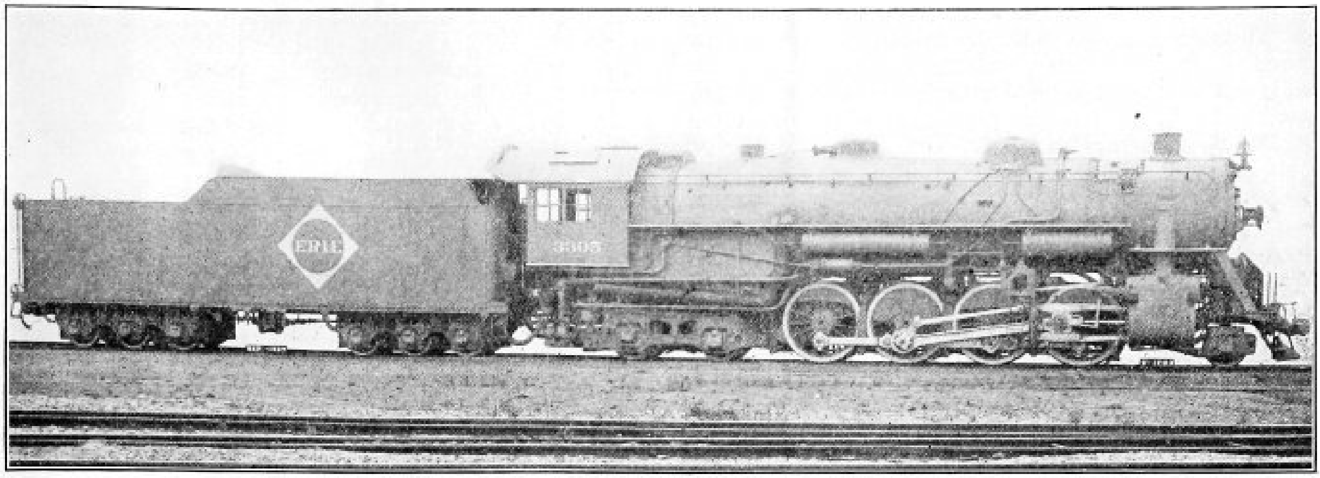
Unveil Bust to Boiler Inventor

The centenary of the construction of the railway between Saint-Etienne and Andrezieux, the first to be built in France, was recently commemorated at Saint-Etienne. M. André Tardieu, Minister of Public Works, who took part in the ceremony, witnessed in the Place Jean Jaures a procession of vehicles representing various periods in the development of the methods of transport. At the beginning of the ceremony M. Tardieu unveiled the bust of Marc Seguin, one of the engineers who invented the tubular boiler for steam locomotives and who was a promoter of the Lyons-Saint-Etienne railway, which was opened for traffic in 1830, three years later than the Saint-Etienne-Andrezieux line.

OBITUARY

John W. Faessler, president of the Faessler Manufacturing Company, Moberly, Mo., a notice of whose death appeared on page 276 of the October issue of THE BOILER MAKER was born in Moberly in 1878 and spent his entire active life in the business established by his father John Faessler for the manufacture of high grade boiler making tools. In 1900 Mr. Faessler succeeded his father, who had died in 1899, as president of the company which at that time was reorganized and incorporated. Only recently through his efforts, a new and enlarged plant was started in which an extensive program of expansion of the business was planned, both to increase the production of Faessler tools and to serve as a monument to his father. Among his other activities Mr. Faessler was head of the Missouri Hay Press Company, vice president and director of the Moberly Trust Company and an active worker in civic affairs. His loss will be greatly felt by his family and host of friends in the industry.

J. W. Faessler



One of the twenty-five 2-8-4 type locomotives recently delivered to the Erie by the American Locomotive Company

Erie Places 2-8-4 Type Locomotives in Freight Service

Comparison of locomotives built by American Locomotive Company and Lima Locomotive Works—Boiler details

THE Erie has recently placed in service 50 locomotives of the 2-8-4 type, 25 of which were built by the Lima Locomotive Works, Inc., and 25 by the American Locomotive Company. While the two orders differ in certain features of the design and proportioning, the two builders worked together to the end that as many of the details as possible would be interchangeable.

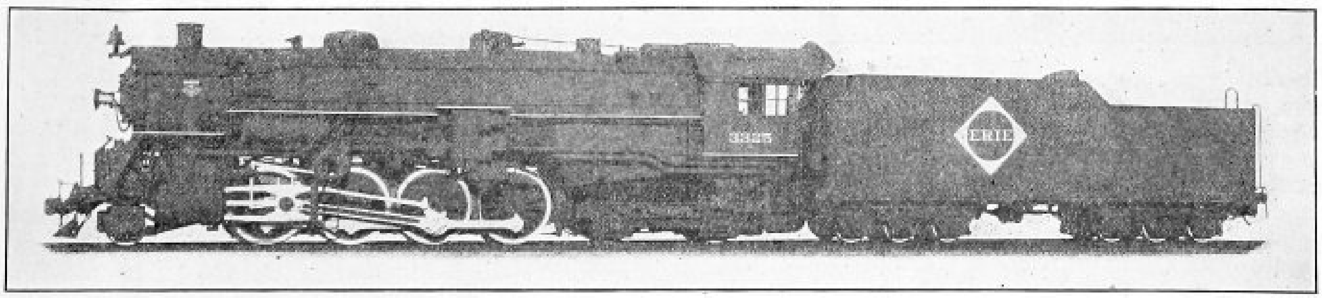
The Erie was faced with the necessity of moving over its main line heavier trains at greater speeds. Thus, the locomotives were designed with 70-in. driving wheels for attaining greater speeds than the Mikado and Santa Fe locomotives which the new engines will replace. The American built engines are being placed in main line service between Marion, Ohio, and Hornell, N. Y., a distance of 477 miles. The Lima built engines are in service between Marion and Meadville, Pa., a distance of 203 miles. In fast freight service some of the locomotives are being tried on continuous runs between Hornell, N. Y., and Marion, Ohio.

The American built locomotives weigh 443,000 lb. of which 276,000 lb. is on the drivers and 120,000 lb. on the trailing truck. They carry 225 lb. boiler pressure and, with a maximum cut-off of 80 per cent, develop a tractive force of 70,000 lb. Including the Franklin booster which drives the rear pair of trailing wheels, the total tractive force is 81,700 lb. The Lima built locomotives weigh 457,500 lb. of which 270,000 lb. is on the drivers and 131,800 lb. on the trailing truck. They carry 250 lb. boiler pressure and, with a maximum cut-off of 60 per cent, develop a tractive force of 72,600 lb. Including the trailer booster, the total tractive force is 85,000 lb. The adhesive weights and the 100-in. outside diameter of the boiler at the throat, on a center line 128 in. above the rail, indicate that advantage has been taken of liberal weight and clearance limitations.

Locomotives Alike in Many Respects

The locomotives built by both companies have the same wheel base, are designed for the same general service and are alike in many respects. The distribution of steam to the 28½-in. by 32-in. cylinders is controlled by the Baker long travel valve gear and the locomotives are equipped with the Precision reverse gear. The diameter of the front and trailing truck wheels and the length and diameter of all the journals are the same for both orders.

The principal firebox dimensions and the grate area



One of the Erie 2-8-4 type locomotives recently delivered by the Lima Locomotive Works, Inc.

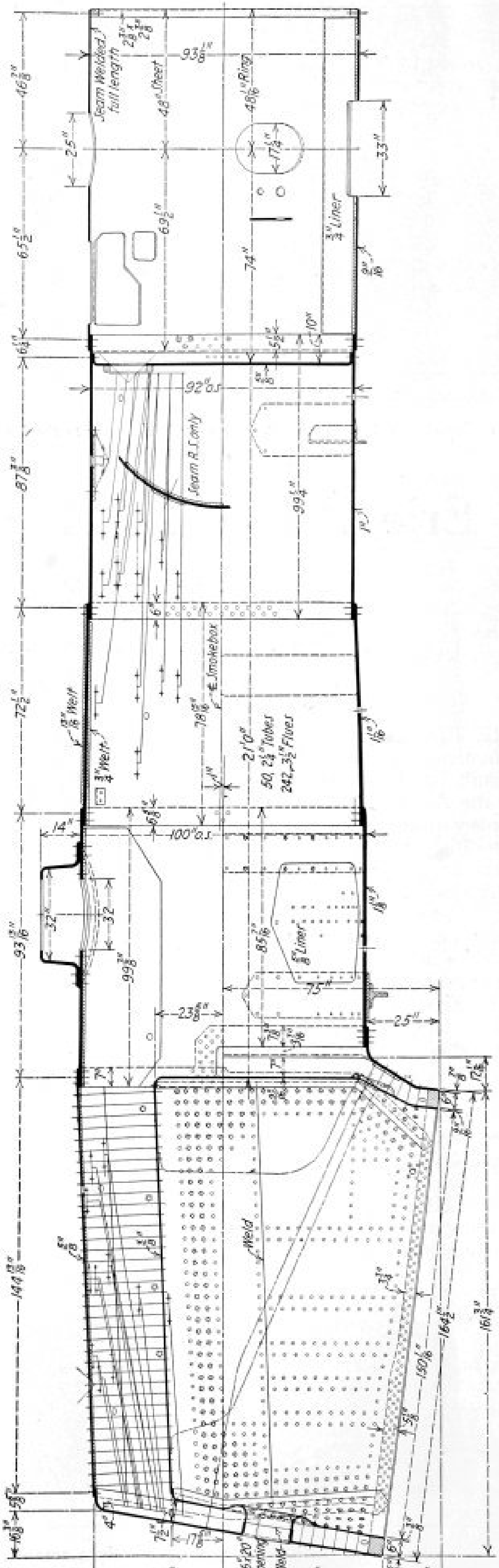
are the same and each firebox is fitted with two Nicholson Thermic syphons and an American brick arch carried on two arch tubes and the syphons. Mine-run coal is fed to the grates by Duplex stokers. The length between the flue sheets is 21 ft. and both boilers contain 243 3½-in. flues and 50 2¼-in. tubes. The Type E superheater with 112 units is used, the header of which contains the American multiple type throttle.

Principal dimensions and data of the Erie 2-8-4 type locomotives built by the Lima and American Locomotive Companies

Builder	American	Lima
Railroad	Erie	Erie
Type of locomotive	2-8-4	2-8-4
Service	Freight	Freight
Cylinders, diameters and stroke	28½ in. by 32 in.	28½ in. by 32 in.
Valve gear, type	Baker	Baker
Valves, piston type, size	14 in.	14 in.
Maximum travel	9 in.	9 in.
Outside lap	1¾ in.	2⅝ in.
Lead in full gear	¼ in.	¼ in.
Cut-off in full gear, per cent	80	60
Weights in working order:		
On drivers	276,000 lb.	274,000 lb.
On front truck	47,000 lb.	51,700 lb.
On trailing truck	120,000 lb.	131,800 lb.
Total engine	443,000 lb.	457,500 lb.
Tender	310,500 lb.	309,000 lb.
Wheel bases:		
Driving	18 ft. 3 in.	18 ft. 3 in.
Rigid	12 ft. 2 in.	12 ft. 2 in.
Total engine	42 ft.	44 ft.
Total engine and tender	86 ft. 2¼ in.	86 ft. 7¾ in.
Wheels, diameter outside tires:		
Driving	70 in.	70 in.
Front truck	33 in.	33 in.
Trailing truck	36 in., 43 in.	36 in., 43 in.
Journals, diameter and length:		
Driving, main	13 in. by 13 in.	Same
Driving, others	11¼ in. by 13 in.	Same
Front truck	6½ in. by 12 in.	Same
Trailing truck	7 in. by 14 in. and 9 in. by 14 in.	Same
Boiler:		
Type	Straight top	Straight top
Steam pressure	225 lb.	250 lb.
Fuel	Bituminous	Same
Diameter, first ring, inside	90 in.	92 in.
Firebox, length and width	150 in. by 9¼ in.	Same
Height mud ring to crown sheet, back	76⅝ in.	72⅝ in.
Height mud ring to crown sheet, front	96⅝ in.	98⅜ in.
Combustion chamber length	None	None
Tubes, number and diameter	50, 2¼ in.	Same
Flues, number and diameter	242, 3½ in.	Same
Length over tube sheets	21 ft.	Same
Tube spacing	4¾ in.	Same
Flue spacing	3 in.	Same
Grate type	Rocking	Same
Grate area	100.2 sq. ft.	100 sq. ft.
Heating surfaces:		
Firebox and comb. chamber	320 sq. ft.	320 sq. ft.
Arch tubes and syphons	129 sq. ft.	128 sq. ft.
Tubes	960 sq. ft.	616 sq. ft.
Flues	4,290 sq. ft.	41,633 sq. ft.
Total evaporative	5,699 sq. ft.	5,697 sq. ft.
Superheating	2,448 sq. ft.	2,545 sq. ft.
Comb. evaporative and superheating	8,147 sq. ft.	8,242 sq. ft.
Tender:		
Style	Rectangular	Same
Water capacity	16,500 gal.	Same
Fuel capacity	24 tons.	Same
Weight proportions:		
Weight on drivers ÷ total weight engine, per cent	62.2	59.8
Weight on drivers ÷ tractive force	3.94	3.81
Total weight engine ÷ comb. heat. surface	54.5	55.5
Boiler proportions:		
Tractive force ÷ comb. heat. surface	8.6	8.73
Tractive force × dia. drivers ÷ comb. heat. surface	601	612
Firebox heat. surface ÷ grate area	3.20	3.20
Firebox heat. surface, per cent of evap. heat. surface	5.62	5.63
Superheat. surface, per cent of evap. heat. surface	42.9	44.7
Comb. heat. surface ÷ grate area	81.4	82.42

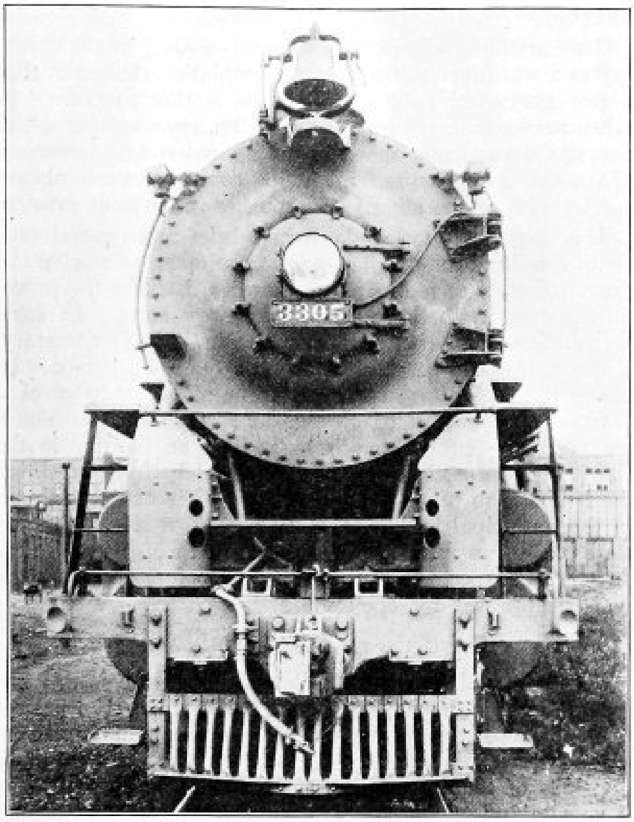
Flextite steam pipe casings are used to eliminate air leaks into the smokebox.

An unusual piping arrangement is used on all of these engines to distribute the superheated steam to the auxiliaries. The steam is distributed from a point on the outside of the smokebox on the left side of the engine. A 2-in. lagged iron steam supply pipe leads directly from a shut-off valve at the superheated header connection to a manifold. A 1½-in. lagged iron pipe leads from the bottom of the manifold and supplies steam to the two air compressors located ahead of the smoke-



Longitudinal section of the Erie locomotive boiler built by the Lima Locomotive Works, Inc.

box. Two ½-in. iron pipes lead from the manifold and pass under the jacket to the back head of the boiler. One of these pipes furnishes superheated steam to the turbo generator, to the preliminary booster throttle and to the stoker engine, and the other pipe furnishes steam to the Worthington feedwater pump. A 1¼-in. pipe



A front view of the Erie 2-8-4 type locomotive built by the American Locomotive Company

line leading from the shut-off valve at the smokebox supplies superheated steam to the blower line. The blower is operated in the cab by an extension rod in which are located two universal joints. A saturated turret is located just outside of the cab to supply steam to the stoker jet line, grate shaker, tank heater, the lubricators and the injectors.

The Tender and Cab Arrangements are Alike

The rectangular type tenders which have a capacity of 16,500 gal. of water and 24 tons of coal, are equipped with Commonwealth water bottom frames and six-wheel trucks. The engine and tender are finished with Duco. The Franklin spring type radial buffer and unit safety drawbar is used between the engine and tender.

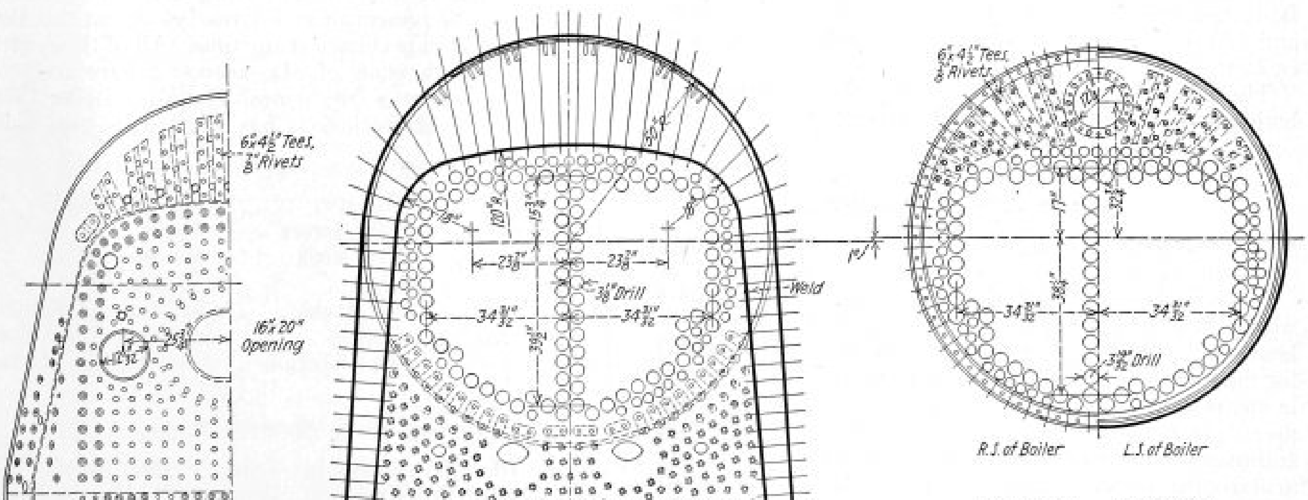
In arranging the control valves and equipment located in the cab, considerable attention has been given to provide for the convenience of the engineman. Of particular interest is the arrangement of the cab lights. Seven outlets are provided on the inside of the cab roof, three on the engineman's side and four on the fireman's side. Heavy, solid rubber cables lead from six of these outlets to the cast aluminum light fixtures which illuminate the faces of various groups of gages and the water columns. A long armored flexible cable leads from one of the outlets on the fireman's side to an extension light which may be carried to any location in the cab.

Wherein the Locomotives Differ

The first 2-8-4 type locomotives built by the Lima and generally known as the Lima A-1, was described in a previous issue of The Boiler Maker. This locomotive with the booster in operation developed a tractive force of 82,600 lb. The new Erie 2-8-4 locomotives built by Lima, the design of which is based on that of the A-1, develop under the same conditions, a tractive force of 85,000 lb. This additional tractive force, with larger wheels, was obtained by increasing the size of the cylinders and the boiler pressure. The grate area is the same, but the heating surfaces have been increased by additional flue length and by an increase in the number of flues and tubes.

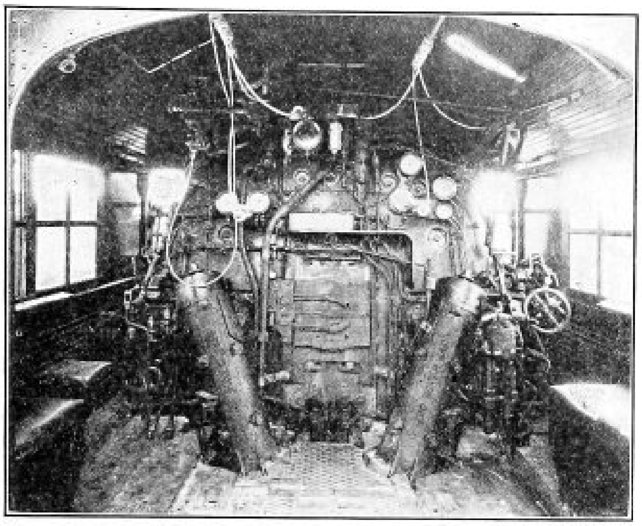
The Lima engines are equipped with the articulated four-wheel trailing truck, the articulated main rod which delivers its load on two outside crank pins, and the compensating port arrangement by which an unbalanced cut-off has been obtained in the two ends of the cylinders at starting, with a resulting increase in the smoothness of the starting torque-curve.

On the American locomotives the Commonwealth Delta four-wheel trailer truck and cradle casting is used.



Cross sections of the Erie 2-8-4 type locomotive boiler

The Commonwealth ashpan was used by both builders. On the American built engines the ashpan is so arranged that it can be removed without dropping the trailer truck. The difference in the type of trailer trucks changed the dimensions from the rear driving axle center to the face of the radial buffer on the two designs. The distance between the trailer truck axle centers on the American engines is 78 in. and on the Lima, 102 in. The distance from the center of the rear trailer truck axle to the face of the radial buffer on the American



The interior of the cab showing the arrangement of the light fixtures

engines is 94 in. and on the Lima engines, 75½ in. The distance from the front of the firebox ring to the center of the rear driving axle for the American engines is 40 in. and for the Lima engines is 48 13/16 in. Thus, the boilers on the American built engines were set 8 13/16 in. farther ahead on the driving wheel base.

The total evaporating surface of 5,699 sq. ft. in the American built engines is made up of 960 sq. ft. in the tubes and 4,290 sq. ft. in the flues, 129 sq. ft. in the arch tubes and syphons and 320 sq. ft. in the firebox. The superheating surface is 2,448 sq. ft. In the Lima built engines the total evaporating surface of 5,692 sq. ft. is made up of 616 sq. ft. in the tubes and 4,633 sq. ft. in the flue, 128 sq. ft. in the arch tubes and syphons and 320 sq. ft. in the firebox. The superheating surface is 2,545 sq. ft.

The principal weights, dimensions and proportions of both locomotives are given in the table.

State Boiler Laws

THE extreme complexity of boiler legislation throughout the various states can hardly be appreciated by one who has not made a study of the subject as a whole. Most boiler manufacturers are well posted, particularly with regard to the states in which they find a market for their product, but persons or firms not directly interested in the manufacture or sale of boilers, though interested as users, are not always aware of existing boiler legislation and may sooner or later run afoul of the law. This is particularly true of contractors, who are moving portable equipment from state to state as the need may arise, and of purchasers of second hand boilers. Used boilers that meet the standards of one state do not necessarily meet those of another. For instance, some states do not permit the installation of used boilers from outside territory unless the boilers are built and stamped in accordance with the A. S. M. E. Power Boiler Code, or are built to the particular rules of the state, as in the case of Massachusetts. Great expense may at times be incurred in moving such equipment only to find on its arrival that it cannot be operated, due, perhaps, to some detail of its construction. Incidents of this kind are of more frequent occurrence than one is likely to credit offhand.

This article is offered as a suggestion—one might almost say as a warning—to the firm contemplating the removal of a pressure vessel from one state to another that steps be taken to obtain in advance authoritative approval for operation of the particular vessel in the desired state. Ignorance of the law is no excuse, and action contrary to law always carries with it the stigma of probable intentional evasion.

It is impossible to lay down in a brief and general article of this kind the detailed steps to be taken to receive approval of state or municipal authorities, because the procedure varies in the case of almost every state. In some jurisdictions compliance with a certain code is necessary, a matter that can be checked up by a qualified person. In others it is a matter of the judgment of one man or of a governmental bureau or commission. One way to obtain the necessary information is to address an inquiry to the chief boiler inspector of the state or municipality into which the boiler is to be moved. Such official is usually located in the municipal building, in the case of a city, or in the state capitol, in the case of a state. A trip of inspection by an official inspector may be necessary before receiving the desired approval for operation.

Function of National Board

The National Board of Boiler and Pressure Vessel Inspectors is an organization of state and municipal inspectors which has for one of its objects the promotion of interchangeability of such vessels between the political subdivisions of the United States. National Board stamping is acceptable in many states and cities, and often facilitates obtaining approval for operation.

The easiest way to arrange for the transfer of a pressure vessel is to put the matter up to your boiler insurance company. If such company has a well distributed corps of boiler inspectors, the expense of securing definite approval or disapproval will be a minimum, time will be saved, and the details in connection with the transfer will be lifted from the shoulders of the owner.

For convenience, a list of the cities and states having boiler laws at the present time is given below, but this list, of course, is subject to change at any time. All of these, with the exception of the state of Massachusetts, have accepted the American Socety of Mechanical Engineers Boiler Construction Code. Massachusetts has adopted its own code.

States That Have Adopted Boiler Laws

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

Cities That Have Adopted Boiler Laws

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

—The Locomotive.

Developing the Pattern for a Two-Piece Dished Tank Head

By D. W. Phillips

We have just sent a rush order to the shop to get completed as soon as possible sixteen 9,500 gallon tanks, 8 feet diameter by 24 feet length overall. The superintendent is away and it will be up to Bill Jones, the shop foreman, and young Smith, the layerout, to do the job on time. Well, Bill Jones is an old timer and has been around this plant for years and knows every nail in the floor; every jig and fixture that has ever been applied to our boiler shop equipment. Besides this, he is a hard worker and, if there is any possible way of speeding things up, from a mechanical standpoint, Bill will do his part. As to Smith, I haven't heard much about him, as to his experience at laying out or as to what interest he takes in the matter of improving his earning capacity by spare time study.

One Way of Doing the Work

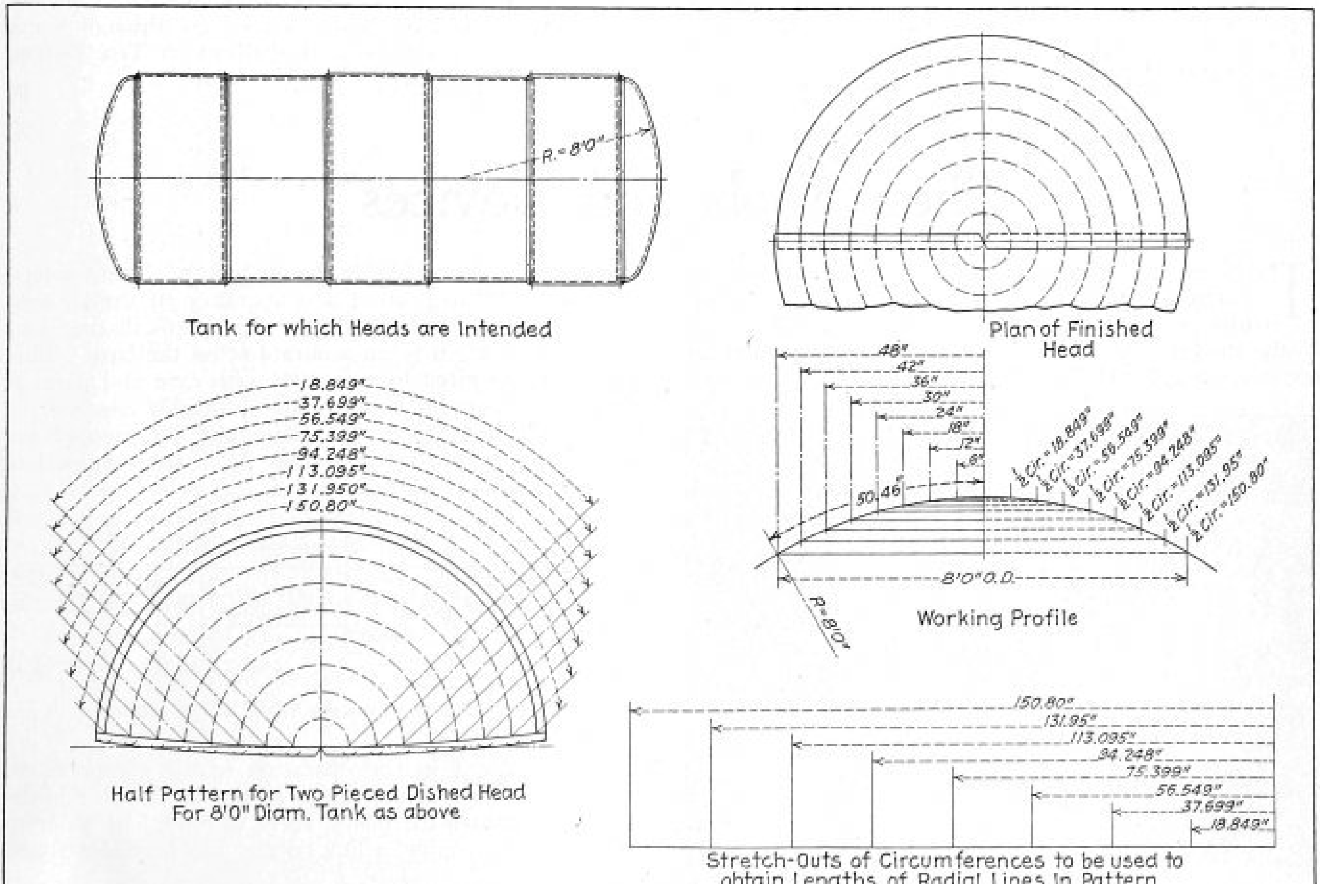
"Hello Jack, where did you spring from?"

"Just up from the shop, been listening to Bill and Smith in their controversy in the matter of laying out the pattern for the heads of those tanks on that rush order. Bill claims that a pattern for the heads can be laid out with all holes put in it, in the flat, so that we can start the work of fabrication at once, but Smith says it's an awful risky undertaking and he is almost sure we will have trouble in assembling the work."

"Call Bill on the 'phone and tell him I want to see him here in the office."

"Hello Bill, have you been able to get started on our rush job yet?"

"Well, yes, we are started in a small way, the material department has delivered the plates to the layerout and now we are about ready to lay out a template, and I have asked Smith if we cannot lay out a template and put all holes in it before dishing and flanging, but he seems to think we will make a bad job of it. You know he came from M——— Co., where they build quite a few of the type we have the order for, and I asked him how they got by with work of this kind over there. Well, he says they take a plate large enough for half of the head, set the trams about 4 inches larger than the radius of the head, locate a radius point on a line dividing the plate in half and about 3 inches in from the near edge they sweep a circle about 180 degrees, then shear the plate on this line. They then use this template and mark and shear all the plates they need for the job. Next they turn to and dish all the plates to the radius required and deliver two or these halves to the layerout. In turn he has a heavy plate leveled up and proceeds to lay it off using a couple of steel squares, a straight edge, and two helpers. He lays off one-half with the holes across the crown for riveting the two halves together. This half is taken to the punch where it is punched and returned to



Details of method employed in laying out shop order of tank heads

the layerout. He then levels the two plates, the one with the holes being on top, and marks the under one off from the top. Then these two are used for templates to mark off all the other dished halves. After the dishing and punching process is completed the plates are assembled in pairs and the layerout lays off the flange for fastening the head to the shell. They are then sheared and flanged after which the layerout lays off the holes in the flange for riveting to the shell. These holes are punched and the head is then inserted in the shell."

"Well, Jones, I think we can eliminate about half the operations you have named, cut the cost of handling 40 percent and slice one-third to one-half off our time of delivery. You go down to the shop and have Mike the sweeper up place three horses in a convenient place, on which have a 5-foot by 10-foot by 3/8-inch plate laid, then have a straight edge, steel square, trams, a measuring wheel, a pair of dividers, center punch-hammer and soapstone all ready and I'll come down and in one hour we will have a punch and shear gang going."

How the Job Was Finally Done

"Well, Bill, here I am, what do you say now? I want you to help me if you can make it convenient and the time we save on this pattern layout will permit us to call Smith over and explain each operation thoroughly to him. Then I believe you will both be surprised when you see how simple the trick is. Here is the plate, now let's measure over from this right hand end 5 feet and square a line right across the plate, now measure up from the near edge on the line just drawn, 2½ inches and put a center punch mark. Now go to the right and about 4 inches from the end and 2½ inches up from the edge place another center punch mark. With the straight edge or chalk line draw a line through these two points the whole length of the plate. Set the trams to a radius equal to the inside diameter of the tank (in this case 8 feet) and with the second center punch mark at the end of the plate as a center scribe an arc to the opposite side of the plate. Measure over 4 feet from the first line drawn, which we will hereafter call the center line, intersecting the arc and at right angles to the center line. This line represents one-half the inside diameter of the tank.

"Now from the point of intersection with the arc divide the arc into an equal number of spaces, in this case 8. Then with the square and straight edge draw lines parallel with the first line from the points in the arc over to the center line. These lines will represent diametrical planes cutting the dish of the head. The circumference of these cutting planes is the stretchout, or length of the radial lines in the pattern. Now to locate the distance of these radial lines from the center point in the pattern, we wheel very carefully the length of the arc as on our plate and find we have 50.46 inches. We divide this distance by 8 and get 6.3075 inches which is our crown flattened out.

"Now to obtain the length of these radial lines in the pattern, which will give us the true shape, we multiply the length of each parallel line in the working profile by 3.1416. These results we mark on the working profile, set them down as in the stretchout shown herewith and transfer them to the radial lines in the pattern thus establishing the rivet line of our seam. To this add the lap, also add the flange to the outer edge, lay off the rivet pitch and the pattern is finished and we are ready for putting the work into production.

"Start your marker, or better still if you have a rack punch, punch directly from the template, thus saving the expense of marking off. Next start your shear gang, which in turn can do the scarfing. Now if you split the lap as shown in the finished profile, dish one-half at a time, while if you lap the whole of one-half out and the other in, dish two at a time and they will fit together closer and give you a metal to metal joint, being careful to lap the one dished in, on the inside."

Bill and I were just 47 minutes laying out this pattern while Smith looked on, and when we got through Smith says: "There's nothing to it, I shall watch THE BOILER MAKER problems more closely in the future."

Shop Tools and Devices*

THE machine illustrated in Fig. 1 is designed for grinding exhaust nozzle seats, being operated with a pneumatic motor bolted to the front end of the smoke box. The exhaust nozzle is clamped at the ends of two adjustable rods connected at the other ends to two eccentrics driven by the air motor. These eccentrics are set 90 deg. apart and operation of the air motor gives the exhaust nozzle the desired oscillating motion for grinding it to an accurate fit on the base. This machine is operated by one man with ease and permits grinding the seats in less time than ordinarily required.

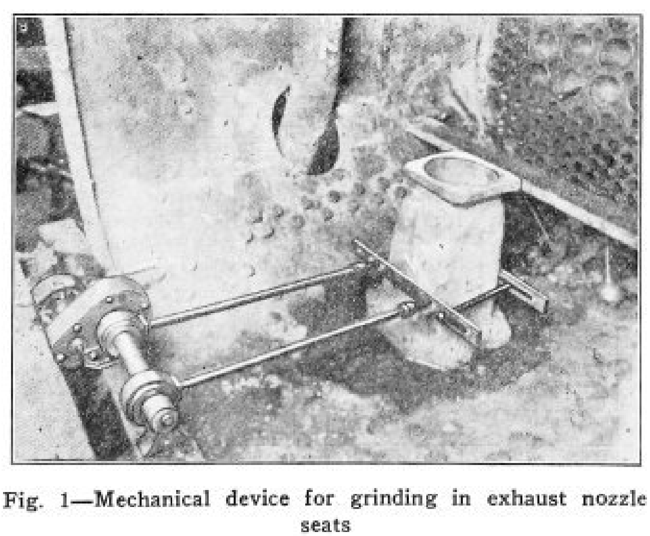


Fig. 1—Mechanical device for grinding in exhaust nozzle seats

A line reamer for cross compound air compressor main valves is illustrated in Fig. 2. Some trouble has

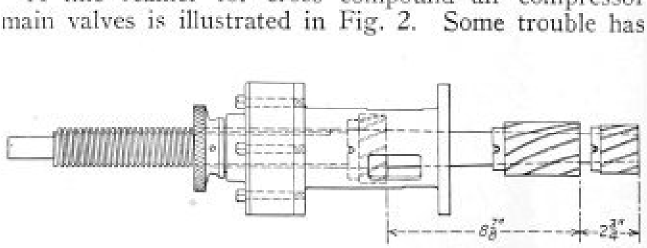


Fig. 2—Air compressor main valve reamer

been experienced in the operation of air compressors, due to the improper alinement of the main valve bushings which causes the piston valve to bind. In order to overcome this trouble, a line reamer has been developed

*Abstract of a report presented by W. R. Millican, tool foreman of the Missouri-Kansas-Texas, Parsons, Kans., at the 1927 annual convention of the American Railway Tool Foremen's Association.

to ream the three different size bushings of the main valve in one operation and in perfect alinement.

The practice on the Katy is to ream each bushing to 1/32 in. oversize before renewing the bushings. However, this amount could be increased without impairing

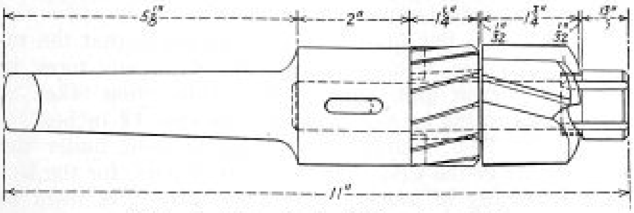


Fig. 3—Flue sheet drill and reamer

the operation of the compressor, thereby creating a nice saving in labor and material.

The reamer is made up with a long arbor with a four-pitch screw on one end for the mechanical feed, which is obtained through gears in the reamer mounting. A fine feed can be used or a coarse feed if desired. The reamers are of the shell type and can be placed on the arbor in any combination, either standard or oversize, for any of the three bushings.

The set-up requires the mounting of the reamer on the compressor head with two or four of the regular cap screws removed from the compressor head. The alinement is insured by a boss which fits into the counter-

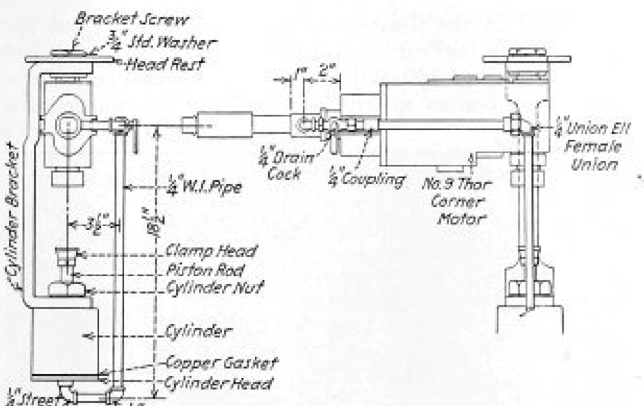


Fig. 4—Flue sheet scarfing machine

bore of the cylinder. After the reamer is mounted it is only necessary to turn the arbor, as the reamer is self-feeding and after the desired depth has been obtained it is advisable to disengage the feed by means of the knurled collar shown in the photo.

After this has been done, turn the reamer two or three times so that no marks will be left at the end of cut. The approximate time for reaming is five minutes.

Flue Sheet Cutter

A combination drill and reamer for cutting flue sheet holes is illustrated in Fig. 3.

This is a built-up tool having a removable pilot which makes the regrinding of the drill an easy operation. Another advantage it has over the older type of drill is that the pilot is always kept in good condition which is necessary to produce good holes.

The drill has a taper shank on which the reamer fits, and the pilot acts as an arbor for both the reamer and drill. They are held by a taper key through the Morse taper shank of the drill and the pilot shank, which pulls the three together and makes it almost the same as a solid tool.

Flue Sheet Scarfing Machine

A flue sheet scarfing machine of the one-man type is illustrated in Fig. 4. This is an attachment used with a close quarter pneumatic motor and an air cylinder se-

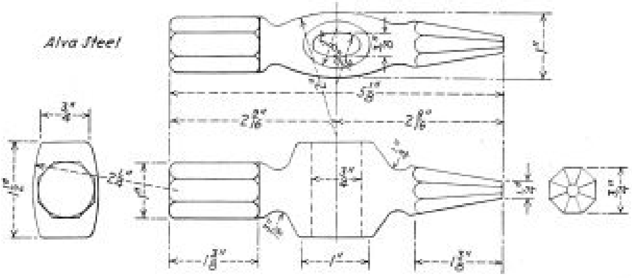


Fig. 5—Locomotive inspector's hammer

cured to the motor by means of a bracket which automatically feeds the cutter into the work. The amount of feed can be controlled with the drain cock shown. The correct angle of the scarfing can be obtained with the head rest. The throttle of the pneumatic drill is drilled and tapped for a 1/4-in. pipe to operate the feed, so that when the throttle of drill is operated it automatically operates the feeding device applied to the drill. One man can easily operate this tool.

Locomotive Inspector's Hammer

A hammer used by inspectors in locomotive shops is illustrated in Fig. 5, being designed so that several standard measurements are shown on the handle. This saves the inspector quite a bit of trouble as he can use the hammer instead of having a number of different tools for this purpose. For instance, the hammer is 5 1/8-in. overall which is used as a coupler gage. The handle is 14 in. long for the minimum length of the draw bar, etc.

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

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

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

Below are given records of the interpretations of the Committee in Cases Nos. 555 to 562 inclusive, as formulated at the meeting of September 16, 1927, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 555. *Inquiry:* Is it permissible, under the rules of the Code, to attach heads to the shells of vertical fire-tube miniature boilers by fusion welding when the shells are extended beyond the heads so that the heads are subject to pressure in a longitudinal direction only and the tubes therein are located so close together and to the shell that they are able to carry practically the entire stress imposed upon the head?

Reply: The Code for Miniature Boilers makes definite provision for shells with integral heads and for circumferentially riveted head joints, but Par. M-7 specifically states that autogenous welding may be used in such joints only where the safety of the structure is not dependent upon the strength of the weld. It is the opinion of the Committee that the stress on the heads of fire tube boilers cannot be considered as fully supported by the expanding and beading of the tubes, as, when overheated, this form of tube attachment loses its supporting power. The heads of such boilers can therefore be considered as fully supported by the tubes independent of the shell only when stay tubes are used with nuts fitted on the ends, or when otherwise stayed in accordance with Par. P-199.

CASE NO. 556. *Inquiry:* Is it permissible to connect a steam generating unit, constructed in accordance with the requirements of the Code for Miniature Boilers, directly to a cast-iron body vulcanizer by means of a close connection? It is to be noted that the entire apparatus is to be tested hydrostatically to a pressure of 600 pounds per square inch; that the working pressure is not to exceed 100 pounds per square inch; that the water level is to be maintained within the generator; and that the combination is to be operated as a closed system, without extraction of steam, which makes it necessary that no valve come between the steam generator and the vulcanizer.

Reply: It is the opinion of the Committee that a vulcanizer so connected should not be considered as a part of the steam boiler and that the Code applies only to the steam generating unit. The combination described should not conflict with the requirements of the Code, as a stop valve between the steam generator and the vulcanizer in a closed system is not required.

CASE NO. 557. *Inquiry:* With reference to Par. P-192*c*, is it permissible to calculate the efficiency of the ligaments which come in a circumferential line by reference to the metal in the entire circumference or one-half the circumference of the drum, or must the efficiency be calculated by reference to the circumferential pitch of the tube holes?

Reply: It is the opinion of the Committee that the efficiency for the ligaments that come in a circumferential line shall be computed in the same way as those which come in a longitudinal line.

CASE NO. 558. (In the hands of the Committee.)

CASE NO. 559. *Inquiry:* Is it permissible, under the requirement of Par. P-314 of the Code, to discharge the feedwater in a horizontal return tubular boiler at a point about three-fifths of the length from the rear head, instead of from the front head, where such boilers are gas or oil fired and the zone of heating is nearer the rear of the boiler, causing a different condition of circulation than with coal firing?

Reply: It is the opinion of the Committee that the intent of the Code was to discharge the feedwater at about three-fifths of the length of the boiler from either end of the boiler which is subjected to the hottest gases of the furnace. The feed pipe should be carried through the head or shell furthest from the point of discharge of the feedwater.

CASE NO. 560. *Inquiry:* Is it permissible to attach the markings on miniature boilers by means of a brass etched or stamped plate which will be attached to the shell by riveting, or by a steel plate with an embossed or stamped lettering to be attached by either riveting or welding?

Reply: It has been the intent of the Committee to provide for the marking of miniature boilers along such lines as will conform in general to the corresponding requirement in the Power Boiler Section of the Code, and it is the opinion of the Committee that to mark miniature boilers by use of a name plate, irremovably attached to the shell plate, will conform to the requirement in Par. M-19.

CASE NO. 561. *Inquiry:* Does Par. U-62 of the Code apply only to cylindrical pressure vessels, or does it apply also to jacketed vessels of any shape such as rectangular, jacketed, staybolted vessels?

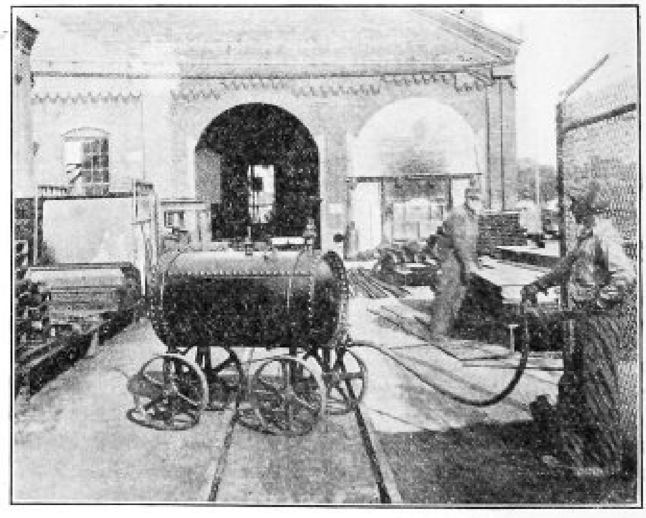
Reply: It is the opinion of the Committee that the requirement in Par. U-62 applies to vessels of any form, in which the largest dimension of any cross-section taken at right angles to the longest dimension exceeds 12 inches.

CASE NO. 562. *Inquiry:* Is it permissible, under the requirements of the Code for miniature boilers, for the hydrostatic testing of completed boilers, to subject them to an equivalent pressure of 1½ times the working pressure with compressed air instead of water? It is noted that a hydrostatic test is called for in Par. P-329, and the question has arisen as to whether the use of water instead of air was not specified in view of the danger which might ensue in case of rupture of a vessel tested with air.

Reply: The Code specifically calls for a hydrostatic test of every boiler after completion, the use of water being required not only for consideration of safety in case of rupture of the vessel, but also for greater effectiveness in detecting leakage that may require calking or other treatment.

Tank for Supplying Fuel Oil to Rivet Heaters

SHOWN in the illustration is a tank wagon used for delivering fuel oil to rivet heaters in the shop. It has a capacity of 100 gallons. A pipe connection is provided at the bottom to which a hose can be attached for loading and unloading. Fuel oil is forced into the tank from the storage tank at about 100 pounds pressure. Delivery from the tank to the rivet heater supply tank is secured by merely attaching the same hose to the tank on the rivet heater and operating the valve on the delivery tank wagon as the operator may desire.



Filling the delivery tank wagon at the storage tank

J. C. Fitzpatrick has been appointed district manager of sales of the Chicago Pneumatic Tool Company, with headquarters at Cleveland, Ohio, to succeed J. L. Westenhaver, who has resigned to enter business for himself.

The Ideal Boiler Shop—III

The Edge Planer—Jib-Crane Air Hoist—A Tool-Grinding Wheel—Edge Planer Tools—Heat Treating Planer Tools

By James F. Hobart

IT requires the best a man has in him to locate the several machines in a boiler shop and not get some machine in the way of something or other. In a small shop, it is impossible to locate the machine tools in such a manner that one of the machines will not be more or less in the way sometime, but, in the large shop where room is practically unlimited, the task of machine location is easier. Even here the attempt is not always successful.

The Edge Planer

This machine should preferably be located well up toward the plate storage described in a previous article, but far enough therefrom, that there may be ample room for laying out work between the edge planer and the plate racks and around the big circular forge already mentioned. In many instances, selections of plates or sheets sufficient for an entire job may be taken by the overhead traveler and transported to some convenient part of the shop, where the paying out as well as the construction will be carried out away from the stock racks. From here the material should progress, step by step, until the boiler, or order of boilers, is finished and ready for shipment.

The edge planer, therefore, should preferably be placed well to one side of the shop and with ample room for layout work between the planer and the storage racks. The planer, like all other machines should be driven by an independent electric motor, either built into the planer or connected thereto by a silent chain drive properly protected and lubricated. The edge planer should be self-clamping. Should it be found desirable to use a planer without air clamping apparatus, the necessary number of suitable air cylinders may be obtained and attached to the sheet planer right there in the shop.

Location of Shear and Edge Planer

Beyond all doubt the location of these important tools in the ideal shop will be criticized as, in some instances, where planer and shear are located as named, next to the plate storage, there must necessarily be some "back-tracking" of stock between shear and planer on account of some plates having to be sheared before they can be edge planed. However in the shop here described, it is assumed that a majority of all the plates used in the shop being for stock and not for job work, will be ordered and received all cut and sheared to exact dimensions required, making shop shearing unnecessary. This being the case, the edge planer is located as described, adjacent to the stock storage and the shear is placed just beyond the edge planer. With the location of the edge planer disposed of as above stated, the shear, drill and punch, are brought together into a convenient group, separated only by the space necessary for handling the steel plates which must be taken to and away from the several machines.

Whenever sheets must be sheared before being edge planed, such sheets are taken by the overhead crane direct from storage or layout territory to the shear and each sheet after being trimmed is removed by the crane and placed beside the edge planer in a single operation. The efficiency of plate edge planing operations depends largely upon the speed with which a plate can be removed from the edge planer, disposed of, and another plate placed in position by that machine.

Overhead Traveler Signals

When making the studies from which the ideal boiler shop was developed, it was found that when a machine was dependent upon an overhead crane for fetching and carrying away material to the machines, that the greatest loss was in the time spent while waiting for the crane to pick up and handle material. In order to shorten as much as possible the time lost in "crane waste" a system of crane signals was devised and put in operation. A set of visual crane signals was arranged at each machine and at several other places in the shop where crane service was required frequently and promptly. A short mast, projecting slightly above the machine, but not high enough to interfere with crane work was erected and two incandescent lamps were placed on top. These lights were controlled by push buttons located near the machine operator. Wires were carried underground and up the shop posts to points on the traveler girders, where there was located a sort of "semaphore switch," which was so arranged that when one of the signal lights was pushed on at a machine the corresponding switch arm would be thrown upward or outward and remain in that position until hit by a "wiper" on the crane which returned the switch to its normal position and also switched off the signal lights at the machine from which the signal was sent.

The operation of this signal system was as follows: When a machine operator found that he would need the overhead crane in a few minutes, he would push a button which switched on an orange colored lamp and also set the switch semaphore on the crane girder. If the crane operator was not busy, he would drift along leisurely and be on the spot ready for work when needed. If busy elsewhere, the crane man kept an eye on the orange light and when the machine man was ready for the crane, the orange light would be switched off and the red light switched on, whereupon the crane man would come as quickly as possible. In case of accident, where crane assistance was needed at once, both the red and orange lights would be turned on, and the crane man would get there "P. D. Q." When the crane arrived at the "red light district" it would run against the semaphore switch, returning that device to its normal position and extinguishing the lamps, one or both, as the case might be. Thus, the machine man signalled the crane operator a cautionary word—or light—and as little time was lost in "crane waiting" as was operatingly possible and attend to all the work in the shop.

In addition to these crane signals an isolated telephone service was installed between several points on the shop floor and the crane man in his overhead car. The phone wires were connected to three bare wires or bars upon the traveler girder, from which contact brushes or commutators carried current to the phone in the crane cage, where a head phone and transmitter hung suspended, convenient to the operator.

Jib Crane Air Hoists

After having developed the "Ideal Boiler Shop" to the point described above, its designer "took a day off" and devoted that time completely and exclusively to a study of his layout. He found that operations carried on by the workmen in handling sheets at the edge planer required still far too much crane and man time. As many of the large sheets would require the planing of but one edge or end, the overhead crane would have to give very frequent attention indeed, or else there must be man-power enough available to shift sheets at such times as the overhead crane could not be available at the exact instant it was needed. Here was a difficulty. Either there must be laborers enough at hand to shift sheets when the traveler was detained elsewhere and these men to remain idle while not temporarily needed at the edge planer, or else, that machine and its operating crew must lose time whenever waiting momentarily for crane service.

It was desirable that two men be able to operate the edge planer—or any other machine in the shop, for that matter—and to meet this condition, the position of the edge planer, shear, punch and drill, were shifted slightly from their original location comparatively close to one side of the shop, with only room enough between the machines and the wall posts of the shop to enable workmen to care for the several machines properly.

With the machines thus located, their working sides were toward the center of the shop and material would have to be deposited in front of, and removed from the machines with as little interference as possible with whatever setting up work might be going on at any time, adjacent to the machines in question.

A change was made by moving the line of machines farther toward the middle of the shop and turning the machines around so as to bring their "work sides" toward the shop wall, but with ample room between for placing, handling and working the largest sheets that came into the shop. By this layout, the overhead traveler would bring sheets down from storage, along the back of the machines, then would swing in between the machines and drop the load of sheets back of the row of machines, away from all possible interference from or to shop operations.

Some light I-beam swivel swing cranes were designed, each of sufficient strength to handle the heaviest sheet used in the shop. One of these light cranes were attached to a post opposite the edge planer as high up as possible, while still clearing the overhead traveler. A similar light swing crane was erected opposite each of the other machine tools. A 4-wheel trolley, arranged to run upon the lower flange of the I-beam, carried a swinging air hoist which was supplied from a hose and controlled by a valve which was operated by a couple of pull chains which depended from its control valve.

It was estimated that a 6-inch air cylinder working under 60 pounds air pressure would furnish all lifting power required after friction waste had been deducted. The cylinder was made about 4 feet long and, being suspended under a swing crane beam 12 feet above the shop floor, allowed a lifting movement of nearly 4 feet which was deemed ample for sheet lifting to and from machines.

The trolley was constructed with four wheels to run upon the lower flange of the crane boom. The wheel journals projected inwardly and each wheel was fitted with a high grade bearing. In order to determine the best form of bearing for the service, three sets of trolley wheels were sent away and fitted by three manufacturers, respectively, with a set of "S.K.F.," "Hyatt," and "Timken" perfected bearings, with the idea of adopting that one of the three which, after a year of use, proved itself best adapted to the service required of it. The use of these high grade bearings permitted the workmen to easily move the trolley with its suspended weight of air cylinder and sheet of steel so the two machine men could readily adjust, insert and remove full sized sheets from the machine, the sheets being brought and removed by the overhead traveler.

The little swing cranes proved to be just the thing required for handling sheets at the several machines and in some instances it would be found convenient to swing a sheet, finished by one machine, as far "down shop" as possible by its crane so the sheet could be taken by the crane belonging to the next machine. In this manner, a single plate, which might be required in a hurry, could be passed from machine to machine by the cranes without having to call the overhead traveler, a point found very useful when that appliance chanced to be busy with other work.

The light wall cranes were so made and arranged that they could be swung around against the wall in case the overhead traveler had business in the territory of the small hand cranes. Furthermore, in case of one of these cranes being unduly left in the way of a crane load, the little crane would swing around out of the way under the impact of the overhead traveler load.

Edge Planer Tools

Tools for the edge planer were not made of ordinary carbon steel as that metal was "too slow" for production. A set of tools made of high speed steel was procured and then the necessary apparatus was set up for heat treating the tools instead of the usual hardening process and drawing the temper. The high speed tools would work perfectly at a cutting speed which heated them almost to a dull red and which caused the chip to heat and smoke heavily, a speed of cutting which would have ruined carbon steel tools before they had cut a chip two feet long.

It was found that heat treatment apparatus could be obtained to meet a variety of conditions: for use with coal as a fuel, with gasoline, gas, distillate or even with crude oil as well as with electricity, and capable of being adjusted to hold temperatures of 1,550, 750, or any other required number of degrees Fahrenheit, which might be necessary for the proper heat treatment of the particular steel which might be in use at the time.

A Tool Grinding Wheel

There were several grinding machines in the shop—a light and a heavy machine for regular shop work, but in addition a two wheel stand was put in especially for grinding edge planer tools and twist drills, together with such other machine tools as were used in the shop.

No workman was ever allowed to grind cold chisels or calking tools upon either of the shop wheels, i.e., those for plate grinding and for sharpening machine tools. Let a workman be caught at either of these wheels grinding a cold chisel and a commotion would arise right then and there.

Several grinding wheels were provided and located in different parts of the shop for the grinding of chisels and calks by the workmen who had full access to these wheels, but not to the other grinding wheels which were each placed in charge of an operator. In this way the wheels were kept in good condition at all times, particularly as the men directly in charge were provided with and instructed in the use of wheel truing instruments, with instructions to always keep the wheels true and in perfect shape for instant use. In this manner most of the loss of efficiency due to trying to work with grinding wheels in poor condition was overcome. Furthermore, the chisel grinding wheels were in the care of a reliable man who, with a wheel-grinding tool in his immediate possession, saw that the chisel grinding wheel was "touched up" frequently and thoroughly.

Business Note

Joseph T. Ryerson & Son, Inc., Chicago, Ill., with offices in twenty cities throughout the country, has recently taken over the distribution of the Foote-Burt line of drills to the railroads. Foote-Burt equipment includes machines for single and multiple spindle drilling for a great variety of work such as mud rings, flue sheets, etc.

Fusion Welding on Boilers and Pressure Vessels*

Tests developed to insure good welds—Suggestions for inspectors to follow in acquiring a knowledge of welding processes

By S. W. Miller†

THE primary function of the members of the National Board is to conserve and increase public safety. A structure that is safe in one state or community is safe in any other state or community. It is equally true that a dangerous structure is dangerous wherever it may be located, so that the importance of your work lies largely in seeing that safety is made uniform through the United States.

There are, of course, different conditions in different communities, and the laws which you have to enforce may be different in different states, but I am quite sure that your ultimate objects are the production and enforcement of proper laws that are uniform throughout our country.

I am quite in accord with this program, and as much of my work is with fusion welding, I am especially interested in having such laws provide not only for safe welding construction, but also for the future safe development of the processes.

It is, I think, quite natural that any process whose development has been rapid should result in some bad work being done. This was true of reinforced concrete, and even of plain concrete in its early stages of development. It was true in the early applications of steel in place of wrought iron. It was true in the early days of electric lighting. In fact, the history of civilization has been a history of education in the ways of arriving at success, and in all cases we have learned by our failures. We have learned to avoid dangerous materials of construction. We do not allow electric wiring to be installed in buildings except under adequate regulations and supervision, and we do not permit concrete structures unless they are designed and built in accordance with well known principles and practices.

In the same way we have learned how to use fusion welding. We do not know all about it, of course, any more than we know all about anything else; but we do have enough knowledge to enable us to say where it can be used safely at the present time, and how its applications shall be made to insure that safety. It may be remarked that the present developments in welding are based on accurate information, and are not empirical, as in the early days. Those who are properly interested in fusion welding know better than to advocate welding of anything unless they are thoroughly convinced by observation and test that it is safe, and because we must keep our consciences clear, we have devised methods which will assure us that our test results may be duplicated in production work.

I shall speak of one instance of how the problems connected with fusion welding have been solved. One of the companies with which I am connected found it necessary to make large storage tanks that were absolutely tight and would stand high pressures and we saw no way to get what was needed but by fusion welding. These tanks are now in many cases a matter of quantity production, of course under our supervision and inspection. We have not arrived at this point in the development without study and care, nor have we done it too rapidly. On the other hand, we are sure that we have not reached what is ultimately possible, and we cannot afford to consider that we will not go any further in our development work, because the possibilities for effecting economies are so great as to be exceedingly attractive.

There is no secret in obtaining successful results by fusion welding, and they can be obtained in either repair work or new construction by anyone who gives proper attention to all of the elements entering into the job.

Experience the Best Guide for Safe Welding

In our work, we design the structures ourselves, using our experience and the results of our tests as guides. We specify the materials, including the welding wire, in accordance with our knowledge and experience. We supervise the work ourselves. We make sure by proper tests that the welders are competent, and finally we apply adequate tests to be sure that the structure is safe. In each new design we take the precaution of making strain gage measurements all over the structure in order to determine the actual stresses that exist under test and in service. In this way we know that no part is stressed beyond what it should be, and if necessary we can change the design to meet this requirement.

When we began designing fusion welded pressure vessels for ourselves, we used 7,000 pounds as the working fiber stress. Strain gage measurements at three times the working pressure convinced us that it was safe to use a higher design stress, and we went to 8,000 pounds. Repeating the strain gage work showed that 9,000 pounds was safe, and we are now using this.

In all cases so far we have tested the tanks to three times the working pressure, so that now they are tested to 27,000 pounds fiber stress, somewhat below the yield point of the material which is about 35,000 pounds per square inch.

We are now having built tanks 7 feet in diameter, 35 feet long, and of 15/16 inch material for 200 pounds working pressure, based on a design fiber stress of 9,000 pounds per square inch. The seams are all double V welded with a welding wire whose tensile strength, as deposited in the weld, is about 65,000 pounds per square inch, and which has an elongation on an average of about 15 percent in 2 inches.

We have also had built tanks 5 feet in diameter, about 40 feet long, of 1⅛-inch plate for 300 pounds working pressure.

These are made in commercial shops, under our supervision and according to our specifications, and I may say that there is just as much thought and care put into their design as is used in any of the rest of our important engineering work, and that we follow the A. S. M. E. pressure vessel code wherever it is possible to do so.

Welding Operators' Work Tested

The welders who do the work have to meet the requirement of a minimum tensile strength in the welded test plates made by them in the same material as used for the tanks, of 45,000 pounds per square inch. This must be obtained in test pieces that have the reinforcement removed.

We have invariably found that the welders are anxious to do good work, and are very much interested in the results of their qualification tests. There is also quite a little rivalry among them as to who shall make the best welds.

*Paper presented at annual meeting of National Board of Boiler and Pressure Vessel Inspectors.

†Research Laboratories, Union Carbide and Carbon Company, New York.

It also should be understood that these welds are not heat treated in any way, but are tested just as they are made.

It will possibly be of interest to see the results of these tests of welders in a typical case, in which six welders were tested, each one making a test plate from which five coupons were cut.

Welder	First Test. Ultimate strength		Second test Ultimate strength	
A	Maximum	47,700 pounds	....	....
	Minimum	41,650 pounds	....	....
	Average	45,800 pounds	....	....
B	Maximum	61,500 pounds	....	....
	Minimum	56,800 pounds	....	....
	Average	59,500 pounds	....	....
C	Maximum	63,100 pounds	....	....
	Minimum	52,700 pounds	....	....
	Average	59,000 pounds	....	....
D	Maximum	55,000 pounds	Maximum	63,700 pounds
	Minimum	41,100 pounds	Minimum	58,000 pounds
	Average	48,400 pounds	Average	60,500 pounds
E	Maximum	51,700 pounds	Maximum	55,000 pounds
	Minimum	39,700 pounds	Minimum	35,400 pounds
	Average	47,900 pounds	Average	44,800 pounds
F	Maximum	49,600 pounds	Maximum	60,750 pounds
	Minimum	17,650 pounds	Minimum	49,650 pounds
	Average	39,100 pounds	Average	54,500 pounds

Welders B and C were accepted on the first test, while the rest were rejected. After a period of instruction, welders D, E and F were again tested, and welders D and F were accepted.

Quite a while ago we realized the importance of testing welders. The cheapest and easiest way is to bend the test piece in a vise or when clamped to an anvil or other heavy block. This gives a good idea of the penetration and fusion obtained, but does not tell the strength, which should be known if real comparisons are wanted. The standard testing machines were not suitable to meet the important condition of portability, so we designed a light, portable tensile machine, with a capacity of 50,000 pounds. It is rugged and so suited for field work, and can be operated by one man. Its accuracy is within about one percent of that of a standard machine. It is about 4 feet long and weighs 750 pounds. We believe that it will be a valuable aid in promoting the efficiency of welders.

The A. S. M. E. Pressure Vessel Code allows a longitudinal fusion welded seam with a maximum working fiber stress of 5,600 pounds per square inch, provided that the diameter of the vessel does not exceed 20 inches, nor the pressure 100 pounds per square inch. These provisions limit the thickness of the shell to 3/16 inch.

On the basis of 60,000 pounds ultimate strength, 9,000 pounds working fiber stress gives a factor of safety of 6⅔. This 9,000 pounds is so much higher than the allowable stress in the A. S. M. E. pressure vessel code that it may cause you some concern. It is not, however, as high as may appear, because at 5,600 pounds was taken from some single V test welds examined by Professor R. J. Roark, the results of which are given in a paper read before the A. S. M. E. meeting at Chattanooga in May, 1922. The 5,600 pounds is not the stress per square inch of plate section, but per square inch of weld section. When reduced to plate section, the figure would be 7,200 pounds. The probable reason that this has escaped attention is that only an abstract of the paper was published in *Mechanical Engineering*, the preprint being relied on for advance information and as the basis for discussion. The table from which the figures was derived is omitted from the abstract.

It should also be remembered that the 5,600 pounds figure was adopted in the fall of 1923, and that very great advances in welding knowledge and procedure have been made since that time.

It, therefore, seems that the figure of 9,000 pounds, which we are using at the present time as our basis of design, is not so much in excess of the 5,600 (in reality 7,200), as might appear at first, and it does not look to me at all out of the way to believe that in a short time we will be perfectly safe in using even higher fiber stresses. Ten thousand pounds working fiber stress, with a weld strength of 60,000 pounds, gives a factor of safety of 6 instead of 5, and as the A.S.M.E. Code allows the use of 11,000 pounds stress in riveted construction, 10,000 pounds does not seem to be too high.

Progress Must Be Sanctioned By Code

Of course, this means that care must be taken all the way through the job, and I would not advocate the use of 10,000 pounds in a code at present.

It seems to me that the best practice must always be beyond any code that may be devised, because progress means going beyond what is being done at present. The important thing is to safeguard the work, so that improvements can be used under proper control. Therefore, it seems to me that all laws in regard to codes or safe practices should contain such provisions as will allow progress to be made when proper authority has been secured, and, of course, such authority would not be granted unless those administering such laws were satisfied that there was no danger.

I might add that I believe the day is not far off when we will be using with safety still higher design fiber stresses. We have found it perfectly possible to make welds having an ultimate strength of 90,000 pounds per square inch, and we have even gone as far as 123,000 pounds per square inch. In the former case, with a factor of safety of 6, the working fiber stress would be 15,000 pounds, and in the latter case over 20,000 pounds.

I mention these high strengths only to show that much improvement is within sight, though it will require further study before definite practical applications can be made.

Problems of the Inspector

An honest inspector has a hard job, no matter what he is inspecting. He is continually confronted by two alternatives, the owner who knows little or nothing about the operation of his plant and who expects it to run without repairs or attention and the more or less rigid instructions he has received from those who employ him. On one hand his duty requires that he condemn the things that are not safe, and on the other he does not feel like shutting down a plant if it can be run with a reasonable degree of safety. Of course, there are conditions where he has no option but to insist on repairs being made at once, or indeed to order the shutting down of part of the plant. These extreme conditions are, however, rare, and in most cases it is a question of judgment on his part as to what shall be done. For the sake of his reputation he must not run any risk, nor must he be unduly severe. In cases where repairs are needed, he draws on his experience how far the repairs shall go and by what means they shall be made.

In the case of fusion welding, the average inspector has not himself ever done any of the work, and he, therefore, is naturally cautious about allowing it to be done. The instructions issued by his superiors are usually somewhat indefinite and simply say that under certain conditions welding can be employed. If the inspector were a good welder, or even if he knew enough about it to tell by watching the operator when a good job was done, or if he was sure that the firm who was doing the work knew that their welders were competent and did good work he would feel safe, and so would his employers, in allowing more latitude than if these assurances were not had.

Inasmuch as an inspector's efficiency depends on his knowledge, it seems to me that the time is coming very rapidly when all inspectors will have to know more about fusion welding than they now do, and I appreciate that this is going to be a difficult matter, because their time is almost altogether occupied with their work, and they have not many opportunities to get acquainted with proper methods and practices in welding. However, when a thing should be done some way is always found to do it, and I believe that this part of the problem will be solved, probably not only in one way, but it will be solved.

Further, from what I know of inspectors, they are anxious to find out about all matters that pertain to their profession, and it has been my almost universal experience that where an inspector had an opportunity to learn something about welding, he seizes it eagerly.

Inspectors Should Have Welding Instruction

I believe that it is the duty of those of us who are advocating fusion welding to give inspectors opportunities to learn more about welding. This can be done by taking one or two of them at a time into a welding shop or laboratory and demonstrating to them just how welding should be done. I would even advocate enough use of welding apparatus by the inspector so that he will have the confidence in his judgment of welding that he has in his judgment of other construction. He should be given opportunities to see the construction of welded pressure vessels, for instance, so that he can become familiar with proper methods and procedure. Such instructions as this cannot fail to increase the value of the inspector to himself, his employer and to the community.

There are other methods by which an inspector can gain considerable knowledge of welding, such as the welding and other trade papers. Almost all mechanical journals devote quite a little space to welding, and if an inspector reads these, he cannot fail to acquire much information. Many inspectors, however, are not inclined to read very much, nor indeed do they have time, so that I think a personal demonstration is of more value, at least as a beginning.

I would also say that the company with which I am connected will be very glad to help any inspector in any way we can to get accurate information on any points that he may inquire about, and I shall be pleased to answer any inquiries you may send me.

I believe that the responsibility for good results should be on the manufacturer, and I think it can be definitely put there.

Sometime ago, California began the revision of its air pressure tank rules, under the supervision of a general committee. Their sub-committee on welding made certain recommendations as to a procedure control to insure dependable workmanship, and I submit it as an illustration of what may be done, and of the thoughts of some people along this line.

Practically all of the instructions on welding issued to inspectors have been in connection with repair work on

Excerpt from Recommendations of Sub-Committee on Welding to San Francisco General Committee on Revision of Air Pressure Tank Safety Orders

Outlining Control Procedure to Insure Dependable Workmanship

3. *Authority to Manufacture:*

Manufacturers must be registered by the Industrial Accident Commission before they may fabricate air pressure tanks by means of the fusion welding process.

4. *Basis for Authorization:*

Manufacturers may obtain a permit to fabricate "Cal. X Std." welded air pressure tanks if they agree to comply with the requirements enumerated below, and may annually renew this permit if upon investigation by the Industrial Accident Commission they are satisfactorily carrying out the requirements.

a. Only welders whose workmanship is satisfactory, as determined by methods prescribed in paragraph 5, shall be permitted to weld upon air pressure tanks.

b. Welded air pressure tanks shall be constructed only in accordance with the material, design and test specifications hereinafter prescribed.

c. A complete record of each welded air pressure tank constructed shall be furnished the Industrial Accident Commission, using forms to be supplied by the Commission.

d. Each welded air pressure tank shall be identified by stamping on the tank the name of the manufacturer, the permissible working pressure, the words "Cal. X Std.", the year built, and the serial number of the tank corresponding to that given in the report specified in Paragraph "c" above.

5. *Examination of Welders:*

In order to qualify for work on welded air pressure tanks, a welder must pass the tests described below to the satisfaction of the Industrial Accident Commission. The applicant shall weld the specimens called for by the process to be used for fabricating the air tanks; or if he desires to qualify for both acetylene and electric welding, a complete set of specimens shall be prepared by each process.

a. Make two specimens joining with a single V weld pieces of ⅜ inch mild steel plate 3 inches wide and approximately 9 inches long of either Firebox, Flange or Class A Grades using low carbon steel welding wire meeting A. W. S. Specifications E1A, E1B, or G1A. The pieces of steel shall be cut with their long direction parallel to the direction of rolling and the weld shall be right angles to the long direction of the specimen. The welds shall not be hammered or annealed to improve the properties as the purpose of the specimens is to test the ability of the welder.

b. Make one single-V weld joining two ⅜-inch or ½-inch plates 3 inches wide lying in a horizontal position.

c. Make one single-V weld joining two ⅜-inch or ½-inch plates 3 inches wide in a vertical position, the weld extending in a horizontal direction.

d. Make an overhead weld, either joining two ⅜-inch or ½-inch plates 3 inches wide lying horizontal, or on the lower side of an 8-inch pipe held stationary. If a pipe is used, sample shall be cut out of under side for bend tests.

The two specimens described in "a" above shall have the weld milled or ground flush with the plate and have ½ inch cut off each edge, either by machining to the shape of the standard test specimen shown in full lines in sketch "x", or by hacksawing straight down as shown in dotted lines. These specimens shall then be subjected to the standard tensile test in any recognized testing laboratory.

If the strength of either of the two welded joints as indicated by this test is below 40,000 pounds per square inch, the welder shall not be permitted to work on air pressure tanks.

Specimen "b", "c", "d", shall be bent cold at the weld on a radius not more than 1 inch, with the deposited metal on the outside, and shall bend through at least 90 degrees without any cracks appearing at or near the weld. When fracture occurs with further bending the welded area shall exhibit a homogeneous structure, with no evidence of porosity, slag, or oxide inclusions, or failure of the filling metal to bond to the base metal. If any of these conditions are not met to the satisfaction of the Industrial Accident Commission, the welder shall not be permitted to work on air pressure tanks.

6. *Record of Examination of Welders:*

Each manufacturer shall maintain a permanent record of the examination of welders in his employ whom he permits to work on air pressure tanks, keeping this record on forms to be secured from the Industrial Accident Commission. With this record shall be kept the test specimens on which the record is based, as directed by the Industrial Accident Commission.

Each welder who successfully passes this examination, and is authorized to work on air pressure tanks, shall be assigned a number or other suitable mark, which shall never be duplicated. The number or mark so assigned shall be included in the welder's record submitted to the Industrial Accident Commission. This number or mark shall be stamped by the welder in the metal adjacent to the beginning and end of each seam welded by him.

7. *Periodic Tests of Work:*

In order to make sure that welders working on air pressure tanks are consistently maintaining the quality of workmanship indicated by their initial test, their work shall be checked at least once in each three months, when they shall be required to make test specimens (a) and (d) described in Paragraph 5 above, and if these specimens fail to satisfactorily meet the requirements outlined in that paragraph, the welder shall not be allowed to continue working on air pressure tanks.

boilers, and I think that these are usually correct. The general principle involved is that tension stress must not come on the weld. It is difficult to write down everything that is allowable, but I think you could well consider it one of your important duties to prepare a quite complete schedule of what is allowable, with any comments on materials, methods, and inspection you might care to include. This has been done to a greater or less extent by others, but an official pronouncement by your Board would carry great weight.

I speak of this because more and more fusion welding on repairs will become possible, and the acceptance of such extensions of the process as you approved would be for the benefit of everyone.

Discussion

Chairman Thomas: Welding is a subject in which we are all interested, and a thing we are going to have to accept along certain lines in the near future, whether we like it or not, because it is going to be demonstrated that it is reliable.

Now in our state we adopted the Unfired Pressure Vessel Code, and we had the pleasure of Mr. Miller's presence just a few days before the Commission took official action. We realize that that Code is very deficient, it will only apply to certain vessels. We have many vessels in our state, as you have in yours, to which this Code cannot apply. Under those circumstances we have to rely upon the information we have found in technical magazines, as well as that which is contained in the Code, and use our best judgment. That is the way we are operating at the present time in the state of Oregon. So far as the Code applies we apply it, but I must say that even with the little experience we have had that we have found the most dangerous conditions existing in places where welded vessels of various kinds of the old type are in use. In our state where manufacturing is limited, and we haven't the number of boilers, or pressure vessels that you have in the larger states, we have thrown out something like 40 percent of the welded vessels which were in use prior to the adoption of the Code. You go to places around your own states, and you will find these common hot-water tanks used for air pressure vessels, in many cases carrying extremely high pressures. We have had several explosions of that type of vessel in the state of Oregon, and we are wiping them out now.

H. H. Mills (City of Detroit): I would like to ask just why, in the welded joint, they make the joint heavier than the plate, why the weld is rounded up, instead of making it the same thickness as the rest of the material.

S. W. Miller: That goes back to the early days of welding. The first material available for welding was low carbon material, really wrought iron. Prior to the war all the welding wire that was made in this country was made from Swedish fillers, which was wrought iron, and of course the material in the weld was weaker than the ordinary plate, so they reinforced the weld in order to make it of approximately equal strength to that of the plate. Now the double V weld, approximately 55,000 pounds to the plate, is pretty nearly equal to the plate, when it is of the same section, that is, it has an ultimate strength of 52,000 pounds, which is pretty close to 55,000, when reinforced a little bit, it has strength equal to the plate. Nowadays there are welding wires which go to a much higher strength than the plate. Nickel steel, of proper composition, will give you samples of about 70,000 pounds, and other materials will give equal strength. So it is not necessary, if you are using boiler plate, to put that heavy reinforcement that is specified in the pressure vessel code. There was nothing in the Code to prohibit the use of low strength wire, and consequently they had to make that safe. It is much cheaper and better in every way to use high strength wire, and to put enough to take care of the holes and hollows.

J. E. Speed (City of Erie, Pa.): How would you satisfy your mind as to a safe vessel after you are through welding, or how can we satisfy our mind?

S. W. Miller: That is a most important question. I would not be able to tell, nor would anybody else, after the vessel was built, any more than you can tell what is in a piece of steel that you do not know the history of, but we have found by experience that if we use the proper procedure control as we call it, test our welders, be sure of the material used in every respect, follow them through the shop, that we do get results that are perfectly safe. It is one of the difficult questions in any work how to inspect it.

Here is a boiler, for instance. The inspector goes out and examines it. He has never seen it before, and it may have no stamp on it. He knows nothing about it. How is he going to tell about the quality of the riveted joints in that vessel? He just can't. He uses his good judgment in the appearance of it, and tests the rivets with the hammer, and if he finds any suspicious look about it he may require some rivets to be cut out, in order to find out whether it is right or not. The same thing can be done in the case of a suspicious pressure vessel. There is one thing of greater insurance to safety than anything else I know, that is the double V weld, welded from both sides. All the accidents without exception that I have ever known of have been with the single V weld, only partially welded through, and that is what Mr. Thomas referred to when he said he had thrown out so many of these pressure vessels in Oregon. They are all welded from one side, just skimmed over. Now if they were welded from both sides, even if the weld were slightly imperfect in the center, it would be made up for, and you would have no danger whatever.

See that the tanks are made right, with double V welds, which is a part of the procedure control, and I do not think you will have any more danger than any other type of construction.

F. A. Page (State of California): I would like to ask Mr. Miller, if he were in the position we are in in California, where we haven't any force to supervise the construction of welded vessels, how he would go about assuring himself that proper workmanship was being done.

S. W. Miller: I would put the responsibility, on the manufacturer. I would make him keep official records of his welders. There is no use blinking that question, you have it to face absolutely, and it is impossible for any state, I think, to have a force of inspectors sufficiently large with the appropriation you get out of the legislature, to put enough inspectors in every welding shop to follow it through. I do not believe it is done, in the case of boilers. There are certain definite things that you know about a boiler. You cannot tell that every rivet in a boiler is properly driven. Every once in a while there is a boiler that gives trouble on account of the seam where the rivets have not been properly driven. Equally, you cannot be sure of every inch of the welded seam, no matter what inspection you put upon it. I do not believe it is at all possible, but if you put the responsibility on the manufacturer, not on the welder—say you must keep a record of every man that goes on that job, and he can work on that job as long as he comes up to a certain standard—the chances of failure are very limited, and that is practically what the sub-committee in California has recommended. We have quite definite tests of how a welder shall be accepted. I want to emphasize that the main point is to put the responsibility on the manufacturer. Legally it is, but if he evades that he has something a little bit beyond that,—the orders of the Industrial Commission of California that he has to meet. He will be a little bit careful how he allows people to work on that tank.

There is another thing that can be done, and has been done in certain cases, in pipe welding in the southwest and in California, where there is an enormous amount of the work done, sometimes the pipe runs up to 20 inches in diameter. (There has been a machine used,—by the way, I sent a description of it to D. O. Wilson, whom I suppose you know. It is nothing but an ordinary little hand milling machine that is adapted with the clamp to put around the pipe, and you can cut out at any place in the weld a little piece about 3/16-inch thick and one inch long. If you are suspicious about a weld all you have to do is to cut out a little test place, and see if there is a proper fusion. If not it can be cut out and done over.) I have given the engineer in charge of the work authority to cut out test places at unknown intervals, irregular intervals. He is not compelled to cut out one in every five, but can cut two in every ten if he wants to, or one right next to the other, in order to see whether the welder has done good work. It may keep him on his toes.

Chairman Thomas: We had considerable trouble in Oregon, when we adopted the Code, to get the manufacturer to comply with the provisions of the Code, as I said before. The Code applies to only certain vessels. The requirements were that each pressure vessel must be inspected in the shop where manufactured by a registered inspector, and a manufacturer's daily data report must be sent to the state department for each and every vessel manufactured, just the same as you do on your boilers, attested by a proper inspector. Now when that order went out, we had various manufacturers outside of the state of Oregon who claimed that it was impossible to comply with that provision. Your eastern manufacturers who were sending plants into our state said that they made them bv the wholesale, and sent them to their distributors, who then dispatched them over the various parts of the country, and they didn't know where they were to go, consequently they could not comply. I wrote to them and wanted to know if it would not be possible for them, knowing which distributors were selling to plants in the state of Oregon, to supply them with the manufacturer's data report for those tanks, and that they, when they shipped to the western territory, could then send the manufacturer's data report for these tanks to us. With no exception they replied that that could be done, and it is being done today. Then I requested the same of the State of California, the manufacturers of that territory, and told them they could not ship tanks into our state unless than provision was complied with. Today, up to the present time, they have ceased shipping the California tanks into the state of Oregon, because they do not want to comply with that shop inspection. Now we are not discriminating against any state, but when we put those rules and regulations down, we put them down for everybody to comply with. When the Code was first adopted, I made a personal visit to every one of them, explained the situation, and told them they all had to comply with those regulations, it was working no hardship on them when all had to comply with them, and they agreed that it was right, and said, we will go shoulder to shoulder with you, and see that it is carried out.

M. A. Edgar (State of Wisconsin): I would like to ask Mr. Miller if there is any consideration given to the licensing of the welder himself?

S. W. Miller: There has been a great deal of discussion of that particular point, but I think it would result very unsatisfactorily for several reasons. In the first place, there is more or less politics connected with it; in the second place, if a welder is licensed all the manufacturer does is to look at his license, and say, "You are licensed, go ahead," and let him go ahead and weld. The responsibility is more or less taken off the manufacturer. It does not seem, from a careful consideration of it, that it will work out nearly as well, with the more or less floating element, not altogether but somewhat floating, as if you put the responsibility on the manufacturer for being sure that his welders are competent. That has been discussed, but everybody that I know of that has given it careful thought and consideration has turned it down as not being practical. Another difficulty is, for instance, in a state as large as California, the number of places that would have to be provided for welders to be examined, without some of them having to travel 1,500 miles, is a pretty serious obstacle to using that. Another thing, the setting of a standard that can be taken care of by the state authorities is not the easiest thing in the world. There would be considerable complaint and objection on the part of the welders, and I think, everything considered, that it is not a feasible scheme.

J. M. Lukens (City of Philadelphia, Pa.): I would like to hear something from Mr. Miller along fatigue of seams.

S. W. Miller: There have never been any definite tests made, that is, authoritative tests, if I may call them that, by the Bureau of Standards on the fatigue of welds. We have made a number of tests at our laboratory for which we have never published the results, because it is a commercial laboratory, and a thing like that does not carry the weight that a body like the Bureau of Standards does. The tests now being worked out by the Welding Society will give definite results. There is no essential difference in the properly made weld between the fatigue response of it and the fatigue response of the plate. You may get two pieces, one will give you 100,000, another a million, another five million,—none are exactly alike. That is a difficulty in making fatigue tests. I think you should remember this: if a tank is operated at a pressure for which it is designed, you are away below the fatigue limit in any case. The fatigue limit in ordinary steel, as shown by Prof. Moore's tests, is approximately half the ultimate strength of the metal. That is true with low carbon steel. You are not working any tank that is properly designed and operated at anything like half its ultimate strength. That would be, in the case of fifty or sixty thousand steel, thirty thousand pounds. The highest stress I know of is 9,000 pounds, which is less than one-third of the fatigue limit. So at the present time there is no danger from operating a tank in ordinary service properly designed and built.

The tests that the Welding Society is going to make will include tests of pieces about one-half inch thick and eight inches wide, so we will have more than the very small test pieces that are ordinarily used for fatigue.

L. R. Land (State of Oklahoma): In forming the double V weld is this weld conducted both at the same time, or is it reheated, and if it is welded on one side, and then gone over later, doesn't that injure the plate when welding, the second heat?

S. W. Miller: No, it does not seem to. If anything, it improves it. The weld metal is coarser grained because it has been fused, the metal next to the weld is said to be overheated, but we have never been able to detect any difference in the physical properties of that metal, if made out of the proper material. You must use a better quality of steel than tank steel to avoid any difficulty. The welding on the second side really refines the grain of the weld very materially, and improves its quality rather than does any damage. Good results are all predicated on proper procedure all the way through. You must use the proper quality of material, you must do the work right, you must do the welding right, you must design it right, and if you do not do these things you will not get good results.

WM. P. EALES (State of Pennsylvania): Mr. Miller has emphasized and recommended very strongly the advantages of double V welding. I suppose this is commercially practical only on heavy plate. I would like to ask Mr. Miller where the practical line between double V and single V welding lies, whether ¼ inch plate, 3/16 inch, or where? Another matter, I have seen a few welded tanks in my day, and I have visited a few shops where they welded on really light plate. For the purposes of inspection, I can tell whether the weld penetrated on the single V weld, which I cannot do on the double V. They can smooth the job up on both sides, but on a single V weld you can tell whether they went all the way over the plate. Now there must be some dividing line where single V weld is more practical than double V's, based on the thickness of the plate. Of course on heavier plate it is necessary. Wouldn't it be better on the light plate to have only single V welding, so you can see the other side, and see that the weld went through, rather than just smear it over on both sides?

S. W. MILLER: I would not draw any lines, Mr. Eales. I would weld plate ⅛-inch thick on pressure vessels on both sides, and there are some considerations there that if you will try it for yourself I think will convince you. With the ordinary low carbon welding rope it is practically impossible to get a perfect fusion through any plate of any thickness. There is a defect at the bottom of the V that is not usually visible, unless you clean the scale off with acid or some other way by which it is thoroughly cleaned or removed. Even though the crack is microscopic it is there. There is a defect at the bottom of the V. The average welder will not attempt to get thorough penetration with a single V weld, because he leaves little drops of metal hanging there, even where they are hanging, if you cut a section through one of them and look at it with the microscope, you will find microscopic cracks there, which is a trouble breeder. On the other hand, with plate up to ¼-inch thick there is no necessity of V-ing, the plate, that is, making actual V. This is very nicely demonstrated by Test No. 5 of the Welding Society, by which it is shown that even an imperfect double V weld, which shows welds with slight defect in the center were equal in strength to those entirely welded through. What was your other point, Mr. Eales, or did that entirely answer your question?

F. A. PAGE (State of California): Which method is considered best, on the butt weld, on the head of the shell, or the shell with head forced down into the shell, and the shell crimped over a little bit, and then welded on?

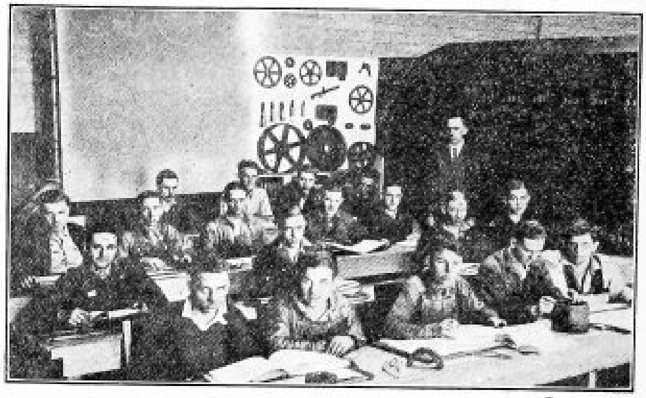
S. W. MILLER: The butt weld is absolutely the best without any question. The crimping of the head over the shell does not add anything to the strength of it. Theoretically you draw one arc of a circle, and then you draw another line through it, on a piece of paper, and they fit, but they do not fit when you turn them out of the shop, and are putting them together. You can't fit them, and consequently that weld gets a binding stress on it, and the A. S. M. E. Code does not permit that kind of welding.

Committee on Locomotive Design Requests Suggestions

The Committee on Locomotive Design and Construction of the Mechanical Division of the American Railway Association, in its report to the annual meeting held this year at Montreal, made certain recommendations under the general subject of design of fundamental parts of locomotives. The Committee wishes to enlarge on this subject during the coming year with a view of ultimately having definite standards for as many of the fundamental parts of locomotives as possible and is asking for suggestions as to what parts should be undertaken for standardization during the coming year. Any suggestions should be submitted to the offices of the A. R. A., located at Chicago.

Burlington Apprentice Schools

VALUABLE work in the training of apprentices is now being done by the Chicago, Burlington & Quincy in co-operation with the local educational systems at two important shop points. The Burlington sponsors training schools at West Burlington, Iowa, and Havelock, Neb. The instruction in both schools is in the nature of extension work, the compensation of the instructors being provided in equal shares by the state, the local school board and the federal government.



Class scene at West Burlington Shops, Iowa

The school work at Havelock is under the direction of the University of Nebraska and at West Burlington is supervised by the director of industrial education and the apprentice instructor of the Burlington schools.

The school at West Burlington is typical. Here the teaching is done by the professor of industrial education at the Burlington high school. The 49 apprentice boys now employed, who represent all the regular shop

Class of shop apprentices at Havelock, Nebraska

trades, such as machinist, blacksmith, boilermaker, sheet metal worker, pattern maker, etc., are divided into three sections, each of which attends school four hours weekly during company time—7 a.m. to 9 a.m.

A class room is fitted up by the railroad in one of the shop buildings where the first group meets on Mondays and Thursdays, the second on Tuesdays and Fridays and the third on Wednesdays and Saturdays. The instruction is entirely on practical lines and in general consists of drawing, mathematics and shop practice. The drawing lessons stress free-hand sketching, not with the idea of making draftsmen, but as a means of fixing in the boys' minds the principles of blueprint reading. For the beginning class a text book on "Shop Arithmetic" is used and enough elementary geometry is given to cover measurement of circles, etc., also cutting and grinding speeds, ratio and percentage. The more advanced pupils have work in strength of materials, gear ratios, gear trains, screw cutting, horsepower of belting and gears, horsepower of engines, and mensuration. Charts and models assist greatly in the work of instruction. In shop sketching, each locomotive part of casting used is selected in order to bring out some specific convention.

Each apprentice is given work for his own specific trade. For instance, while the machinist apprentice is sketching castings, the tinsmith apprentice is sketching elbows. roof flanges, etc.; the boilermaker apprentices and tinsmith apprentices are given sheet metal pattern drafting. This work must be accurate and in the case of boilermakers, all changes due to rolling, flanging, etc., are taken into consideration. For the blacksmith apprentices considerable time is given to figuring stock requirements, also heat treatment of steel.

Each apprentice receives his regular wages for the four hours spent weekly in attending these schools, so that his time is paid for while he is given free instruction. The only cost to the student is for books and sketch paper. The boys are encouraged to present any problems encountered in the course of their work. If of general interest they are taken up during the class period. If not, the instructor works them out with the individual at some other time.

Monthly reports of the school room work are checked against reports of shop work, rating the ability of each apprentice according to his workmanship, accuracy, application, aptitude and skill.

The course of study is designed to continue through the apprenticeship term of four years, at the end of which each student is to receive an appropriate certificate of proficiency attained.

Although the schools were started only seven or eight months ago, the respective shop superintendents who have opportunity for daily observation are convinced that the plan has amply demonstrated its value. They are impressed with the interest shown by the boys and their apparent efforts to show progress in their work, both at school and in the shop. They note an improved morale among the apprentices and an inspiration to do their best, because of the interest which the management is taking in their training. If the school did nothing beyond this it would justify itself, but it promises even greater returns for both company and the apprentices through the making of better mechanics and the development of talents that might otherwise remain latent. As in all schools, the result depends upon the student. With enthusiastic instructors and the intelligent co-operation of foremen, the progress of an apprentice pupil is governed only by his own personal limitations.

The Burlington is so well satisfied with its two schools that it is endeavoring to enlist the universities of other states where it has shops, in order that as many apprentices as possible may be given the same advantages of training.

Revisions and Addenda to the A. S. M. E. Boiler Construction Code*

It is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision in the rules in its codes. Any suggestions for revisions or modifications that are approved by the committee will be recommended for addenda to the code, to be included later on in the proper place in the code.

Important addenda that have been suggested for insertion in the code are published below and are submitted for criticism and comment thereon from anyone interested therein. Discussion should be mailed to the secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

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

Revisions Continued

Par. C-117. Revised:

C-117. Careful examination of the interior of the boiler shall be made for cracks, BROKEN STAYS, pitting, corrosion, EROSION, scale, and thin places in the shell. The upper half of drums in the steam space shall be examined particularly for signs of grease and oil.

Par. C-119. Revised:

C-119. The [location] CONDITION of the feed [discharge] PIPE and [the condition] of the trough under it IF USED, shall be noted. Dry pipes shall be examined to see that their openings and perforations are free from deposits. All interior fittings shall be examined for loose connections.

Par. C-123. Revised:

C-123. Where soot blowers are used the inspector should examine them and also examine the boiler tubes for injury due to DISCHARGE FROM THE BLOWER NOZZLES [impingements of steam].

Par. C-128. Revised:

C-128. An examination of the condition of the main header and its connections to the boiler shall be made to ascertain that it is properly supported, that due allowance is made for expansion AND CONTRACTION without throwing strains on the boiler, and that the non-return stop valves are in good working condition and so placed that there is no pocket in the connection to hold water unless it be properly drained.

Par. C-129. Revised:

C-129. The plant inspector shall note the position of the steam gage and gage cocks AND MAKE SURE THE WATER PIPE CONNECTING THE WATER COLUMNS DRAINS TOWARD THE BOILER. [Ascertain that the pipes leading to the water column and water glass are level and] Check the position of the water glass by leveling across the top row of tubes or from the position of the fusible plug.

*The first section of the revisions appeared on page 296 of the October issue of The Boiler Maker.

PAR. C-156. REVISE FIRST SENTENCE TO READ:

Do not allow the setting or adjustment of safety valves by any one but a competent AND AUTHORIZED person.

PAR. C-166. REVISED:

C-166. When making a hydrostatic test of a boiler, remove the safety valves and blank the opening, or clamp the valve disks securely to the seats. Also remove the water column floats if necessary. Make sure that the safety valve is placed in good working condition after the hydrostatic test has been made, AND TEST THE SAFETY VALVES BEFORE THE BOILER IS AGAIN PLACED IN SERVICE.

CENTER HEADING. REVISE CENTER HEADING TO READ: CONTROL OF [excessive] COMBUSTION.

PAR. C-171. REVISE SECOND SENTENCE TO READ:

[In general] In cutting in a boiler to a steam header already in service, the steam line between the boiler and the header is usually warmed up by [backfeed through the drip line or by] means of the by-pass valve, and the header valve then fully opened to allow the boiler to cut itself in automatically with the non-return valve.

PAR. C-172. REVISED:

C-172. Care shall be used that there is no SERIOUS weakening of the boiler structure due to fire cracks, abnormal DETERIORATION [crystallization] of parts, [and] OR other defects because of intensified combustion due to an increase in the rate of operation, increased stoker capacity, or change of fuel.

PAR. C-174. REVISE SECOND SENTENCE TO READ:

Gas pressure in the furnace shall be AVOIDED [minimized] as far as practicable, as pressure in the furnace forces hot gases out through the crevices in THE setting and tends to destroy it.

PAR. C-217. REVISE SECOND SECTION TO READ:

When kerosene is employed for cleaning the blades of steam turbines, provisions should be made TO PREVENT IT FROM GAINING ENTRY INTO THE FEEDWATER [for discharging the used portions direct into the sewer or other waste].

PAR. C-220. REVISED:

C-220. Where open heaters are used, [these] THEY should be well vented to the atmosphere for carrying off corrosive gases. A separator should be provided for removing any oils that may exist in the exhaust steam for heating the water. AN OVERFLOW FOR REMOVING ACCUMULATIONS OF IMPURITIES FROM THE TOP SURFACE OF THE WATER WITHIN THE HEATER and blow-down connections of ample size should be provided for discharging solid materials that may settle from the water.

PAR. C-228. REVISED:

C-228. GREATEST care SHOULD [shall] be used to prevent the entrance of oil ESPECIALLY THOSE CONTAINING ANIMAL OR VEGETABLE FATS into a boiler as it IS LIABLE TO [will] collect in clots on the heating surfaces, causing bagging or rupture.

PAR. C-233. REVISE LAST SENTENCE TO READ:

Removal of scale from the exterior of fire tubes by vibrating them with an internal cleaner or hammer must be practiced with caution as it may [cause] DAMAGE THE [a serious strain on] thin tubes.

PAR. C-243. REVISED:

C-243. Where pitting is experienced [the surface of] THE CAUSE SHOULD BE ASCERTAINED AND REMOVED. UNTIL THE CAUSE CAN BE REMOVED ALL OF THE CORRODED SURFACES should be cleaned TO THE METAL [carefully] and [the pits filled with zinc oxide paste or other] SOME protective coating APPLIED to check FURTHER corrosive action.

PAR. C-246. REVISE LAST SENTENCE TO READ:

For this alkalinity use 1.5 [1.2 pounds] ounces of caustic soda per 100 pounds of water contained within the boiler.

PAR. C-249. REVISED:

C-249. Boilers in service may be exposed to external leaks of different kinds which tend to corrode the shell. The operator shall guard against leaky safety valves and steam mains which drop condensation on the boiler and cause external corrosion, especially where the water MAY run under THE protective coverings.

PAR. C-255. REVISE FIRST SENTENCE TO READ:

C-255. When a firetube boiler is to be out of service for a long period, the [exposed portion of] shell AND TUBE SURFACES THAT COME IN CONTACT WITH THE PRODUCTS OF COMBUSTION shall be given a coat of grease, red lead, black japan, or tar paint to prevent external corrosion.

PAR. C-268. REVISED:

C-268. All structures over boilers, whether they are part of the boiler installation or building structure, shall be inspected periodically to see that DETERIORATION [corrosion] does not occur, and shall be kept IN GOOD CONDITION [well painted] at all times.

PAR. C-271. REVISED:

C-271. The fastenings of all interior fittings such as braces, baffles, feed troughs, OR PIPES, gratings, zinc baskets OR PLATES, and dry pipes shall be maintained secure [and free from lost motion].

PAR. C-279. REVISE LAST SENTENCE TO READ:

No welding or patching shall be done except upon and in accordance with the advice of AN authorized boiler inspector.

PAR. C-280. REVISE LAST SENTENCE TO READ:

Isolated pits, not affecting the strength of THE material may be prevented from becoming serious by cleaning the pit carefully and electrically welding, or by APPLYING SOME FORM OF [filling in with zinc paint or other] protective coating.

PAR. C-288. REVISE FIRST SENTENCE TO READ:

C-288. Tubes in firetube boilers which have been rolled several times and still leak, may be WELDED AS SPECIFIED IN PAR. C-279 OR improved temporarily by rolling and beading the tube and then inserting a tight-fitting internal ferrule of boiler tube stock of a gage equivalent to that of the tube and of a length equal to 3 times the thickness of the tube sheet.

PAR. C-295. REVISED:

C-295. All boilers, with their auxiliaries and appurtenances shall be located, as far as practical, where they will be least liable to damage from external forces such as building failures, flywheel OR TURBINE explosions, flood, fire, or explosions from the storage of inflammable material, belt-transmission failure, and other possible disasters.

PAR. C-312. REVISE LAST SENTENCE TO READ:

Escape pipes should be supported so as to prevent any UNDUE strain upon the safety valve.

PAR. C-335. REVISED:

C-335. Pipe lines connected to boilers shall be installed with provision for expansion and contraction. Pipe lines shall be braced to prevent UNDUE strains on boiler or connecting pipe lines, and supports shall be of sufficient strength and designed to withstand strains set up by possible water hammer or vibration.

PAR. C-336. REVISE LAST SENTENCE TO READ:

Supports for piping shall not be attached to wooden or steel structures such as floor or roof beams, WHEN THEIR ALINEMENT MAY BE SERIOUSLY AFFECTED BY DEFLECTIONS CAUSED BY CHANGES IN LOAD [where liable to be affected by changes in load].

PAR. C-337. REVISED:

C-337. When stacks are supported from structures directly above the boilers, or from the boilers themselves, SUITABLE PROVISIONS SHALL BE MADE [care shall be taken] TO PREVENT [all steelwork from] corrosion OF ALL STEELWORK caused by water at this location running down on the stack, or from the roof.

PAR. C-339. ADD THE FOLLOWING NEW PARAGRAPH:

C-339. PROPERLY GUARDED LADDERS, STAIRWAYS, PLATFORMS, AND RUNNING BOARDS SHOULD BE PROVIDED FOR ALL BOILERS AND THEIR ACCESSORIES WHERE NEEDED.

PAR. C-340. ADD THE FOLLOWING NEW PARAGRAPH:

C-340. GOOD LIGHTING SHOULD BE PROVIDED ALL ABOUT THE BOILERS ESPECIALLY ON TOP OF BOILERS FOR EMERGENCY USE—AND AMPLE EXTENSIONS FOR USE IN AND ABOUT THE BOILERS FROM TWO SOURCES IF PRACTICAL.

PAR. C-341. ADD THE FOLLOWING NEW PARAGRAPH:

C-341. NUMEROUS EXITS SHOULD BE PROVIDED FROM BOILER ROOMS, SINCE DERANGEMENT TO BOILERS AND THEIR ACCESSORIES IS ALWAYS LIABLE TO OCCUR.

Dictionary of Locomotive Boiler Terms

Definitions of boiler parts adopted by Master Boiler Makers Association at annual convention

AT the recent annual convention of the Master Boiler Makers Association, W. H. Laughridge, chairman of the committee on "Standard Boiler Terms" proposed that the association adopt such portions of the "Dictionary of Terms" appearing in the *Locomotive Cyclopedia* published by the Simmons-Boardman Publishing Company, New York, as applied to boiler work. The convention passed the motion unanimously and adopted the definitions of terms which for the benefit of members of the association and all others connected with locomotive boiler work appear in part below. Earlier sections appeared on page 171 of the June issue, page 201 of the July issue, page 236 of the August issue, page 265 of the September issue and page 294 of the October issue. Further instalments of these terms will be published in later issues.

Definition of Terms

Smokebox Crane Bracket. A support for the smokebox crane.

Smokebox Crane Traveler. A movable carriage on the crane arm.

Smokebox Door. A circular door hinged at the side of the smokebox front, and held in place by clamps held by nuts screwed on studs set in the smokebox front, or by hinged bolts fitting in radial slots in the edge of the door. Usually made of cast iron or pressed steel. Also called front end door.

Smokebox Door Catch. A bent piece of metal used to fasten a smokebox door to a smokebox front.

Smokebox Door Clamp. A small forging or casting in the form of a clamp through which a bolt passes, fastening it to the smokebox front. The clamp turns about the bolt and can be placed so that one end laps over the smokebox door while the other rests on the smokebox front and by tightening a nut on the bolt the smokebox door is fastened securely to the smokebox front. By loosening the nut and turning the clamp about the bolt the door can be opened without entirely removing the bolts or clamps.

Smokebox Door Handle. An arm attached to a smokebox door to operate the catch and to swing the door open.

Smokebox Door Hinge. One or two hinges riveted to a smokebox door and held by pivots passing through projections or lugs on the smokebox front.

Smokebox Door Liner. A metal plate or sheet riveted on the inside of a smokebox door to avoid overheating it by the accumulation of sparks in the front end.

Smokebox Draft Regulating Damper. A damper placed in the smokebox for the purpose of regulating the draft.

Smokebox Extension. A cylindrical ring secured at the front of a smokebox, thus extending or lengthening it 20 or 30 inches and providing space for the accumulation of sparks or cinders which if thrown out of the stack might cause fires near the track.

Smokebox Front. The cast iron or pressed steel front of a smokebox, usually somewhat convex. It has a large circular opening, closed by a hinged door, through which access can be had to the steam and exhaust pipes, draft appliances and tubes.

Smokebox Front Door Washer. A gasket of some heat-resisting material placed under the edge of a smokebox to make an air-tight joint with the front.

Smokebox Front Ring. A heavy ring riveted inside the front edge of a smokebox to form a bearing for attaching the smokebox front.

Smokebox Joint Ring. See SMOKEBOX MIDDLE RING.

Smokebox Middle Ring. A heavy ring inside a smokebox sometimes used to connect the two plates of which the smokebox is built up. Usually used in extended smokeboxes.

Smokebox Netting. A network of wire having meshes from 3/8 inch to 1/2 inch square, placed in the front end of the locomotive to prevent the sparks from entering the smokestack. The netting is usually provided with a door, so as to give ready access to the upper part of the steam pipes and exhaust nozzles. Sheet steel with perforations or meshes stamped out is frequently used. Also called deflector. British, spark arrester.

Smokebox Netting Basket. A cylindrical basket made of netting placed around the exhaust nozzle and supported from the table plate to prevent sparks being thrown out of the stack.

Smokebox Netting Manhole. An opening, with a door, in the netting, to give access to the tubes or steam pipes without removing the whole netting.

Smokebox Netting Manhole Frame. A metal frame bolted to the netting around the manhole to which the netting manhole door is attached.

Smokebox Perforated Plate. See SMOKEBOX NETTING.

Smokebox Ring. Any one of the three rings, back, front and middle, used in building up a smokebox.

Smokebox Shell. The sheet or plate that forms the smokebox.

Smokebox Steam Pipe Connection. Primarily a stuffing box forming an air-tight joint where an outside steam pipe passes through the smokebox shell to connect to the steam chest, also allows considerable flexibility and movement of the smokebox and steam pipe.

Smokebox Superheater. A superheater placed in the smokebox and utilizing the heat in the waste gases for superheating the steam before it enters the cylinders. Usually made in the form of a large drum with the tubes passing lengthwise through it. See SUPERHEATER.

Smoke Stack. A cast iron, sheet steel or pressed steel pipe or chimney, secured to the top of a smokebox to convey the products of combustion and exhaust steam from the smokebox to the outer air. The size and shape depends greatly on the fuel used and the clearance limits.

Smoke Stack Barrel. The straight portion of a smoke stack. Called also smoke stack body.

Smoke Stack Base. A plate or foundation casting secured to a smokebox to support the barrel of a stack which is fastened to it by bolts. In some designs the base is cast solid with the barrel.

Smoke Stack Base Bolt. A bolt passing through a lug on the barrel of a stack and through a corresponding lug on the base.

Smoke Stack Bead. A small flare around the top of a smoke stack for ornamental purposes.

Smoke Stack Cone (Diamond Stack). An inverted conical casting supported in the bell of a diamond stack over the barrel mouth to break up large sparks which are thrown out.

Smoke Stack Extension. An extension cast integral with, or bolted to, the smokestack and projecting down into the smokebox. See PETTICOAT PIPE.

Smoke Stack Hood or Smoke Deflector. A movable elbow attached to the top of a stack which can be thrown down clear when running in the open and can be raised to deflect the smoke and cinders back over the engine when running through tunnels.

Smoke Stack Lift Pipe. See Smoke Stack Extension.

Smoke Stack Liner. A cylindrical steel casing sometimes used inside a smoke stack to protect it from abrasion by sparks.

Smoke Stack Netting. A mesh of wires placed across the bell of a diamond stack to prevent large sparks from being thrown out.

Smoke Stack Opening. An aperture in the top of a smokebox shell around which the smoke stack or smoke stack base is fitted.

Smoke Stack Top. The upper portion of a stack on top of the barrel or body.

Stack. See Smoke Stack.

Staggered Riveting. A name applied to a method of setting rivets in a boiler seam. Two parallel rows of rivets are put in, and each rivet in either row is opposite the space between two rivets in the other row. See Chain Riveting.

Staybolt. A bolt with both ends threaded used for staying the inner and out plates of a firebox. The ordinary staybolt is screwed through both plates and its projecting ends are hammered and riveted over the plates. Flexible staybolts are used to afford some elasticity between the inner and outer firebox sheets, whose different rates or degrees of expansion cause numerous breakages of staybolts. Hollow staybolts are used for admitting air above the fire. It is usual to drill a ⅛-inch hole to a depth of about ¾-inch in the outer ends of staybolts in order to more easily discover a broken staybolt by the escape of steam and water.

Steam. The vapor of water formed by its ebullition when heat is imparted to it. The temperature of ebullition, or at which water boils, depends upon the pressure to which it is subjected. At atmospheric pressure the boiling temperature is 212 deg. Fahr.; at 100 lb. per square inch it is 338 deg., and at 200 lb. 388 deg. The formation of steam in a locomotive boiler is a physical change caused by the application of heat; but there also occurs a chemical change, due to the same cause, which results in precipitating the mineral salts held in solution in the water when it enters the boiler, forming a hard crust or scale on the plates and tubes. This scale is a bad conductor of heat, and if it accumulates to any extent, seriously affects the efficiency of the boiler.

Steam Gage. A device for showing the steam pressure in a boiler, consisting of a slightly flattened bent tube filled with steam or water from the boiler and which tends to alter its curvature with any change of pressure. The free end of the tube is connected by an arm to a toothed sector which meshes in a small pinion to which an index or hand is fastened. A very slight change in curvature is thus multiplied and is easily observable on the dial or face of the gage over which the hand or pointer moves.

Steam Gage Cock. A stop cock in the steam pipe between the boiler and the steam gage.

Steam Gage Fittings. The pipes, couplings, outlets, turrets, nuts, etc., used to attach a steam gage to a locomotive boiler.

Steam Gage Stand. A bracket secured to the boiler inside the cab for the attachment of a steam gage or other gages.

Stoker. A device attached to a locomotive for the purpose of supplying fuel to the grate and lessening the labor of the fireman. There are two general classes, those that supply the fuel from above the grate and those that supply it from below, commonly called underfeed stokers.

Straight Top Boiler. A locomotive boiler having the shell of uniform diameter. In many designs the roof sheet slopes toward the back head and in some cases the course immediately ahead of the firebox has a taper on the bottom to furnish more water space around the tubes and combustion chamber.

Suburban Locomotive. A locomotive having three pairs of coupled driving wheels. Designed for short run passenger service. Sometimes of the tank type.

Superheater. An arrangement of tubes through which the steam passes and is "superheated" before being used to produce power.

Superheaters may be divided into two classes—fire tube and smokebox. The latter type gives only a low degree of superheat and is not used to any great extent.

Superheater Damper. A door in the plate forming the floor of the enclosure for the superheater header in the smokebox, and which regulates the flow of gases through the superheater flues.

Superheater Damper Cylinder. A small cylinder attached to the outside of the smokebox shell containing a piston connected to the superheater damper. The action of steam on the piston causes the damper to open when the cylinders are using steam.

Superheater Damper Cylinder Arm. A small arm pivoted to the damper cylinder and receiving its motion from the damper cylinder piston which it conveys to the damper through the damper shaft link and arm.

Superheater Damper Cylinder Steam Pipe. A small copper pipe conveying steam from the steam chest or steam pipe to the damper cylinder.

Superheater Damper Shaft. A shaft resting in bearings in both sides of the smokebox shell and on which the damper turns.

Superheater Damper Shaft Arm. A lever connected at one end to the superheater damper shaft and having a counterweight at the other end.

Superheater Damper Shaft Bearing. A casting fastened to the smokebox shell and furnishing a bearing for the damper shaft.

Superheater Damper Counterweight. A weight secured at one end of the damper shaft arm for the purpose of closing the damper when the throttle valve is closed.

Superheater Flue. See Flue.

Superheater Header. A metal manifold with partitions which separate the saturated from the superheated steam, and to which the superheater units are attached. The saturated passages connect to the dry pipe and the superheated steam passages connect to the steam pipes.

Superheater Header Support. A bracket secured to the inside of the smokebox shell to support the superheater header.

Superheater Heating Surface. The combined area in square feet of the superheater units measured on the outside of the pipes and including the return bends. It is not customary to include the area of the superheater header.

Superheater Pipe. A length of seamless steel tubing comprising one of the tubes of a superheater unit.

Superheater Pipe Band. A band of iron around the superheater pipes at short distances along their length to hold the tubes together and prevent warping.

Superheater Pipe Return Bend. A steel casting connecting the ends of the superheater pipes where they form the loops.

Superheater Pipe Support. Small supports fastened to the superheater units at short distances along their length for the purpose of holding the unit in position in the superheater flue.

Superheater Pyrometer. The electrical pyrometer or temperature indicator is a device which indicates the actual temperature of the steam in the steam chest. Its purpose is to assist engineers and firemen in obtaining the highest degree of efficiency in the operation of superheater locomotives.

Superheater Torpedo Return Bends. The forged ends of the superheater pipes which form the returns or bends for the steam passage. So named because of their shape.

Superheater Unit. Superheater pipes in combination with the return bends and fittings making the connection between the saturated and superheated steam passages in the header and located in a superheater flue.

Superheater Unit Clamp. A support for holding the superheater units to the superheater header.

Superheater Unit Tee Type Bolt. A tee head bolt fitting in a slot in the superheater header for securing the superheater units and the unit clamp.

Superheater Unit Through Type Bolt. A bolt passing through the superheater header for securing the superheater units and clamp.

Swash Plate. One of several transverse plates secured in a tender tank to prevent any violent surge or rush of water caused by stopping or starting suddenly. British, splash plate.

Switching Locomotive. A locomotive used for shifting or switching cars in yards and terminals. Sometimes termed switcher. Usually built to carry all its weight on the driving wheels.

Syphon (Nicholson Thermic). A triangular shaped water leg, used singly or in multiple for adding to the heating surface of the firebox, promoting circulation of water in the boiler.

T

Table Plate. A flat sheet or plate level with the exhaust nozzle, and extending across the smokebox, one edge connected to the lower end of the diaphragm and the other connected to the netting and diaphragm apron. Used to throw the sparks downward and toward the smokebox front.

Tank. That part of a locomotive tender, or of a tank locomotive, that contains the water. Tender tanks for large modern locomotives hold from 4,000 to 16,000 gallons of water.

Tank Angle. A piece of steel bent at right angles, used to brace or secure any of the plates or sheets of which a tender tank is built.

Tank and Coal Bunker. The coal box and water tank on an extension of the main frames of a tank locomotive. In some designs a water tank is placed on each side of the boiler.

Tank Brace. A steel rod, flat bar or tee or angle riveted to two tank plates to serve as a brace or stiffening piece.

Tank Bracing. The system of rods, bars, tees or angles used to strengthen and secure the various plates composing a tender tank.

Tank Coal Board. A gate or partition composed of several boards or steel plates sliding in vertical ways riveted to the legs of a tender tank for the purpose of holding back the coal or allowing only a little at a time to slide to the most convenient point to be reached by a fireman.

Tank Coal Board Slide. A vertical channel or slide formed by steel angle strips riveted to the inner sides of the legs of the tender tank for a sliding gate or rack that keeps the coal in place. See TANK COAL BOARD.

Tank Coal Bracket. A narrow plate of metal riveted longitudinally to the top of a tender tank to prevent the coal from falling off.

(*To be concluded*)

Boiler Maker As Independent Contractor

By Leslie Childs

WHERE a boiler maker is employed to perform a given piece of work, the question of whether he is an employee, or an independent contractor, may become one of considerable importance in the event he suffers injury. This is true because, if his status is that of an independent contractor he may have no claim on his employer for injuries received, while if his status is that of an employee his right to workmen's compensation may be clear. So, now let us see.

In the first place, it may be stated broadly, if a boiler maker is employed to do work at a given price and without any supervision whatever save as to results, he will usually be held to be an independent contractor. On the other hand, even though his employment is for work at a given price, if the work is required in the usual course of the employer's business and is supervised by the latter, the status of the boiler maker will generally be that of an employee.

From the foregoing, it is obvious that each case of this kind must necessarily be decided in the light of its facts, and that the subject cannot be covered by any hard and fast rule. However, as an illustration of judicial reasoning in a case of this kind, the recent Texas case of Lumbermen's Reciprocal Association v. Wells, 297 S. W. 884, may be reviewed with interest and profit.

Boiler Maker Employed to Make Repairs

In this case the plaintiff, a boiler maker, was employed to do certain repair work on the boilers of a basket factory. The defects in the boilers had been discovered by an inspector, who had furnished the basket company with a report covering the repairs to be made.

Upon the plaintiff's arrival at the plant of the basket company, the superintendent of the latter explained what was to be done, and gave the plaintiff the inspector's report for his guidance. It was agreed that plaintiff should be paid by the day and that the basket company would furnish all needed help and materials, though the plaintiff was to furnish his own tools and appliances.

During the course of the employment, the plaintiff was not required to use the time clock, as was demanded of the other employees, but kept his own time. And, while the plaintiff was given a free hand, it appears that the superintendent of the plant exercised supervision over the work as it progressed. All right.

After the plaintiff had worked three or four weeks and while under a boiler adjusting an iron bar, a water tank fell against the boiler knocking it down upon him. As a result of this accident, the plaintiff was severely injured and he thereafter filed a claim for compensation under the Texas Workmen's Compensation Law.

In this claim the plaintiff set up that he was an employee of the basket company at the time of his injury. The Industrial Accident Board sustained this claim and awarded him compensation in sums which aggregated $2,662.80. From this award the insurance carrier appealed to the courts, on the ground that the plaintiff was not an employee of the basket company at the time of his injury, but an independent contractor and hence not entitled to recovery under the Workmen's Compensation Law.

In support of its contention, the insurance carrier set up that the plaintiff was employed to do certain specific work; that he was permitted to "keep his own time," and was not treated as an employee in that he was not required to use the time clock. In addition, it was pointed out, the plaintiff brought and used his own tools in the prosecution of the work.

Further, the insurance carrier took the position that before the plaintiff could be found to be an employee of the basket factory, it would have to appear that the work he was employed to do was performed in the "usual course" of the latter's business. And it was contended that the repair of the boilers could not be held to be within the "usual course" of the employer's business.

Upon the trial of the case the plaintiff was held to be an employee of the basket factory at the time of his injury. In accordance with this finding, the court rendered judgment in favor of the plaintiff. From this an appeal was taken, and the higher court in stating the contentions of the insurance carrier, in part, said:

The Questions Stated

"The contentions presented in appellant's [insurance carrier] brief are: (1) That it conclusively appears from the evidence that appellee's [plaintiff] relationship to the work he was doing was that of an 'independent contractor'; (2) that, if it did not so appear that such was his relationship to the work, it did conclusively appear that he was not an 'employee' of the basket factory within the meaning of the Workmen's Compensation Law * * *"

In passing upon the foregoing contentions, the court, after a review of the facts as they have been outlined, in part, said:

"It appeared without dispute in the testimony in this case that, while appellee was not instructed *how* to do the work, he was fully instructed as to the particular repairs he was to make and was furnished the help and material he needed in making same. Moreover * * * the basket factory's superintendent testified, and his testimony was not contradicted, that he supervised the work appellee did * * *"

Following the foregoing disposition of the question of the relationship of the plaintiff (appellee) to the work he was doing, the court turned to the further contention that the work was not done in the "usual course" of the basket factory's business. In passing on this point the court said:

"Certainly keeping machinery it uses in repair is within the 'usual course of business' of a manufacturing concern. It could not very well carry on its business without doing that. In many instances repairs necessary are simple and can be and are made by operatives of machines used. It would be unreasonable, it seems to us, to say that such an operative while engaged in repairing a machine he was using ceased to be employed in the 'usual course' of his employer's business * * *"

In conclusion the court affirmed the judgment of the lower court in favor of the plaintiff boiler maker. Taking the position, as outlined in the opinion quoted from above, that in view of the character of the employment the plaintiff was not an independent contractor but an employee and as such was entitled to the protection of the Workmen's Compensation Law.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. J. Zusy

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Cleaning Burrs from Tube Holes

Q.—I have been a reader of your magazine for several years and have received information from it that has been of much use. We have just completed two boilers of the Sterling type. We lost a lot of time and had trouble in cleaning the burrs from the tube holes after they had been drilled and reamed. We use an air grinder and files to clean the burrs. the tube holes are in the shell of the drums. Could you tell me of some easier and quick way to take the burrs from the tube holes?—W. A. V.

A.—I know of no other method of removing the burrs from the tube holes, where tubes enter the drum of water-tube boilers, other than hand filing or the use of a small portable air grinder.

Designing a Spherical Tank

Q.—Can you give formula for designing a spherical tank 8 to 9 feet in diameter to stand 5 to 8 pounds per square inch vacuum? When filling the tank with water for testing and the tank is half full, would there be any danger of its collapsing with two supports about 3 feet long? To be built of dished plates and single butt straps.—N. J. G.

A.—The following formula for calculating the stress on hollow sphere is based on the object being truly spherical in shape. In this particular case a liberal factor of safety should be allowed due to the size and method of construction which will result in inaccuracy in the shape:

Let,

P = normal pressure.
r = radius of sphere, in inches.
t = thickness of shell, in inches.
e = efficiency of joints.
p = pressure on meridian plane.
T = tension or compression per lineal unit of shell.
s = unit stress.

Then

$$p = \pi r^2 P.$$

$$T = \frac{\pi r^2 P}{2\pi r} = \frac{Pr}{2}$$

$$s = \frac{Pr}{2ts}$$

To avoid any danger of collapsing, when the sphere is half full of water for testing, the supports should be designed so that the weight per square inch on the bearing surface of supports does not exceed the external pressure per square inch due to the partial vacuum for which the sphere is designed.

The supports should be uniformly spaced over the bottom surface of the sphere to properly distribute the stresses over the entire surface.

Cause of Boiler Studs Leaking

Q.—We are experiencing considerable trouble with boiler studs leaking in eleven new locomotives recently purchased. There are six Pacific and five Mountain type engines, and the studs are leaking in both types. The Pacifics have refined iron and the Mountain type have mild steel studs. All stud holes were tapped with the air motor. Tapered taps were used, tapered ¾-inch in 12 inches, V threads. I am of the opinion that the stud holes are not perfectly round after being tapped with air motor, owing to vibration of the motor on the tap. The threads in the holes and on the studs are perfect, as far as inspection can determine, and they are all tight, but they are leaking. If you or some of the readers will tell me what is wrong, I will appreciate it very much.—V. E. P.

A.—I do not believe the material of the studs has any bearing on the trouble you are experiencing with leaky studs on new boilers. If the leaky studs are not confined to any particular location, but are spread over the entire boiler, I would say it is just a case of poor workmanship and lack of inspection at the time the locomotives were built. If the leaky studs are confined to a certain location, such as waist sheet angles, air pump bracket, etc., it may be due to the design of these parts.

The large locomotive builders and railroad shops do all of their tapping with air motor and no excessive trouble is experienced with leaky studs. While it is possible that air motor tapping may be responsible for the condition as found on your engines, especially, if the tapping was done by a careless workman, as a general rule no more trouble is experienced with air motor tapping than with hand tapping.

Recently a large order of locomotives was completed at one of the locomotive builder's plants where stud tapping was done with an air motor. A record was kept of the number of studs found leaking under hydrostatic test and the cause of the leak determined. It was found that less than 1 percent of the studs leaked under test. Twenty-five percent of the studs found leaking were shouldered, that is, the studs were slightly undersize and screwed into the sheet up to the end of the threads. The remaining 75 percent were poor threads, due in most cases to worn threading dies resulting in undersize threads.

Tapered Pipe Intersecting a Cylinder

Q.—Would you kindly give me the development for the pipe in the enclosed sketch. I seem to be in difficulties about the length of the base triangles at the wide end. It is a 48-inch pipe entering a 96-inch pipe at an agle of 107 degrees, the size of the pipe at the intersection being 48 by 66 inches. I would appreciate it very much if you would let me know as soon as possible.—G. C.

A.—To develop a tapered pipe intersecting a cylinder at an angle it is necessary to construct, as shown in Fig. 1, a front elevation *a*, end views of tapered pipe *b* and *b'* and a bottom projection *c*.

The development of the tapered pipe is then made by employing the triangulation method. First divide the semicircle representing half end view of tapered pipe *b* into a convenient number of equal spaces, eight in this case, then divide half the periphery of the tapered end of the pipe into the same number of equal spaces.

Letter these points of division, alternating between lower and upper bases. Draw in succession, lines alternately from the points on the lower base to the points on the upper

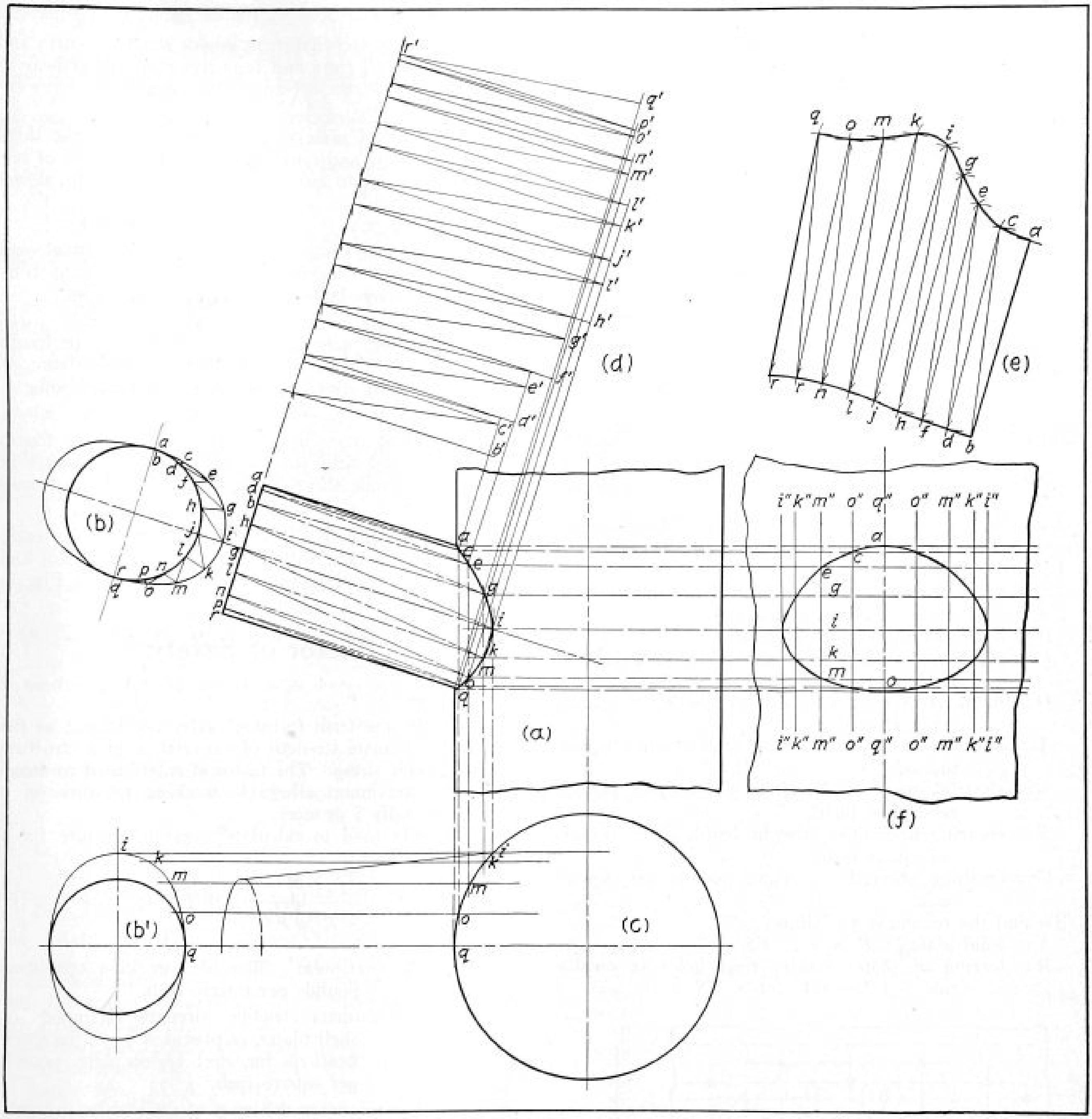


Fig. 1.—Development and patterns for tapered pipe and cylinder intersection

base; *a-b* being on the line of the diameter, draw *b-c*, *c-d*, *d-e*, etc. Project these points to the elevation and again draw in the lines *b-c*, *c-d*, *d-e*, etc.

The surface of the pipe is thus divided into a number of triangles. The lengths of the sides *b-d*, *d-f*, *a-c*, *c-e*, etc., may be taken as chord distances directly from the end view, since they are there shown in their full length.

A construction of right-angled triangles is necessary, however, in order to find the true lengths of lines *b-c*, *c-d*, *d-e*, etc., and in order to construct them, the line representing the end of pipe *b-r* is extended indefinitely toward upper part of the drawing to *r'* as shown in *d*.

At a convenient distance from the elevation draw vertical height of angle parallel to the center line *g-i* and project the base *b'-c'* from *c* on elevation. Take the distance *b-c* as shown on end view, and set it off with the dividers as at *b'-c'*. The hypotenuse of the right angle triangle thus found is the true length of line *b-c*. The same procedure must be followed to obtain the true lengths of all lines *c-d*, *d-e*, *e-f*, etc., except lines *a-b* and *r-q*, which are shown in their true lengths in the elevation and a triangle is, therefore, not required for these lines.

The true lengths of all the lines having been determined, the next step is to construct the pattern as shown at *e*. Draw line *a-b* making it equal in length to line *a-b* in the elevation, next, describe an arc from *a* as a center, with a radius *a-c* taken from end view *b*; intersect this arc by an arc described from *b* as a center, with a radius equal to the length of the hypotenuse of the triangle whose base is *b'-c'* in *d*. This completes the triangle *a-b-c* at *e*. The triangle *b-c-d* is next constructed in a similar manner and the completion of the pattern is accomplished by a continuation of the methods described.

The development of the hole in the intersected cylinder as shown at f is accomplished in the following manner.

One-quarter of the periphery as shown in b' is divided into four equal spaces the same as in b. The division points i, k, m, o, q are projected over the junction line of the pipe and cylinder as shown in c. Construct the center line q''-q'' in f and draw parallel lines o''-o'', m''-m'', etc., on both sides of the center line q''-q''. The distance between the center line q''-q'' and line o''-o'' is the chord distance between the points q, o on the bottom projection c; likewise the distance between the lines o''-o'' and m''-m'' is the chord distance between o-m on the bottom projection c, etc.

The points $a, c, e, g, i, k, m, o, q$ shown on the junction of the tapered pipe and cylinder in the elevation a are then projected to the development f and the points where the lines a-q'', c-o'', e-m'', etc., intersect will give the development of the hole in the cylinder.

Efficiency of Quintuple Riveted Joint

Q.—Will you please calculate the efficiency of strength in quintuple riveted joint for which a rough sketch is enclosed. Please publish same in a future number of THE BOILER MAKER.—P. F. G.

A.—The efficiency of the quintuple riveted butt joint as shown in Fig. 1 is calculated in the following manner:

Let

TS = tensile strength of plate, pounds per square inch.

t = thickness of shell plate, inches.

B = thickness of welt strips, inches.

P = pitch of rivets, inches, on row having greatest pitch.

D = diameter of rivet after driving, inches = diameter of rivet holes.

A = cross sectional area of rivet after driving, square inches.

s = shearing strength of rivet in single shear, pounds per square inch.

S = shearing strength of rivet in double shear, pounds per square inch.

C = crushing strength of plate, pounds per square inch.

To find the resistance to failure;

A = solid plate $= P \times t \times TS$.

B = tearing of plate between rivet holes in outside row $= (P - D) \times t \times TS$.

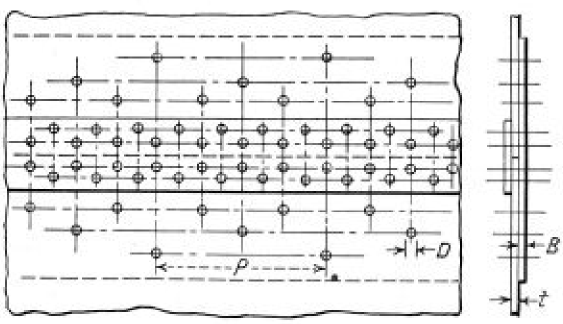


Fig. 1.—Typical quintuple riveted joint

C = tearing of plate between rivet holes in third row and shearing one rivet in single shear in the outside row and one rivet in single shear in second row $= (P - 2D) \times t \times TS + 2A \times s$.

D = tearing of plate between rivet holes in the fourth row and shearing one rivet in single shear in the outside row, one rivet in single shear in the second row and two rivets in single shear in the third row

$= (P - 4D) \times t \times TS + 4A \times s$.

E = shearing eight rivets in double shear in fourth and fifth rows and four rivets in single shear in first, second and third rows

$= 8A \times S + RA \times s$.

F = tearing of plate between rivet holes in the third row and crushing welt strip in front of one rivet in outside row and one rivet in second row

$= (P - 2D) \times t \times TS + 2D \times B \times C$.

G = tearing of plate between rivet holes in fourth row and crushing welt strip in front of four rivets in first, second and third rows.

$= (P - 4d) \times t \times TS + 4D \times B \times C$.

H = crushing plate in front of eight rivets in fourth and fifth rows and welt strip in front of four rivets in first, second and third rows

$= 8D \times t \times C + 4D \times B \times C$.

I = crushing plate in front of eight rivets in fourth and fifth rows and shearing four rivets in single shear in first, second and third rows

$= 8D \times t \times C + 4A \times s$.

Divide B, C, D, E, F, G, H or I (whichever is the least) by A, and the quotient will be the efficiency of a butt and double strap joint, quintuple riveted, as shown in Fig. 1.

Factor of Safety

Q.—Will you please inform me of the meaning of the term factor of safety of a boiler.—K. P.

A.—Briefly, the term factor of safety is defined as the ratio of the ultimate strength of material or of a structure to the allowable stress. The factor of safety used in determining the maximum allowable working pressure on a boiler is generally 5 or more.

The formula used to calculate working pressure for a boiler is given as

$$\frac{TS \times t \times E}{R \times FS} = WP$$

where,

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

TS = ultimate tensile strength stamped on shell plates, as provided for in the specifications for steel boiler plate, pounds per square inch.

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

E = efficiency of longitudinal joint or of ligaments between tube holes (whichever is the least).

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

FS = factor of safety, or the ratio of the ultimate strength of the material to the allowable stress.

For new constructions FS in the above formula = 5. This formula can be transposed so that in terms of the other factors the factor of safety would be

$$FS = \frac{TS \times t \times E}{R \times WP}$$

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States

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

Cities

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
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States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
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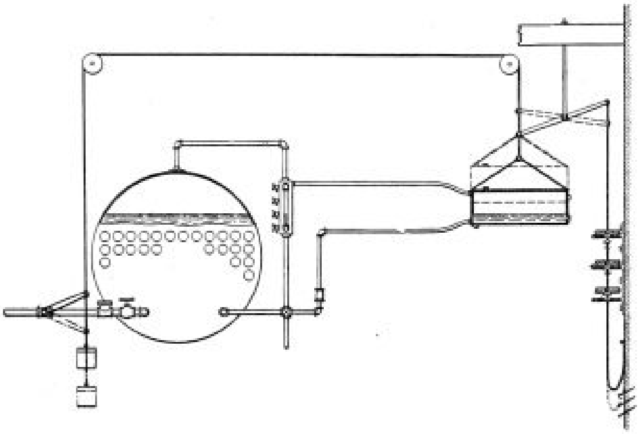
SELECTED BOILER PATENTS

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

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

1,641,612. ANDREW A. ATKINS, OF MINERAL, VIRGINIA. BOILER-FEED REGULATOR.

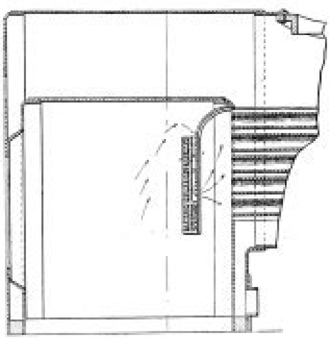
Claim. In a feed water regulating mechanism, the combination with a water receptacle, a water supply conduit having connection with the receptacle, a regulating valve in said supply conduit, a vertically movable water drum communicating with the receptacle, a cable having connection



with said drum and said regulating valve and including a weight, a lever fulcrumed and having one end connected with said cable adjacent the drum, a second cable connected with the other end of the lever and depending therefrom, a plurality of stops fixed to the second cable at spaced intervals, a weight slidably mounted on the second cable above each stop, and a support arranged beneath each weight having an aperture for the passage of the cable and stops.

1,642,371. CARL E. JOHNSON, OF CHICAGO, ILLINOIS. BAFFLE PLATE FOR BOILER FIRE BOXES.

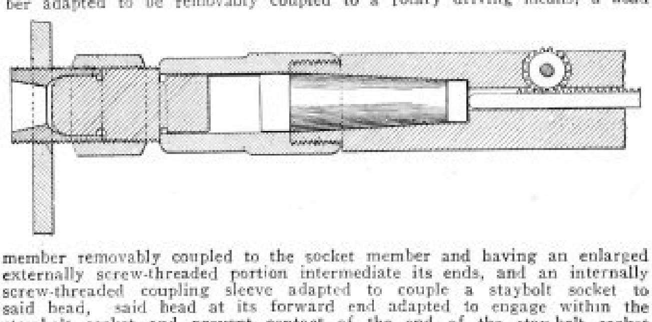
Claim. In combination with a boiler, of a fire box therefor having an arch-shaped top, a plurality of flues extending from said fire box through



said boiler, a plurality of baffle plates pivoted to the side walls of said fire box for baffling said fire box from said flues and means formed on the top of said baffle plates and conforming to the arch-shaped top of said fire box whereby said baffle plates may be swung to a position parallel with the sides of said fire boxes.
Twelve claims.

1,637,949. HARRY ANTHONY LACERDA, OF WATERVLIET, NEW YORK. BOILER TOOL.

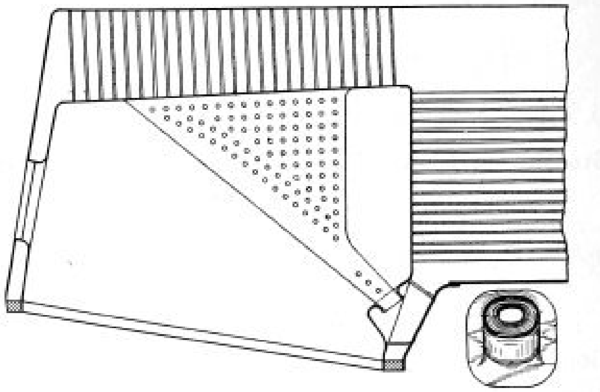
Claim 1. A tool of the character described, comprising a socket member adapted to be removably coupled to a rotary driving means, a head



member removably coupled to the socket member and having an enlarged externally screw-threaded portion intermediate its ends, and an internally screw-threaded coupling sleeve adapted to couple a staybolt socket to said head, said head at its forward end adapted to engage within the stay-bolt socket and prevent contact of the end of the stay-bolt socket with said head member. Four claims.

1,643,128. JOHN L. NICHOLSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE. EXPANSION AND CONTRACTION ANCHORAGE FOR THERMIC SIPHONS.

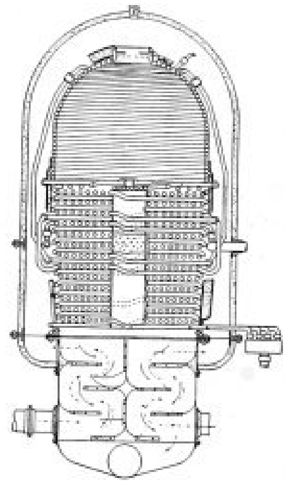
Claim. A locomotive firebox embodying therein a throat sheet and containing a thermic siphon having a neck, the line of expansion and contrac-



tion of said siphon extending at an acute angle to said throat sheet, an inverted cylindrical pot incorporated in said throat sheet with its axis in substantial alignment with said line of expansion and contraction and having a wall with an opening therein to receive the end of said neck.
Four claims.

1,644,078. JOHN HUGH O'NEILL, OF SPRINGFIELD, MISSOURI, AND WARD LEATHERS, OF HAWORTH, NEW JERSEY. CONTINUOUS-WATER-TUBE FLASH-TYPE STEAM GENERATOR.

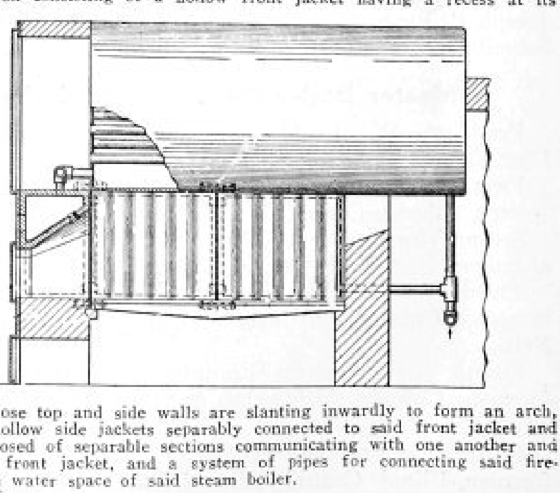
Claim. In a flash type steam generator, a plurality of continuous water and steam conduits, said conduits being arranged in parallel relation in



alternate layers of spiral coils and radially disposed portions of said conduits, said conduits being adapted to form supports, spacers and tying members in one layer for the other layer, said conduits in one layer crossing said conduits in the next adjoining layer, said conduits being autogenously welded together at said crossings.

1,641,162. LEWIS GLASHOW, OF NEW YORK, N. Y. STEAM BOILER.

Claim. As an article of manufacture, a metal fire box adapted for installation in an old steam boiler in lieu of the brick firebox thereof, said metal firebox consisting of a hollow front jacket having a recess at its



bottom whose top and side walls are slanting inwardly to form an arch, and two hollow side jackets separably connected to said front jacket and each composed of separable sections communicating with one another and with said front jacket, and a system of pipes for connecting said firebox to the water space of said steam boiler.
Two claims.

The Boiler Maker

Volume XXVII | December, 1927 | Number 12

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Chicago: 105 W. Adams St.
Cleveland: 6007 Euclid Ave.
Washington: 17th and H. Sts., N. W.
San Francisco: 74 New Montgomery St.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

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

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

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

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

CONTENTS

Annual Index

THE annual index of The Boiler Maker for the year 1927 will be published separately from the magazine at the end of the year. As the complete index will be useful only to those of our subscribers who have kept a complete file of the magazine for the year, only a sufficient number of copies will be printed to meet the requirements of those who notify us at once of their desire for a copy. A copy of the annual index will be mailed without cost to each subscriber whose request for it is received at our New York office on or before January 16, 1928.

Enter Your Kinks in the Prize Contest

ON page 343 of this issue a second notice of the "Boiler Shop Kinks Prize Contest" appears. The first announcement of the contest was made on page 305 of the November issue. Posters giving the rules of the contest have been sent to every boiler shop and plate shop in the country, so that no individual in any way engaged in designing, laying out, building, inspecting or repairing boilers, tanks and heavy plate work should be uninformed on the requirements of the competition. Special notices have also been sent to all our readers.

A great many letters have been received from mechanical officials and foremen expressing their appreciation of this effort to not only bring to light valuable devices and methods of doing boiler work but also to give the men responsible for developing them due credit for their work.

Some question has been raised as to the advisability of basing the awards on the best two kinks submitted by one individual. Many men feel that they have one excellent device or method that would have a good chance of being a prize winner but that they would have difficulty in describing a second one that would be equally good. In answer to this question, the idea of the competition is not only to bring out the shop kinks which are best known in the shops but also to create an incentive to the men to examine every device and method in use in the shop and select those that they find most valuable in saving time, labor or in reducing production costs. Nothing is ever gained without a certain amount of effort and in this instance the necessary study should be given to all the useful kinks in the shop and from them select the best for describing and submitting in the contest.

So long as your description gives a comprehensive idea of the device or method it will receive the same consideration as every other one submitted. It should of course be carefully prepared and any illustrations, either photographs or drawings, explaining it should be clearly made but no description will be judged on its literary merit or length. The industry is interested in the kink itself and its possible value in improving operations in shops other than the one in which it was used originally.

Furthermore every good kink that is submitted will receive remuneration whether it is a prize winner or not. If the judges consider it useful in any way, a description of it will be published in one of the future issues of THE BOILER MAKER and will be paid for at regular magazine rates.

The effort involved in describing devices and methods which you are using all the time is not very great. If in return for this small amount of work you win one of the prizes it will be a good start for the New Year. Do not fail to submit your ideas on what good "Boiler Shop Kinks" should be at an early date.

Developments in Fusion Welding

FROM the early days of the fusion welding industry, the art has been under fire from a great many different angles. Wherever a new application of the process has been made the results have been keenly observed and, in the case of failures, which were not altogether unknown in the early days, great criticism of the process has almost invariably followed in many quarters. The art has advanced rapidly under adversity, however, and at the present time welding is being applied in branches of construction work where a short time ago its use was not even considered a possibility.

In the pages of THE BOILER MAKER a careful record has been maintained of the development of the fusion welding processes, both oxy-acetylene and electric arc welding, since their inception. In this interval the equipment, material, design of welded structures, technique and methods of testing have been improved to a point where the art has finally taken its place in the sun of approval. Limitations are rightly placed on its application in structures subjected to stress such as power boilers where a f ilure would cause disaster, but in other forms it is widely applied, greatly to the advantage of the user both from a speed and cost standpoint. The hundreds of miles of welded pipe line and great numbers of welded pressure vessels and tanks of all kinds bear evidence to its value.

In spite of the favorable service records of such applications of welding, a spirit of antagonism still seems to persist in certain quarters. The point most frequently raised against the use of the several processes is that until welds can be examined and tested in place after the completion of a structure and a direct measure of the strength of that structure ascertained the dependence placed on it should not be very great.

In this connection it is interesting to note that methods of making such tests have been developed so that now it is possible even in the field to remove samples of welded material from a pipe tank or other vessel, test it in a portable testing machine and determine exactly the value of the weld. The physical and metallurgical properties of weld metal are now so well known that a micrographic examination of an etched sample of the metal will indicate almost exactly the condition of the weld. Machines for carrying on tests of this character will be described in early issues of the magazine.

The All-Watertube Locomotive Boiler

IN this issue is described a proposed all-watertube locomotive type boiler. So far, developments of watertube boilers for locomotive use have been in combination with conventional firetube designs. The present design would seem to offer an excellent basis for an investigation of the possibilities to be obtained from carrying the watertube principle in connection with locomotives to its logical conclusion. Comments on the design will be welcomed by the author and they will appear in the magazine for the benefit of the industry at large.

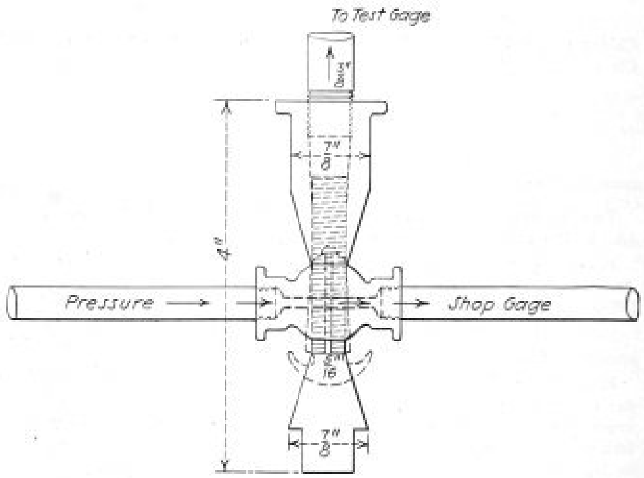
LETTERS TO THE EDITOR

Attachment for Test Gage

TO THE EDITOR:

The boiler inspector who came to our shop last week to test some new boilers, had with him the quickest device for attaching his test gage without the usual routine of connecting nipples and fittings to the line on which our gage was attached that I have ever seen.

This device consisted of but two parts. One part of brass 2 inches long, $\frac{7}{8}$ inch in diameter for half its length and the other half tapered to $\frac{1}{2}$ inch. From the tapered



Convenient device for use with test gages

end for half its length it was drilled and threaded with $\frac{1}{4}$ inch machine thread and the other half length from the center was drilled and tapped for $\frac{3}{8}$ inch pipe thread where his gage was screwed in.

The other half of the connection was also of brass and a full 2 inches in length. At one end was a $\frac{5}{8}$ inch square for tightening with a wrench. Then it tapered from $\frac{7}{8}$ inch to $\frac{1}{4}$ inch machine thread. The length tapered was $\frac{3}{4}$ inch and the length machine threaded was 1 inch. The machine threaded section was grooved the entire length in two places on opposite sides. The slotted or grooved places were 1/32 inch wide and the full depth of the thread.

MANNER OF USING DEVICE

After removing the set screw from the shut off cock to our gage, the inspector then removed the washer and plug of the cock. He next inserted the threaded portion of the connection and from the opposite side he screwed the tapped portion of his fitting to the threaded part and tightened it slightly with a small monkey wrench. This left one side of the opening in the pet cock blank and the other side open for his test gage which he attached. The test was made in the usual manner and his gage removed in a fraction of the time consumed had it not been for this method.

Not only did we find a similar connection to the one described in use with the tested boiler a handy connection, but we have since found it very useful about the boiler shop where there was no connection installed for attaching a test gage, but where there was a pet cock in the gage line.

Coatesville, Pa. E. N. TREAT.

Spacing Rivet Holes

To the Editor:

"How do you do it?" asked a young boiler maker of his shop foreman. "You laid out these inner and outer courses for a boiler and the holes I've just punched, all come fair with each other. How did you lay out the holes in the inner and outer courses and have every hole come exactly fair, for the outside course is about 3 inches longer than the inside course?"

There are several ways of getting at this matter. One way, is to find the exact lengths of both inside and outside courses, establish the distance between the first and last holes in each course, then divide each length into spaces of approximately 3 inches. This is supposed to be the approximate rivet spacing in this little shell made of ½-inch plates. The pitch above as used is not according to code, but is assumed to make easier the spacing calculations which are to be done mentally, in this case. The assumed shell diameter is to be 4 feet, outside of the inner and inside of the outer courses. This calls for a nominal circumference of about 12 feet 7 inches, or 151 inches. Deducting three times the plate thickness, or 1½ inches, leaves 149½ inches between the lap holes of the inside course. Adding 1½ inches to 151 gives 152½ inches as the length of the outside course. Dividing by 3, gives 51, nearly, which may for the present, be assumed as the number of rivets in a girth seam of the little boiler. Dividing 51 into 152½ and into 149½, will give the length of rivet spacing in the two courses. By setting the dividers to space each sheet exactly in 51 steps, must result in laying out the two sheets in such a manner that the rivet holes will member when the courses are slipped together.

Indianapolis, Ind. James F. Hobart.

Future of Boiler Welding

To the Editor:

It is with the greatest pleasure that I have read in recent issues of The Boiler Maker several papers on welding which have been read before the National Board of Boiler and Pressure Vessel Inspectors of the United States and Canada.

We have yet in my opinion, however, a lot to learn about welding before we can put it to general use with safety, in the construction of boilers and I am afraid it will be some years before we in England see boilers welded throughout and working at high pressures.

Insurance companies and associations in this country look with suspicion even now, and rightly too, on all welded unfired pressure vessels and many will not pass these unless the welding is strengthened by stays, etc. A welded longitudinal seam only in a shell or barrel would certainly not pass without some other additional strengthening appliance. The reason is obvious, how can the strength of a welded seam be calculated with accuracy? At present I cannot see how this can be done as so much depends on the individual who has welded the seam. It may be a good weld and equal in strength to the solid plate, yet on the other hand it may look good but be only a fair weld and only 25 percent to 50 percent strength of the solid plate. We are to a large extent in the dark and have no data upon which we can calculate this required strength and so long as this uncertainty remains I do not hold out much hope of an all welded boiler coming into general use.

The sooner welding experts can give us definite data on this point the sooner welding will take the place of rivets in seams of boilers and pressure vessels.

We are I know in this country getting very near the all welded article, which will be accepted by insurance companies, particularly in the high pressure steam locomotive class of boiler. I personally know of several working at 230 pounds pressure daily and they are welded throughout, with the exception of the end plates which are riveted to the shell. The longitudinal seam of the shell although welded is reinforced by an external riveted butt strap. Hot water boilers welded throughout and working at 30 and 40 pounds pressure are of course common and to be found in this country by the hundreds, but we have not come to that stage with steam raising boilers.

Streatham, London, England. P. G. Tamkin.

A Boiler Explosion

One of the most recent official boiler explosion reports of the Board of Trade in England deals with the failure of a single ended boiler, on board a small trading steamer, which resulted in the death of four men, and is a glaring example of the necessity for the proper inspection of all steam generators.

The boiler was 10 feet 3 inches in diameter by 9 feet long, and was worked at a pressure of 135 pounds per square inch. It was twenty-five years old, but had not been regularly inspected for a period of four years, excepting such examination as may have been carried out by the late chief engineer. The explosion was caused by the failure of the bottom plate of one of the combustion chambers, producing a hole 2 feet 1 inch in length by 15 inches maximum width, through which the contents of the boiler were discharged, and seriously scalded the four men in the stokehold.

Considerable repairs had been made to the boiler during the past ten or twelve years, and electric welding had been resorted to several times to strengthen the plating of the combustion chamber, which was apparently so thin that at least on one occasion a scaler drove his hammer right through it.

In his report on the accident the Board of Trade surveyor says: "I made my way to the stokehold, and found the platform of the passage way between the engine room and stokehold and most of the stokehold platform lying in the bilges. The whole of the fittings, bridge, firebars, etc., were lying about the stokehold. The furnace front had been blown off and the smokebox door had been blown open, and had remained in the open position by being jammed against the stokehold bulkhead. On going into the starboard combustion chamber, I found the bottom plate had ruptured athwartships, for a length of 2 feet 1 inch, with a maximum width at the center of 15 inches, which gradually tapered to each end until it ended in a crack. The thickness of the material at the edges of the fracture varied from ⅛ inch at about the middle 3 inches of its length to ¼ inch at each end. The original thickness is not known definitely, as the firm that made the boiler is now out of business, and a drawing of the boiler could not be obtained. The greatest thickness now measures ½ inch, so that, allowing for slight wastage, the original thickness was probably about 9/16 inch. Immediately behind the fracture, i.e., between it and the combustion chamber back plate, there remained a crust of salt and ashes to the depth of about 9 inches, measured from the center of the combustion chamber bottom. No doubt this crust had been fairly uniform over the whole of the combustion chamber bottom, but most of it had been blown out by the force of the explosion.

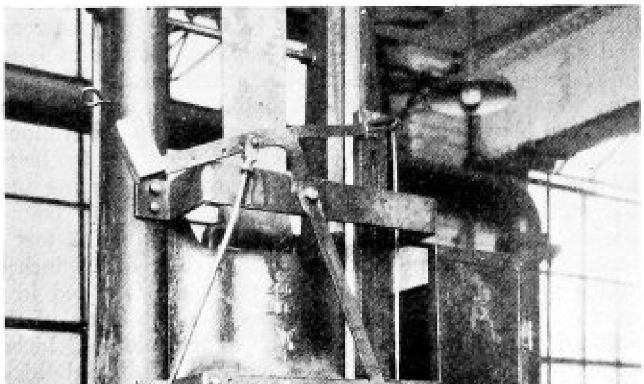
"The appearance of the plate which ruptured was such as might deceive anyone making but a casual inspection, as the thickness of the plate could not be determined visually, owing to the uniformity of the corrosion which is usually associated with that caused by a layer of damp salt. The presence of the latter, however, and the fact that holes had already appeared in each of the combustion chamber bottoms, and had been filled up by electric welding, should have been sufficient indication to anyone that the thickness of each of these plates was at least suspect, and steps should have been taken to ascertain the actual thicknesses by drilling."

In his observations the engineer-surveyor-in-chief says: "The case is an instance of the casual way in which some boiler owners treat their steam plant, and of the terrible consequences which may be the result of such conduct. It is also to be expected that when a person, having knowledge and experience of boiler maintenance, makes any examination of a boiler, he would take into consideration its age and the condition under which it worked. The repeated repairs to the chambers by welding would be evident in this case, and should have been a warning to the inspector.

"The case also suggests that the indiscriminate use of a process for depositing metal upon wasted surfaces and other defective parts may be dangerous, and that the scope of such methods of repair should be confined to cases where the wastage is not widespread and has not affected the strength of the part seriously."—*The Engineer.*

Swinging Gate Guard for Belt or Board Drop Hammers

A SWINGING gate guard for board or belt drop hammers is one of the latest safety devices in operation at the Bridgeport, Connecticut Works of the General Electric Company. A single operating handle controls the gate guard as well as the safety dog just behind it which prevents the large 500 pound hammer from dropping. Thus with one motion the dog is thrown out of the way and the gate closed. The accompanying illustration shows the gate swung back to the right with the safety dog just behind it.

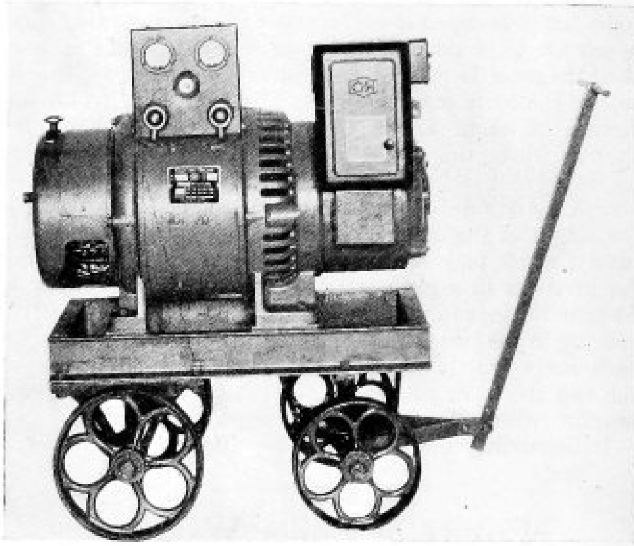


Easily fitted guard for drop hammers

Motor Driven Arc Welder

THE most recent addition to the Fuzon line of arc welders is a direct current machine operated by a three phase, alternating current motor, either 220 or 440 volts supply. Both the welding generator and motor are mounted on the same shaft making a two bearing unit.

The feature of this welding generator is its unique arc. The arc is probably best described as "flexible" because it not only possesses unusual stability but responds instantaneously to changes in arc length. For example, it is possible to instantly increase or decrease the arc length by a half inch without extinguishing it. The flexibility is made possible because all of the auxiliary apparatus usually incorporated in an arc welding unit has been eliminated. The Fuzon No. 300 welder has no external stabilizer, no field rheostat and no separate exciter. These auxiliaries, especially the external stabilizer, introduce electrical inertia in the circuit so that the welding operator is really not directly connected to his source of current. When the auxiliaries are eliminated, the sluggishness due to the inertia disappears with them and the arc responds instantly to all fluctuations.



Fuzon arc welder

The elimination of the auxiliaries from the Fuzon No. 300 welder reduces the weight and at the same time permits a rugged construction. The fact that there is but one control to govern the welding current and that this control is accomplished not by means of a rheostat, but by a simple brush shifting device, gives the welder a wide range. The current can be varied from 50 amperes to 300 amperes and, over this range, the arc is equally flexible and stable. This is due to the fact that shifting the brushes not only controls the current going to the operator but, at the same time, and by the same control, alters the volt-ampere characteristic of the machine in such a manner that the most suitable characteristic is supplied at each current to which the machine is set. This permits welding metals from the thinnest to the thickest with equal facility by merely setting the current at the desired amperage.

This welding set was publicly exhibited for the first time at the National Steel & Machine Tool Exhibition in Detroit in September by the Fusion Welding Corporation, Chicago, Ill.

Proposed High Pressure Watertube Locomotive Boiler

Boiler designed for 500 pounds pressure indicates lines along which steam locomotives of greater efficiency and higher powers may be developed

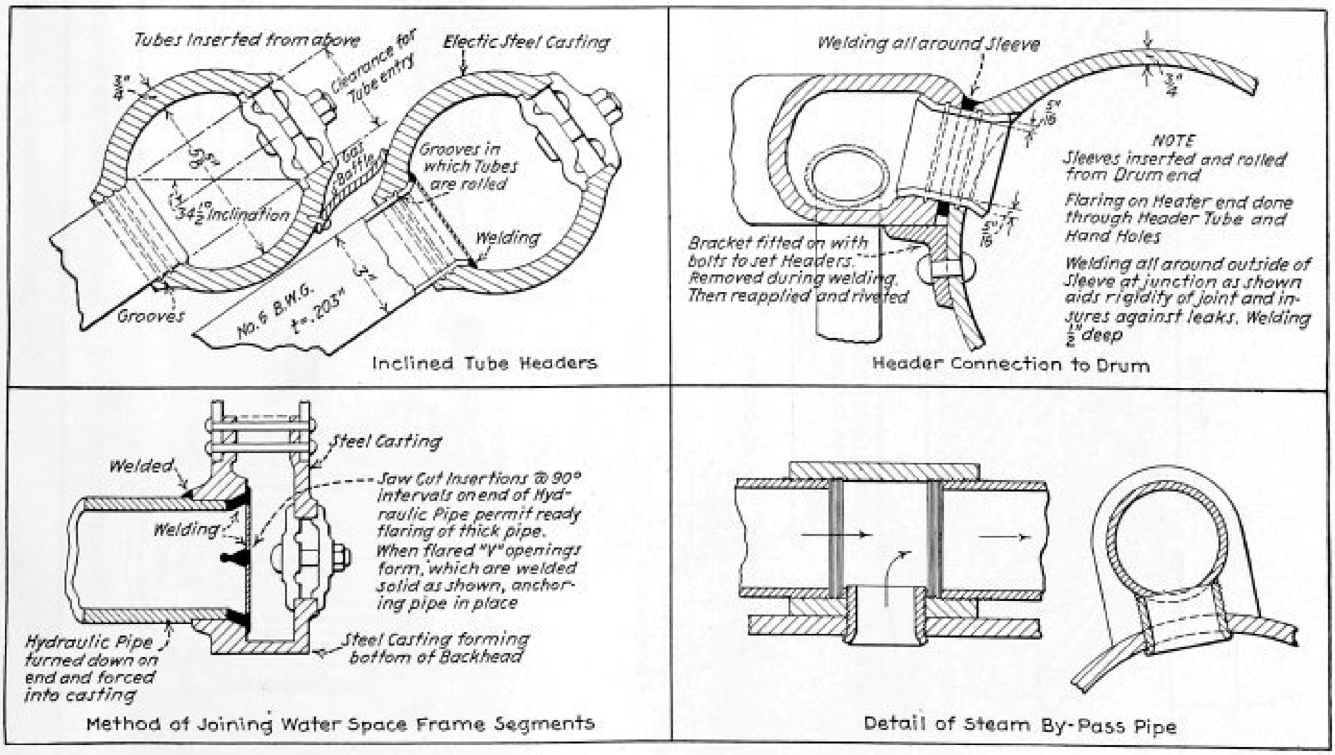
By Louis A. Rehfuss

THE passage of years will unquestionably bring a wide demand for increased power and efficiency in the use of steam locomotives. The staybolted, firetube type of boiler with which our present day locomotives are equipped, seems ill adapted to reach into these fields. The several types of firetube boilers with watertube fireboxes now being tried seem but a transitory step towards a distinct change in design, which will definitely feature all-watertube boilers, already so strongly entrenched in the stationary field. The later, because of the limited diameters of all pressure containing sections, may be extended for use to any pressure which the future may demand.

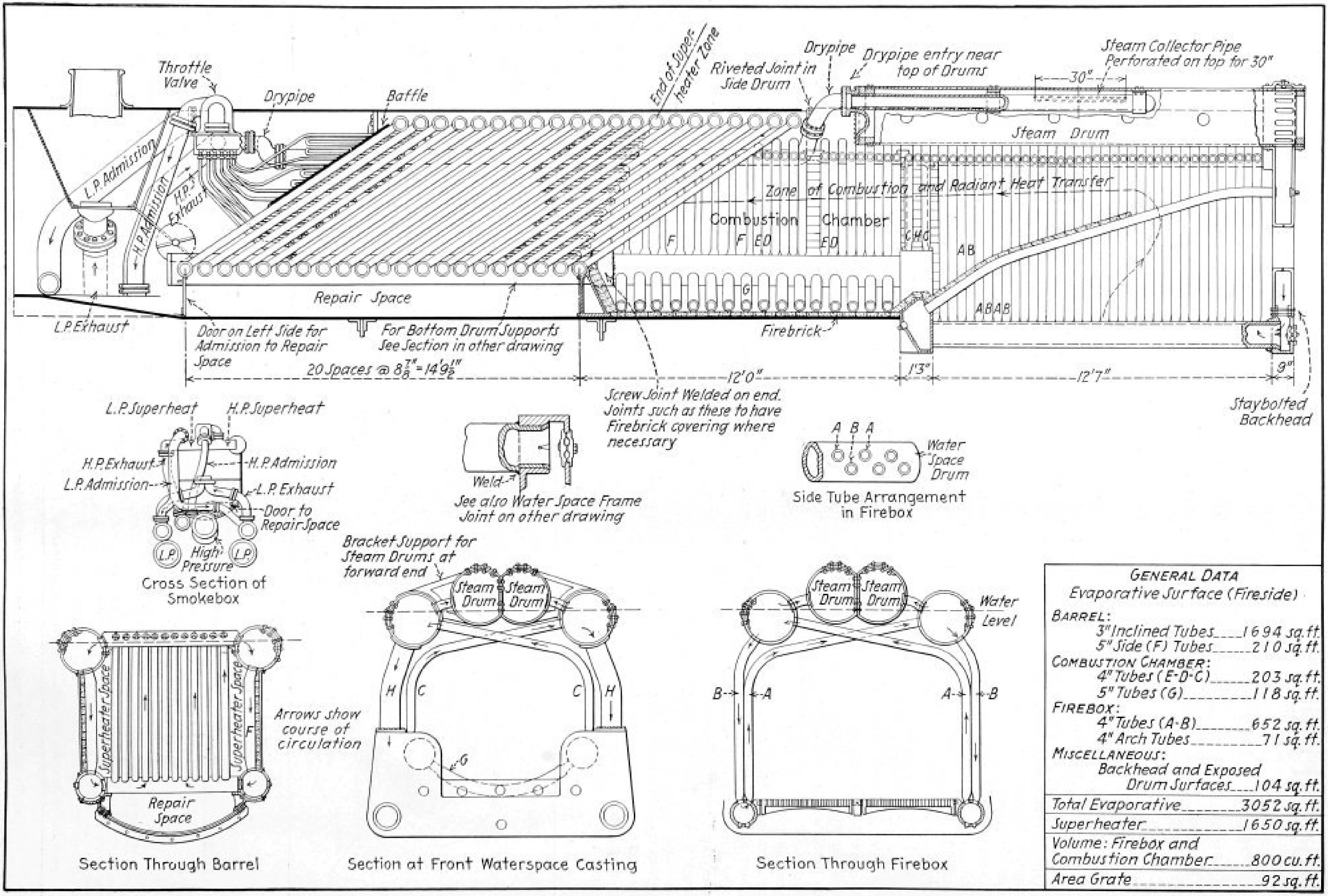
The first difficulty encountered in designing the proposed all-watertube locomotive boiler for a pressure of 500 pounds per square inch was the disposal of the watertubes in the barrel section of the boiler. If these tubes are placed longitudinally and at too low an angle, the degree of overload rating to which the boiler could be driven is limited. If we arranged these vertically our tubes would become too short and the number of joints excessive. By arranging the tubes inclined in the manner shown in the accompanying drawings these difficulties, we feel, are largely overcome. The tubes are kept straight and thus easily cleaned and replaced and are sufficiently pitched and short enough to stand the high degree of overload rating required in locomotive practice. By pitching the tubes from the front and rising to the rear, we obtain a counter current circulation of water and gases, considered so desirable by boiler authorities. This enables the water to keep rising into gases of progressively higher temperatures, thus aiding the steam formation. It also enables the low temperature gases to do more work, as they strike the coolest end of the system, where the feedwater is introduced at the front end of the lower drums, just before these gases pass into the smokebox.

Stress Placed on Combustion Efficiency

One noteworthy feature of the proposed boiler is the emphasizing of combustion efficiency at the expense of evaporative efficiency. That over-emphasis has been placed in the past on evaporative surface can be readily shown. From test data it has been estimated that in a normal firetube boiler we could cut the flue length to two-thirds its normal amount without affecting the flue evaporation more than 9 percent and the overall boiler evaporation (firebox included) more than 5 percent. It is also claimed that we could plug up half the flues without affecting the flue evaporation more than 4 percent, which would make the overall boiler evaporation loss little more than 2 percent. In the former case the draft would be less than normal and in the latter much more than normal. Actually we should be able to cut the total boiler evaporation surface by 35 or 40 percent, and by keeping the draft normal by proper sizing of the flue passages, while the gas weight remains constant, it is unlikely that the total evaporation would be more than 3 percent or 4 percent below that of the ordi-



Details of header and drum connections, water space frame segments, and steam by-pass pipe



GENERAL DATA
Evaporative Surface (Fireside)

BARREL:	
3" Inclined Tubes	1694 sq. ft.
5" Side (F) Tubes	210 sq. ft.
COMBUSTION CHAMBER:	
4" Tubes (E-D-C)	203 sq. ft.
5" Tubes (G)	118 sq. ft.
FIREBOX:	
4" Tubes (A-B)	652 sq. ft.
4" Arch Tubes	71 sq. ft.
MISCELLANEOUS:	
Backhead and Exposed Drum Surfaces	104 sq. ft.
Total Evaporative	3052 sq. ft.
Superheater	1650 sq. ft.
Volume: Firebox and Combustion Chamber	800 cu. ft.
Area Grate	92 sq. ft.

Sectional views of proposed high pressure all-watertube type of locomotive boiler

nary heavily tubed boiler. A design which gives a vigorous water circulation would tend to eliminate even this small loss by increasing the unit surface evaporation.

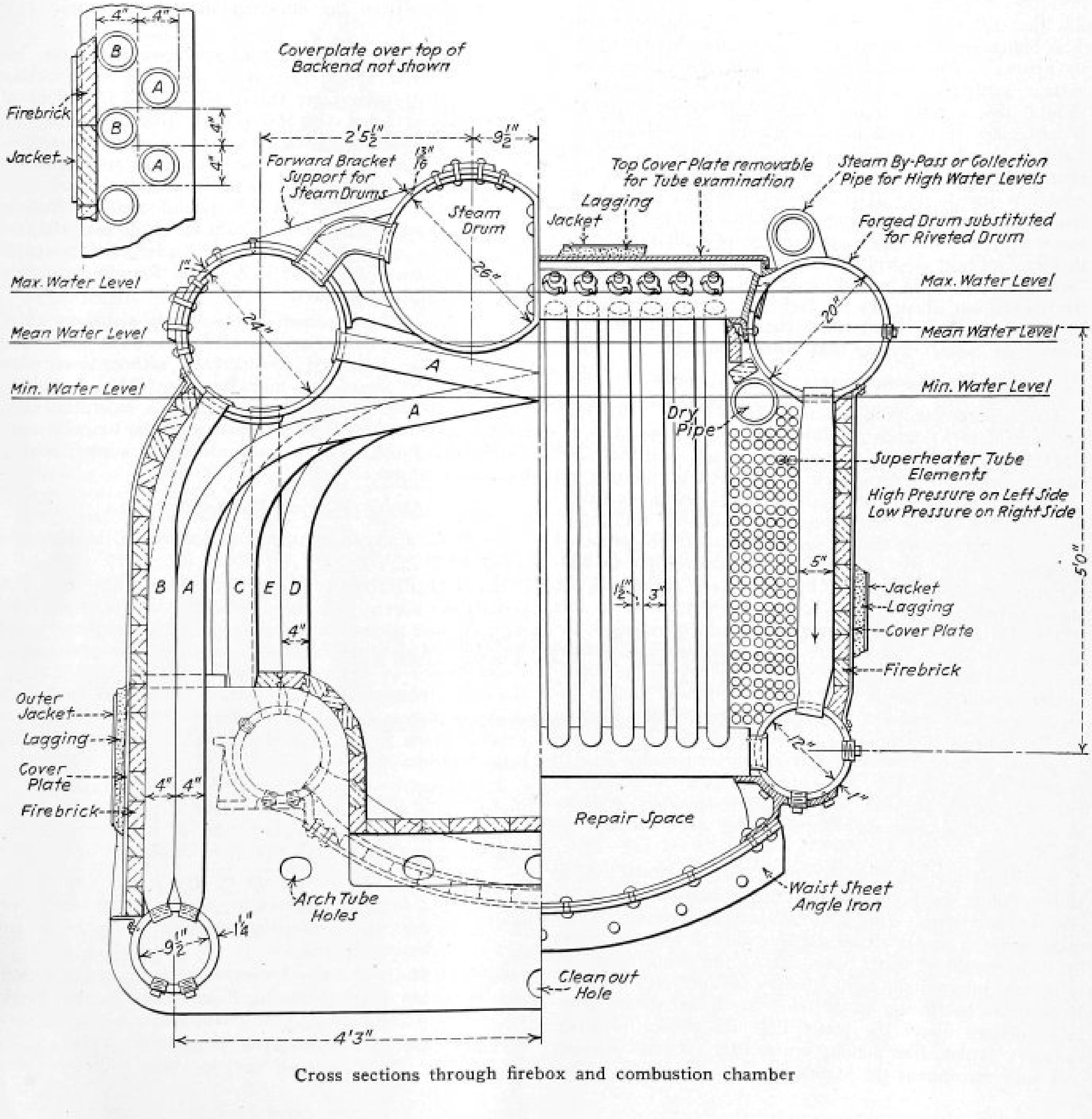
If this tube space saved were added to the firebox and combustion chamber, it is reasonable to suppose that the unburned fuel loss, which reaches 25 percent to 30 percent at full power, would be greatly lessened, because the gases would stay in the combustion space long enough to burn the floating carbon particles. Curves plotted from tests based on coal burned per cubic foot of firebox volume, particularly in the case of the higher volatile coals, show strikingly the value of this additional firebox volume; and in recent stationary installations, rates of operation are commonly measured in terms of coal burned per cubic foot of firebox volume as a contrast to grate area.

It is evident from an examination of test reports, particularly at the higher rates of burning, that combustion inefficiency is the greatest waste we have in locomotive boiler operation, so that design should give it the most consideration. The reverse has been the case with locomotive boilers to date, partly due to the fact that the expansion of heated crown sheets, where the latter were made too long, gave trouble from staybolt breakage. The proposed design permits the combustion chamber to be made as long as desired.

A further aid to combustion efficiency is the inclined tube arrangement rising to the rear. This enables sparks which strike it to be deflected to hot bricks in the floor of the combustion chamber where they may be consumed.

Advantage of the Air Preheater

To improve the combustion efficiency still more a proposed innovation is the air preheater. Test plant results have shown that while some oxygen remains in the smokebox gases, actually in many cases there is not nearly enough to consume the unburned fuel loss at full power rates, even had the gases been left in the combustion chamber long enough for thorough combustion. From 4 percent to 8 percent of free oxygen is desirable in the smokebox gases. When the coal burning rate is raised over 100



Cross sections through firebox and combustion chamber pounds per square foot of grate per hour, many locomotive tests show this oxygen as low as 2 percent. It is evident that some means for adding air to the firebox is desirable, but it should be preheated to avoid chilling the gas mixture. The location of this preheating air system is not shown, but in place of the firebrick in the side walls of the waist section, a corrugated plate may be used back of the side circulation tubes, between which and the cover plate the air may pass, driven from the front by the velocity of the engine and heated by the heat that would normally strike the firebrick. While at first glance this may seem as though we merely rob the hot water in the downflow pipes of a little heat to send back to the firebox, in reality it is more than this. The gain comes from the greater addiition of oxygen at times when most needed, resulting in a higher combustion efficiency than could otherwise be obtained. This air supply could be controlled by a shutter arrangement.

While the evaporative surface has been limited to 3,000 square feet in the present design, which is only 60 percent to 65 percent that of a comparable firetube boiler, nevertheless because of the rapid water circulation, it is felt that the evaporative efficiency will be up to normal. The boiler sections in the drawings show this circulation by arrows. The considerable pitch of the inclined tube system, setting up a vigorous, *countercurrent* circulation, should give a considerably higher unit evaporation than is customary in normal firetube practice. The long combustion chamber permits a higher percentage of radiant heat absorption than usual, so that the barrel tubes have relatively less to do. It is a known fact that not only the live coals, but the hot gases themselves at high temperatures emit a considerable percentage of radiant heat, so that radiant heat absorption is not limited to surfaces which "see" the fire. This conception of radiant heat is comparatively new, but illustrates the fact that the evaporative surface lining a long combustion chamber is not limited to convection contact for its heat absorption.

Double Superheater Employed

The superheater proposed is a double one. The high pressure of 500 pounds employed permits the steam to exhaust from the high pressure cylinder at approximately 200 pounds, so that superheating intermediately becomes an attractive proposition. In fact in order to get the full thermal benefits of the high pressure proposed, this intermediate superheating should be employed. In the proposed boiler we devote the left half of the superheater to high pressure superheating, while the right side superheats the steam between the high and low pressure stages. In this way the initial temperature of the steam is kept well within the 700-degree temperature limit considered advisable. Due to the density of the steam, the capacity of the superheater should be ample and this very density should increase the heat transfer per unit of superheater surface. At 500 pounds pressure one pound of saturated steam has a volume of only 0.90 cubic feet and a temperature of 470 degrees F., compared to 2.14 cubic feet and 388 degrees F. for 200 pounds pressure steam. The smokebox arrangements for this compound superheating are indicated on the drawing.

It will be noticed from the print that the water line is shown below the bottom of the upper headers of the inclined tube system. This is an advantage, however. Where tubes enter a water drum considerably below the water line, the weight of water above causes the steam formation to become intermittent and explosive at high rates of firing. Experiment has shown on the other hand, that where watertubes deliver above the water line, the steam formation causes a syphon-like action, which only becomes stronger and more continuous the higher the fires are forced. Thus a wide variation in water line is permissible in the proposed design, taking care of unusual steam demands; and any overheating of the tubes at unusually low water levels is kept within safety bounds by the stronger syphon action that occurs at such times. The main steam drums receive only secondary heat from the fire, so that they are in no danger of overheating. This is also true of the inclined tube headers.

The steam by-pass or collection pipe is provided to take care of steam collection in the forward portion of the upper side drums when the water levels run too high or when surges of water in starting or on hills cause temporarily high water levels in part of the system.

Dry steam is assured by the fact that the main portion of the dry pipes is at a lower level than the steam entrance into the superheater header. The dry pipes hence collect the moisture, which tend to protect them from the hot gases with which they come in contact.

The construction of the proposed boiler with drums on the four corners of square cross section, makes it easy to brace by any strap construction desired. This detail has been omitted from the drawings in order not to destroy their clarity.

The overall weight of the boiler is somewhat large, but the lesser water weight carried as compared to a firetube boiler partially overcomes this objection. The weight of the proposed boiler, for 500 pounds pressure, including firebrick linings and various cover plates, but exclusive of superheater, grates, lagging and jacket, is approximately 135,000 pounds empty and 162,000 pounds loaded with water to the water line. A 200 pound pressure firetube boiler of about similar power would weigh around 105,000 pounds empty and 155,000 pounds loaded with water to the water line. The boiler is designed for approximately 4,000 cylinder horsepower.

The first cost of a normal boiler is only about one-third the cost of a locomotive as a whole, so that the boiler first cost might be increased considerably without increasing the locomotive first cost, unreasonably. This would be justified if thereby sufficient savings in operation and maintenance cost could be attained, or if the ton-mile costs could be reduced through the building of more powerful locomotive units.

Advantages of Proposed Boiler

To recapitulate, the expected advantages of the proposed boiler are:

1. *High Pressure:* The drawings are made for a 500 pounds per square inch pressure boiler, but the general design, because of the limited diameter of all sections, could with limited changes be readily employed for extension to 1,000 pounds or whatever the future might demand. Aside from the thermal efficiency involved, the fact that such steam occupies such small volumes permits the use of greater power within limited cylinder diameters than has heretofore been possible.

2. *Superior Combustion Efficiency*—particularly at higher rates of firing. This makes it possible to couple large grate areas with higher rates of burning and thus secure higher powers than have been customary in the past.

This superior combustion efficiency is obtained by:

(a) *A long, open flameway,* with a design which permits the combustion chamber to be made any length desired.

(b) *Inclined Tube Arrangement* as an aid to deflecting sparks, causing them to fall on hot bricks where they may be consumed.

(c) *Use of Preheated Air, if desired.*

(*Continued on page* 349)

Boiler Shop Kinks Prize Competition

IN the November issue of THE BOILER MAKER, page 305, announcement was made that a "Shop Kinks Prize Contest" was being inaugurated by the magazine for the purpose of bringing to light such shop made devices and short cut methods as have been developed in boiler shops throughout the country.

This contest closes January 20, 1928. For the benefit of those who have not been informed of the requirements of the contest the details are repeated below: For the best two practical boiler shop kinks or methods submitted by each individual, a first prize of $50; for the second best set of two, $35, and for the third best set of two, $20. All contributions to the contest that are suitable for publication, but which do not win prizes, will be paid for at regular space rates at the time they appear in the magazine. Also, if more than two descriptions of kinks are included in a prize-winning contribution, space rates will be paid in addition to the prize at the time such articles are published. All material submitted that is suitable for publication will therefore receive remuneration.

The length of contributions will not be the determining factor in selecting the prize winner, descriptions of 500 words or less for each kink are the most desirable. Photographs, drawings or sketches are desirable and should accompany descriptions whenever possible. The sketches need not be made on a drawing board but should be prepared carefully and accurately, so that they may be readily understood by the judges and by the draftsman who will make a finished drawing for publication. Consideration will be given to the appearance of the article; that is, all descriptions should be written legibly on one side of the sheet only.

Do not feel that you are unable to write well enough to enter such a competition, the prime factor in determining awards will be the extent to which the method or device submitted is valuable in saving labor, time, cost, ease in handling the work or in the promotion of safety. The *idea* is the thing, not the manner in which it is presented. You are not restricted to two kinks, methods or devices, but may send as many as you like. The awards will be made on the basis of what the judges believe to be the best two which you submit.

As has been noted in these columns many times, one of the most instructive features of discussions at meetings of a body of boiler makers or other craftsmen is the exchange of practical ideas on how any given job may be done and the tools to be used in doing it more easily or better. While it is only possible to discuss such kinks with a few people at any time, THE BOILER MAKER offers an opportunity of exchanging ideas with men throughout the entire country every month. The present prize competition is being conducted to stimulate the interest of men in the boiler making trade in taking advantage of the opportunity offered of using its pages to exchange their experiences in developing shop and tool improvements so that everyone may be benefited by a wider contact with his fellow craftsmen.

Shop poster describing contest

Every boiler maker, layerout, welder, foreman, inspector, apprentice and any individual connected with the trade is eligible to submit kinks or methods which he has found useful in his shop.

A group of judges has been selected, all practical men who will recognize the value of the kinks offered and who will select the three sets of prize-winning contributions.

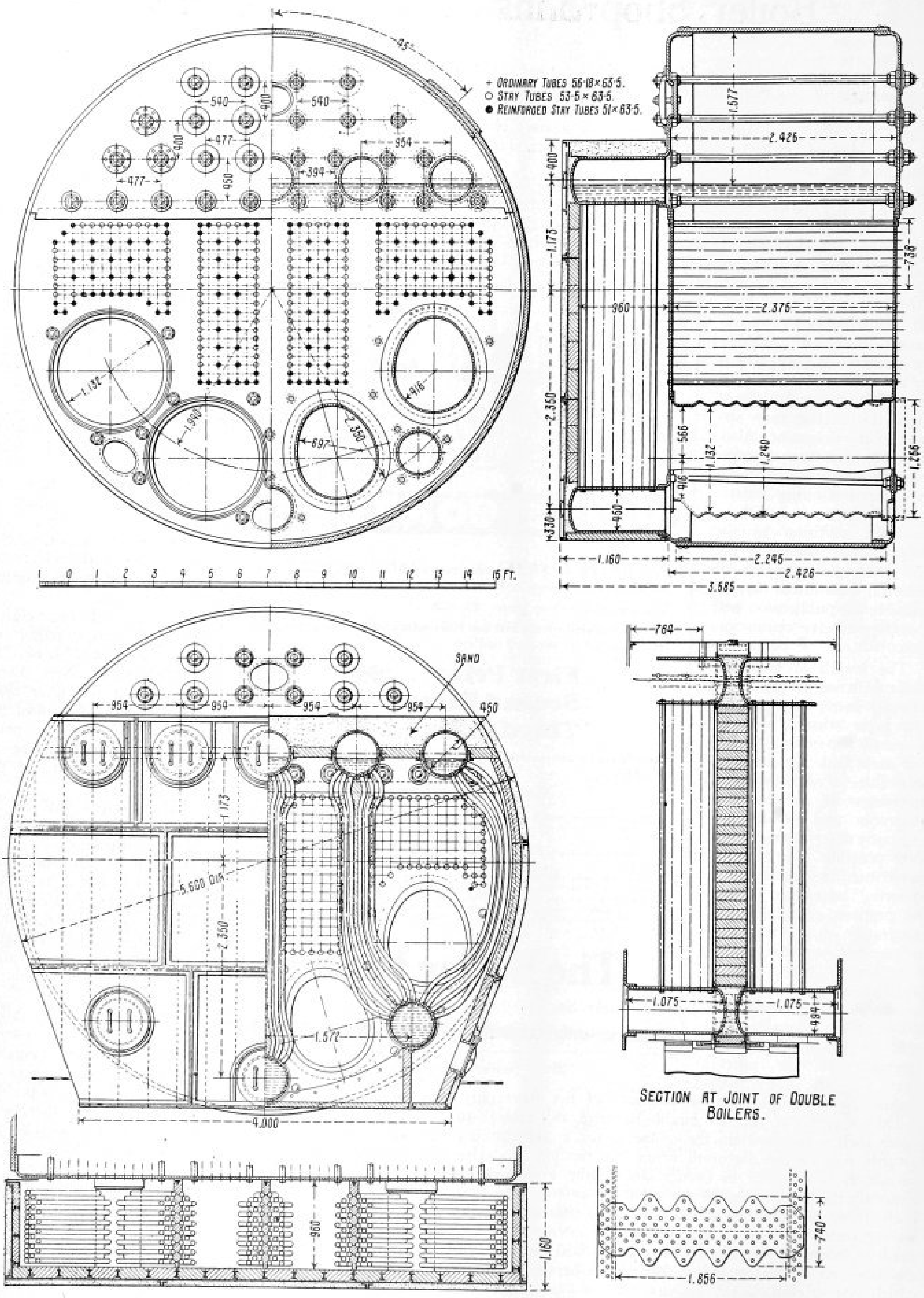
Articles will be received by the contest editor of THE BOILER MAKER, 30 Church street, New York, up to, but not later than January 20, 1928, and the announcement of the prize winners will be made in the February issue of the magazine.

Manuscripts will be returned if requested. If so desired, the author's name will not be published with his article but it is highly desirable that full credit be given to each individual who submits a kink that is accepted for publication by publishing his name as the author.

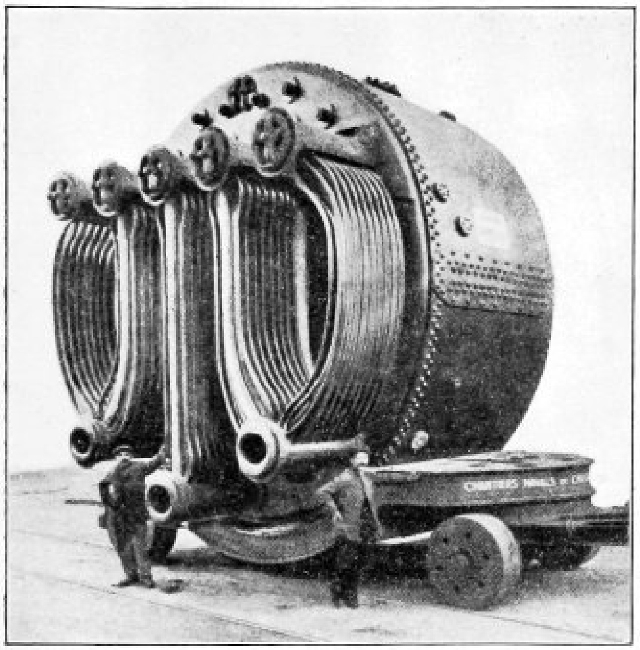
In addition to publishing notices of the competition in the magazine posters have been sent out to every railway, marine and stationary boiler shop, plate shop and boiler repair shop in the country with the request that they be posted on a prominent bulletin board so that all those interested in doing so might submit kinks.

If any shop has not received copies of the poster, an illustration of which appears on this page, notify the Contest Editor of THE BOILER MAKER and they will be forwarded at once. The poster is 12 inches by 18 inches and contains all the rules of the competition.

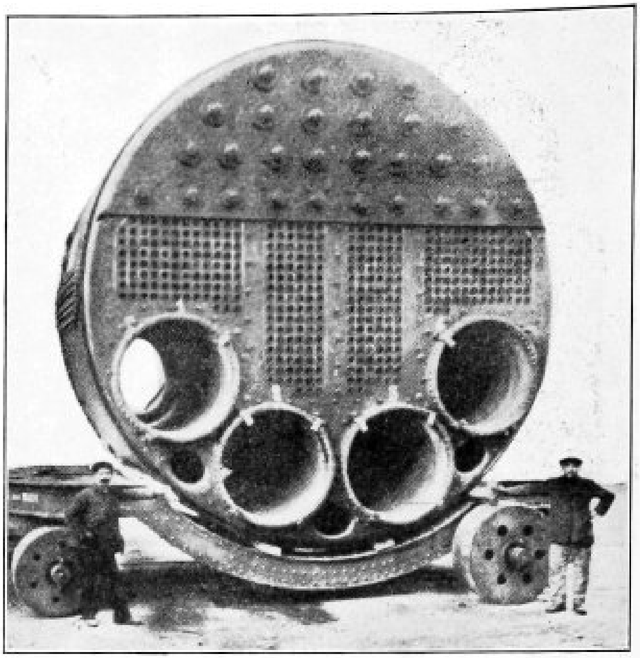
Remember—everyone connected with the boiler making industry is eligible to submit "Kinks" in the contest. Do not wait until nearly the closing date, but send your "Kinks" to this office now.



One of the Prudhon-Capus accelerated circulation boilers in the S. S. Ile de France



Back view of Prudhon-Capus boiler



Front view, showing furnace arrangement

Combined Firetube and Watertube Boiler

Details of Prudhon-Capus type boilers installed in the French Liner Ile de France

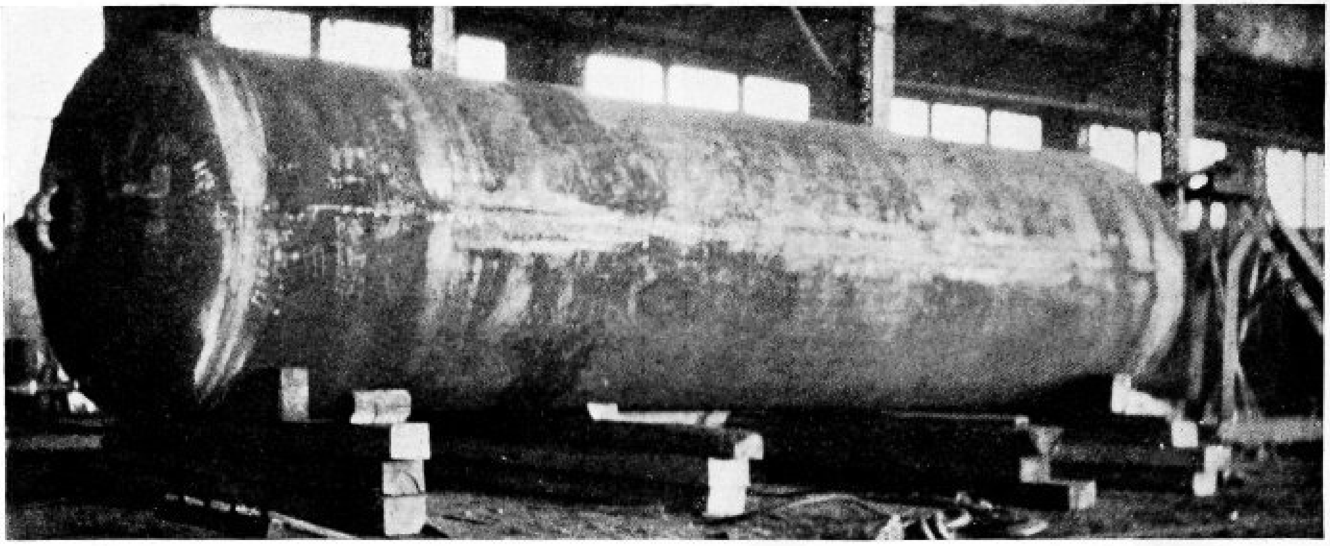
THE French liner *Ile de France,* which has been in service for some months, is fitted with combined firetube and watertube boilers known as the Prudhon-Capus type which during the last few years has aroused considerable interest both here and abroad. Twenty-four of these boilers supply steam to the main and auxiliary machinery. Half of this number were supplied by the Chantiers Navals et Chaudronneries du Midi, Marseilles, and the remaining 12 were constructed under the special license by the builders of the vessel, the Société des Chantier et Ateliers de Saint-Nazaire-Penhoët for the Cie. Générale Transatlantique. The twenty-four boilers are arranged 3 abreast in 4 boiler rooms, half the number being of the double-ended type while the remaining boilers are single ended. The general design of these boilers is shown in the accompanying illustrations. The designed working pressure is about 225 pounds per square inch and the boilers are all arranged to burn oil fuel on the White low pressure system. Each boiler has an evaporation rate of about 25,300 pounds of steam per hour.

Structural Details

Although a short description of this type of boiler was published in the March, 1925, issue of THE BOILER MAKER, the following information about the construction is given for the benefit of our readers. We are indebted to the *Shipbuilding and Shipping Record* for drawings and details of the Prudhon-Capus boilers as installed on the *Ile de France.*

This boiler consists essentially of a cylindrical drum with furnaces and return firetubes, all of the form usually found in the cylindrical return tube type of marine boiler, but instead of having combustion chambers within the drum connecting the furnaces with the return tubes, a large combustion chamber is attached to the back of the main cylindrical drum, the furnaces and the firetubes passing right through this drum, connection being made in this external combustion chamber. Two groups of "collectors," consisting of short cylindrical drums attached to the rear end of the boiler, and open to the main drum, are placed in the combustion chamber, one group being at the bottom of the boiler between the furnaces and the other at the top just above the tubes. These drums are connected by means of groups of watertubes, as shown, so that the drums together with their connecting tubes constitute what may be termed the watertube portion of the boiler. The combustion chamber, not being subjected to the working pressure of the boiler, is constructed of light plating and then lined with fire brick, being subdivided by means of fire brick partitions placed between the intermediate sets of watertubes, thus yielding a distinct combustion chamber to each furnace.

It will be observed that the watertubes do not lie in the direct path of the furnace gases, but since the temperature of the gases reaches its highest figure in the combustion chambers, the tubes are exposed to the radiant heat of the combustion and thus a rapid circulation is set up on the tubes which leads to an increase in the efficiency of the boiler and at the same time enables steam to be raised more rapidly from cold than is possible or desirable in the ordinary cylindrical type of marine boiler. In addition, it is claimed that owing to the larger volume of the combustion chambers in the Prudhon-Capus boiler, good mixing of the gases is obtained, thus enabling forced draft to be economically employed with increased efficiency of combustion. A further advantage of this arrangement of the combustion chamber lies in the fact that all the interior stays are eliminated, thus removing a fertile source of trouble, and, further, a sweeping door can be fitted at the base of the chamber.



Completed tank built for 300 pounds pressure

Procedure Control in Pressure Vessel Welding*

Design of vessel for 300 pounds pressure—Selection and preparation of material—Welding longitudinal seams—Welding reinforcing rings

By H. E. Rockefeller†

THE oxy-acetylene welding of large pressure vessels during the past year has gained considerable impetus and is creating a rather widespread interest both among purchasers and manufacturers of this equipment. During the past year one company alone purchased over 60 oxy-acetylene welded pressure vessels ranging in diameter from 4 to 7 feet and in operating pressure from 125 to 400 pounds per square inch.

Among the recent applications, the construction of six vessels, 6 feet in diameter by 26 feet in length and designed for 300 pounds operating pressure, presents probably the most representative example of the present status of pressure vessel welding. It shall be my purpose, therefore, to describe the manner in which these vessels are being fabricated and the methods followed from an advisory and supervisory capacity.

The practices which have been established to regulate and advance the application of oxy-acetylene welding are known as "procedure control" standards. This term, I am sure, is a familiar one to most of you as it has come to mean to welding what standardization and scientific management mean to industry in general. It implies an analysis of the factors involved in any welding application and the consequent intelligent pursuit of certain known and desired results. These factors as we have determined them for pressure vessel welding include:

(a) Correctly designing the vessel and welded joints.

(b) Selecting material of good welding quality.

(c) Determining the ability and knowledge of the welding operators.

(d) Properly preparing the material for welding.

(e) Applying approved welding technique.

(f) Satisfactorily testing the completed vessel.

We shall, therefore, discuss the aforementioned pressure vessel under these items and consider them in the order given.

Design of Vessel and Welded Joints

Fig. 1 shows the general design of the vessel and the detail of the welded joints. Since it was to be designed for an operating pressure of 300 pounds per square inch on a 6-foot diameter, a shell thickness of 1¼ inches was required based on a design fibre stress of 9,000 pounds per square inch. This design fibre stress, it might be mentioned, was adopted for pressure vessel construction in July, 1926, and represents a gradual increase based upon experience and investigation since 1923 when 7,000 pounds per square inch was the limiting fibre stress in design. The heads it will be noted are of a design which gives a total depth of dish equal to one quarter the diameter of the tank. The two sections of spheres composing the knuckle and crown radii were selected so as to give an approach to a semi-ellipsoid whose major axis is twice the minor axis. The manhole reinforcing ring, is also of a special design and is so dimensioned as to reduce to normal, the stresses about the manhole opening. A more detailed discussion of these designs for use on welded pressure vessels will be given a little later on in this paper. The outlets and sump were designed so as to permit of satisfactory welding of the lighter outlet wall to the heavy shell wall.

It will be noted that the design of the welded joints for all seams is of the double Vee butt type, the included angle of Vee being specified between 90 degrees and 100 degrees with a reinforcement on each side of the weld of not less than $\frac{3}{16}$ inch. The ultimate strength of this type of joint when properly executed, considerably exceeds the requirement of the factor of safety of 5 based on the comparatively low design fibre stress used. It will also be noted that the shell is made up in three long plates with no girth seams between the heads. This design was

* Paper presented at the annual meeting of the International Acetylene Association held in Chicago, November 18, 1927.

† Engineering Development Department of the Linde Air Products Company, New York.

employed because of the greater facility in welding longitudinal seams.

Selection of Material

In order to insure the quality of the material used, firebox steel with a maximum carbon content of 0.20 percent and a minimum tensile strength of 50,000 pounds per square inch was specified. The specifications also call for the use of $\frac{5}{16}$ inch high test welding rod. It might be said in connection with the material secured for this job that the maximum carbon content on all the plates as indicated in the mill test reports was 0.19 percent and the minimum tensile strength 52,560 pounds per square inch.

Check of the Welders

As a check on their ability to meet the welding specifications, each operator was required to pass a qualification test. The test included the welding together of two sections of plate, each 9 inches by 12 inches by 1¼ inches in thickness, the plate being double beveled along the 12-inch side. Six specimens were cut from each of the test plates and the reinforcement removed from half the specimens. The requirement for passing this qualification test was that none of the specimens show an ultimate strength of less than 50,000 pounds per square inch of plate section.

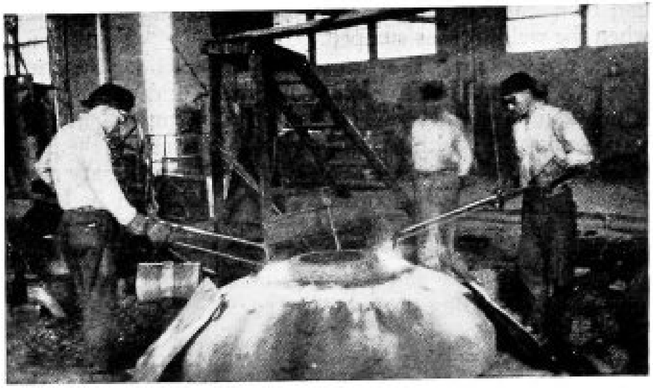
In most instances only the specimens ground flush with the plate were tested. This was done because of the uniformly high strength exhibited by the ground off specimens. All welders submitting test specimens, with the exception of the one designated by the letter "N" were accepted on the first qualification test. This welder after further experience submitted another test coupon which showed a minimum weld strength of 56,100 pounds per square inch.

These figures are also interesting in that they show the usual large percentage of fractures to have taken place in the plate even where the weld reinforcement was ground off.

Preparation of Material for Welding

The steps taken in the fabrication of the plates preparatory to welding are noteworthy because of their simplicity. In laying out the plates, it was only necessary to establish

Heavy plate used in tank ready for welding



Welding the handhole reinforcing ring

guide lines for beveling and re-squaring. These operations, furthermore, were accomplished on a single set up of the plate planer. The edges of the plate were next set to the proper curvature for a distance of 12 inches to insure complete concentricity of the shell.

Following the rolling operation, the three plates comprising the shell, were fastened by means of wedge clamps and then moved to the portion of the shop where the welding was to be done.

The wedge clamp used for joining the shell plates is simple in design and satisfactory in operation. It is made from a flat plate with a slot punched in it through which two wedges are advanced until the plates are brought into alignment. Prior to welding each of the longitudinal seams, one end was tack welded and the other separated the required distance to provide for contraction. For tacking, a spacing of ⅛ inch was used and a tack weld made about 1½ inches in length. When necessary, a turnbuckle was employed to secure this desired spacing. The spacing of the seam for welding was secured by inserting a wedge at the open end and spreading the plate edges about 5 inches at this point. This provided an allowance for contraction during welding of approximately ¼ inch to the foot.

In order to minimize the tendency of the plate to force outward on the ends of the seam, a heavy plate clamp was employed. The plate clamp was inserted at both ends of the seam on the under side when welding the outer Vee and on the outside when welding the inner Vee of each of the longitudinal seams.

Welding Longitudinal Seams

In joining the longitudinal seams, the welding of the outer Vee was accomplished first. One welder was responsible for each seam, he being given assistance when necessary, from a helper who adjusted the wedges and clamps so that the spacing could be controlled properly and so that the distance between the abutting edges at the point where the welding was being done was maintained the proper distance. By doing this, a spacing of 5/16 inch between the plate edges, 1 foot ahead of the point of welding and about 1/16 inch at the point of welding, was maintained for the entire length of the seam. This provided a sufficient opening to secure thorough penetration easily without slowing up the welding operation as occurs when too wide a separation exists at the bottom of the Vee.

When welding had to be stopped because of the necessity of having the welder take a rest or because of shutting down time, the wedge used to maintain the spacing was thoroughly secured and the plate clamps and jack also tightened up so that the alinement could be maintained. Before starting up again, the weld was reheated for a distance of about 12 inches to open up the seam and relieve the pressure which had been imposed on the wedge by the cooling of the seam when the welding was stopped.

After completing the seam from the outside, the inner Vee was chipped out to remove the oxide and excess metal which had penetrated to the inside of the seam without being thoroughly fused with the base metal. In welding the inner Vee, preheating was employed to provide the necessary additional heat required after one side of the seam had been welded. This preheating medium, furthermore, which consisted of a charcoal box about 24 inches long and 6 inches wide, fed with coke and air, had the tendency to anneal the seam as the welding progressed.

WELDING OF HANDHOLE REINFORCING RING TO HEAD

The reinforcing ring was first set up and leveled so that the beveled edges of the ring and manhead coincided about the entire seam, an equal spacing of about 1/4 inch being provided. Four tack welds were next made at equidistant points on the seam, each two being made simultaneously at points 180 degrees apart. These tack welds were about 4 inches in length and without reinforcement. Upon the completion of the tack welding, a preheating fire was started

Completed weld on handhole reinforcing ring

under the head which was so designed as to provide the greatest amount of heat at the seam and in the heavy section of the manhole reinforcing ring. A natural draft was provided entering through openings around the bottom of the head and leaving through the elliptical opening in the reinforcing ring. Charcoal was used as a preheating medium, being distributed within the furnace from the elliptical opening. Preheating was carried on until the manhole reinforcing ring and head in the vicinity of the weld had been brought up to a dull red. Welding was then started by two welders working simultaneously 180 degrees apart and using long-handled blowpipes. A flat weld was employed on this seam as it was found to give a more satisfactory design.

The illustrations give an idea of the manner in which the welding operation on the handhole reinforcing ring was carried out.

After completing the weld from one side, the head was allowed to cool slowly to room temperature. The excess metal was then chipped from the inner Vee and the head again preheated and welded as previously described. In order to eliminate any locked-up stresses, the head was completely annealed following the completion of the welding.

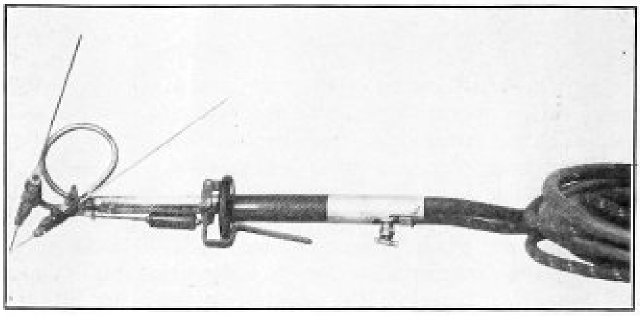
The final plate shows the completed weld on the handhole reinforcing ring and gives a good idea of the amount and distribution of the metal required to reinforce this opening properly.

(To be continued)

Equipment for Welding with Atomic Hydrogen

METHODS of producing a flame of atomic hydrogen and its probable use for welding have been previously described in THE BOILER MAKER. The investigations leading up to the discovery were directed by Dr. Irving Longmuir of the General Electric research laboratory located at Schenectady, New York.

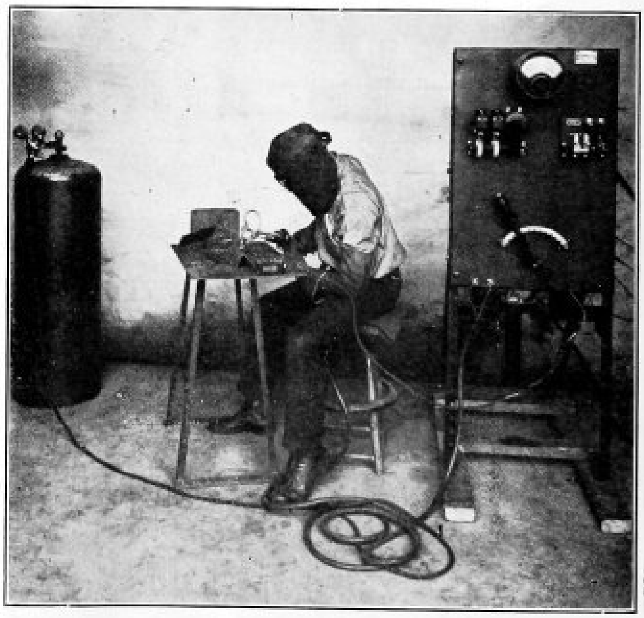
Since that time the process has been put to extended use in the shops of the company, notably in the production of



Atomic hydrogen welding torch for general use

its automatic refrigerator unit. This permitted the development of the equipment, which is now ready for sale.

In brief, this method utilizes the passage of a stream of hydrogen through an arc struck between two metal electrodes. The heat of the arc breaks up the hydrogen molecules into atoms. A short distance beyond the arc these atoms recombine into molecules of the gas, and in so doing liberate a great amount of heat. This heat gives the jet of gas the appearance of a flame, and it is used exactly as an oxy-acetylene welding flame—that is to say, it will melt



Operator at work with new welding equipment

without oxidation the abutting edges of any metals, and reinforced joints may be made by the addition of suitable welding rods

The welding outfit consists of a single-phase transformer for converting 60-cycle single-phase power to the voltage suitable for the welding equipment, a specially designed, variable reactor to provide the proper welding current and voltage for different classes of work, the welding torch by means of which the actual work of welding is performed, a cylinder of hydrogen with pressure reducing regulator, and the necessary hose, cables, hood and electrodes.

The torch consists of a holder supporting two tungsten wire electrodes with the electric conductors, and the tubing and valve for hydrogen gas. Each electrode is supported inside a nozzle through which the gas is forced out around the electrode. The combination of electrodes and nozzles is set at an angle and the distance between electrodes, or arc length, is readily adjustable by pressure on the hand lever. When welding ceases, the circuit is automatically interrupted until such time as the operator is again ready, when the circuit is automatically restored. In contrast to the usual method of electric arc welding, there is no current flowing from the electrodes to the work to be welded; the circuit is completed from one electrode to the other and the heat transmitted to the work by the jet of gas.

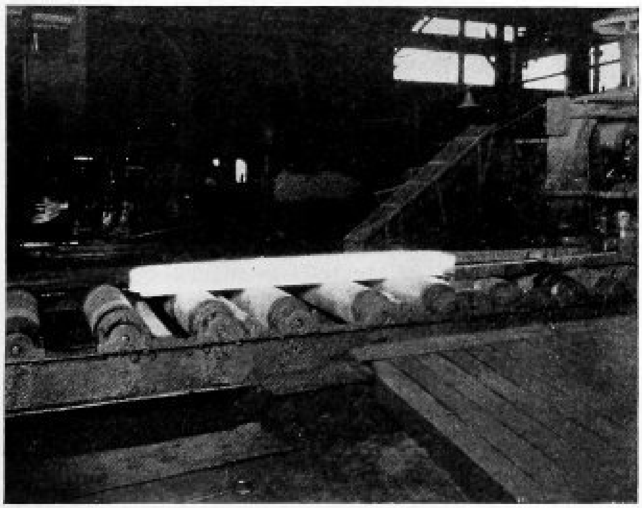
The new equipment is recommended by the company for use on ordinary metals less than 1/4-inch in thickness, or on hitherto unweldable metals of greater thickness.

Ryerson Takes Over Sale of Glasgow Iron

JOSEPH T. RYERSON & SON, INC., Chicago, Ill., has taken over the exclusive sales of the famous Glasgow iron billets to the railroads of the country.

Glasgow iron is a pure puddled doubly refined rolled wrought iron, made by the Glasgow Iron Company of Pottstown, Pennsylvania. This firm, organized in 1876 is well known as a manufacturer of iron plates, bars, billets and boiler specialties. For many years it has been specializing in the manufacture of refined iron.

Glasgow billets are a hand puddled product, made



Glasgow iron billet in process of rolling

wholly from pure pig iron, double refined and slab piled. After the billets are rolled to size the ends are cropped and careful inspection is made for blisters. This insures a strong, clean iron, free from seams or other defects.

The material competes with hammered iron billets and is used for forging draw bars, car parts, equalizers, and other various forgings where an especially high grade iron is needed.

The billets are furnished in sizes from 2 1/2 inches to 8 inches thick and from 6 inches to 18 inches wide. Also in 6-inch to 10-inch squares in the usual lengths. The specifications are as follows:

Tensile strength—about 45,000 pounds to 46,000 pounds per square inch.

Yield Point—50 percent tensile strength minimum.

Reduction of area—32 percent to 37 percent.

Elongation in 8 inches—22 percent to 25 percent.

(Depending on size.)

Glasgow billets meet the American Society for Testing Material Specification A84-24, Grade C.

Proposed High Pressure Watertube Locomotive Boiler

(*Continued from page 342*)

3. *Superior Circulation*, which materially overcomes the handicap to evaporative efficiency occasioned by a comparatively small amount of evaporative surface. This also lessens the scaling effect of bad waters and reduces priming.

4. *Quick Steaming:* It should be possible in a watertube boiler of this type to raise steam from cold water in half the time it takes with the ordinary firetube boiler.

5. *Compound Superheating:* This is made advantageous because of the high pressure employed.

6. *Safety from Crown or Other Extensive Explosions.*

7. *Steam Capacity:* With steam at 0.90 cubic feet per pound, it is possible to store 2.4 times the weight of steam in the same space compared to 200 pounds pressure steam. Measured in actual *volumes* the proposed boiler has but 60 percent of the steam capacity and water capacity of a comparable firetube boiler. Actually the steam storage capacity measured in terms of weight is about 45 percent greater than that of a 200 pounds pressure locomotive. In terms of power it is about twice as great. Owing to the syphon action of the tubes and the absence of crown sheet, a wide variation in water line may occur without serious danger to the boiler.

8. *Maintenance:* Objection to the number of joints to be kept tight is counterbalanced by the fact that there are no staybolts to maintain except in the backhead. Even these might be eliminated by employing circular waterlegs for the back connection between top drums and water space frames, but such waterlegs should be large enough to permit a generous circulation at the back.

Welding of Joints

The judicious use of electric welding should take care of most of the joints in the actual construction. Take the header connections to the drums, for example. As finally assembled and welded before tubes are installed, these headers make a permanent connection to the drums almost as solid as a casting. They should require no maintenance. The lower drums made from hydraulic pipe or steel castings may be machined on the ends a trifle larger than the bore they enter and either forced on under hydraulic pressure or shrunk on. Serrations or grooves in the tube hole entrances permit the smaller tubes to be tightly rolled, as well as increase the holding power three-fold over smooth bores. They should then be flared and welded through the handholes.

The removable cover over the top of the inclined tube system enables the tubes to be readily examined, and these tubes can be thoroughly scaled without removal, a valuable asset in bad water districts. Being straight they can be readily replaced without disturbing any section of the boiler.

The Cause and Prevention of Embrittlement of Boiler Plate—III*

By S. W. Parr† and F. G. Straub‡

TO obtain a clear conception of the possible chemical attack taking place under stress above the yield point of the metal, it becomes necessary to visualize what is taking place within the steel at the yield point. During a static test in which the load is applied at a definite rate, it is found that at the yield point there is a marked increase in the elongation of the metal without any noticeable increase in load. What takes place within mild steel to allow this permanent deformation is at present a matter of conjecture. Undoubtedly it must be due to rearrangement within the metal. The yield point can be said to be a function largely of the crystal strength. When the stress becomes greater than the crystal strength, slip takes place within the crystal. In an aggregate of grains such as there is in mild steel, the slip is stopped partly by interference of adjacent grains and partly by resistance on the slip plane itself. The metal as it is stressed below the yield point is slightly elastic, having an elastic stretch in this range of about 0.1 percent of the length. As the stress reaches the yield point it becomes sufficient to start slip on the crystal faces. This initial slip is stopped by increase of strength along the slip plane as well as by "end thrust" against adjacent grains. Thus slip in one crystal allows distribution of the stress which in turn increases the stress on the adjacent crystals. At the yield point, it may then be conceivable to think of the realinement of stresses within the metal so as to bring more of the crystal planes and boundaries into opposing the outer stress. After this "reorganization" within the metal there would be a permanent deformation and further external stress would produce additional slip and drawing out of the crystals in the direction of pull at the time of realinement stresses within the metal, the stresses at the grain boundaries undoubtedly are of a great order of magnitude. The metal has stretched now to a length more than one percent of its length. "It is the be assumed that the amorphous cement supposed to exist at the grain boundaries is electropositive to the crystal metal, and therefore has a high internal energy content. This would account for its greater susceptibility to chemical attack." There must also be a storing up of energy when the grain boundaries are so highly stressed, which in turn would make them still more chemically active than they were before stressing.

Once the penetration has started, the chemical attack follows the more chemical active path which is between the grain boundaries. As the boundaries are attacked the stresses are necessarily concentrated, which favors still more intercrystallin penetration. Observation of the progression of cracks in embrittled steel shows that the cracks do not always start at grain boundaries. Often a crack starts by penetration through the outer grain, but once it reaches a grain boundary it progresses along the boundaries.

If another metal like nickel, which in small amounts is completely soluble in the crystal of ferrite, is added to steel the yield point is raised, since the solid solution of nickel in ferrite is stronger than ferrite and slip starts at a higher value which in turn retards the reorganization within the metal. If on the other hand sulphur and phosphorus are increased we have an increase in the strength of ferrite accompanied by a higher percentage of these elements in the boundaries. The yield point is raised but chemical action is not retarded until the yield point is reached, due to the fact that the grain boundaries are much more active.

In a metal which has been heavily cold-worked, the grains have been completely changed, slips have occurred along various planes, the grains are elongated, the original crystal boundaries have been almost entirely replaced and the maximum strain is on the slip planes of the crystals. A higher stress would appear probable here before the chemical action would progress. It would appear probable that a small amount of cold work would have very little effect on the subsequent embrittling of the metal.

In the pearlitic areas of steel we would expect to find obstacles to the slip of the crystals and as the carbon increases the yield point should increase. The paths of embrittlement cracks should be such as to avoid passing across the lines of pearlite and this is found to be almost invariably so.

Cause of Embrittlement in Steam Boilers

It has already been shown that the production of intercrystallin cracks in mild steel can be brought about only by the combined action of stress and proper chemical attack. The limits set for each apply only to the conditions of the laboratory tests and the time of the tests. There is a possibility of a slower action taking place over a period longer than has been tested for, which may lower the stress or the concentration of solution necessary to some degree. Another point to be considered is that the embrittlement tests were run with the metal surrounded by a solution, while in boilers the solution is penetrating between the plates in a thin film and the limits of concentration of solution necessary to produce embrittlement may be altogether different. It is possible to conceive of the stress passing the yield point and the solution reaching the high concentrations used in the tests when one considers that embrittlement only occurs in the riveted areas which are under tension.

Probably in all boiler plates the stresses at the edge of rivet holes occasionally reached the yield point of the metal. It should be remembered that the mathematical theory of elasticity indicates that the localized stresses at the edge of a hole in a plate may be nearly three times the average stress in the plate. This stress concentration at the edge of holes, such as rivet holes, would in itself be sufficient to account for stresses almost high enough to start embrittlement should a solution of proper concentration penetrate to the rivet holes. In addition it should be noted that during the fabrication of the boiler the seams are put together by riveting. The riveting is done hot and, granting only sufficient riveting pressure is used to maintain tight seams, very high localized stress occurs under the rivet heads and around the rivet holes. When one observes the appearance of the plates and straps after they have been removed from a boiler which has been in service and sees the rings around the holes where the straps and plates have been held together by the rivets, there remains little doubt that the

*This paper was presented at the 29th annual meeting of the American Society for Testing Materials. The paper is reproduced herewith as it was also presented in part and formed a special feature of the recent annual meeting of the American Boiler Manufacturers' Association. Instalments of this report appeared on page 204 of the July issue, and on page 267 of the September issue.

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metal has been stressed beyond the yield point. When this stress is combined with the stress incident to operation of the boiler, additional local stresses develop which may still more favor embrittlement. The sharp angle which the rivet head makes with the shank combined with the stress forcing the rivet heads apart undoubtedly produces sufficient stress at this point to allow embrittlement to start. It is not uncommon to have rivet heads drop off embrittled boilers long before the plates are embrittled sufficiently to detect cracks.

This concentration of stresses exists in all boilers to a greater or smaller degree, yet in the absence of the proper chemical in the boiler water no embrittlement results. If the proper chemical, sodium hydroxide in the absence of much sulphates or carbonates, exists in the boiler water there is a possibility that sooner or later that boiler will become embrittled. The concentration of sodium hydroxide in the boiler seldom surpassed 17,000 parts per million or about 1,000 grains per gallon. Laboratory tests show that solutions of this concentration are not detrimental to the steel. There is a possibility that the actual concentration of caustic soda in the vicinity of the seam does sometimes reach a value much above this but still far below 400,000 parts per million or about 23,000 grains per gallon. It is known that sodium hydroxide even of such a low concentration as met with in boiler operation cannot readily be kept under pressure in containers with screw connections. Solutions of other salts can be retained, but with caustic soda leaks tend to develop. The presence of caustic soda under pressure in the boiler tends to produce a seepage of the solution into the seam between the metal surfaces. As the solution penetrates between the plates there is a tendency for concentration due to the steam being released back to the boiler or escaping to the outside. As the concentration progresses, the penetration of the solution further into the seam continues. With time, the concentration becomes sufficient to start embrittlement and if localized stresses are sufficient at the point of concentration embrittlement starts. Often this concentration is reached and embrittlement does not progress, apparently due to lack of sufficient strains and the penetration progresses until a free leak develops. On examination, no presence of embrittlement can be found. At other times embrittlement develops, the plates are weakened and a leak develops which indicates trouble. When the plates are removed from the seams of embrittled boilers soluble salts are found between the plates. This alone would indicate that there must have been considerable concentration in the seams. Another evidence of chemical attack in the seams is the presence of finely divided black magnetic oxide deposited on the surface of the plates.

The fact that the two main factors for embrittlement must occur simultaneously makes it possible for some boilers to operate under conditions which might point toward embrittlement without developing any distress. The fact that no distress (apparent by general inspection) has occurred is no sign that the boiler is free from danger. An example of this is shown in the case of one installation operating on alkaline water. This plant has been in operation for over eight years and was cited as an example of a boiler operating on alkaline water free from embrittlement. Six months later this plant discovered its distress, which turned out to be a very bad case of embrittlement, the engineer in charge has often since expressed wonder at the fact that one boiler in particular had not exploded, it was so badly cracked.

The real cause of embrittlement in steam boilers can be summarized, therefore, as concentration of caustic soda in the seams in the absence of much sulphate or carbonate together with the existence of localized stresses in the seams.

Prevention of Embrittlement

The results of the experimental work on the prevention or inhibition of embrittlement indicates that it can be stopped, but at present these experiments are not complete enough to cite final ratios and concentrations of the chemicals involved. The data collected from plant operation point out that the maintaining of certain ratios of the chemicals will prevent this trouble.

The removal of stresses is not to be considered in a commercial installation, and if it were possible it would not be applied to the many plants already in operation. The practice of inside caulking in drums will, if it can entirely prevent seepage into the seams, tend to retard the occurrence of this type of distress.

The removal of the source of the sodium hydroxide by changing the supply water would be the most effective of any method, but in some instances this is not possible and in others would lead to the use of waters which produce other boiler complications.

The removal of a large percentage of the sodium carbonate with the building up of a sodium-sulphate sodium-carbonate ratio either by the use of sulphuric acid, aluminum or magnesium sulphate all have their disadvantages. The acid treatment is not to be recommended unless installed under the advice and supervision of an expert in such matters and operated under supervision of a chemist or an engineer who understands all the possibilities of its danger. The aluminum and magnesium-sulphate treatment is very effective when used in connection with settling tanks and filters which remove the possibility of scale-forming ingredients in the boiler. These two chemicals are as dangerous, if used in excess, as is the use of acid and should be installed only after a thorough checking of the necessary amounts by a chemist who understands the reactions involved.

One point of particular interest is the fact that un-

TABLE XI—ANALYSIS, GRAINS PER U. S. GALLON OF WATER TAKEN FROM VARIOUS BOILERS

	Embrittled			Not Embrittled			
	Denver, Colo.	Champaign, Ill.	University of Illinois, Untreated	Bloomington, Ill. 1925	Chicago, Ill. Treated	University of Illinois, Treated	Illinois Central Railroad, Champaign, Ill.
Sodium Hydroxide, NaOH	176	31.8	60	2	28.2	22	33
Sodium Carbonate, Na_2CO_3	22	10.0	32	10	5.33	9	57
Total Alkalinity as Sodium Carbonate, Na_2CO_3	256	52.0	112	13	42.7	38	174.0
Sodium Sulphate, Na_2SO_4	70	17.8	0.0	200	89.8	90	11
Ratio Sodium Carbonate to Sodium Hydroxide	0.12	0.31	0.52	5.0	0.19	0.4	1.7
Ratio, Sodium Sulphate to Sodium Hydroxide	0.4	0.55	0.0	100.0	3.2	4.0	0.33
Ratio, Sodium Sulphate plus Sodium Carbonate to Sodium Hydroxide	0.52	0.87	0.52	105.0	3.4	4.5	2.06
Ratio, Sodium Sulphate to Total Alkalinity as Sodium Carbonate	0.27	0.34	0.0	15.4	2.1	2.4	0.63

decomposed sodium carbonate acts as an inhibitant. Thus if a plant should operate with a high percentage of make-up high in carbonates, the amount of hydroxide formed may be lower since the introduction of fresh carbonates would tend to keep the carbonate-hydroxide ratio high and may in turn inhibit embrittlement. Cases have been cited where the sodium-sulphate to sodium-carbonate ratio has been exceedingly low without any indications of embrittlement and the neutral effect of sodium carbonate is the obvious explanation.

This raises the question as to what ratio should be considered. In the past in the few plants operating on a ratio basis on alkaline waters, it has been customary to consider the ratio of sodium sulphate to the total alkalinity (in-boiler waters) expressed as sodium carbonate. This ratio is exceedingly safe since it considers all sodium carbonate as potential hydroxide, but it is misleading in interpreting the operations of certain boilers. Table XI shows the results of analysis of water from the boilers of seven different installations. The first three are from embrittled boilers while the rest represent boilers which are free from trouble. The Bloomington plant is now operating on a sulphate water treated with lime and soda ash and illustrates the high sodium sulphate due to the reaction of calcium sulphate and sodium carbonate during the softening. The Chicago Station and the University of Illinois are carbonate waters treated with sulphuric acid. The ratio of sodium sulphate to sodium carbonate is about 2 in both cases. The Chicago Station working with a lower make-up and a higher steam pressure has a lower amount of remaining sodium carbonate than the University of Illinois water. Assuming that sodium carbonate is also an inhibitant the ratio from actual boiler analysis should be sodium sulphate plus sodium carbonate to sodium hydroxide. When this is the condition, the lower pressure plant with higher make-up is apparently more protected and could in turn work with a lower sodium-sulphate to sodium-carbonate ratio. The ratio of sodium sulphate to sodium carbonate will be misleading in a few isolated cases. The Illinois Central Railroad locomotives operating locally in Champaign on alkaline water illustrates this since the sulphate-carbonate ratio is shown to be as low as 0.63 but the sodium-sulphate plus sodium-carbonate to sodium-hydroxide ratio is over 2 which is much safer and apparently sufficient to stop embrittlement. These illustrations will serve to show that each plant must be considered by itself in order to set any prescription for feed-water treatment in order to inhibit embrittlement.

The information thus assembled, which in some of its phases should without question be extended, is sufficiently conclusive on the fundamental factors to justify its publication at the present stage.

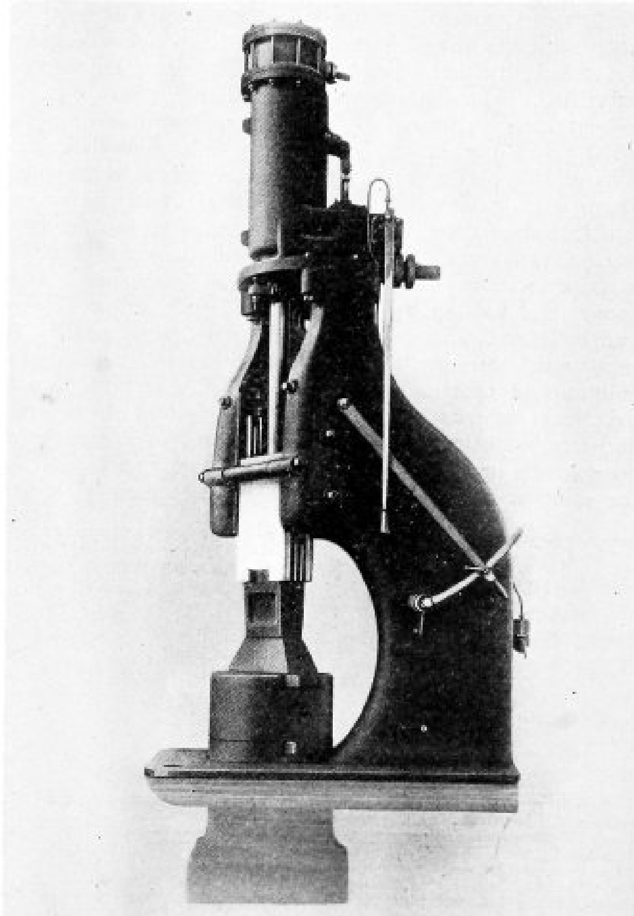
High Frame Type Guided Ram Hammer

IN order to provide ample working space during operation, the Chambersburg Engineering Company, Chambersburg, Pa., has developed a high frame type of guided ram hammer. With this hammer it is possible to forge large disks and rings, to upset high stems, form arch bars, etc., on the most economical size of tool. Long punching with drifts is facilitated. It is stated by the company that the increased clearance from the upper to the under side of the frame increases the capacity of the hammer thus reducing production costs.

The best economy in the use of steam or air is secured by the carefully designed cylinder. Deeper stuffing boxes than are ordinarily used are provided on the steam connections. The steam joint common to most hammers between the intake stuffing box and the cylinder has been eliminated. Self-draining arrangements have been made on the cylinder which eliminates delays necessary to pump out the condensate. Among other special features of this hammer are:

Patented safety cylinder cover which provides a cushion of live steam or air at the top of the cylinder. This limits the stroke to protect the cylinder and avoids the hazard and expense of broken cylinder covers in the event of rod breakage or loosening.

The Chambersburg safety valve, a stop arranged under the operating valve, shuts off the steam or air in the event of damage to the valve gear. The throttle valve is of the rotary self-seating type ground in place, while the operating valve is of the balanced piston type ground in a renewable iron gage. The frame is made of air furnace, semi-steel designed in reinforced box section with front tie bars on sizes under 3,000 pounds falling weight and with front and rear tie bars on larger sizes. These are solid with the base plate under 5,000 pounds and on larger sizes are bolted to the base plate. The guides are of semi-steel supported on 5 sides by the frame. The ram is an open-hearth annealed steel forging set at an angle to the frame.



New Chambersburg air or steam hammer

The Harnischfeger Corporation, Milwaukee, Wis., has opened a branch office at 194 Boylston street, Boston, Mass. E. J. Calder is district manager.

The Baldwin Locomotive Works and the Standard Steel Works Company have removed their St. Louis, Mo., offices from the Boatmen's Bank building to the Telephone building, 1010 Pine street.

Application of Screen Glass to Welding Operations*

Proper filtration of injurious light rays and physical aspects essential requirements

By W. G. King†

WHEN we speak of a screen or welding glass we mean a glass that is interposed between the eyes and the flame of a welder's torch, or the arc of an electric welder's electrode. The function of the glass is primarily to protect the operator's eyes from the injurious rays emitted by the flame, arc or molten metal, and in addition, through its filtering medium to assist the user to meet his production factor with the least discomfort to his eyes through a reduction of the so-called glare annoyance and at the same time to provide clarity of detail.

That such requirements are necessary leads us to wonder what physiological effects result through contact with the injurious invisible rays, the ultra violet and infra red, when the eyes are unprotected. When the eyes are tired, the body is tired all over; a tired worker cannot be efficient or happy, so that the condition of eye strain or uncorrected visual errors slow down production and decrease the quality of the product.

Dr. Nelson A. Black states in "The Eye in Industrial Accidents," "That exposure of unprotected eyes to very intense light sources rich in violet rays produces acute and painful inflammation of the outer coating of the eyes; that long continued or frequent short exposures to ultra violet radiations of moderate intensity may result in severe inflammation by its cumulative action. Instances of lasting and permanent injury to the eyes have been reported from comparatively short exposure to very intense light."

From another authority in the medical profession we are told that the infra red rays dry out and burn the eyes and the skin, producing reddening or irritated eyelids, watering of the eyes and headache and frequently these disturbances are of such intensity as to prevent sleep.

Proper Welding Glass Protects the Eyes

The welder on the job recognizes this sensation of burning which is described by him as being like hot sand in the eyes. Those of us having experience in welding operations are familiar with these complaints of workmen, but in recognizing this condition, we sometimes fail to control the conditions through a safety device in the form of efficient welding glass. Undoubtedly, some, if not all of us, can look back a few years when we considered that an ideal welding glass could be made from a series of several pieces of colored glass, usually red, green and blue mounted in layers. Such glass was obtained at the nearest paint or glazier's shop, or perhaps we liked best the color combination of red and blue. Little did we realize that we were offering little or no protection from the invisible injurious infra red rays.

All glass, with the exception of quartz, under most practical conditions, affords protection from the ultra violet. This, however, cannot be said of the infra red. It has been found that clear window glass transmits 78.5 per cent of the infra red rays, while an efficient welding glass transmits less than one per cent. It is also interesting to note that it has been determined that there is only approximately 2.5 per cent variation in the transmission of the rays through thick plate glass over that of the ordinary window glass. It is quite evident from this investigation that the thickness of the screen has little control in arriving at high absorption efficiency, when this thickness is compared with that of welding glass .093 in. thick.

Recently, we learned of a transmission test made on welding glass (so-called) built up of several pieces having a total thickness of ¾ in., which transmitted eight per cent of the infra red rays. Frequently in screen glass, thickness may control the depth of shade or density, but it will not necessarily govern its absorption efficiency.

To the casual observer any piece of glass of a dark hue may be a good welding glass if he is looking only toward a reduction of the incidental light and its annoying glare, giving no attention to the vital factors, its absorption efficiencies of the invisible rays. These can be determined only through laboratory tests, for the ultra violet through a spectroscope and the measurement of the infra red through a diathermic ray instrument.

Physical Aspects of a Good Glass

Appreciating the absorption qualities of a welding glass, we can now look toward some of the physical aspects and their relation to the total of a good glass. It must be free from pits, fine holes, creases, stria, or opalescence—factors that produce distorted vision. It should be of uniform thickness throughout and should transmit enough of the incident light to permit the operator to observe the details of his work without eye strain.

It is on this latter point that the establishment of shades or densities has been developed. The personal factor in the selection of welding glass is interesting and should be taken into consideration. The selection of a light or dark shade of glass for the same job is an indication of the variation in the sensitivity of the eyes to the incidental light of the same intensity. As previously mentioned, the shade or density in most cases is a control of individual discomfort. It is for this reason that we frequently hear men say a glass is too light or too dark. It has been shown that the eye is most sensitive to light rays of wave lengths approximately 5,500 to 5,650 Angstroms, producing a color of yellow bearing on the green. Consequently, a welding glass giving this shade enables the welder to observe detail and to do his best work. If the color field approaches either the red or the blue, the operator's perception of detail is decreased and the possibility of the transmission of the infra red is increased.

Selection of the Mounting Important

In conjunction with efficient welding glass, an intelligent selection should be made of its mounting or container, goggle, helmet or hand shield. If a goggle, it should be of the so-called eye cup construction, con-

*A paper read at the monthly meeting of the New York section of the American Welding Society, held October 19, 1927.

†Director, safety division, American Optical Company, New York.

forming to the contours of the face, enclosing the eye at the top, bottom and sides, ventilated, but eliminating the possibility of light leak. The goggle is worn first as a protection from the injurious invisible rays, and secondly as a protection against molten metal splashes or foreign particles. It should be borne in mind that a goggle that might prove ideal on a scrap pile job in the yard, may be wholly inefficient on a job in a firebox of a boiler or inside a tank.

A helmet or hand shield should be designed to afford ample protection to the face, forehead and throat, and made of a material that is a low conductor of heat and not, as sometimes found, made of sheet metal having the contours of an inverted sugar scoop.

To summarize this paper, let me quote our Dr. Charles Sheard: "Welders and those working near high power arcs need protection against the ultra violet, a reduction in the visible and elimination of the infra red. It is necessary for all persons whose work requires exposure of the eyes to excessively bright or highly radiating surfaces to wear suitable light absorbing or protection glasses.

"A filtering glass, which should be used, is one which will cut off both ends of the spectrum, the ultra violet and infra red and which transmits in reduced quantity only rays of high visibility, such as the yellow and green radiations giving the maximum visibility with the minimum reception of energy."

Designing Furnace Tubes for Horizontal Internally Fired Land Boilers

Types of joints developed in furnaces to withstand the higher boiler pressures in use

By "Boilers"

The defects caused by expansion and contraction of the furnace tubes of internally fired boilers have brought about many changes in the design of these tubes. The various methods of construction are discussed in this article.

Originally when boilers were worked at low pressures, plain furnace tubes were used with lap joints. These plain tubes were sometimes stiffened against collapse by riveted angle or tee rings, no regard being paid to expansion and contraction stresses. Defects were fairly common and consisted chiefly of cracks and lap fractures which necessitated repairs by patching. The Bowling hoop expansion ring was the first step in the right direction. This ring strengthened the tube and also allowed a certain amount of elasticity in a longitudinal direction. It is expensive to make and has the disadvantage of the lap riveted tube, in that the rivet heads are exposed to the flame and hot gases and the rivet holes are liable to fracture out to the lap. The Adamson flanged seam (shown in Fig. 4) is very popular.

It is made by flanging each end of the rings and inserting a calking ring between each section of the tube. This type of flanged seam allows fairly free movement in a longitudinal direction and stiffens the tube considerably against collapse. The flanges should be made of large radii in order to avoid local stress due to expansion strains. It will be noted that all the rivet heads are in the water space and that wasting of these heads will not affect the strength of the tube in the same manner as would be the case where the rivets are in tension as in the Bowling hoop connection.

Modifications of Adamson Furnace

There are several modifications of the Adamson flanged seam in use. The Adamson absorber flanged seam consists of one flange of the usual dimensions and an adjacent flange somewhat deeper as shown in Fig. 5. Usually every alternate ring of the tube beyond the furnace has deep or absorber flanges and the rings are about 2 inches less in diameter than the other rings. This arrangement allows free movement of the tube and the deep flanges take up a great deal of the stress due to expansion.

The Beeley-Pogson flanged seam shown in Fig. 11 is another modification of the ordinary flanged seam. In this case the flanges are made to standard dimensions (about 3¼ inches) at the bottom of the tube and gradually increased to the top where the depth of the flange is about 4½ inches. It is claimed for this arrangement that resistance to collapse is greater at the hottest part of the tube and that the deep flange is situated where the strains due to expansion are most likely to occur.

The Paxman and Hawksley-Wild flanged seams are shown in Figs. 6 and 8. In the former, both ends of each ring are flanged and the internal diameter of the tube is constant. In the Hawksley-Wild method of construction alternate rings are flanged and the tube varies in diameter. In both the foregoing cases the heads of the rivets in the seams are exposed to the flame and hot gases. Wasting of the heads of the rivets on the water side will reduce the efficiency of the seams.

The Arnold furnace, Fig. 9, is barrel shaped and has flanged seams fitted together usually without calking strips. The shape of this furnace is designed to take up the strains of expansion and contraction and also stresses due to hogging of the tube when the fire is first started.

Fig. 3 shows a furnace ring connection used in the Midgeley furnace tube, and consists of inverted expansion rings inserted between flanged seams. This arrangement allows free movement of the tube in a longitudinal direction and the inverted rings projecting into the furnace tend to break up the flow of gases. The rings form a pocket for scale and sediment, the cleaning of which is apt to be neglected.

Cone Shaped Furnace Rings

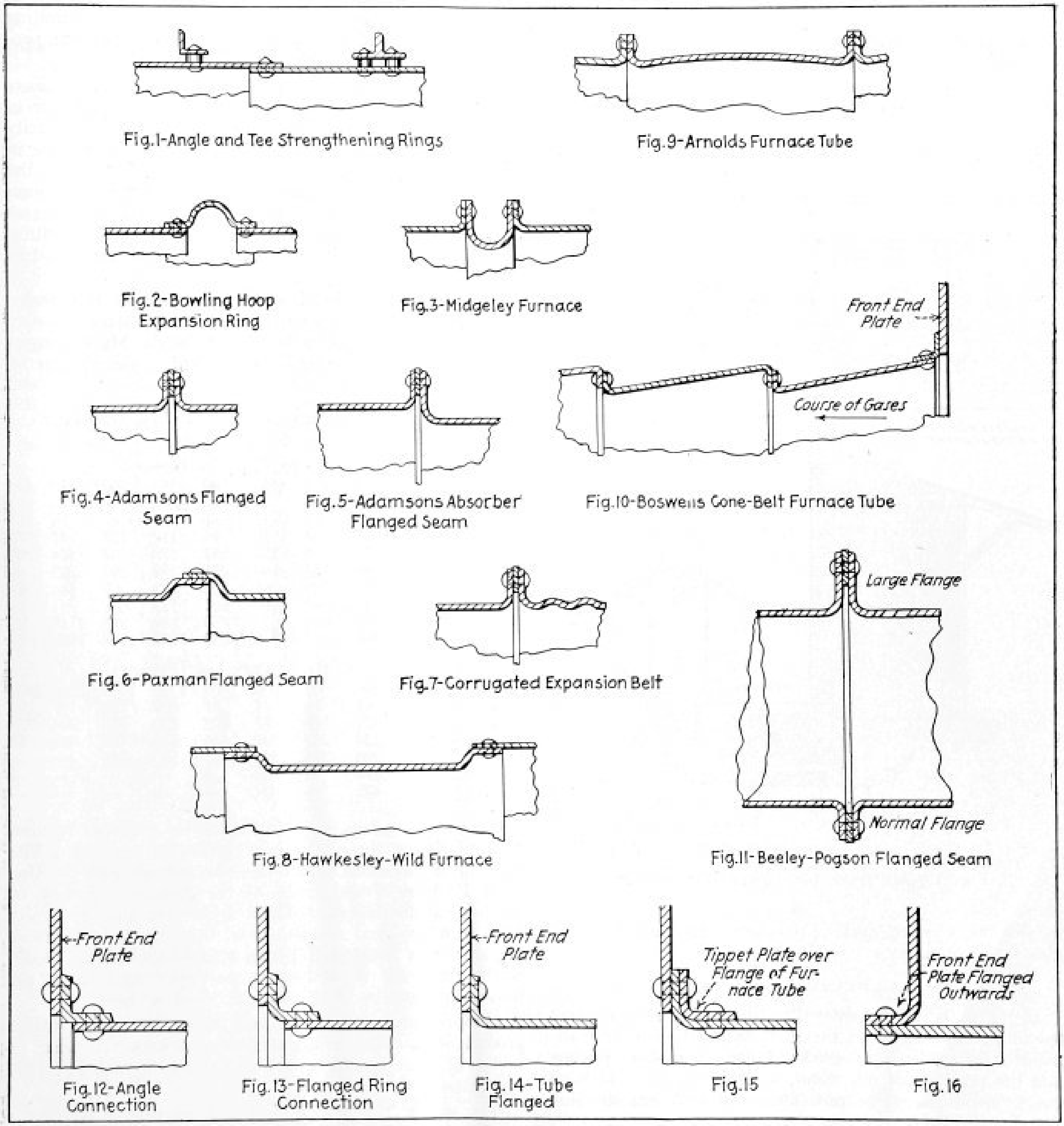
The Boswell tube unlike those previously described is not parallel and is made up of coned rings. The large ends of the rings are flanged inwards and the small ends flanged outwards. The taper of the rings is made equal to the depth of the flange in order to permit the whole tube to be withdrawn through the angle connecting the tube to the front end plate, without removing the front end plate. The tube is arranged with the large ends of the coned rings towards the front end in order that the rivets in the seams will not be exposed to the action of the furnace gases.

Often a corrugated ring is used in a tube in conjunction with rings having flanged seams. This is usually done where rigid end plates are used and where the front end plate stays are very strong.

The connection of furnace tubes to the front end plate should be designed as flexible as possible consistent with strength, as it is often found that defects due to expansion strains occur at this part. Rigid angle connections cause the stresses to be transmitted to the front end plate causing grooving. Flexible flanged connections will groove in the root of the flange. Where the front end plate is flanged outwards trouble may be expected at the seams of the tubes or at the gusset rivets and where the front end plate is cambered and not stayed expansion stresses may cause grooving at the connection of the end plate to the shell.

The best type of seam for furnace tubes is the one which will distribute the stresses over the whole length of the tube in preference to causing local stresses and consequently more rapid failure to occur.

Jack L. Jacobson has been appointed representative in the New York territory of the Reading Iron Company, Reading, Pa. He will assist H. S. Carland, district sales representative at New York. Mr. Jacobson was formerly associated with the Barrett Company, of Chicago, Ill.



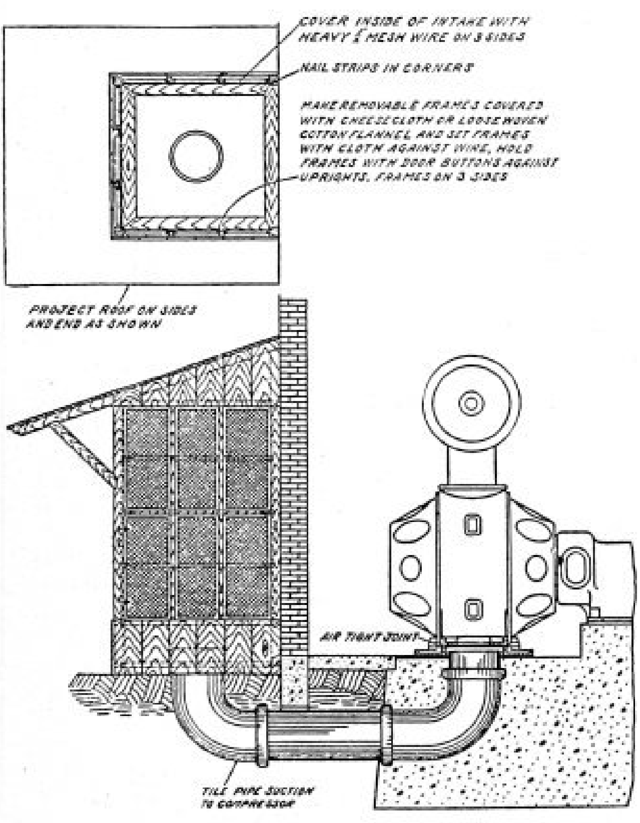
Details of various type connections for internally fired furnaces

Prevention of Air Tank Explosions

By Geo. H. Stickney*

AIR tank explosions are due to a great variety of causes, some of which are common to all pressure vessels, while others are peculiar to compressed air systems. The fault may have been in the original design, or a defect that gradually appeared, or the result of improper operation, but whatever the cause, frequent inspections would go a long way toward reducing the number of such accidents.

The air tank or receiver is most frequently the seat of the explosion, but attention to this vessel alone will not greatly reduce the hazard. The system as a whole must be considered—tanks, compressors, and piping—and when any part of the system is dismantled for repairs, the opportunity of examining that part should be taken full advantage of. The internal inspection of a tank should be as thorough as possible and should include complete dimensions for computing the maximum safe working pressure. Should the system be in operation and the tank under pressure, it may not be possible to obtain these necessary data, but at least some approximation should be made and checked against the observed working pressure to ascertain the probable factor of safety.



From *Trade Standards* of the Compressed Air Society

Fig. 1.—Air filter for compressor intakes

Internal Examination Essential

If the tank can be entered or the inside seen through openings, the interior of the shell should be carefully examined for evidence of cracks, general corrosion, pitting, and the presence of oil, water, or other deposit. If there are no openings and no pipe fittings of sufficient size that can be dismantled for the purpose of interior examination, hand holes of ample size should be cut into the vessel, the number of holes depending upon the size of the tank. Special attention should be paid to the possibility of finding internal corrosion on the bottom of the vessel, or cracks at the turn of the head flanges. The bottom heads of vertical tanks and the lower portions of heads of horizontal tanks should be given particular attention.

All air tanks should have a blow off connection fitted to the lowest part of the vessel, and it should be used at least daily in order to prevent the accumulation of oil and water. Vertical tanks should be installed with the "plus" head at the bottom to afford complete drainage. A safety valve, or valves, of proper construction and size and set at the maximum allowable pressure should be installed so as to properly protect the tank or system. A device commonly known as an unloader, which governs the pressure by controlling the air supply, is not by itself considered sufficient protection against overpressure.

Safety valve sizes are based on the allowable pressure and the maximum commercial rating of the compressor in cubic feet per minute of free air at sea level. This capacity is reduced about 3 percent for every 1,000 feet increase in altitude. The maximum commercial rating is taken as the displacement in cubic feet per minute at the maximum speed of the compressor. In a multiple stage compressor the capacity of the large or low pressure cylinder, handling free air taken from the atmosphere, is alone considered in the rating.

The following table showing maximum air compressor ratings in cubic feet per minute for different sizes of safety valves at stated pressures is taken from the Massachusetts Air Tank Regulations and can be used in the absence of local regulations:

MAXIMUM AIR COMPRESSOR RATINGS FOR DIFFERENT SIZES OF SAFETY VALVES

Diameter of	Gage Pressure (Pounds)							
Valve (in.)	50	100	150	200	250	300	350	400
¼	—	—	—	—	—	—	—	53
½	20	32	42	51	59	67	74	111
¾	37	59	78	96	112	127	141	176
1	58	94	124	152	178	202	224	248
1¼	84	135	180	221	259	293	325	—
1½	114	186	248	302	354	400	444	—
2	189	306	410	501	592	668	741	—
2½	282	457	613	750	880	998	1114	—
3	393	638	856	1050	1230	1398	1557	—

Diameter of	Gage Pressure (Pounds)							
Valve (in.)	500	600	800	1000	1200	1600	2000	2400
¼	61	70	84	97	109	128	147	160
½	129	147	177	205	230	270	304	330
¾	224	232	242	346	386	423	474	518
1	286	324	390	450	500	586	—	—
1¼	374	—	509	—	—	—	—	—
1½	472	—	634	—	—	—	—	—

Close investigation should be made for improper repairs, particularly by the autogenous method of welding. The welding of the seams should be in accordance with the Unfired Pressure Vessel Code of the American Society of Mechanical Engineers. Brazed seams are quite generally used with apparent freedom from failure. It is believed, however, that brazing of plates over ⅜-inch thick should not be practiced. Brazed seams can be distinguished by the brassy appearance of the surface when scraped.

Compressed air tanks should never be buried under ground or installed in inaccessible locations. At least 12 inches of space should be left all around the tank to facilitate inspection.

The use of the proper kind and amount of oil in the compressor cylinder has a very important bearing on the prevention of explosions in air tanks and connecting pipe

*Superintendent boiler department, Hartford Steam Boiler Insurance and Inspection Company, Hartford, Conn. Article originally appeared in *The Locomotive*.

lines. Mineral oil only should be used, and the proper grade of such oil for service in an air compressor should be specified by some reputable oil company making that particular kind of oil. It should be borne in mind that much less lubrication is required in air compressors than in steam engine cylinders. Too much oil may lead to greater difficulties than an insufficient amount.

Control of Air Temperature Important

Aside from over pressure in the tank (due to poor design, cracks, corrosion, lack of safety valves or inoperative safety valves), temperature control of the air leaving the compressor is perhaps most important for the prevention of explosion. Many explosions in compressed air systems have been attributed to the high temperature of the air, causing ignition of combustible matter in the pipe lines or receivers. It is essential to have sufficient clean cooling water from an unfailing source circulated through the coolers and jackets of the compressor cylinders so that the temperature of the discharge air is not materially above that of the surrounding atmosphere. With multiple stage compressors, intercoolers between the cylinders and an aftercooler between the high pressure stage and the tanks are usually found necessary, not only to reduce the temperature of the air but also to condense any water vapor and create a dry condition of air for service.

Other causes for high temperature are leaky compressor suction valves and pistons, mud or other deposit filling up the jacket space or adhering to the walls of the cylinders and coolers, hot and dirty inlet air, and high speed of compressors too small for the service required. Still another cause is operating with the jackets only partly filled with water. The pipe lines leading to the water jackets and coolers are usually fitted with stop valves on both the inlet and outlet connections and the flow is often regulated by the inlet valve, but this is poor practice. If the inlet valve is only slightly opened and the discharge valve opened wide, it sometimes happens that the coolers and jackets are only partly filled with water due to the water running out faster than it is fed. On the other hand, if the inlet valve is kept wide open and the discharge valve used for regulation, the cooling spaces will be completely filled with water, lower air temperatures will be maintained and, by keeping the air out of these spaces, corrosion will be reduced. Of course, where there is an open jacket, the jacket is full of water at all times and the regulation must be by means of the inlet valve. A good way to make sure that a constant flow of water is passing through the cooling system is to have the discharge in the open where it is readily and conveniently visible.

The end of the compressor air intake pipe should be located in a place where clean suction air is available. It is advisable to install an air filter or screen over the end of the pipe for protection against the drawing in of dust, smoke, and other material which may be combustible. Air filters should be regularly cleaned and otherwise maintained in good condition. A simple form of air cleaner recommended by the Compressed Air Society is shown in Fig. 1, on page 356. Quoting from Trade Standards of the Society:

"[It] consists of a wooden frame box made with removable panel frames covered with heavy ½-inch mesh wire to which cheese cloth or loosely woven cotton flannel is tacked. The cheese cloth takes up all the heavy particles of dust and foreign matter, and when the cloth gets completely covered it should be renewed with new cloth. Ample screen area should be provided at least 1 square foot of surface per 25 cubic feet per minute free air capacity of the compressor. With this amount of surface there will be no appreciable loss of pressure in the air going to the compressor."

Use of Water Tanks for Air Receivers is Dangerous

The ordinary kitchen variety of hot water supply tanks, sometimes called range boilers, are frequently used as air tanks particularly in garages. As these tanks are intended for water containers only, they are not constructed with a sufficiently high factor of safety for use with compressed air, and should not be so used.

Since it is hoped this article will come to the attention of many users of compressed air, it may not be amiss to call attention to a misuse often made of air under pressure, that is, the initial testing of tanks with air instead of water. Tanks, particularly when they are to hold valuable liquids such as gasoline, are specified to be air tight at a certain pressure. This necessitates testing the tank under air presure, but the air test should not be made before the tank is hydrostatically tested for strength. Explosions of tanks while under test pressure are not infrequent, especially in boiler shops, and they are usually attended by fatalities because workmen are in close proximity to the vessel looking for, or calking, leaks. Several such cases have been previously reported.

Use of Kerosene Oil

It is not uncommon to find kerosene oil used for cleaning compressed air systems. This practice should be discontinued because the volatility and ease of ignition of kerosene predisposes toward a combustion explosion.

Fusible plugs are recommended, and one should be installed on the receiver and one on the discharge pipe as near the compressor cylinder as possible.

The states of California, Massachusetts, and Minnesota, and the cities of Detroit, Chicago, and Omaha have air tank laws and rules.

Conference on Welding

At the time of going to press a 3-day conference dealing with the use of electric thermit and oxy-acetylene welding was just being completed at Purdue University, Lafayette, Ind. This is the third annual conference of the kind and was held on December 13, 14 and 15 under the joint direction of the Engineering Extension Department and the Department of Practical Mechanics with the School of Chemical Engineering and the manufacturers of welding equipment cooperating. The program included addresses and discussions on Welded Joints in Structural Work, Uses of Welding in Manufacturing Operations, Latest Developments in Thermit Welding, Welded Joints as a Mechanical and Structural Detail, Theory and Practice of Gas Cutting, Resistance Welding and Its Application to Welding Thin Plates, Replacing Castings by Means of Welded Frames, Pipe Welding, Welding Rods.

The exhibits and demonstrations held during the Conference covered modern welding equipment; electric, gas and thermit welding, aluminum welding, hand cutting, mechanical cutting, bronze welding, pipe welding, stelliting.

The Lincoln Electric Company, Cleveland, Ohio, announces the transfer of R. P. Nick from the Baltimore, Maryland, office to the Lancaster, Pennsylvania, office, where he will be in charge of the sale of "Linc-Weld" motors and "Stable-Arc" welders.

The company also announces the transfer of E. F. Hoff from the welder division at Cleveland to the welder division at New York where he will be in charge of welder service under the direction of G. N. Bull, district manager.

Dictionary of Locomotive Boiler Terms

Definitions of boiler parts adopted by Master Boiler Makers Association at annual convention

At the recent annual convention of the Master Boiler Makers Association, W. H. Laughridge, chairman of the committee on "Standard Boiler Terms" proposed that the association adopt such portions of the "Dictionary of Terms" appearing in the *Locomotive Cyclopedia* published by the Simmons-Boardman Publishing Company, New York, as applied to boiler work. The convention passed the motion unanimously and adopted the definitions of terms which for the benefit of members of the association and all others connected with locomotive boiler work appear in part below. Earlier sections appeared on page 171 of the June issue, page 201 of the July issue, page 236 of the August issue, page 265 of the September issue and page 294 of the October issue. Further instalments of these terms will be published in later issues.

Definition of Terms

Tank Coal Gate. A door for holding back the coal on a tender and preventing it from spreading over the apron and deck.

Tank Coal Gate Hinge. One of two hinges on which a gate for holding back coal in a tender turns.

Tank Collar. Called also tank wings and tank dashboard. A vertical or slightly inclined strip of metal secured around the sides and back end of the top of a tender tank to prevent coal from spilling off.

Tank Dashboard Bracket. Metal strips or holders riveted to the sides and end of a tender tank to hold the projecting edge or dashboard.

Tank Drain Pipe. A piece of pipe open at both ends screwed into a flange riveted to the tank top near the manhole and passing down through the tank bottom to allow any water spilled on the top plate when filling the tank to run off.

Tank Equalizing Pipe. A pipe passing under the boiler connecting both legs of a saddle tank to equalize the water level.

Tank Filling Hole. An opening in the top of the tank near the back cover with a lid through which the tank is filled with water. Also called Tank Manhole or Tank Funnel.

Tank Filling Hole Lid. A cover on a tank filling hole or manhole, usually hinged for convenience in opening.

Tank Filling Hole Lid Handle. A curved piece of metal fastened to a filling hole lid to serve as a handle for raising or lowering it.

Tank Filling Hole Lid Hinge. A hinge fastened to the edge of a filling hole and to its lid.

Tank Fire Tools Bracket. A bent piece of metal riveted to a side frame or tank collar of a tender to hold the poker, hoe, or any other long-handled tools used in firing.

Tank Funnel. A term used instead of Tank Manhole or Tank Filling Hole.

Tank Goose Neck. A curved cast-iron pipe to convey water from the front end of a tender tank to a hose which couples to the injector feed pipe. One goose neck is placed in the bottom of the tank leg on each side of a tender. British, swan neck.

Tank Hand Hold. A piece of malleable or wrought iron or steel secured to the ends of a tender tank to assist a man in getting on or off.

Tank Handle Post. A short piece of metal riveted to a tender tank to hold one end of a tank handle.

Tank Hose. A hose between the tender and engine for the purpose of conveying water from the tank to the injector.

Tank Hose Sleeve. A brass collar fitting loosely around the end of a tank goose neck and having lugs on it for a spanner wrench. It screws on the hose nipple of the suction pipe.

Tank Hose Strainer. A large strainer used in the water tank over the end of each suction pipe so as to exclude foreign matter. Also placed in the suction pipes near the tank.

Tank Knee. A right-angled plate used as a brace or stiffening piece in the ends and corners of a tender tank.

Tank Ladder. A metal ladder fastened to the back end of a tender to give access to the tank top from the back bumper. Also placed inside the tank, at the manhole, and providing a means of entering the tank from the manhole.

Tank Water Bottom. That portion of the water tank extending under the coal space.

Tank Water Legs. The front portions of a tender tank, or those nearest the engine and forming the side of the coal space.

Tank Locomotive. One having a water tank and coal box on the main frames and operated without the usual tender. Used for contractor's industrial and suburban service. See Saddle Tank Locomotive, Side Tank Locomotive.

Tank Lug. An angle or bracket riveted to the sides or top of a tender tank for securing the collar or dashboard. Also for securing the tank to the underframe floor.

Tank Manhole. See Tank Filling Hole.

Tee Head. A T-shaped pipe attached to the front tube sheet in the smokebox and forming the connection between the dry pipe in the boiler and the steam pipes in the smokebox. Also called steam head, nigger head and branch pipe, and in Great Britain, steam pipe tee piece. On locomotives equipped with fire tube superheaters the tee head is designed to form the superheater header.

Templet. A form for laying out work.

Ten-Wheel Locomotive (4-6-0). Specifically a locomotive having ten wheels, but commonly applied only to locomotives having a four-wheel front truck and three pairs of coupled driving wheels, but no trailing truck. Used in fast freight and passenger service.

Ten-Wheel Switcher (0-10-0). A locomotive having five pairs of coupled driving wheels, but no front or trailing truck; used for heavy switching service.

Tender. A car for carrying the water and fuel for a locomotive. It consists of the usual trucks and underframe, upon which is carried the tanks for fuel and water. It is coupled to the locomotive and is a part of it while the locomotive is in service.

Texas Type Locomotive (2-10-4). A locomotive having a two-wheel leading truck, five pairs of coupled drivers, and a four-wheel trailing truck. First used on the Texas & Pacific in 1925.

Thermic Syphon. See Syphon.

Thimble. A bushing.

A sleeve or tube through which a bolt passes, and which may act as a distance piece. A thimble is usually round, but sometimes square. See Crown Bar Thimble.

Throat Brace. A bar or rod fastened to the back tube sheet and to the shell of a boiler to brace the tube sheet below the bottom row of tubes at the throat of the firebox.

Throat Brace Eyebolt. An eye formed on a throat brace where it is connected to the shell of a boiler by means of a pin or rivet.

Throat Brace Pin. See Throat Brace Eyebolt.

Throat Seam. The joint where the top part of the throat sheet joins the boiler shell and the roof sheet.

Throat Sheet. A boiler plate flanged to a shape suitable to connect the cylindrical portion of the boiler with the firebox side sheets. In some designs the throat sheet is made to extend entirely around the boiler, connecting the cylindrical shell with the firebox side sheets and roof sheet.

Tube. Also called flue. One of the small pipes that convey the products of combustion from the firebox to the smokebox and stack, and which do not contain superheated pipes. Tubes are fitted in holes in the tube sheets at each end of a boiler, and where they enter the holes in the firebox tube sheet copper ferrules or sleeves are placed over the ends of the tubes to make a tight joint. Generally made of charcoal iron or mild steel. In Europe, brass and copper tubes are frequently used. See Ferrule, Flue and Arch Tube.

Tube Heating Surface. The heating surface of a locomotive boiler contained in the fire tubes. When fire tube superheaters are used the heating surface contained in the flues accommodating the superheater units is added to the fire tube heating surface. In locomotive practice it is common to measure the tube heating surface by multiplying the outside circumference of a tube, in feet by the distance between the tube sheets, in feet, and by the number of tubes expressing the result in square feet.

Tube Plug. A slightly conical piece of metal used to close a tube opening in a tube sheet in case a tube bursts or ruptures. It is inserted by means of a bar of special design called a PLUGGING BAR. See BOILER INSPECTION.

Tube Sheet. A plate or sheet forming one end of a locomotive boiler shell, and having a large number of holes in which the ends of the tubes are inserted. The plate next the smokebox is called the front tube sheet, and that next the firebox the back tube sheet.

Tube Sheet Brace. A steel bar, rod or plate fastened at one end to a bracket or lug on the front tube sheet and at the other to the waist or shell of the boiler. Its purpose is to strengthen the tube sheet.

Tube Sheet Brace Crow Foot. See CROW FOOT.

Tube Sheet Brace Jaw. A fork or bifurcation formed of one end of a front tube sheet brace at the point of attachment to a crow foot or lug fastened to the front tube sheet.

Tube Sheet Brace Pin. A short rod or bolt passing through one end of a front tube sheet brace, to secure it to the lug or bracket.

Tube Sheet Ring. A ring made of wrought or cast iron or steel, riveted around the hole in the front tube sheet through which the dry pipe passes, to strengthen the tube sheet and furnish a secure support for the tee or nigger head.

Tube Sheet Stay. See THROAT BRACE.

Twelve-Wheel Locomotive (4-8-0). Specifically a locomotive having 12 wheels, but commonly applied only to locomotives having a four-wheel front truck and four pairs of coupled driving wheels, but no trailing truck. Rarely used.

V

Vanderbilt Boiler. A locomotive boiler having a corrugated cylindrical firebox requiring no staying. See LENTZ BOILER.

Vauclain Compound Locomotive. A four-cylinder compound locomotive having a high and low pressure cylinder on each side outside the frames and placed one above the other, with the two pistons attached to a common crosshead. See COMPOUND LOCOMOTIVE.

W

Wagon Top Boiler. A boiler having the steam dome over the firebox and a sloping course from in front of the firebox to the cylindrical shell. In some designs the steam dome is placed in the sloping course. Not in general use. See EXTENDED WAGON TOP BOILER.

Waist (of Boiler). That part of the boiler shell immediately in front of the firebox. See WAIST SHEET.

Waist Sheet. A vertical steel plate riveted to the waist sheet crosstie and to an angle piece which is also fastened to the waist of a boiler to secure that part to the frame, and at the same time allow a small amount of expansion and contraction. See EXPANSION KNEE.

Waist Sheet Angle. The angle riveted to the boiler shell to which the waist sheet or buckle plate is riveted.

Waist Sheet Angle Liner. A small plate or pad riveted to the inside of the boiler shell where the waist sheet angle is attached, the rivets passing through each for strengthening the plate.

Waist Sheet Crosstie. A transverse brace or casting binding the frames together in front of the firebox and having a plate fastened to it and to the boiler to support the waist of the boiler at this point. See EXPANSION CROSSTIE.

Waist Sheet Wearing Plate. A steel strip riveted to the waist sheet angle to reinforce the bearing or support of the boiler at this point.

Washout Plug. A short, solid metal cylinder with a screw thread cut on the outside and a square or hexagonal head for convenience in applying a wrench, screwed into the washout plug holes of a boiler. See WASHOUT PLUG HOLE.

Washout Plug Hole. Holes cut in the boiler shell into which the washout plugs fit. Usually placed just above the crown sheet and at the firebox corners so that these parts of a boiler are made easily accessible for cleaning. See BELLY WASHOUT HOLE.

Washout Plug Hole Flange. A flange riveted around a washout plug hole to strengthen the boiler shell and to furnish a secure attachment for the washout plug or cover.

Waste Cock or Waste Valve. An arrangement attached to and forming part of the body of some types of injector, consisting of a valve provided with a handle or lever. If this valve is left open when the steam and water supply valves to the injector are also open, steam passes back through the injector feed pipe and may thus be used to prevent the water in the tender tank from freezing.

Water Gage or Water Glass. A device to enable an engineman or fireman to observe the height of water in a locomotive boiler. It consists of two brass fittings screwed into the back head, one above the other, and connected by a stout glass tube or a metal frame in which a glass is inserted which communicates, through the fittings, with the water and steam in the boiler. The water level showing in the glass tube is the same as that inside the boiler.

Water Gage Cock. One of two brass fittings screwed into a locomotive boiler head, having a valve or plug cock for opening or closing communication between the boiler and the water gage glass.

Water Gage Cock Extension. A piece of pipe sometimes required to connect a water gage cock to the boiler, as when the boiler lagging is too thick for the gage cock to reach through.

Water Gage Cock Gland. A neck or extension formed on a water gage cock to receive the end of the glass tube, or the stem of the cock or plug.

Water Gage Nut. A hexagonal brass nut surrounding a water gage glass near the end and holding an elastic washer so as to prevent leakage of water or steam around it.

Water Gage Protector. A casing attached to a water gage to prevent the glass from flying about in case of breakage.

Water Glass. See WATER GAGE.

Water Grate. See GRATE, WATER PULL BAR GRATE.

Water Leg. The space between the inner and outer sheets of a fire box. See SIDE WATER SPACE.

Water Pull Bar Grate. A grate designed for burning anthracite coal, consisting of tubes running longitudinally through the bottom of the firebox and communicating with the front and back water legs, usually screwed into the tube sheet and expanded into the back sheet, a copper ferrule being used to insure a tight joint. Between the water tubes, iron pull bars, enclosed in short tubes, pass completely through the back water leg and project a short distance outside the back head. These outer ends have slots in them, into which a rod can be put, and the bars pulled out for the purpose of dumping or cleaning the fire. Midway of the length of the firebox is a bearer or bridge that supports both the tubes and bars that form the grate. A similar bearer is placed at the front end of the box to hold the bars. See GRATE.

Water Purification. See FEED WATER TREATMENT.

Water Space. That part of a locomotive boiler that is filled with water, in contrast with the part normally occupied by steam. Usually designated as FRONT, BACK and SIDE WATER SPACE. WATER LEG, which see, is also called a water space.

Water-Tube. A pipe containing water and surrounded with hot gases in contrast to a fire tube surrounded by water and having hot gases passing through it. See ARCH TUBE.

Water-Tube Boiler. A boiler in which water circulates through tubes surrounded by hot gases, the products of combustion in the firebox. Not extensively used for locomotives, although used to some extent in Europe, and on a recent locomotive built for the Delaware & Hudson. See BOILER.

Water-Tube Firebox. An arrangement of tubes in a vertical position, with the lower ends welded into a hollow firebox ring and the upper ends into water reservoirs forming the walls of the firebox. With this design a greatly increased heating surface is obtained.

Welt. A steel plate riveted to and joining the ends of a boiler plate, forming a butt joint. Usually, an inside welt is riveted over the seam on the inside of the boiler shell and an outside welt is riveted on the outside, making a double reinforcement of the seam. Generally used on LONGITUDINAL SEAMS.

Wide Firebox. A wide, shallow firebox resting on the frames and extending out beyond driving wheels at the sides. The Wootten Firebox is a wide firebox for burning anthracite coal. See FIREBOX.

FREDERICK F. FITZPATRICK, president of the American Locomotive Company, with headquarters at New York, died suddenly at his home at Larchmont, N. Y., on November 16, from an attack of heart disease.

At the time of his death Mr. Fitzpatrick was also chairman of the board of the Railway Steel-Spring Company, and president of the Montreal Locomotive Works, the Canadian Steel Tire & Wheel Company, the American Locomotive Sales Corporation, and the Richmond Locomotive Works. He also held directorships in the American Brake Shoe & Foundry Company, the American Car & Foundry Company, the American Car & Foundry Securities Company, the Emigrant Industrial Savings Bank, the Saftey Car Heating & Lighting Company, the Seaboard National Bank, U. S. Life Insurance Company, and the Superheater Company. He was active in the affairs of the Railway Business Association and was serving as a vice-president of that organization at the time of his death.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. J. Zusy

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Layout of an Elliptical Cone

Q.—I am a constant reader of THE BOILER MAKER. I would like very much to have you explain the layout in detail of an elliptical cone. Thanking you for previous favors.—R. H. L.

A.—To develop the surface of an irregular object having parallel bases such as you describe, it is necessary to draw a plan and elevation, as shown at Fig. 1. Draw the horizontal diameter *a-q* through the plan, dividing the object into symmetrical halves. It will now be seen that, if a development is made of the lower portion of the object, as seen in the plan, a duplication of the figure will be the complete development.

In order to locate the sides of the triangles that are to be assumed on the surface of the object, the outline of the bases is divided into the same number of equal parts (in this case eight), as at *a, c, e,* etc., on the lower base and *b, d, f,* etc., on the upper base. Draw, in succession, lines alternately from the points on the upper and lower bases; *a-b* being on the line of the diameter, draw *b-c, c-d, d-e,* etc. Project these points to the elevation and draw in the lines *b-c, c-d, d-e,* etc.

The surface of the object now being divided into a number of triangles, the next step is to develop the length of the lines representing the sides of the triangles that are not shown in their full length in either the plan or the elevation. The length of the sides *b-d, d-f, a-c, c-e,* etc., may be taken as chord distances directly from the plan, as they are there shown in their full length. A construction of right angled triangles is necessary in order to find the true lengths of lines *b-c, c-d, d-e,* etc., as shown at (*a*); and in order to construct them, the lower base line *a-q* of the elevation is extended indefinitely towards the right of the drawing to *q'*, as shown at (*b*). At a convenient distance from the elevation locate a point on this line, as at *b'*. Take the distance *b-c*, as shown in the plan, and set it off with the dividers, as at *b'-c'*; in like manner, make *c'-d'* equal to *c-d*, as shown on the plan, and proceed to copy all the distances there shown until the point *q'* is reached. It will be seen from an examination of the projections that the lines *a-b* and *q-r* are shown in their true length in the elevation, and a triangle is therefore not required for these lines. Since the bases of the object are parallel, the ver-

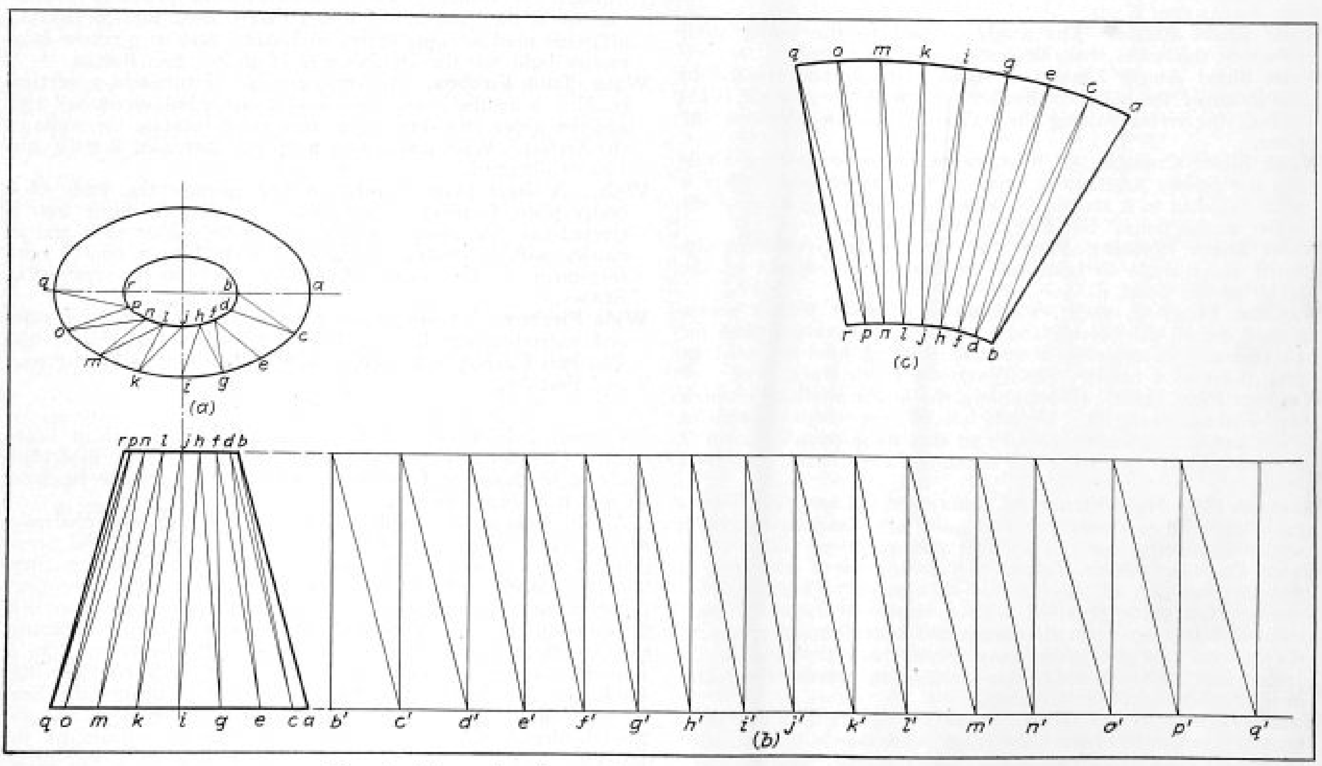


Fig. 1.—Plan, elevation and true length layout of elliptical cone

tical height of the triangles at (*b*) is the same in all cases, and may be projected from the elevation as shown.

The true lengths of all lines now being determined, the triangles may be constructed as shown at (*c*). Draw the line *a-b*, making it equal in length to the corresponding line in the elevation; next, describe an arc from *a* as a center, with a radius *a-c* taken from the plan at (*a*); intersect this arc by an arc described from *b* as a center, with a radius equal to the length of the hypotenuse of the triangle whose base is *b'-c'* at (*b*). This completes the triangle *a-b-c* at (*c*). The triangle *b-c-d* is next constructed in a similar manner, and the completion of the development is accomplished by a continuation of the methods described.

Flue Connecting Boiler and Stacks

Q.—Please show me how to go on a job and make a mechanical drawing of a flue connecting a boiler and a stack in order to come back to the shop and lay it out.—J. F. D.

A.—In order to construct the flue connecting the boiler with the stack, it is but necessary to know the size and shape of the holes in the boiler and stack and the location of the hole in the boiler relative to the hole in the stack. However, assuming that an existing flue is to be replaced in kind, it will be necessary to obtain the dimensions as called for in Fig. 1.

Fig. 1 consists of a plan and a projection which is taken at right angles to the flue in order to show the flue in its full length and also the angle of the connecting elbows.

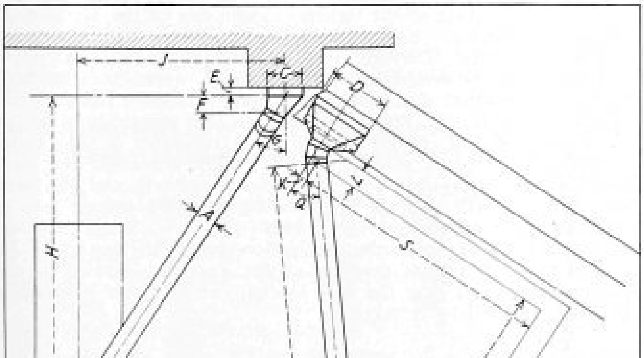


Fig. 1.—Method of making flue connection

The plan shows the shape of the hole in the boiler and the width of the hole in the stack. It also shows the angle of the connecting piece between the upper elbow and the stack.

Dimensions *A* and *B* cover the diameter and length of the flue, *C* and *D* the size of the hole in the stack, *E* the distance the rectangular portion of the connecting piece projects beyond the stack, *F* the distance from the rectangular portion of the connecting piece to the cylindrical portion which connects with the upper elbow. The angle *G* of the connecting piece can be found by making a layout of the right angle triangle whose base is *H* and altitude *J*. The foregoing dimensions are all that are required to construct the straight portion of the flue and the connecting piece between the upper elbow and the stack.

The two connecting elbows can be constructed from the dimensions, *K*, *L* and *M*, *N* with the angle *P* and *Q* found by making a layout of the right angle triangle whose base is *R* and altitude *S*.

The conical shaped connecting piece between the boiler and lower elbow is represented by the height *T*. The top is cylindrical and is necessarily the same diameter as the elbow. The size and shape of the bottom of this connecting piece can best be obtained by making a template of the contour of the flange on the boiler.

If, after you have obtained all of the dimensions shown, you find you are unable to proceed with the development of any part of this construction, we will be glad to furnish additional information upon receipt of a sketch of the part in question with the necessary dimensions.

Circulation of Boiler Feedwater

Q.—1. Is it possible in a marine boiler, internally fired, to have a steam pressure of 200 pounds and water at the bottom cold?

2. Can a horizontal waste heat boiler with 268 two-inch tubes, operated with induced draft, this induced draft to be constant vary in temperature from cold water on the bottom to a steam pressure of 200 pounds at gage; inlet temperature 2,100 degrees, outlet temperature 1,100 degrees?—H. M.

A.—It is possible in an internally fired marine boiler or a waste heat boiler to have a steam pressure of 200 pounds and the water at the bottom of the boiler cool, especially if the feedwater is not preheated.

A uniform temperature throughout the water in the boiler depends entirely upon the circulation of the water in the boiler and is heated only by coming in contact with the heating surface.

Water is practically a non-conductor of heat although not entirely so. If water at a temperature of say 33 degrees was brought to the boiling point at the surface by coming in contact with a heating unit at the surface, it would take about 2 hours for the heat to be transmitted through the water so as to increase the temperature a few degrees at a depth of 3 inches.

This same condition holds true in a boiler so constructed that water is contained below the heating surface with no means provided in the design to promote circulation.

Location of Gage Cocks

Q.—Will you please give me the rule for locating gage cocks on a vertical type boiler or in other words how high from the crown sheet.—G. A. T.

A.—The location of the water glass and gage cocks is dependent upon the service in which the boiler is operating. If the boiler is used in connection with locomotives other than those propelled by steam, rule 317 (a) of the Interstate Commerce Commission's "Rules and Instructions for the Inspection and Testing of Locomotives Other than Steam" applies.

Rule 317 (*a*).—Every boiler shall be equipped with at least one water glass, and three gage cocks which can be easily opened and closed by hand. The lowest gage cock and the lowest reading of the water glass and the line on the badge plate shall correspond and be not less than 2 inches above the danger line. The danger line shall be that at which there will be no danger of overheating any part of the boiler. The danger line for vertical firetube boilers shall be not less than one-half the length of the tube above the lower tube sheet and for vertical submerged tube boilers, the upper surface of the top tube sheet.

If the boiler operates under the jurisdiction of any of the various state industrial commissions which accept boilers complying with the A. S. M. E. Boiler Code the following rules will apply:

A. S. M. E. Boiler Code, paragraph P-294.—Each boiler shall have three or more gage cocks, located within the range of the visible length of the water glass, except when such boiler has two water glasses with independent connections to the boiler and located on the same horizontal line and not less than 2 feet apart.

A. S. M. E. Boiler Code, paragraph P-291.—Each boiler shall have at least one water gage glass, the lowest visible part of which shall not be less than 2 inches above the lowest permissible water level. The lowest permissible water level shall be that at which there will be no danger of overheating any part of the boiler when it is operated with the water not lower than that level.

A. S. M. E. Boiler Code, appendix, paragraph A-21f.—Vertical submerged tube boilers—The lowest permissible water level is not less than the upper tube sheet.

Pitching of Staybolts

Q.—I am enclosing a sketch of the firebox of a locomotive type oil country boiler. The problem is to establish the maximum distance of the outside rows of staybolts in the stayed surfaces as indicated. Will you please check this sketch and notify me of the correct solution of any errors found?—T. C. E.

A.—Your interpretation of the A. S. M. E. Code for staybolt pitching is correct with the exception as noted below, assuming that you use the proper value for p in each case, as the value for p is not the same for all of the locations in which you show p on your sketch.

The distance from the flange of the throat, to the nearest row of stays to the flange, your dimension D, should be arrived at in the following manner:

There are two sheets that require staying and a different rule applies to each sheet. Both rules should be employed and the result used which comes within the limits set by both rules.

The throat sheet is governed by the last part of paragraph p-205. "When the edge of a flat stayed plate is flanged and riveted, the distance from the outermost stays to the inside of the supporting flange shall not exceed the pitch of the stays, p plus the inside radius of the flange. The value of p is found by rule accompanying Fig. A-8D";

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

Where,

$C =$ constant (see p-199),
$T =$ thickness of plate in sixteenths of an inch,
$P =$ maximum allowable working pressure, pounds per square inch.

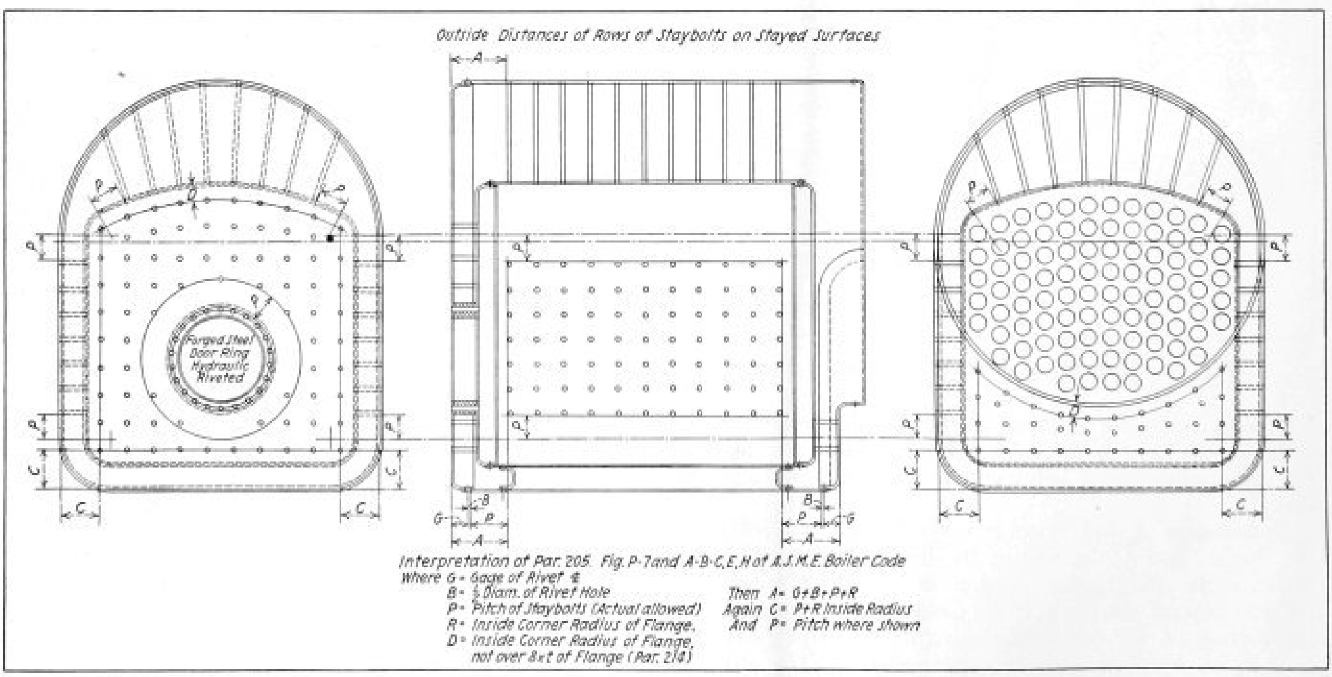
The rear tube sheet is governed by rule found in paragraph p-203b. "The maximum distance between the edges of the tube holes and the center of other type of stays shall be determined by the formula in paragraph p-199, using the value of C given for the thickness of the plate and the type of stay used."

It is found that the stays cannot be applied close enough to the tubes in the rear tube sheet, to meet the requirements on account of the stays entering the heel of the flange of the throat sheet. They should be applied as near as is practicable to the flange and the unsupported area on the tube sheet between the stays so located and the tubes, should be supported by the rear tube sheet stays or so-called belly braces.

Mechanical Division Convention and Exhibit at Atlantic City

At a joint meeting of the General Committee of the Mechanical Division, American Railway Association, and the Executive Committee of the Railway Supply Manufacturers' Association at New York, November 16, arrangements were made to hold the 1928 convention and exhibit at Young's Million Dollar Pier, Atlantic City, N. J. Arrangements for the proper housing of the convention and exhibit include the erection of a substantial building on the ocean side of the boardwalk adjoining the pier, which will be accessible both from the boardwalk and the pier. This building will provide approximately 50,000 square feet of additional floor space.

The original dates for the convention, namely, June 13 to 20, decided upon at a joint meeting of the executive bodies of the two associations during the last Mechanical Division convention at Montreal, will be adhered to.



Locomotive type oil country boiler staybolt problem

ASSOCIATIONS

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

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William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

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

States

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

Cities

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

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

States

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

Cities

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

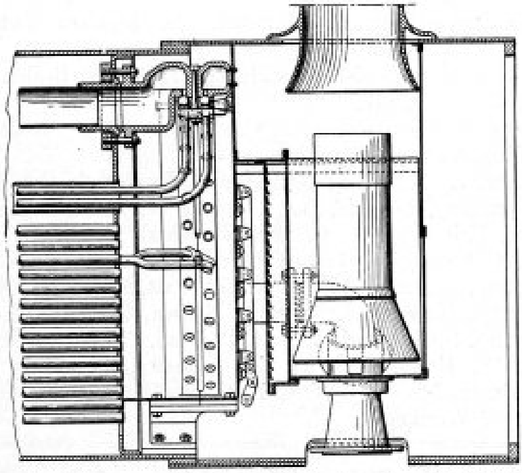
SELECTED BOILER PATENTS

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

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

1,555,015. COLUMBUS K. LASSITER AND JULIUS KINDERVATER, OF NEW YORK, N. Y.; ANNIE FRANCES LASSITER ADMINISTRATOR OF SAID COLUMBUS K. LASSITER, DECEASED. SUPERHEATER HEADER.

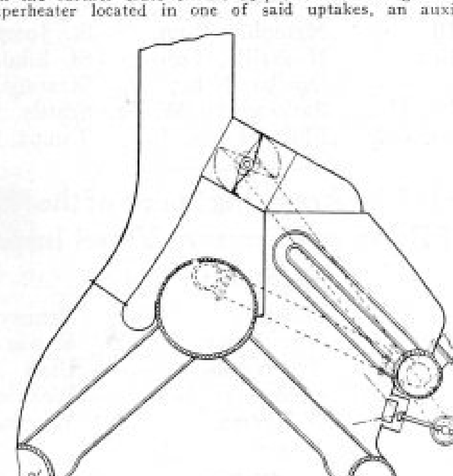
Claim 1. In a superheater, a header comprising a unitary casting of oblong rectangular form in plan and embodying a plurality of pairs of longitudinally straight saturated and superheated steam compartments, said compartments being of unitary formation and separate from and independent of connection with each other except at the base and each composed of integral top, side and end walls, the adjacent side walls of the



compartments being spaced by longitudinal channels extending from end to end of the header, and a base plate of unitary construction integral with said walls of the compartments and closing the bottoms thereof and having portions bridging across and closing the bottoms of said channels; the portions of the base plate forming the bottom walls of the compartments being provided with an even number of longitudinal rows of tube receiving openings communicating with the compartments, said openings being also arranged in transverse rows of even number across the series of compartments, and said bridging portions of the base plate being provided with longitudinal rows of bolt receiving openings communicating with the base of said channels, said bolt receiving openings being also arranged in transverse rows alining with the transverse rows of tube receiving openings. Five claims.

1,625,759. HAROLD E. YARROW, OF GLASGOW, SCOTLAND. STEAM SUPERHEATER.

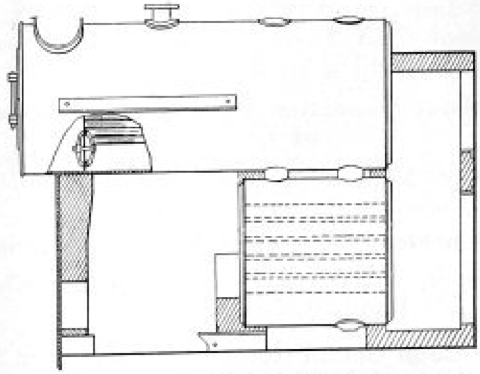
Claim—A water tube boiler comprising two upwardly converging sets of steam generating tubes, a main combustion space located between the said sets of generating tubes, two uptakes separated by a partition and located on the farther sides of the respective sets of generating tubes, a steam superheater located in one of said uptakes, an auxiliary heating



device located in said uptake between said superheater and the set of steam generating tubes adjacent thereto, said auxiliary device comprising a plurality of oil fuel burners the axes of which are directed towards the said generating tubes and away from the superheater device, a damper located in the said uptake beyond the said superheater, and means for operating the said damper and for controlling the fuel supply to the oil burners interdependently.

1,646,428. MARK E. SMITH, OF ERIE, PENNSYLVANIA, ASSIGNOR TO UNION IRON WORKS, OF ERIE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA. BOILER.

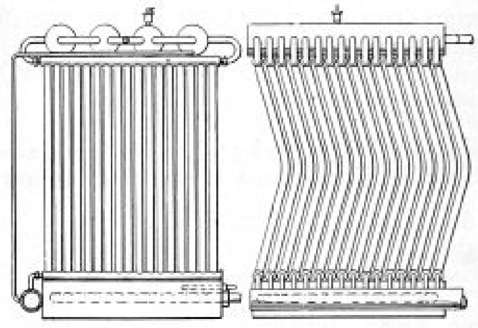
Claim—In a boiler, the combination of a lower drum; an upper drum, the upper drum having an opening in register with an opening in the lower drum; a ring between the drums surrounding the openings, said



rings having perforations with sockets leading to the perforations from one face of the ring; rods extending through the perforations and the shells of the drums, said rods having shoulders arranged in the sockets; and means securing the rods to the shells, said means within one of the shells drawing the shoulders into clamping engagement with the bottoms of the sockets. Four claims.

1,646,382. JOHN H. BAKER, OF DETROIT, MICHIGAN. BOILER.

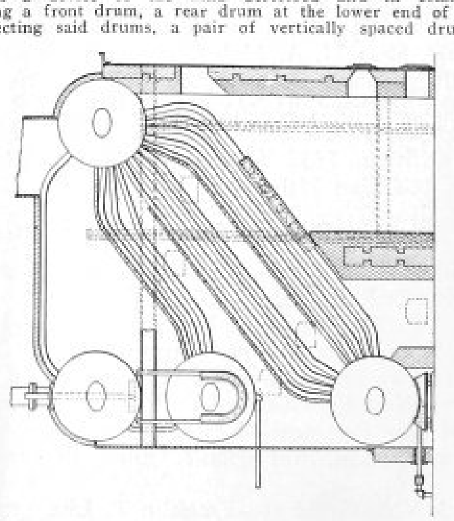
Claim—A sectional boiler of the class described, comprising a row of steam domes, adjacent domes being connected in communication with each other; a feed water pipe; a plurality of headers extending transversely of said domes and arranged in sets of pairs, the upper header o,



each pair being in close proximity to said domes, and the other being spaced therefrom; a plurality of bow-shaped pipes connecting the headers in each set; individual connection between each of the lower headers and said feed water pipe; and individual connection for each end of each of the upper headers connected to the outermost of said domes. Four claims.

1,645,330. GEORGE LASKER, OF CHICAGO, ILLINOIS. WATER-TUBE BOILER.

Claim—In a device of the kind described and in combination, a boiler having a front drum, a rear drum at the lower end of the boiler, tubes connecting said drums, a pair of vertically spaced drums at the



rear of said boiler above said rear drum, tubes connecting said pair of drums, tubes connecting each of said pair of drums directly with the front drum, said first-mentioned rear drum communicating with said pair of drums solely through said front drum, means for introducting feed water into the uppermost drum of said pair of drums, and a steam outlet from one of said drums. Six claims.